

## Keynote Lectures



# Selection of cements for maximizing clinical success

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Byoung In Suh

BISCO, Schaumburg, IL, USA

## ABSTRACT

When placing indirect restorations, what are your cementation options? Should you bond or cement the restoration? If you bond, is your adhesive compatible with your dual-cured resin cement? What are the potential benefits of using a self-adhesive cement? Answers to these questions, and other adhesion and restorative principles will be addressed and provide you with the knowledge to help facilitate material selection for better and simplified cementation, and ultimately, successful long-term restorations. The issues of adhesion incompatibility with some composites/cements, and the differences between dual-cured luting cements on the market will be explained. Research shows that not all dual-cured cements are equal. Depending on the material, light-curing may or may not be necessary to achieve the highest degree of conversion. However, with some cements, light-curing may or may not inhibit the self-cure mechanism. How can you effectively bond your indirect restorations and insure that your dual cure cement is completely polymerized? In this lecture, participants will learn optimal cementation protocols, including how to select the proper materials and techniques when bonding different types of indirect restorations like porcelain and zirconia. Cementation options, including when to bond and when to cement, and the potential benefits of using a calcium silicate self-adhesive cement, will be explained.

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# Current status and future advances in dental composite restorative materials



**Jack Ferracane**

Department of Restorative Dentistry, School of Dentistry, Oregon Health & Science University, Portland, OR, USA

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## ABSTRACT

Dental composites have evolved based on the needs and requests of dental practitioners desiring materials capable of being used in more extensive applications, and with greater ease of use. Existing products produce high-quality restorations with excellent longevity. In the past, new formulations focused on better esthetics, polishability, handling, and wear resistance. More recently commercial materials have been designed with reduced polymerization shrinkage and shrinkage stress, and enhanced depth of cure for use as bulk-fill restoratives. Looking to the future, the next series of developments will likely be to produce direct composite restoratives with self-adhesive qualities, already present in some flowable and cementing materials, and resin restoratives that are more resistant to the degradatory effects of intraoral hydrolysis and attack from salivary and bacterially derived enzymes. Other developments will likely include materials that are bioactive, interacting with the environment by releasing essential ions for remineralization processes, as well as releasing important molecules capable of recruiting cells to specific sites to aid in the healing and repair of lost tooth structure. Materials capable of repair of internal and external defects can also be envisioned. The development of dental resin-based composites continues to represent one of the most exciting areas of dentistry.

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# S-PRG filler: advanced 'bioactive' material for restorative and preventive dentistry

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**Satoshi Imazato**

Department of Biomaterials Science, Osaka University Graduate School of Dentistry, Osaka, Japan

## ABSTRACT

Surface Pre-reacted Glass-ionomer filler (S-PRG filler) developed by SHOFU INC and incorporated into various restorative/coating materials is the technology of great interest. S-PRG filler, prepared via an acid-base reaction between fluoroboroaluminosilicate glass and a polyacrylic acid, has the pre-reacted glass-ionomer phase on its surface which allows release of  $F^-$ ,  $Al^{3+}$ ,  $BO_3^{3-}$ ,  $Na^+$ ,  $SiO_3^{2-}$ , and  $Sr^{2+}$ . Due to release of such multiple ions, the functions exhibited by S-PRG filler are diverse. These include strengthening of tooth substrates, acid neutralization, promotion of calcification, antibacterial effects, and inhibition of bacterial biofilm formation. Restorative or coating/sealing materials containing S-PRG filler are thereby expected to provide clinical benefits for prevention and management of caries or periodontal disease. In this presentation, the advanced technology of S-PRG filler and its usefulness in the field of restorative and preventive dentistry will be summarized.

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# Dental caries – the new paradigms

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**David Manton**

Faculty of Medicine, Dentistry and Health Sciences, The University of Melbourne, Melbourne, Australia

## ABSTRACT

Dental caries, a behaviourally and genetically influenced bacterial disease moderated by individual characteristics, is one of the world's most prevalent primarily preventable conditions. In many communities worldwide, a large proportion of children are still severely affected by dental caries. In the past 50 years, the prevention of dental caries has concentrated on the delivery of fluoride, whether it be via reticulated water, toothpaste, or professionally applied products such as varnishes. Despite still being the 'gold standard' for prevention, the action of fluoride is limited somewhat by the concentration of bioavailable calcium and phosphate. Several products containing or having the ability to stabilize calcium and phosphate are now available commercially. Surprisingly, the primary cause of dental caries—a cariogenic diet, has often been ignored or barely mentioned, as modifying the diet involves behaviour modification, a difficult proposition in many people. In some individuals, modification of the risk factors is unlikely or not possible, so other methods, such as low viscosity resin infiltration of early carious lesions, become the most appropriate intervention.

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November 8–10, 2019 · Seoul, Korea



## Keynote Lectures



# Vital pulp therapy – an old thought but a new paradigm in restorative dentistry



**Reuben H. Kim**

Section of Restorative Dentistry, Division of Constitutive & Regenerative Sciences, UCLA School of Dentistry, Los Angeles, CA, USA

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## ABSTRACT

Vital pulp therapy, such as direct pulp capping, is a conservative restorative treatment modality with a goal of preserving vitality of the otherwise diseased pulp tissue. Biologically, vital pulp therapy allows for reparative dentin regeneration by dental pulp stem cells, formation of which serves as a 'biological seal' to protect the underlying pulp tissue. Calcium hydroxide has been used more than 80 years for this purpose in restorative dentistry; however, its clinical utilization has been less appreciated due to unpredictable outcomes that often resulted in a complete removal of the pulp tissue via root canal therapy. On the other hand, recent introduction of hydraulic calcium silicate cements (HCSCs), derivatives of prototype mineral trioxide aggregates (MTAs), confers reliable and predictable outcomes that increasingly gained its popularity and enabled vital pulp therapy as a viable conservative treatment option. In this seminar, we will discuss about the current status of vital pulp therapy and present some of our research findings related to reparative dentin regeneration at the molecular, preclinical, and clinical levels. We will also propose that vital pulp therapy is a new paradigm in managing the diseased pulp tissues in restorative dentistry.

## Keynote Lectures



# Minimally invasive aesthetic restoration with innovative materials

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**Junji Tagami**

Department of Cariology and Operative Dentistry, Tokyo Medical and Dental University, Tokyo, Japan

## ABSTRACT

The recent adhesive and restorative materials provide excellent performance and enable us to apply the minimally invasive aesthetic restorations with extremely simplified procedures. Understanding the recent adhesive materials and restorative materials is required to obtain maximum performance of the materials. The clinical procedures, such as application of adhesive, irradiation to bonding resin, composite resin filling technique and irradiation, and cavity configuration are also very significant factors to affect the quality of restorations. The lecture provides information on the adhesive resin materials from the basic and clinical issue for the successful restorations. Furthermore, monitoring of restorations is needed for long lasting function of restoration in both biologically and esthetic points of view.

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# Direct restoration procedures in anterior and posterior teeth

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**Gaetano Paolone**

Department of Restorative Dentistry, Dental School, Università Vita-Salute San Raffaele, Milano, Italy

## ABSTRACT

During the last 25 years there has been a real evolution in adhesive dentistry, by which the number of treatment possibilities has expanded. Initially, direct composite restorations were only indicated for simple restorations. Nowadays the clinical indications for direct composite restorations are stretched towards more complex situations. Composite can give the clinician the capability to solve a wide range of clinical situations. Modeling techniques in anteriors and posteriors will be the main focus of the lecture.

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November 8–10, 2019 · Seoul, Korea

## Keynote Lectures



# Dental fitness – the paradigm change in dentistry

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Ivo Krejci

Clinique Universitaire de Médecine Dentaire, University of Geneva, Geneva, Switzerland

## ABSTRACT

Dentistry of the past was characterized by a continuous degradation of the dentition through the lifetime of the patient, requiring continuous imperfect repairs of heavy clinical symptoms, and finally leading to extractions and replacements of the missing teeth by implant-supported crowns, bridges, and dentures. This obsolete vision has been progressively replaced by modern dentistry which integrates new high-tech diagnostics and high-tech non-invasive treatments and allows keeping the population in good dental health life-long. The practical container for this modern approach is a concept which the author calls 'Dental Fitness'. The presentation will focus on the key elements of this concept.

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# Severe tooth wear, when and how to restore?

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**Niek Opdam**

Department of Dentistry, Radboud University Medical Centre, Nijmegen, The Netherlands

## ABSTRACT

Rehabilitation of severe tooth wear presents problems for the dentist, as restorative protocols are complicated and extensive, including raising the bite in increased vertical dimension of occlusion. Especially for this 'high-risk' group of patients showing bruxism and erosion, prognosis of these rehabilitations is likely to be limited due to recurrent wear and fracture of the restorations. Therefore, for these patients with reduced dental tissues, a minimally invasive approach is mandatory in order to enable future retreatments. At the Radboud University in Nijmegen, the Netherlands, there is a special care center for severe tooth wear running several clinical studies. In this lecture, the Radboud Philosophy on treatment of severe tooth wear and results of the minimally invasive strategies will be discussed: from monitoring severe cases to total rehabilitations with minimally invasive techniques, either using direct composites or indirect composite and computer-aided design and computer-aided manufacturing (CAD/CAM) restorations. Many examples of clinical cases will show failures and successes in treatments of this difficult patient group.

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# Successful bonding from etching to light curing

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**Lorenzo Breschi**

Department of Biomedical and Neuromotor Sciences, University of Bologna, Bologna, Italy

## ABSTRACT

The aim of the presentation will be a critical review of the latest improvements of dental bonding systems. Chemical background and physical characteristics of the adhesives will be presented to understand the clinical capabilities and the possible role of the clinician to obtain the highest bonding performances, in terms of improved bond strength, extended durability, and reduced post-operative sensitivity. The lecture will also clarify the mechanisms that affect the stability of the adhesive interface over time, analyzing the role of different degrading phenomena synergistically contributing to degrade the hybrid layer. The lecture will provide clinical step-by-step procedures along with 'tips and tricks' to achieve the highest clinical success in terms of aesthetic requirements, biomechanical properties of adhesive restorations, bond strength, and stability of the adhesive interface over time.

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# Current clinical approaches for adhesive luting of CAD-CAM block restorations

Keynote Lectures



**Bart Van Meerbeek**

Department of Oral Health Sciences, Biomaterials Research Group (BIOMAT), KU Leuven (University of Leuven), Leuven, Belgium

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## ABSTRACT

Digital technology is indispensable in today's dental practice. The first digital revolution occurred several years ago with the introduction of computer-aided design and computer-aided manufacturing (CAD-CAM) technology for the production of semi-direct (chair side) and indirect (via dental lab) restorations. Currently, most CAD-CAM systems are based on 'subtractive' manufacturing processes, where restorations are milled out of industrially manufactured blocks. Various types of ceramic, resin-based composite, and polymer-infiltrated ceramic CAD-CAM blocks are today available for chair-side partial and full crown restorations. This lecture will address the different clinical approaches for (adhesive) luting of CAD-CAM block restorations, thereby focusing on both the cement-tooth and the cement-restoration interfaces. Inevitably, one may expect that 'additive' manufacturing processes or so-called '3D printing' will soon find more applications in restorative dentistry.

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## Keynote Lectures



# Clinical success of composite restorations with universal adhesives

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**Masashi Miyazaki**

Department of Operative Dentistry, Nihon University School of Dentistry, Tokyo, Japan

## ABSTRACT

In the past few decades, an increase in the desire for tooth colored restorations and minimally invasive treatments have been advocated, and the popularity of direct restorations using resin composites has increased. These trends are based on the development of adhesive dentistry as well as resin composites technologies. Universal adhesives are recently introduced to overcome the shortcomings of self-etch adhesives. Universal adhesives are thought to provide benefits to clinicians owing to their simplified bonding steps and broad applicability in numerous clinical situations. One of the most important expectations for universal adhesives is that the adhesives can be used with either self-etch or total-etch modes. This multi-mode usage of universal adhesives has been reported to enhance enamel bond durability with a total-etch approach and to reduce damage to dentin with a self-etch approach. Thus, practitioners should select the optimal etching mode when using universal adhesives in accordance with cavity features such as depth, size, location, and proportion of enamel and dentin. This presentation will explore the importance of adhesive systems in clinical dentistry and discuss about their long-term durability.

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## Keynote Lectures



# Micro-invasive dentistry: from ‘Drill and Fill’ to ‘Heal and Seal’

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**Sebastian Paris**

Department of Operative and Preventive Dentistry, Charité – Universitätsmedizin Berlin, Berlin, Germany

## ABSTRACT

Restorative dentistry is changing nowadays. Due to widespread fluoridation and other preventive measures, caries is progressing slower and the disease burden shifts more and more from children and adolescents towards older people. A new caries paradigm describes caries as a lifestyle—disease rather than an infectious disease. Due to these changes, besides the classic approach of caries treatment by excavation of diseased tissue and restoration of the defect, new treatment options emerged. These new methods aim to ‘heal’ caries lesions without excavation either by addressing etiological factors or by micro-invasive measures such as sealing and infiltration of caries lesions. The lecture will present new non- and micro-invasive treatments as well as the evidence regarding their clinical efficacy.

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# Minimally invasive in endodontics, trend or necessity?

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**Marino Sutedjo**

Private Practice, Surabaya, Indonesia

## ABSTRACT

Nowadays often we hear the term of minimally invasive dentistry. This minimally invasive thing is pretty much applied to almost any field of dentistry. Its main purpose mostly is to preserve healthy tooth/tissue structure as much as possible and it is interesting that now we are thinking to do as conservative as we can. But in endodontics does this 'minimally invasive' thinking give us a substantial benefit? In this lecture, this issue will be discussed along with scientific evidences to proof that whether minimally invasive approach in endodontics gives us a real benefit or it is just a trend.

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## Keynote Lectures



# 3D root canal enlargement, disinfection, and obturation

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**Bekir Karabucak**

Department of Endodontics, School of Dental Medicine, University of Pennsylvania, Philadelphia, PA, USA

## ABSTRACT

Three-dimensional instrumentation, disinfection, and obturation of a canal system are essential for the success of a root canal treatment. Recently, new file systems called XP Shaper and Finisher file systems (FKG; La Chaux-de-Fonds) have been introduced featuring the MaxWire Technology allowing files to expand and adapt the three-dimensional structure of root canal. This technique creates conservative canal preparation preserving more dentin tooth structure but, also, provides more efficient anatomical treatment of dentin surfaces. In the last decade, mineral trioxide aggregate (MTA) has been used successfully with a range of treatments such as endodontic microsurgery, perforation repair, pulp capping, or revascularization. MTA became the material of choice based on biological principals; however, its handling properties remain a practical obstacle to its application in root canal obturation. Recently, other calcium silicate based bioactive cements and sealers have been introduced, changing the rational and methods of accepted endodontic techniques in root canal obturation, perforation repair, or endodontic microsurgery. This presentation will explore the clinical applications, outcomes of XP file systems, and bioceramic sealer obturation technique in endodontic practice.

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# Dental caries: a global phenomenon in Indian context

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**Usha Sathyanarayanan**

Internal Quality Assurance Cell, Director- Accreditation, Sri Balaji Vidyapeeth, Puducherry, India

## ABSTRACT

Dental caries disease has been a global burden since pre-historic times. Though a dramatic decline has been witnessed in the recent decades, it is still prevalent in certain countries. The philosophy of 'eradicating the disease,' has been replaced by 'life-time control.' This change is due to the current understanding of etiopathogenesis and the strong role of socio-economic factors that influences the process and progress of the disease. Thus, despite being a global phenomenon, dental caries might be widely varying in the psycho-social, socio-cultural and socio-economic contexts, at the national/regional level. Though international guidelines have been proposed for caries management at population level, at patient level, and at lesion level, they must be extensively adapted to the uniqueness of the regional contexts. India being a country of diversity in all aspects and caries being a life-style disease, significant variations are inevitable in the disease presentation and the perception of prevention. This presentation attempts to project the Indian challenges and variations, in terms of prevalence, education, patient service, and clinical research in dental caries.

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# An appraisal of the start of a caries lesion

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**Anthony Tzong-Ping Tsai**

Department of Pediatric Dentistry, National Taiwan University Children's Hospital, Taiwan

## ABSTRACT

The fundamental understanding of how a caries lesion may start will affect many aspects in managing the caries disease. The presentation will focus on the sequence of conditions to start a caries lesion. There are limitations of current practice of caries risk assessment. Silver diamine fluoride may have a role in these areas.

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## Country Representative Session

# Caries risk assessment



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**Paul Brunton**

Faculty of Dentistry, University of Otago, Dunedin, New Zealand

## ABSTRACT

As part of clinical care, it is important to consider a caries risk assessment, the factors that inform such an assessment and how it should affect future treatment planning decisions. This presentation will consider this subject in some detail using clinical examples to support the protocols being advocated.

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## Country Representative Session



# Management of caries: from classroom to real world



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**Liang Lin Seow**

Clinical Dentistry, Restorative Division, School of Dentistry, International Medical University, Kuala Lumpur,  
Malaysia

## ABSTRACT

The International Caries Detection and Assessment System (ICDAS) is a clinical scoring system designed for use in dental education, clinical practice, research, and epidemiology. Together with other parameters, *e.g.*, caries risk assessment, this provides a holistic approach in diagnosis and clinical management of caries. In Malaysia, all dental schools adopt ICDAS scoring system in the undergraduate dental program. This presentation will provide insight into teaching cariology and caries management in the dental curriculum and relate it to clinical circumstances, including emphasis on personalized treatment plan to improve oral wellness of patients.

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## Country Representative Session



# Clinical implication of optical fluorescence technology in dentistry



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**Baek Il Kim**

Department of Preventive Dentistry & Public Oral Health, Yonsei University College of Dentistry, Seoul,  
Korea

## ABSTRACT

The optical fluorescence technology is commonly used in the biological field for the detection of specific target cells. The main cause of dental caries and periodontal disease is dental biofilm which is formed by various oral microorganisms. Therefore, it would be possible to detect dental biofilm by fluorescence changes using optical properties of oral microorganisms. The quantitative light-induced fluorescence (QLF) is the representative optical technology to use the difference in fluorescence from oral environment. QLF technology is the quantitative visible blue light induced fluorescence system which can capture changes in mineral contents from teeth and bacterial porphyrin induced red fluorescence at high resolution. During the growth phase of the dental biofilm, secondary colonizer bacteria produce a unique bacterial metabolite called porphyrin. These porphyrin-containing biofilms manifest as red QLF, and the fluorescence intensity is significantly correlated with various variables related to dental caries. The red fluorescent biofilm detected using QLF is a mature plaque existing on the tooth surface that has been present for at least 3 days. This optical fluorescence technology can extend not only dental caries but also tooth crack detection. In this presentation, the various clinical applications of this optical fluorescence technology in the dentistry will be introduced.

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# Self-etching adhesives and bonding modification



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**Pipop Saikaew**

Department of Operative Dentistry and Endodontics, Faculty of Dentistry, Mahidol University, Bangkok,  
Thailand

## ABSTRACT

Adhesive system can be divided into 2 strategies: smear layer removal (etch-and-rinse) and smear layer modification (self-etch). Smear layer is completely removed by phosphoric acid in etch-and-rinse system. On the other hand, due to the weak acidity of the self-etching system, smear layer is partially dissolved by acidic monomer. The residual smear layer is subsequently incorporated into the hybrid layer. There was a concern that smear layer might affect the penetration of self-etching adhesive to underlying dentin, especially mild self-etching adhesives. However, previous studies demonstrated the controversial results about this issue. In addition, characteristics of smear layer may vary according to the instrument used for surface preparation and lead to the different outcome when bonded to self-etching system. Therefore, this lecture will explain the effect of smear layer on bonding performance of self-etching adhesives based on the different surface preparation techniques, the characteristics and the reactions of smear layer to various etchants and bonding modification techniques to improve the effectiveness of self-etching adhesives.

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# Can fiber posts be luted with light-initiated composite resin?



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**Yu-Chih Chiang**

Department of Restorative and Aesthetic Dentistry, School of Dentistry, National Taiwan University,  
Taipei, Taiwan

## ABSTRACT

Fiber posts are commonly used to restore endodontically treated teeth when their remaining coronal tissue can no longer provide adequate retention or resistance for the restoration. They are passively retained inside the root canals with dual cured resin-based luting cements. However, bonding and mechanical strength of dual cured resin cement is not so reliable compare to light-initiate composite resin. In addition, light penetration decrease from the coronal part to the apical part of the root canal space; inadequate polymerization of light-activated resins was recorded at deeper levels of the post space. A significant reduction in light intensity occurs when the light scattering within the resin cement and shadowing produced by both tooth structure and fiber post. Even luting with dual cured resin cement, the degree of conversion decreased apparently along the depth of root canal consequently, much less luting with light-initiated composite resin. The present study investigated light-transmitting ability through the newly developed esthetic post systems. A light curing flowable composite resin was used to bond the test posts. By contrast, the fiber optical post can transduce highest light intensity and achieve promising degree of conversion of resin cement in deeper part. Based on our findings, we will also talk about some applications in clinical cases.

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# The evidence and potential viability for using glass ionomer in load bearing restorations

Michael F. Burrow,<sup>1,2</sup>

<sup>1</sup>Faculty of Dentistry, The University of Hong Kong, Hong Kong

<sup>2</sup>Faculty of Medicine, Dentistry and Health Sciences, University of Melbourne, Melbourne, Australia



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## ABSTRACT

Glass ionomer cements (GICs) have typically been used to restore small carious lesions in incisors or the cervical region of teeth. Recently, GICs have undergone several modifications that have resulted in increased strength and wear resistance. These GICs have typically been used for atraumatic restorative treatment restorations where dental facilities and basic water and power supply may be limited. However, with the introduction of these newer materials and resin coating methods, manufacturers have begun to promote the wider use of GICs for load bearing restorations in posterior teeth in a conventional clinical scenario. This talk will review the current clinical evidence with regard to where and how current GICs might be used for restoring carious lesions in posterior teeth in a load bearing situation in adult patients.

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# DIY instrumentations for biomechanical research in Conservative Dentistry

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In-Bog Lee

Department of Conservative Dentistry, Seoul National University School of Dentistry, Seoul, Korea

## ABSTRACT

Biomechanics is defined as the application of engineering principles to biological systems. In dental composite restoration, the biomechanical factors include the rheology of composite prior to cure, change in dimension and modulus of the materials during curing, polymerization shrinkage stress at bonded tooth-composite interface, cusp flexure of tooth, and the hydrodynamics of dentinal fluid flow between the cavity base and pulp. To investigate the biomechanical phenomenon, we should measure physical parameters such as length, force, mass, temperature, light intensity. In many cases, commercially available instruments could be used. However, researchers sometimes cannot find any adequate device for a special experiment. Most measurement instruments consist of transducers (sensor and actuator), amplifier and filter, an analog to digital converter to store data on a computer. To date, there are many open source hardware and software platforms that can be used to build your own instruments. This presentation will show some DIY style instruments made in my laboratory for biomechanical research using an open source microcontroller (Arduino) and a free programming platform (Processing), and to verify the usability of those instruments with published data.

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# Regeneration in endodontics: current trends and future perspectives

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**S. Sai Kalyan**

Department of Conservative Dentistry and Endodontics, Rural Dental College, Pravara Institute of Medical Sciences, Loni, MH, India

## ABSTRACT

The future of regenerative endodontics lies in overcoming the existing roadblocks and incorporating cutting edge technologies to improve the clinical and histological outcomes. The lecture outlines the current trends and lays emphasis on the future strategies for successful endodontic regeneration.

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# Dentin-pulp regeneration concept: how can we translate to clinical practice?

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Won-Jun Shon

Department of Conservative Dentistry, Seoul National University School of Dentistry, Seoul, Korea

## ABSTRACT

The regeneration of the pulp-dentin complex has been reported in several animal studies using exogenous biological cues or stem/progenitor cells. The animal and human studies using endogenous biological molecules released from ethylenediaminetetraacetic acid-conditioned dentin or evoked bleeding have shown the formation of tissues that are of periodontal origin. Endogenous biological molecules have a release profile with a high initial burst followed by rapid reduction, perhaps accounting for the lack of regeneration in clinical studies. We investigated biological function and mechanisms of Cpne7 in regulation of dental and non-dental mesenchymal cell differentiation into odontoblasts via epithelial mesenchymal interaction. Cpne7 induces the differentiation of dental mesenchymal cells, such as human dental pulp cells or non-dental origin mesenchymal cells, into odontoblasts and dentin formation *in vivo*. This presentation introduces the potential roles of Cpne7 in vital pulp therapy (direct pulp capping, indirect pulp capping, hypersensitivity treatment) and regenerative endodontic procedure through animal study. If we fully understand about Cpne7 function and reactive mechanism, clinicians can induce artificially tertiary dentin that produced by such as caries, abfraction, or dental treatment to protect pulp tissue naturally.

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# Pain and dentistry: orofacial pain? or more than restorative dentistry for our patients

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**Tan Hee Hon**

National University of Singapore, Singapore, Singapore

## ABSTRACT

Diagnosis and management of acute and chronic pain is part of dentistry. Pain has been puzzling to dental or medical healthcare providers, and sometimes pain can pose challenges in the management of patients. We often come across patients who have acute or chronic pain, temporomandibular disorders, orofacial pain or chronic overlapping pain, this presentation focuses on the interactive factors in explaining and diagnosing chronic orofacial pain/temporomandibular disorders and mechanism of pain. We can all help in the management of patients who are in 'Pain.'

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# Another look at composite resin- unlocking potential of composite resin, 5 years follow-up

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**Fa-Jen Wang**

National Taiwan University and National Taiwan University Hospital, Taipei, Taiwan

## ABSTRACT

Thanks to advances in restorative material and adhesive techniques, several treatment options are currently available to restore anterior teeth that are not harmonious in color, shape, or size, or that have a diastema.

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# Achieving ultimate esthetics with composite resin

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**Mohan Bhuvaneswaran**

Vignesh Dental Hospital, Chennai, India

## ABSTRACT

The direct bonded restorations open up the avenues of conserving the tooth structure to the maximum extent possible. The current concepts in bonding and the best way to handle the present generation of composite in creating beautiful smiles will be discussed.

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# Improve aesthetics by closing the midline diastema

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**Chun-Hung Chu**

Faculty of Dentistry, The University of Hong Kong, Hong Kong

## ABSTRACT

A maxillary midline diastema (MMD) often is an aesthetic complaint of patients in our clinic practice. Although an MMD can be transient in mixed dentition stage and, therefore, requires no intervention for children, treatment of MMDs in the permanent dentition of adults requires a detailed examination and appropriate care. This presentation will discuss management of MMD using 5 clinical cases in adults to illustrate the available restorative and orthodontic options. Successful treatment requires an accurate diagnosis and intervention which is agreed by the patient. While some patients with MMD should be referred to orthodontist for management, general dentists can play a significant role to address patient aesthetic concern on MMD and perform a range of restorative and orthodontic treatments in appropriate clinical situations.

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# Conservative and ultraconservative ceramic laminate veneers



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**Hassan Eslami**

Department of Restorative and Esthetic Dentistry, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran

## ABSTRACT

It has been more than 3 decades that ceramic laminate veneers were introduced to restorative and esthetic dentistry. During these decades some different techniques have been proposed for the elimination of sound tooth reduction. On the other hand, many researches have been done to determine most appropriate preparation design. Undoubtedly, there exist numerous factors that can affect the final outcomes and durability of ceramic veneers. Different preparation designs, ceramic material selection, type of occlusion, cementation procedures and also patient's desire are most effective factors in order to get the best results. The only significant factor that patients are really concerned about is the amount of tooth reduction. Consequently, all the attempts should be considered to rest them assured that the newest and most conservative methods have been applied. In this lecture most recognized preparation methods along with the different reduction thicknesses will be discussed through different cases considering their advantages and disadvantages. In addition, some criteria of ceramic selection for the introduced cases will be identified. Accordingly, by increasing the demands for esthetic treatments and due to the long clinical success rate and conservative nature of ceramic veneers, dentists should get mastered in newest techniques to serve their patients with the most appropriate treatment plan.

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# Clinical technique in endodontics



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**Hiromichi Yumoto**

Department of Periodontology and Endodontology, School of Dentistry, Tokushima University,  
Tokushima, Japan

## ABSTRACT

The basic concept of treatment of periapical periodontitis is debridement and disinfection within the root canal system, which are the most important points in endodontic treatment, because periapical periodontitis with radiolucent lesion is caused by an inflammatory reaction to bacterial infection in root canal. However, it is quite difficult to completely remove bacteria and all causal agents from the root canal system by using current routine endodontic procedures that depend on chemomechanical debridement due to inaccessibility by its anatomical and morphological complexities. Moreover, bacteria growing as biofilms in the root canal system can invade the extraradicular area. Once bacterial biofilms form in the extraradicular area, it is also impossible to remove those on the root surfaces by current routine non-surgical endodontic procedures. Extraradicular bacterial propagation and persistence involve in the pathogenesis of refractory periapical periodontitis. Therefore, it is necessary to develop novel methods of bacterial control against infected root canal-associated bacteria. Our previous *in vitro* studies demonstrated that High-Frequency Wave Irradiation (HFWI) has bactericidal effect and activates osteoblastic cells to enhance their cell growth and the gene expression of various growth factors and osteopontin via extracellular signal-regulated kinase 1/2 and p38 mitogen-activated protein kinase pathways. *In vivo* study using rat periapical periodontitis model also showed that HFWI promotes healing of the periapical lesion through the induction of growth factors expression. These *in vitro* and *in vivo* experimental findings suggested that the direct application of HFWI to periapical lesions may accelerate the healing of the lesions and be effective for clinical application to refractory periapical periodontitis as non-surgical technique. I would like to present the basic experimental results showing HFWI has bactericidal activity, oral pathogen inactivation, and activating effects on the osteoblastic cells and also present clinical cases using HFWI as a novel non-surgical treatment for refractory periapical periodontitis.

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# Post-endodontic restoration: a paradigm shift in concepts and techniques

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Hatem M. El-Damanhoury,<sup>1</sup> Nesrine A. Elsahn,<sup>2</sup>

<sup>1</sup>Department of Preventive and Restorative Dentistry, College of Dental Medicine, University of Sharjah, Sharjah, United Arab Emirates

<sup>2</sup>Department of Restorative Dentistry, College of Dentistry, Ajman University, Ajman, United Arab Emirates

## ABSTRACT

Restoration of endodontically treated teeth continues to be a challenge in restorative dentistry. A common protocol for restoring such teeth has been to use a post and core to aid the retention of an overlying crown. However, many clinical and laboratory studies have reported that placing a post will contribute to the retention of the core portion of the restoration but may have a weakening effect on the root. Failure of post & core/crown systems is a common problem that may be due to different material mechanical behaviors relative to tooth structure in response to intra-oral cyclic stresses. With the increasing popularity of adhesive dentistry, a shift in treatment decisions towards more conservative modalities has been observed. With the current advances in adhesive dentistry and the development of dental computer-aided design/computer-aided manufacturing, custom-made fiber post and core, ceramic inlays, onlays, and endocrowns became better alternatives. This presentation discusses these approaches, its advantages and limitations when compared to conventional treatment options.

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# Establishing vertical dimension in full mouth rehabilitation

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**Jayshree Hegde Anil**

Restorative Dentist and Endodontist, Ridgetop Dental International Pvt Ltd., Bengaluru, KA, India

## ABSTRACT

Loss of vertical dimension is a common sequelae of worn dentition. Establishing vertical dimension of occlusion is a critical step during full mouth rehabilitation. The re-established vertical dimension is a permanent change and it should create a harmonious relationship between teeth, periodontium, muscle and the temporomandibular joint. So, it is important to follow the right technique prior to placement of permanent restorations, to prevent any damage to the masticatory system. This lecture discusses the clinical considerations and techniques for increasing the vertical dimension of occlusion.

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# Oral rehabilitation of vertical dimension loss



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Min-Huey Chen,<sup>1,2</sup>

<sup>1</sup>Graduate Institute of Clinical Dentistry, School of Dentistry, National Taiwan University, Taipei City, Taiwan

<sup>2</sup>Department of Esthetic Restoration, National Taiwan University Hospital, Taipei City, Taiwan

## ABSTRACT

Alterations of vertical dimension are quite common problems in many dental clinics. In this presentation we are going to consider the following questions: How vertical dimension should be established? Whether it can be modified? What outcome will be if it is modified incorrectly? There are several correct answers to the same problem. We should understand occlusal vertical dimension and the related factors. There are 3 parts need to be considered including the growth of the ramus, the gonial angle of the mandible, and the eruption of the teeth. Most common reasons for patients asking for clinical alteration of vertical dimension are to improve esthetics by altering facial form and/or tooth and gingival display, to improve occlusal relationships, such as correcting anterior open bites, and to gain space for the restoration of short or worn teeth. During clinical alteration of vertical dimension, there are some points need to be concerned including the effects on the temporal mandibular joint, muscle pain, stability of altered vertical dimensions, impact on muscle activity levels, and effects on speech. There are different methods for determining a new vertical dimension including using freeway space, trial appliances, transcutaneous electrical neural stimulation, measurements using the cemento-enamel junction, and the method of facial proportion. Some clinical cases of full mouth oral rehabilitation of patient suffered from vertical dimension loss were also demonstrated.

## Country Representative Session



# How to approach to treatment of root surface caries in elderly patients with special needs

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Juhea Chang

Special Care Clinic, Seoul National University Dental Hospital, Seoul, Korea

## ABSTRACT

An increased severity and activity of caries lesions in the root surface are often found in elderly patients. Exposure of the root surface by gingival recession and a decreased salivary flow by multiple medication induce a high risk of caries development. Moreover, many elderly patients with special needs poorly manage their oral hygiene due to a lack of motivation and impaired physical dexterity. Consequently, they often exhibit quick development of rampant root surface caries, resulting in multiple loss of the involved teeth unavoidable. In this lecture we will discuss about the considerations posed for caries-prone elderly patients. And, clinical cases of root caries will be reviewed according to the severity of the caries development in the mild, moderate and severe phases. The sequence of the restorative intervention needs to be applied with meticulous operative techniques and adequate material selection. Non-invasive and preventive treatment regimens are also essential to enhance the caries-resistance of elderly patients. Active collaboration between patients' caregivers and dental healthcare personnel needs to be also implemented. Comprehensive clinical protocols of caries management will be beneficial to elderly patients who are at extremely high risk of developing root caries.

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# Japan's pioneering guideline for treating caries based on 'minimal intervention' policy

**Mikako Hayashi**

Department of Restorative Dentistry and Endodontology, Osaka University Graduate School of Dentistry, Osaka, Japan



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## ABSTRACT

Japan has set the laudable goal of 80–20 meaning that at the age of 80, people would have at least 20 of their natural teeth. But to achieve this, dentistry needs to undergo a paradigm shift. Everyone involved, government and dentists particularly must enhance the concept of minimal intervention (MI). Experts from the Japanese Society of Conservative Dentistry in 2009 published a guideline for evidence-based treatments of caries based on MI policy. This was followed in 2015 by an expanded version incorporating recommendations for remineralizing incipient enamel and root caries. The aim was to make drilling of healthy tooth a thing of the past. This will make it easier to keep healthy teeth longer as well as taking a lot of the pain out of dental treatments. This presentation will explain the latest scientific evidence, the best modern materials, the advanced clinical techniques that are combining with MI to make dentistry a key partner in helping patients lead longer healthier lives.

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# Biomimetic endodontics



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cited.

**Emre Nagas**

Department of Endodontics, Faculty of Dentistry, Hacettepe University, Ankara, Turkey

## ABSTRACT

This topic attempts to provide a better understanding of the relative position of the  
biomimetic endodontics in the context of the past and present endodontic approaches.

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# Endodontic surgery: procedure or decision?

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**Abdulla Alsharif**

Saudi Endodontic Society, Riyadh, Saudi Arabia

## ABSTRACT

New approach of decision and procedures of endodontic surgery with clinical examples will  
be covered.

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# Adequate surface treatment of ceramic and composite restorations

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**Kyoung Kyu Choi**

Department of Conservative Dentistry, School of Dentistry, Kyunghee University, Seoul, Korea

## ABSTRACT

Tooth-colored restorations are widely used because of their durability, esthetics, and excellent biocompatibility. Recently, computer-aided design/computer-aided manufacturing (CAD/CAM) is popular among the advances in dental technology, used for the fabrication of ceramic and composite restorations. The optimal surface condition should be established to make mechanical and chemical stability. However, there are many reasons to decrease the bonding durability of these restorations resulting in failure in clinical practice. In this lecture, we can review the adequate conditioning methods of indirect restoration including zirconia ceramics and examine the influence of saliva contamination before and after try-in and cleaning methods in bonding procedures of each restoratives. We may find out the answers when and how to do the surface treatment of various indirect restorations, so that you can get a confidence through organizing procedures and concepts for tooth-colored indirection.

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# Cementation tips for CAD/CAM tooth colored restoration

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**Sung-Ho Park**

Department of Conservative Dentistry, Yonsei University College of Dentistry, Seoul, Korea

## ABSTRACT

It is true that computer-aided design/computer-aided manufacturing (CAD/CAM) technique let dentists make indirect tooth colored restoration more easily and conveniently, but internal and marginal adaptation of CAD/CAM restoration is less favorable than traditional indirect tooth colored restorations. Proper cementation techniques have become more important for successful CAM/CAM restoration. In this presentation, clinical tips for cementation of CAD/CAM restoration will be provided.

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# Calcium silicate cements, updates and summaries

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**Luke Sung Kyo Kim**

Department of Conservative Dentistry, School of Dentistry, Kyungpook National University, Daegu, Korea

## ABSTRACT

Calcium silicate cement starting with mineral trioxide aggregate (MTA) is commonly used in endodontic procedures involving root-end filling, perforation repair, root canal sealer and pulp regeneration including pulp capping, pulpotomy, apexogenesis, and apexification. With the superior laboratory and clinical performance of MTA in comparison with previous endodontic repair cements, such as calcium hydroxide, many different products of calcium silicate cement have been developed with enhanced handling properties. The aim of the present presentation is to review and summarize the available old and recent literature on current calcium silicate cement products, and to give recommendations for the clinical use of these materials.

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## Education Forum



# Starting from the basics: anatomy knowledge and isolation techniques

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**Gaetano Paolone**

Department of Conservative and Restorative Dentistry, Università Vita e Salute San Raffaele, Milano, Italy

## ABSTRACT

Restorative dentistry procedures are strictly related to dental anatomy knowledge. In the first part of the lecture the importance of knowing how to draw the basic anatomy will be outlined: drawing exercises and tests for students. The second part will describe the importance of teaching isolation procedures. An overview of the most used isolation scenarios, simple tools, and simplified clamp selection can help the dental students to be confident with the isolation of the operatory field.

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## Education Forum



# Enhancing dental student learning and skill with adhesive dentistry using a shear bond strength test and light-curing exercise

**Reuben H. Kim**

Department of Restorative Dentistry, University of California, Los Angeles (UCLA) School of Dentistry, Los Angeles, CA, USA



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## ABSTRACT

Teaching dental students, the proper protocol and application of bonding agents for improved composite restorations in the preclinical setting can be challenging due to difficulty in translating their bonding technique to clinical outcomes. In the University of California, Los Angeles (UCLA) School of Dentistry, we have implemented shear bond strength test and light-curing exercises during the pre-clinical courses. Here we will discuss how these hands-on exercises served as innovative methods of emphasizing proper technique with adhesive dentistry, while helping to build student confidence in the preclinical laboratory.



## Education Forum



# Cognitive apprenticeship

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**Dong-Hoon Shin**

Department of Conservative Dentistry, College of Dentistry, Dankook University, Cheonan, Korea

## ABSTRACT

It is believed that the clinical competency of students can be enhanced through the educational system of 'cognitive apprenticeship.' It is a process in which learners receive certain knowledge and skills from experts to become a member of the professional community. This way of teaching applies the principles of traditional apprenticeship to the cognitive domain. It is based on the view that learners begin with passive participation in problem solving at first, but ultimately learning is done with active participation and initiative.

This course consists of six teaching methods.

- 1) The core of cognitive apprenticeship (modeling, coaching, scaffolding) designed to help students acquire an integrated set of skills through processes of observation and guided practice.
- 2) The next 2 (articulation and reflection) are methods designed to help students both to focus their observations of expert problem solving and to gain conscious access to (and control of) their own problem-solving strategies.
- 3) The final method (exploration) is aimed at encouraging learner autonomy, not only in carrying out expert problem-solving processes but also in defining or formulating the problems to be solved.

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# Adhesive dentistry in dental education in the Netherlands: the Radboud Philosophy

Niek Opdam

Department of Dentistry, Radboud University Medical Centre, Nijmegen, The Netherlands



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## ABSTRACT

Adhesive dentistry nowadays is the main part of restorative dentistry and therefore, it is mandatory that dental students are trained in skills on bonding, cementing and composite placement. However, adhesive dentistry is not a goal in itself, ultimately it's all about the oral health of our patients. At Radboud University in Nijmegen, the Netherlands, the mission in dentistry is to have a significant impact on oral health care using minimal intervention to achieve the maximum results. In the 6-year undergraduate program leading to a master degree, integrated treatment planning is the key in restorative dentistry. In the master clinic, 4th, 5th and 6th year students treat patients in collaboration according to an integrated concept. In this extensive clinical training program, adhesive dentistry plays a major role. Amalgam is not used anymore since 2000 and today also indirect restorations are preferably metal free and adhesively cemented. For that purpose, undergraduates need a good training program on phantom heads, using appropriate manikin models and materials. The choice for adhesive techniques and materials is determined by scientific evidence, resulting in using the same bonding system for 20 years, as well as innovation, while we aim for pragmatic approach and high quality of restorations.

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## Education Forum



# Ten golden rules for excellent bonding

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**Lorenzo Breschi**

Department of Biomedical and Neuromotor Sciences, University of Bologna, Bologna, Italy

## ABSTRACT

The lecture will provide clinical step-by-step procedures along with “tips and tricks” to achieve the highest clinical success in terms of aesthetic requirements, biomechanical properties of adhesive restorations, bond strength and stability of the adhesive interface over time.

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# Relationship between the electronic apex locator and the apical constriction in 3D-printed tooth models

Juhee Nam,<sup>1</sup> Sung-Ho Park,<sup>2</sup> Sin-Yeon Cho<sup>1</sup>

<sup>1</sup>Department of Conservative Dentistry, National Health Insurance Service Ilsan Hospital, Goyang, Korea

<sup>2</sup>Department of Conservative Dentistry, Yonsei University Dental Hospital, Seoul, Korea



**\*Presenting author**

**Juhee Nam**

Department of Conservative Dentistry,  
National Health Insurance Service Ilsan  
Hospital, 100 Ilsan-ro, Ilsandong-gu,  
Goyang 10444, Korea.  
E-mail: joeyn@gmail.com

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## ABSTRACT

**Objectives:** It is controversial whether the electronic apex locators (EALs)' mark indicates the apical constriction (AC) or the major foramen (MF). The limitation of previous studies is that they used natural teeth in which locations and forms of AC and MF varies, and therefore, cannot be controlled. Three dimensional (3D)-printed tooth models with designated AC and MF instead of natural teeth were used to overcome such limitation. This study aimed to find the most reliable and consistent location indicated by EAL marks in 3D-printed tooth models.

**Materials and Methods:** Five single-rooted tooth models, with identical MF but different locations of the AC, were designed and printed. The measuring apparatus was custom-made for precise file movements and measurement. Two types of EAL devices (Root ZX mini and Propex pixi) were used and upper and lower margins of 2 marks (0.5 and APEX marks) were recorded for each EAL.

**Results:** With both the Root ZX mini and Propex pixi, all signs significantly follow MF rather than AC ( $b = 0.001$ ,  $p < 0.001$ ). The APEX mark shows a more constant distance from MF, regardless of the position of the AC. The mean width between the lower and upper margins of APEX mark was smaller than that of 0.5 mark ( $p < 0.0001$ ).

**Conclusions:** The 2 EALs followed MF rather than AC. APEX marks produced more reliable and consistent results than 0.5 marks.

**Keywords:** Apex locator; Apical constriction; Major foramen

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# Development of *in vitro* model for ultrasound Doppler detecting simulated pulpal blood flow

Min-Jung Yoon,\* Sung-Ho Park, Do-Hyun Kim, Il-Young Jung

Department of Conservative Dentistry, Yonsei University College of Dentistry, Seoul, Korea

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### \*Presenting author

Min-Jung Yoon

Department of Conservative Dentistry, Yonsei University College of Dentistry, 50-1 Yonsei-ro, Seodaemun-gu, Seoul 03722, Korea.  
E-mail: elza79@naver.com

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## ABSTRACT

**Objectives:** Recently, ultrasound Doppler graphy has been successfully used for the measurement of pulpal blood flow *in vivo*. This study tested that ultrasound Doppler graphy can detect simulated blood flow from extracted human teeth. In addition, we simulated pulpotomy status and used ultrasound Doppler graphy to measure simulated blood flow.

**Materials and Methods:** We used 21 extracted human upper and lower anterior teeth. In all teeth, we had created a channel from the apex to the center of the crown of the lingual side (control group). And we made 2 holes under the cemento-enamel junction (pulpotomy group 1) and the apical 1/3 of the root (pulpotomy group 2). We used extracted human teeth to simulate the state of pulpotomy and blood-mimicking fluid was pumped through the channel by microfluidic system. An ultrasound Doppler graphy was used for the measurement of flow velocity.

**Results:** In extracted human teeth, ultrasound Doppler graphy can detect the simulated blood flow. In pulpotomy group 1, ultrasound Doppler graphy is able to detect the blood flow. In pulpotomy group 2, the simulated blood flow is not detected.

**Conclusions:** This *in vitro* study showed the ultrasound Doppler graphy can detect the blood flow not in crown level but also in cemento-enamel junction level.

**Keywords:** Pulpal blood flow; Pulpotomy; Ultrasound Doppler graphy

## ACKNOWLEDGEMENT

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### \*Presenting author

#### Mayuko Fujii

Department of Pulp Biology and Endodontics,  
Division of Oral Health Sciences, Graduate  
School of Medical and Dental Sciences, Tokyo  
Medical and Dental University (TMDU), 1  
Chome-5-45 Yushima, Bunkyo-ku,  
Tokyo 113-8510, Japan.  
E-mail: m.fujii.endo@tmd.ac.jp

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# HIF1 $\alpha$ inhibits LPS-mediated induction of IL-6 synthesis via SOCS3-dependent CEBP $\beta$ suppression in human dental pulp cells

Mayuko Fujii,<sup>1</sup> Nobuyuki Kawashima,<sup>1</sup> Shion Orikasa,<sup>1</sup> Sonoko Noda,<sup>1</sup>  
Keisuke Nara,<sup>1</sup> Kentaro Hashimoto,<sup>1</sup> Kento Tazawa,<sup>1</sup> Shigenori Nagai,<sup>2</sup> Takashi Okiji<sup>1</sup>

<sup>1</sup>Department of Pulp Biology and Endodontics, Division of Oral Health Sciences, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University (TMDU), Tokyo, Japan

<sup>2</sup>Department of Molecular Immunology, Division of Oral Health Sciences, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University (TMDU), Tokyo, Japan

## ABSTRACT

**Objectives:** The development of circulatory impairment in dental pulp inflammation due to encasement within the rigid tooth structure induces ischemia and hypoxia following inflammatory exudation. Hypoxia in turn may modify the inflammatory state of the pulp, however the details remain unclear. This study aimed to evaluate the roles of hypoxia-inducible factor 1 $\alpha$  (HIF1 $\alpha$ ), a transcriptional factor induced in hypoxia, in the expression of interleukin 6 (IL-6), a typical inflammatory cytokine, in lipopolysaccharide (LPS)-stimulated human dental pulp cells (hDPCs).

**Materials and Methods:** hDPCs isolated from pulp tissues obtained from healthy wisdom teeth (Tokyo Medical and Dental University [TMDU] ethics committee #D2014-039-01) were cultured in hypoxia (1% O<sub>2</sub>) in the presence of LPS (100 ng/mL). Expression of HIF1 $\alpha$ , CCAAT enhancer binding protein beta (CEBP $\beta$ ) and suppressor of cytokine signaling 3 (SOCS3) in the hDPCs were analyzed by real-time polymerase chain reaction (PCR) and western blot. Expression of IL-6 was evaluated by real-time PCR and enzyme-linked immunosorbent assay. Specific siRNAs were used to down-regulate the expression of CEBP $\beta$  and SOCS3. Enforced expression of HIF1 $\alpha$ , CEBP $\beta$  and SOCS3 was induced by transfection of their expression vectors. The result was statistically analyzed using analysis of variance and Turkey's test at  $p < 0.05$  level.

**Results:** LPS promoted the expression of HIF1 $\alpha$  and IL-6 in hDPCs. Hypoxia and enforced expression of HIF1 $\alpha$  down-regulated IL-6 and CEBP $\beta$  which is known to bind to the promoter region of IL-6 gene, in LPS-stimulated hDPCs. Enforced and repressed expression of CEBP $\beta$  in hDPCs promoted and depressed, respectively, IL-6 expression after LPS stimulation. Moreover, hypoxia and enforced expression of HIF1 $\alpha$  up-regulated SOCS3 expression in LPS-stimulated hDPCs. When SOCS3 was forcibly expressed in hDPCs, LPS-induced CEBP $\beta$  and IL-6 expression was depressed, and down-regulation of SOCS3 expression in hDPCs induced up-regulation of LPS-induced-IL-6 expression.

**Conclusions:** HIF1 $\alpha$  suppressed IL-6 expression via SOCS3-dependent down-regulation of CEBP $\beta$  in LPS-stimulated hDPCs.

**Keywords:** CEBP $\beta$ ; hDPCs; HIF1 $\alpha$ ; Hypoxia; IL-6; SOCS3

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### \*Presenting author

#### Shion Orikasa

Department of Pulp Biology and Endodontics,  
Division of Oral Health Sciences, Graduate  
School of Medical and Dental Sciences, Tokyo  
Medical and Dental University (TMDU), 1  
Chome-5-45 Yushima, Bunkyo-ku,  
Tokyo 113-8510, Japan.  
E-mail: s.orikasa.endo@tmd.ac.jp

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# Hypoxic condition induces hypoxia-inducible factor 1 $\alpha$ and upregulates Wnt/ $\beta$ -catenin transcriptional cofactors, *Bcl9* and *Bcl9l*, in mouse dental papillae cells

Shion Orikasa,\* Nobuyuki Kawashima, Mayuko Fujii, Mioko Yamamoto,  
Kentaro Hashimoto, Kento Tazawa, Takashi Okiji

Department of Pulp Biology and Endodontics, Division of Oral Health Sciences, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University (TMDU), Tokyo, Japan

## ABSTRACT

**Objectives:** Pulp tissue mineralization is known to occur following tooth replantation, which may be accompanied by hypoxic condition attributed to circulatory disturbance in the pulp. Hypoxia-inducible factor 1 $\alpha$  (Hif1 $\alpha$ ), a transcriptional factor induced in hypoxia, is a positive regulator of bone formation (Bone Research, 2019 Vol. 7), but its precise function is still unclear. B-cell CLL/lymphoma 9 (*Bcl9*) and *Bcl9* like (*Bcl9l*) are essential co-activators of Wnt/ $\beta$ -catenin signaling in cancer, and Hif1 $\alpha$  promotes the expression of *Bcl9/Bcl9l*. This study aimed to test the hypothesis that hypoxia-induced Hif1 $\alpha$ /*Bcl9* and/or Hif1 $\alpha$ /*Bcl9l* signaling is involved in the osteogenic marker expression of mouse dental papillae cells (MDPs).

**Materials and Methods:** MDPs were cultured under normoxic (20% O<sub>2</sub>) or hypoxic (1% O<sub>2</sub>) conditions. Dimethylxaloylglycine (DMOG, 1 mM, a Hif1 $\alpha$ -specific prolyl hydroxylases inhibitor) was used to stabilize Hif1 $\alpha$ . Expression of Hif1 $\alpha$  was detected by western blotting using a specific antibody against Hif1 $\alpha$ . mRNA expression of vascular endothelial growth factor (*Vegf*; a Hif1 $\alpha$ -target gene), *Bcl9*, *Bcl9l*, osteocalcin (*Oc*; a typical osteogenic marker) and *Axin2* (a Wnt/ $\beta$ -catenin signaling target gene) was determined by a real-time polymerase chain reaction using specific primers and complementally DNA converted from RNA extracted from MDPs. The results were statistically analyzed using analysis of variance and Turkey's test ( $\alpha = 0.05$ ).

**Results:** Hif1 $\alpha$  protein was detected and *Vegf* mRNA expression was induced in the MDPs cultured in hypoxia. DMOG treatment showed similar results. Hypoxia and DMOG-treatment promoted mRNA expression of *Oc*, *Bcl9/Bcl9l* and *Axin2* in MDPs ( $p < 0.05$ ).

**Conclusions:** Hypoxia and DMOG-treatment up-regulated mRNA expression of *Oc*, a typical osteogenic marker in MDPs. Hypoxia and DMOG-treatment up-regulated Hif1 $\alpha$  expression, mRNA expression of *Bcl9/Bcl9l*, Wnt/ $\beta$ -catenin transcriptional cofactors, and *Axin2*, a canonical Wnt signaling target gene, which may interact each other and they may be involve in the osteogenic differentiation in MDPs.

**Keywords:** *Bcl9/Bcl9l*; Hif1 $\alpha$ ; Mouse dental papilla cells; Osteoblastic marker; Wnt/ $\beta$ -catenin signaling



## KACD-JSCD Joint Meeting



# Effect of elastin-like polypeptide incorporation on the adhesion property and maturation of mineral trioxide aggregates

Hyun-Jung Kim,<sup>1\*</sup> Duck-Su Kim,<sup>1</sup> Ji-Hyun Jang,<sup>1</sup> Seok-Woo Chang,<sup>1</sup>  
Kyoung-Kyu Choi,<sup>1</sup> Sun-Young Kim<sup>2</sup>

<sup>1</sup>Department of Conservative Dentistry, Kyung Hee University, Seoul, Korea

<sup>2</sup>Department of Conservative Dentistry, Seoul National University, Seoul, Korea

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### \*Presenting author

Hyun-Jung Kim

Department of Conservative Dentistry, Kyung Hee University, 7-13, Kyunghedae-ro 6-gil, Dongdaemun-gu, Seoul 02453, Korea.  
E-mail: creamykeren@gmail.com

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## ABSTRACT

**Objectives:** The aim of this study is to investigate the effect of elastin-like polypeptide (ELP) incorporation on the adhesion properties and maturation of mineral trioxide aggregates (MTA).

**Materials and Methods:** Two types of ELPs (V125, V125E8) were synthesized and diluted to 10 wt% solution. Three holes of 1.5 mm diameter in each dentin disc were filled with MTA mixed either with ELP solutions or deionized water as a control. The push-out bond strength test was performed following storage in simulated body fluid (SBF) during 1, 2, 4, and 8 weeks ( $n = 12$ ). The interface between dentin and MTA was observed with scanning electron microscope (SEM). The stickiness ( $n = 3$ ) and flow rate ( $n = 3$ ) of each of the freshly mixed MTA were evaluated. Micro-computed tomography analysis for porosity evaluation was also conducted. The maturation of MTA was evaluated with stereoscopic microscope, SEM, and X-ray diffraction.

**Results:** Specific ELP (V125E8) incorporation significantly increased the bond strength of MTA to dentin in every maturation period ( $p < 0.05$ ). The bond strength of MTA also increased with a longer maturation time ( $p < 0.05$ ). V125E8-incorporated MTA showed the highest stickiness and flow rate ( $p < 0.05$ ) and also showed more intimate interface with dentin in SEM images. V125E8 showed a relatively dense structure and fewer air gaps in cavity wall ( $p < 0.05$ ).

**Conclusions:** V125E8 incorporation enhanced the adhesion property of MTA. The sticky and highly flowable characteristics of V125E8-incorporated MTA might provide an intimate interface with dentin, and supply a less porous cement structure. The improved mechanical property of MTA during maturation under physiological conditions might also lead to better adhesion to the dentin. This study suggests that ELP-incorporated MTA might be used as a repair material for large defects in tooth structure due to its improved adhesion properties.

**Keywords:** Elastin-like polypeptide; Flow rate; Mineral trioxide aggregate; Push-out bond strength; Stickiness

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# CPNE7 induces a biological dentin sealing in dentin hypersensitivity model

Sohyun Park,\* Wonjun Shon

Department of Conservative dentistry, Seoul National University Dental Hospital, Seoul, Korea

## OPEN ACCESS

### \*Presenting author

Sohyun Park

Department of Conservative Dentistry, Seoul National University Dental Hospital, 101 Daehak-ro, Jongno-gu, Seoul 03080, Korea.  
E-mail: psh5432@naver.com

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## ABSTRACT

**Objectives:** This study aims to investigate the formation of tertiary dentin when copine 7 (CPNE7) is applied to intentionally exposed dentin with nothing over it *in vivo*, whether it affects microleakage of the teeth, and the penetration ability of CPNE7 molecules through dentinal tubules *in vitro*.

**Materials and Methods:** Class V-like lesions were prepared to expose dentin at the cervical 1/3 of both maxillary incisors and premolars in 5 beagle dogs. For one side of teeth, recombinant CPNE7 (rCPNE7) was applied for 5 minutes, the other was not as control group. Four weeks later, the beagle dogs were sacrificed, and histological, scanning electron microscopy analysis were done. The effect of dentinal tubule occlusion was evaluated by dentin permeability test. To confirm the dentinal tubule penetration ability, rhodamine B labeled with rCPNE7 was treated on human third molar specimen and observed by a confocal laser scanning microscope (CLSM).

**Results:** The *in vivo* hypersensitivity model with anterior teeth of beagle dogs showed newly formed tertiary dentin at dentin-pulp boundary in rCPNE7-treated tooth when compared to rCPNE7-untreated control group in histological analysis. The scanning electronic microscope analysis revealed that there were occluded sites with mineral deposition of intratubular dentin. In permeability test, the mean microleakage value of CPNE7-treated group were significantly lower than the control group ( $p < 0.05$ ). The tubular penetration of rhodamine B combined CPNE7 was confirmed under a CLSM.

**Conclusions:** CPNE7 induces formation of tertiary dentin through shallowly exposed dentinal tubules, which makes dentin permeability decrease.

**Keywords:** CPNE7; Dentin hypersensitivity; Tertiary dentin; Vital pulp therapy

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### \*Presenting author

Citra Kusumasari

Department of Cariology and Operative Dentistry, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University (TMDU), 1 Chome-5-45 Yushima, Bunkyo-ku, Tokyo 113-8510, Japan.  
E-mail: ckusumasari@yahoo.com

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# Effect of papain enzyme and NaOCl-based gel on sealing performances of self-etch adhesives

Citra Kusumasari,\* Masatoshi Nakajima, Ahmed Abdou, Takashi Hatayama, Keiichi Hosaka, Junji Tagami

Department of Cariology and Operative Dentistry, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University (TMDU), Tokyo, Japan

## ABSTRACT

**Objectives:** To investigate sealing performance of self-etch adhesives after application of papain enzyme and sodium hypochlorite (NaOCl)-based gel compared to 6% NaOCl solution under swept source optical coherence tomography (SS-OCT) observation.

**Materials and Methods:** Tapered cylindrical cavities (4 mm in diameter; 2 mm in depth) were prepared 0.5 mm coronal to cemento-enamel junction of bovine anterior teeth. Papacarie (Formula & Acao) and Carisolv (RLS Global AB, Sweden) were applied into the cavity for 60 seconds then rinsed with deionized water for 10 seconds, while 6% NaOCl was applied for 15 seconds followed by water rinsing for 10 seconds. One-step self-etch adhesive; G-Bond Plus (GBP; GC Corp.) or 2-step self-etch adhesive; Clearfil SE Bond 2 (CSE; Kuraray Noritake Dental Inc.) was applied according to manufacturer instruction on the pre-treated cavity, then filled with a flowable resin composite; Clearfil Majesty ES Flow (Kuraray Noritake Dental Inc.), followed by light-cured with LED curing unit for 20 seconds. The percentage of gap length was calculated in each cavity wall of enamel and dentin lateral walls and dentin cavity floor using SS-OCT (IVS-2000, Santec Corp.) after 24-hour water storage at 37°C. In addition, attenuated total reflection-fourier transform infrared analysis was used to observe deproteinizing effects at enamel and dentin surfaces by measuring the amide: phosphate ratio. Data analyzed using Kruskal-Wallis test followed by Mann-Whitney *U* test for pairwise comparison ( $\alpha = 0.05$ ).

**Results:** Application of Papacarie significantly reduced the gap formation with both self-etch adhesives at all the cavity walls, compared with control group ( $p < 0.05$ ). Additionally, for the Papacarie and control group, CSE significantly reduced the gap formation at all the cavity walls compared to GBP. All application of deproteinizing agents significantly reduced the amide: phosphate ratio on smear layer-covered enamel and dentin surfaces.

**Conclusions:** Application of Papacarie could improve sealing performance of 1 and 2-step self-etch adhesives at enamel and dentin lateral walls and dentin cavity floor.

**Keywords:** NaOCl-based gel; Papain enzyme-based gel; Sealing performance; Self-etch adhesive; Smear layer deproteinizing; SS-OCT

## KACD-JSCD Joint Meeting



# Effect of glass-beads blasting on bonding performance of super-translucent zirconia

Leila Nasiry Khanlar,<sup>1\*</sup> Tomohiro Takagaki,<sup>2</sup> Masanao Inokoshi,<sup>3</sup> Masaomi Ikeda,<sup>4</sup> Akifumi Takahashi,<sup>1</sup> Kumiko Yoshihara,<sup>5</sup> Noriyuki Nagaoka,<sup>6</sup> Toru Nikaido,<sup>2</sup> Junji Tagami<sup>7</sup>

<sup>1</sup>Department of Cariology and Operative Dentistry, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University (TMDU), Tokyo, Japan

<sup>2</sup>Department of Operative Dentistry, Asahi University Medical and Dental Center, Tokyo, Japan

<sup>3</sup>Department of Gerodontology and Oral Rehabilitation, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University (TMDU), Tokyo, Japan

<sup>4</sup>Oral Prosthetic Engineering, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University (TMDU), Tokyo, Japan

<sup>5</sup>National Institute of Advanced Industrial Science and Technology (AIST), Health Research Institute, Tokyo, Japan

<sup>6</sup>Okayama University Dental School, Advanced Research Center for Oral and Craniofacial Sciences, Tokyo, Japan

<sup>7</sup>Department of Cariology and Operative Dentistry, Tokyo Medical and Dental University (TMDU), Tokyo, Japan

## OPEN ACCESS

### \*Presenting author

Leila Nasiry Khanlar

Department of Cariology and Operative Dentistry, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University (TMDU), 1 Chome-5-45 Yushima, Bunkyo-ku, Tokyo 113-8510, Japan.  
E-mail: lnasirykhanlar@gmail.com

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## ABSTRACT

**Objectives:** The aim of this study was to evaluate the effect of alumina or glass beads sandblasting on surface roughness (Sa), surface topography, and bond strength to super-translucent zirconia ceramics.

**Materials and Methods:** Two hundred fully-sintered disk-shaped zirconia specimens of Y-PSZ (Katana ST, Kuraray Noritake Dental) were prepared. The specimens were divided into 5 groups according to the pretreatment: 1) as-sintered (control), 2) alumina blasting (AB)-0.2 MPa, 3) AB-0.4 MPa, 4) glass beads blasting (GB)-0.2 MPa, and 5) GB-0.4 MPa. After blasting, each group was divided into two subgroups according to primer used: experimental primer with 1% mouse dental papillae cell (MDP) or Clearfil Ceramic Primer Plus (MDP/silane, Kuraray Noritake Dental). Stainless steel rods were bonded to the zirconia specimens with PANAVIA V5 (Kuraray Noritake Dental) with 4 mm bonding area. The tensile bond strength (TBS) were measured after 24 hours or 5,000 thermocycling (TC) at crosshead speed of 2 mm/min followed by the failure modes analysis ( $n = 10$ ). The data were statistically compared using Weibull analysis. Sa was measured using a 3D-Laser Scanning Confocal Microscope ( $n = 5$ ) and analyzed by  $t$ -test with Bonferroni correction ( $\alpha = 0.05$ ).

**Results:** In MDP-silane groups, AB-0.4 MPa showed highest TBS after 24 hours. However, GB-0.4 MPa showed the highest TBS after 5,000 TC. In MDP groups, AB groups resulted in the significantly higher TBS than GB groups. The highest TBS was in AB-0.4 MPa after 24 hours, in AB-0.2 MPa and AB-0.4 MPa after TC. All specimens in GB groups showed pre-test failures after TC. AB-0.4 MPa group showed the highest Sa value, there were no difference among control, GB-0.2 MPa and GB-0.4 MPa.

**Conclusions:** AB followed by MDP primer or GB followed by MDP-silane primer application showed durable bonding performance to super-translucent zirconia ceramics.

**Keywords:** Bond strength; Glass beads; Super-translucent zirconia

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### \*Presenting author

Seol-Ah Jo

Department of Conservative Dentistry, Seoul National University School of Dentistry, 101 Daehak-ro, Jongno-gu, Seoul 03080, Korea.  
E-mail: lrgrwons@hanmail.net

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# Effect of pulse-width-modulated LED light on the temperature change of composite resin in tooth cavities

Seol-Ah Jo,<sup>\*</sup> In-Bog Lee

Department of Conservative Dentistry, Seoul National University School of Dentistry, Seoul, Korea

## ABSTRACT

**Objectives:** The purpose of this study was to investigate the effects of the radiant emittance and irradiation time of pulse-width-modulated (PWM) LED light on the temperature change of composite resin and dentin.

**Materials and Methods:** Class I cavities were prepared on 30 extracted human molars and bucco-lingually vertically sectioned. Cavities were filled with bulk fill posterior restorative and cured with an LED light. The duty ratio and irradiation time of the LED light were controlled using an Arduino UNO microcontroller (PWM) as follows (6 groups,  $n = 5$ ): 10%/100 seconds, 30%/33.3 seconds, 50%/20 seconds, 100%/10 seconds, increase (0% → 100%)/20 seconds, and decrease (100% → 0%)/20 seconds. Real-time thermograms of the specimen were recorded using an infrared thermal camera. Temperature change data were statistically analyzed using 2-way analysis of variance and Tukey's *post hoc* test at  $\alpha = 0.05$ .

**Results:** A rapid temperature increase occurred within the cavity during light curing. The maximum temperature rises ( $\Delta T_{\max}$ ) were observed at 0.625 mm apical from the top and middle of the cavity. The  $\Delta T_{\max}$  ranged 7.62°C–16.74°C at 0.625 mm apical from the top, 4.83°C–11.39°C at the floor of the cavity, and 3.16°C–8.09°C in the dentin 1 mm beneath the cavity base. The  $\Delta T_{\max}$  of composite resin and dentin increased and the time to reach  $\Delta T = 5^\circ\text{C}$  decreased with increasing duty ratio at constant radiant exposure. The  $\Delta T_{\max}$  in the Decrease group was similar to that of 100%/10 seconds group. At constant radiant exposure and irradiation times, the increase group showed lower and slower temperature rises than the 50%/20 seconds and the decrease group.

**Conclusions:** The PWM LED curing light system controlled by a microcontroller provided a useful tool of varying the radiant emittance and irradiation time to evaluate temperature change of composite resin and dentin. Within the limitations of this *in vitro* study, when radiant exposure is constant, a curing light with lower radiant emittance can induce relatively low thermal transfer, thereby decreasing the risk of pulpal damage.

**Keywords:** Composite resin; Infrared thermal camera; LED curing light; Pulse width modulation; Temperature change

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### \*Presenting author

Koji Yamashita

Department of Restorative Dentistry, Faculty of Dental Medicine and Graduate School of Dental Medicine, Hokkaido University, Sapporo, Japan.

E-mail: ky.92.93.2345@gmail.com

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# Simplified sample preparation for $\mu$ TBS test of adhesive cements using small bonding area: preliminary study

Koji Yamashita,<sup>1</sup> Yu Toida,<sup>1</sup> Shimpei Kawano,<sup>1</sup> Midori Kawamura,<sup>2</sup>  
Patrick Jehung Jumond,<sup>1</sup> Abu Faem Mohammad Almas Chowdhury,<sup>1</sup>  
Mariko Matsumoto,<sup>1</sup> Shuhei Hoshika,<sup>1</sup> Chiharu Kawamoto,<sup>1</sup> Takatsumi Ikeda,<sup>1</sup>  
Toru Tanaka,<sup>1</sup> Monica Yamauti,<sup>1</sup> Hidehiko Sano<sup>1</sup>

<sup>1</sup>Department of Restorative Dentistry, Faculty of Dental Medicine and Graduate School of Dental Medicine, Hokkaido University, Sapporo, Japan

<sup>2</sup>Department of Dental Medical Laboratory, Hokkaido University Hospital, Sapporo, Japan

## ABSTRACT

**Objective:** The purpose of this study was to evaluate a new simplified sample preparation procedure for micro-tensile bond strength ( $\mu$ TBS) evaluation of resin cements using computer-aided design/computer-aided manufacturing (CAD/CAM) resin block and resin core.

**Materials and Methods:** CAD/CAM resin blocks (ESTELITE P BLOCK, Tokuyama Dental) ( $n = 2$ ) and a resin core blocks (ESTECORE, Tokuyama Dental) ( $n = 2$ ) were used in this study. One CAD/CAM resin block and one resin core block were used for  $\mu$ TBS test using conventional sample preparation procedure and the rest were used for the new simplified sample preparation procedure. In later case, each block was sectioned perpendicular to the interface into 15 beams (cross-sectional area: 2 mm  $\times$  2 mm) using a diamond saw (IsoMet, Buehler). Round holes of 1.13mm diameter were punched into 0.08 mm thick teflon tapes (AS FLON Tapes, AS ONE). The tapes were then attached to the adhesive surface of the CAD/CAM resin beams. A universal bond (BONDMER LIGHTLESS, Tokuyama Dental) was applied on both the adhesive surfaces of CAD/CAM resin beams and resin core beams according to the manufacturer's instruction. Each CAD/CAM resin beam was bonded to resin core beam using a resin cement (ESTECER II, Tokuyama Dental, Japan) and light cured for 20 seconds from every direction. After 24 hours storage into distilled water at 37°C, the  $\mu$ TBS of all the beams were measured with a desktop testing apparatus (EZ test, Shimadzu) and expressed in MPa.

**Result:** The mean bond strengths and standard deviations (MPa) were  $82.92 \pm 19.19$  and  $74.42 \pm 6.14$  for the conventional and the new simplified sample preparation procedures.

**Conclusions:** The new simplified sample preparation procedure demonstrated to be feasible. Further studies are necessary to evaluate the effect of preparation procedures on bond strength between different materials and/or substrates.

**Keywords:** CAD/CAM resin block; Microtensile bond strength; Resin cement; Resin core



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### \*Presenting author

Koji Yamashita

Department of Restorative Dentistry, Faculty of Dental Medicine and Graduate School of Dental Medicine, Hokkaido University, Sapporo, Japan.

E-mail: ky.92.93.2345@gmail.com

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# Simplified sample preparation for $\mu$ TBS test of adhesive cements using small bonding area: preliminary study

Koji Yamashita,<sup>1</sup> Yu Toida,<sup>1</sup> Shimpei Kawano,<sup>1</sup> Midori Kawamura,<sup>2</sup>  
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Toru Tanaka,<sup>1</sup> Monica Yamauti,<sup>1</sup> Hidehiko Sano<sup>1</sup>

<sup>1</sup>Department of Restorative Dentistry, Faculty of Dental Medicine and Graduate School of Dental Medicine, Hokkaido University, Sapporo, Japan

<sup>2</sup>Department of Dental Medical Laboratory, Hokkaido University Hospital, Sapporo, Japan

## ABSTRACT

**Objective:** The purpose of this study was to evaluate a new simplified sample preparation procedure for micro-tensile bond strength ( $\mu$ TBS) evaluation of resin cements using computer-aided design/computer-aided manufacturing (CAD/CAM) resin block and resin core.

**Materials and Methods:** CAD/CAM resin blocks (ESTELITE P BLOCK, Tokuyama Dental) ( $n = 2$ ) and a resin core blocks (ESTECORE, Tokuyama Dental) ( $n = 2$ ) were used in this study. One CAD/CAM resin block and one resin core block were used for  $\mu$ TBS test using conventional sample preparation procedure and the rest were used for the new simplified sample preparation procedure. In later case, each block was sectioned perpendicular to the interface into 15 beams (cross-sectional area: 2 mm  $\times$  2 mm) using a diamond saw (IsoMet, Buehler). Round holes of 1.13mm diameter were punched into 0.08 mm thick teflon tapes (AS FLON Tapes, AS ONE). The tapes were then attached to the adhesive surface of the CAD/CAM resin beams. A universal bond (BONDMER LIGHTLESS, Tokuyama Dental) was applied on both the adhesive surfaces of CAD/CAM resin beams and resin core beams according to the manufacturer's instruction. Each CAD/CAM resin beam was bonded to resin core beam using a resin cement (ESTECER II, Tokuyama Dental, Japan) and light cured for 20 seconds from every direction. After 24 hours storage into distilled water at 37°C, the  $\mu$ TBS of all the beams were measured with a desktop testing apparatus (EZ test, Shimadzu) and expressed in MPa.

**Result:** The mean bond strengths and standard deviations (MPa) were  $82.92 \pm 19.19$  and  $74.42 \pm 6.14$  for the conventional and the new simplified sample preparation procedures.

**Conclusions:** The new simplified sample preparation procedure demonstrated to be feasible. Further studies are necessary to evaluate the effect of preparation procedures on bond strength between different materials and/or substrates.

**Keywords:** CAD/CAM resin block; Microtensile bond strength; Resin cement; Resin core

## KACD-JSCD Joint Meeting



# Correlation of mechanical strength of resin core build-up materials with root dentin bond strength and pull-out force at different times in resin cores with a fiber post

Akimasa Tsujimoto,<sup>1</sup> Yusuke Shimatani,<sup>1</sup> Yuko Nagura,<sup>1</sup> Kie Nojiri,<sup>1</sup> Ryo Ishii,<sup>1</sup> Toshiki Takamizawa,<sup>1</sup> Masashi Miyazaki,<sup>1</sup> Ko Hinoura<sup>1,2</sup>

<sup>1</sup>Department of Operative Dentistry, Nihon University School of Dentistry, Tokyo, Japan

<sup>2</sup>Hinoura Dental Office, Tokyo, Japan

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### \*Presenting author

Akimasa Tsujimoto

Department of Operative Dentistry, Nihon University School of Dentistry, 1 Chome-8-13 Kanda Surugadai, Chiyoda, Tokyo 101-8310, Japan.

E-mail: tsujimoto.akimasa@nihon-u.ac.jp

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## ABSTRACT

**Objectives:** The purpose of this study was to investigate the correlation of root dentin bond strength and pull-out force with the mechanical strength of resin core build-up materials at different time points in resin cores with a fiber post.

**Materials and Methods:** Eight resin core build-up materials and three resin luting materials were used. Flexural strength, shear bond strength to root dentin, and pull-out force were measured at 3 time points: 1) immediately after setting (immediate), 2) after 24 hours of water storage (24 hours), and 3) after 20,000 thermal cycles (TC). Correlation analysis was performed for flexural strength, bond strength, and pull-out force. Scanning electron microscopy observations of the fiber post surface after measurements of the pull-out force were also conducted.

**Results:** Flexural strength was measured as 39.1–122.3 MPa in the immediate group, 108.0–172.8 MPa in the 24 hours group, and 83.8–153.9 MPa in the TC group. Bond strength was 9.8–25.6 MPa in the immediate group, 15.3–25.5 MPa in the 24 hours group, and 11.3–22.2 MPa in the TC group. The pull-out force was 213.6–330.3 N in the immediate group, 229.3–385.1 N in the 24 h group, and 203.8–391.0 N in the TC group. Flexural strength had a statistically significant correlation with shear bond strength ( $r = 0.508$ ,  $p = 0.0026$ ), and a weak positive correlation was also seen with pull-out force ( $r = 0.398$ ,  $p = 0.0218$ ).

**Conclusions:** The results of this study indicate that the material strength of resin core build-up materials is an important factor in both the bond strength to root dentin and the pull-out force of the fiber post.

**Keywords:** Fiber post; Flexural strength; Presenting author; Pull-out force; Resin core build-up material; Root dentin bond strength

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## Free Lectures



# Retreat or surgery? techniques and treatment options

## OPEN ACCESS

### \*Presenting author

**Ayman Omar Mandorah**

Restorative Department, Taif University, Al  
Hawiyah, Ta'if, Makkah, Saudi Arabia.

E-mail: amandorah@tudent.edu.sa

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**Ayman Omar Mandorah\***

Restorative Department, Taif University, Makkah, Saudi Arabia

## ABSTRACT

The optimal goal of endodontics is to treat apical pathology and to prevent recurrence of infection to root canal systems. Periapical lesions may fail to heal after primary root canal treatment due to different mechanical or biological causes. However, correct decision regarding the retreatment options is difficult and challenging, depending on the accessibility to root canal systems.

Learning objectives:

1. Identify the causes of post-treatment diseases
2. Evaluate the clinical outcomes of surgical and non-surgical retreatment
3. Understand alternative options for retreatment approaches and techniques

**Keywords:** Endodontic surgery; Nonsurgical retreatment; Success

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## Free Lectures



# Digitalization in endodontics: dawn of an era

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### \*Presenting author

**Niraj Kinariwala**

Department of Conservative Dentistry & Endodontics, Karnavati University, A/907, Uvarsad-Vavol Road, Uvarsad, Gandhinagar, GJ 382422, India.  
E-mail: drnirajkinariwala@gmail.com

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**Niraj Kinariwala\***

Department of Conservative Dentistry & Endodontics, Karnavati University, Ahmedabad, India

## ABSTRACT

Primary objective of digitalization is to improve diagnostic acumen and treatment outcomes. Other goals also include efficiency and convenience for the practitioner; however, these additional goals would only be justified if they do not interfere with the first objective and provide safety and cost-effectiveness for the patient. Cone beam computed tomography (CBCT) imaging is indispensable tool in diagnosis, treatment planning, and execution of root canal treatments because of its enhanced capacity to reveal the detailed morphology of the roots and to locate calcified root canals. Working length measurement can be carried out digitally on software such as 3D Endo. CBCT-dependent 3D guides are becoming an extremely useful tool for safer interventions in management of calcified canals. 3D guide or template can be designed with help of softwares such as SICAT Endo, BlueSkyBio, and CoDiagnostiX. Diagnosis, working length determination, and treatment planning can be carried out digitally with help of CBCT. Static guidance and dynamic guidance are changing dynamics of dentistry. X Guide and Navident are now also being used for dynamic navigation in osteotomy and apicoectomy procedures of surgical endodontics. This lecture will encompass overview of all these technologies and softwares to improve treatment accuracy and operator convenience.

**Keywords:** 3D Endo; 3D printing; CBCT; Digitalization; Guided endodontics; SICAT Endo

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# Sleep and dentistry: the role of dental professionals in management of obstructive sleep apnea

Frank Lee\*

Department of Operative Dentistry, Endodontics and Prosthodontics, Faculty of Dentistry, National University of Singapore, Singapore



### \*Presenting author

Frank Lee

Department of Operative Dentistry,  
Endodontics and Prosthodontics, Faculty of  
Dentistry, National University of Singapore,  
9 Lower Kent Ridge Rd, Level 10, Singapore  
119085, Singapore.  
E-mail: denlkff@nus.edu.sg

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## ABSTRACT

Sleep is a vital part of life, taking up almost one third of an individual's life. Patients with obstructive sleep apnea (OSA) have poor sleep quality due to lower oxygen levels, and increased build-up of carbon dioxide in the blood. This can lead to debilitating co-morbidities. Diagnosis of OSA is usually via sleep studies, either home-based or hospital-based. Management of OSA may be multi-pronged, from ENT surgeons to respiratory physicians, and even dentists and other allied health professionals. How do we, as dental professionals, assist in the management of this debilitating condition? What are mandibular advancement devices and how do they work?

**Keywords:** Management; Mandibular advancement devices; Obstructive sleep apnea

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## OPEN ACCESS

### \*Presenting author

Frank Lee

Department of Conservative Dentistry, Seoul St. Mary's Hospital, The Catholic University of Korea, 222 Banpo-daero, Banpo-dong, Seocho-gu, Seoul 06591, Korea.  
E-mail: jeui99@catholic.ac.kr

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# Biocompatibility of calcium silicate-based pulp capping materials on human dental pulp stem cells

Sin-Young Kim\*

Department of Conservative Dentistry, Seoul St. Mary's Hospital, The Catholic University of Korea, Seoul, Korea

## ABSTRACT

The aim of vital pulp therapy such as direct pulp capping is to preserve exposed dental pulp with a protective agent. The most important factors affecting the outcome of vital pulp therapy are preexisting health of the pulp, adequate removal of infected hard or soft tissues, careful operative technique to avoid damage on residual tissue, and choice of proper capping materials. The material used in vital pulp therapy should have the properties of biocompatibility and odontogenic differentiation ability. Calcium hydroxide paste and mineral trioxide aggregate (MTA) were the commonly used capping materials. Calcium hydroxide has been the gold standard for pulp capping. The effect of calcium hydroxide is regarded as the result of the chemical injury. Firm necrosis causes slight irritation and stimulates the pulp to defend and repair to form a reparative dentin. The success rates for 5 years were lower than 50%, therefore, direct pulp capping is considered controversial by many clinicians. The advantages of MTA are believed to be its sealing ability, biocompatibility, bioactivity, and differentiation ability. Also, MTA is suggested to be superior to calcium hydroxide due to its more uniform and thicker dentin bridge formation, less inflammatory response, and less pulp necrosis. However, some disadvantages of MTA include long setting times and poor handling. Biodentine was recently introduced, it contains tricalcium silicate, calcium carbonate and oxide, and zirconium oxide. It has shorter setting time and efficacy similar to that of MTA. Resin-modified MTA cement such as TheraCal LC is a light-curing, resin-modified calcium-silicate-filled single paste, containing calcium oxide, calcium silicate particles, strontium glass, fumed silica, barium sulphate, barium zirconate, and resin. The inflammatory response was more intense than MTA, and it does not stimulate mineralization. In this lecture, biocompatibility of various direct pulp capping materials on human dental pulp stem cells will be presented.

**Keywords:** Biocompatibility; Calcium hydroxide; Calcium silicate-based materials; Direct pulp capping; Human dental pulp stem cells

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# Enemy at the gates

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### \*Presenting author

#### Jaikailash Shanmugam

Department of Dental Surgery, Government  
Coimbatore Medical College and Hospital,  
No.1619 A, Trichy Rd, Coimbatore, Tamil Nadu  
641018, India.

E-mail: drsjaikailash@gmail.com

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### Jaikailash Shanmugam\*

Department of Dental Surgery, Government Coimbatore Medical College and Hospital, Coimbatore, Tamil Nadu, India

## ABSTRACT

In recent years there are a lot of evidences of dental infection causing dangerous systemic complications in children, resulting in long term hospitalization. In this presentation, a case will be reported on a previously healthy child who presented with infection at different sites (brain, eyes, salivary gland, and neck), but did not respond to any systemic antimicrobial administration with recommended dosage and duration. The nidus of infection stayed elusive for the clinicians. As a last resort, oral foci of infection were considered. When examined by us (dental surgeons), there were multiple carious teeth with no obvious alarming clinical signs of infection within the oral cavity. Elimination of focal sepsis was contemplated with extraction of the affected teeth in a phased manner, which resolved the disease. The virulence of *Streptococcus* should never be underestimated and a thorough examination of oral cavity in any systemic diseases should be done.

**Keywords:** Dental caries; Oral sepsis; Streptococcus; Systemic complications

## Free Lectures



# A spectrometric analysis of byproducts formed by chemical interaction between octenidine dihydrochloride and eight different commonly used endodontic irrigant solutions

Prasanth Dhanapal,\* Shweta Varghese, Mohammed Sagir, Biju Babu, Kennett Chirayath

Department of Conservative Dentistry and Endodontics, Royal Dental College, Chalissery, Palakkad, Kerala, India



### \*Presenting author

Prasanth Dhanapal

Department of Conservative Dentistry and Endodontics, Royal Dental College, Iron Hills, Chalissery, Palakkad, Kerala 679536, India.  
E-mail: prasanthdhanapal@gmail.com

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## ABSTRACT

The aim of root canal treatment is to eliminate microbes from the infected root canal as much as possible and prevent reinfection. Microbes cannot be totally eliminated from the root canal by biomechanical cleaning and shaping alone by virtue of anatomical complexities and many bacterial factors. Thus, various chemicals as irrigants are used for disinfection of the root canal system. Usage of multiple irrigating solutions during endodontic therapy could result in interactions between the different irrigants within the canal. Few of these interactions are known to form byproduct precipitates. The formed precipitate may compromise dentin permeability for diffusion of intracanal medication and also affect the obturation seal. The precipitate can leach into the periradicular region, affecting biocompatibility. Precipitate formation involving use of chlorhexidine is debated in terms of its potential carcinogenicity. The objective of this study was to characterize the byproducts formed on interacting 0.1% octenidine with 8 different irrigating solutions, namely, 2% chlorhexidine, NaOCl (5.25%, 2.5%, and 1%), 1% peracetic acid, 17% ethylenediaminetetraacetic acid (EDTA), 3% hydrogen peroxide, and saline solution. 0.1% octenidine was mixed with 8 different irrigating solutions in 1:1 ratio using 1.5 mL flat polypropylene microtubes. The color changes were recorded. The microtubes were centrifuged at 3,000 rpm for 10 minutes and supernatant discarded. The precipitate formed was analyzed by hybrid quadrupole-orbital mass spectrometer for determining the chemical composition. Notable among the byproducts was the formation of chlorobenzene, when octenidine interacted with 1% peracetic acid. Chlorobenzene is a toxic chemical. From this study it can be concluded that using 0.1% octenidine as an irrigant is safe and does not produce any precipitate or harmful byproducts except when 1% peracetic acid is subsequently or precedingly used as an irrigant. On interacting octenidine with peracetic acid, chlorobenzene was formed which is toxic.

**Keywords:** Byproduct; Endodontic irrigants; Interaction; Octenidine; Precipitate; Toxicity

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## OPEN ACCESS

### \*Presenting author

#### Sudipto Barai

Department of Conservative Dentistry and Endodontics, Institute of Dental Sciences, Siksha 'O' Anusandhan, (Deemed To Be) University, Bhubaneswar, OR 751003, India.  
E-mail: drsudiptobarai@yahoo.com

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# Comparative evaluation of the degree of conversion, surface micro-hardness, and monomer elution of dental resins at 24 hours, 30 days, and 90 days

## Sudipto Barai\*

Department of Conservative Dentistry and Endodontics, Institute of Dental Sciences, Siksha 'O' Anusandhan (Deemed To Be) University, Bhubaneswar, Bhubaneswar, OR, India

## ABSTRACT

The aim of this study was to evaluate and compare the degree of conversion (DC), surface micro-hardness, and monomer elution of two bulk fill and two incremental fill dental composite resins at intervals of 24 hours, 30 days, and 90 days. Two bulk-fill resins, Centon N and Tetric EvoCeram Bulkfill (Ivoclar Vivadent) and two incremental-fill resins, Herculite Precis (Kerr Corporation) and Estelite Sigma Quick (Tokuyama Dental Corporation), were tested. In total, 120 specimens ( $n = 30$ ) were prepared using Teflon molds. Each group was further divided into three sub-groups ( $n = 10$ ) according to the parameters tested and stored in artificial saliva. Fourier transform infrared spectroscopy, Vickers micro-hardness testing, and high-performance liquid chromatography were conducted to assess the DC, surface micro-hardness, and monomer elution, respectively, at 24 hours, 30 days, and 90 days. The data were analyzed with the Kruskal-Wallis and Friedman tests, and pair-wise comparisons were made using the Wilcoxon signed rank test and Mann-Whitney test at a significance level of  $p < 0.05$ . DC was found to be highest for Estelite (74%), which was significantly higher ( $p = 0.000$ ) than that of all other tested resins. No significant difference was observed between Centon N and Tetric EvoCeram Bulkfill at 24 hours ( $p = 0.170$ ). Surface micro-hardness values were highest for Estelite Sigma Quick (HV/64.11) and lowest for Centon N (HV/53.09). Significant differences ( $p = 0.000$ ) were found among all groups at all time intervals. Monomer elution was recorded in the following decreasing order: Bis-GMA > UDMA > TEGDMA > DCP, with elution increasing with time. Estelite Sigma Quick, with a higher filler loading content, provided greater DC and a higher surface micro-hardness. Residual monomers (Bis-GMA, TEGDMA, UDMA, and DCP) were eluted selectively from all the tested restoratives at all time periods, and monomer elution increased with time.

**Keywords:** Bulk-fill composite; Degree of conversion; Elution of monomer; High performance liquid chromatography; Incremental fill composite; Microhardness

## Free Lectures



# Bonded restorations - exploring newer paradigms in restorative dentistry

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### \*Presenting author

**Vijit Narayana**

Department of Endodontics & Restorative Dentistry, Innocent Smiles Dental Clinic, 7/550, Kizhakkekara Building, Ambadimoola, Palachuvadu, N.G.O. Quarters - Mavelipuram Road Kakkanad, Kochi, Kerala 682021, India.  
E-mail: drvadhyar@gmail.com

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**Vijit Narayana,\* Kavita Kumar**

Department of Endodontics & Restorative Dentistry, Innocent Smiles Dental Clinic, Kochi, India

## ABSTRACT

Bonded restorations offer numerous advantages over non-bonded ones, the most important being conservation of tooth structure. Though the history of bonding resins to tooth substrates is more than half a century old, bonding was never popular until recently, owing to the complexity of procedures or unpredictability of outcomes. Advances in adhesives and material science have simplified the clinical procedures of bonding and also made it more predictable. This, along with the increasing demands for minimally invasive and esthetic solutions, added to the popularity and general acceptance of bonded restorations among clinicians. This presentation aims to explore the recent trends and advancements in the field of bonded restorations.

**Keywords:** Adhesion; Bonded restoration; Minimally invasive dentistry

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## Free Lectures



# Effect of fluoride on hydroxyapatite crystal growth

Sumi Kang,<sup>1\*</sup> Sung-Ho Park,<sup>1</sup> Chan Young Lee,<sup>1</sup> Jeong-Won Park<sup>2</sup>

<sup>1</sup>Department of Conservative Dentistry, Yonsei University Dental Hospital, Seoul, Korea

<sup>2</sup>Department of Conservative Dentistry, Gangnam Severance Dental Hospital, Seoul, Korea



### \*Presenting author

Sumi Kang

Department of Conservative Dentistry, Yonsei University Dental Hospital, 50-1, Yonsei-ro, Seodaemun-gu, Seoul 03722, Korea.  
E-mail: smjty@yuhs.ac

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## ABSTRACT

Hydroxyapatite (HA) is generally considered as the prototype for the mineral found in teeth and bones. Crystal growth using HA seeds in well-defined, supersaturated solutions has enhanced our understanding of the process and mechanism involved in seeded crystal growth. Therefore, it is essential to investigate the mechanism of crystal growth of HA by using synthetic hydroxyapatites as seed crystals to study the remineralization of the HA. When fluoride ions substitute completely for hydroxyl ions on the hexagonal axis, they give rise to fluorapatite. This can decrease the dissolution rate of apatite and increases the rate of remineralization. As a result, an increase in crystallinity, a decrease in crystal strain, and an increase in thermal and chemical stability are obtained. In a supersaturated solution in which fluoride is available together with calcium and phosphate ions, fluoride ions are incorporated into the apatite lattice through precipitation and participate in growth of the apatite. In a recent study, the nature of nucleation will determine the structure and morphology of the crystallites. Another study found that the ordering of the HAP crystallites' assembly, which is directly related to the mechanical properties of dental enamel. Since some literature reported that fluorides affected the morphology of HA, it is necessary to investigate the crystal growth of HA with fluorides. The seeded crystal growth model was regarded as a useful method of evaluating the crystal growth of HA *in vitro*. In this lecture, the author will discuss the basic understanding of the crystal growth of HA and the effect of fluoride on HA crystal growth through experiments using a seeded crystal growth model.

**Keywords:** Crystal growth; Fluoride; Synthetic hydroxyapatite

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## Free Lectures



# Effective treatment protocol in C-shaped canals



### \*Presenting author

Sungeun Yang

Department of Conservative Dentistry, Seoul St. Mary's Hospital, The Catholic University of Korea, 222 Banpo-daero, Banpo-dong, Seocho-gu, Seoul 06591, Korea.  
E-mail: dentyeun@catholic.ac.kr

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Sungeun Yang\*

Department of Conservative Dentistry, Seoul St. Mary's Hospital, The Catholic University of Korea, Seoul, Korea

## ABSTRACT

The purpose of this presentation is to establish effective treatment protocol in complex C-shaped canals and raise the success rate of root canal treatment. C-shaped canals are quite common especially in Asian patients. C-shaped canal system has various complex structures and it is hard to get proper debridement of bacteria and their by-products during cleaning and shaping procedures. Because the major goal of root canal therapy is complete elimination of irritant and smear layer generated during mechanical preparation, a number of irrigation methods and protocols have been introduced to do this. Passive ultrasonic irrigation (PUI) means that ultrasonic waves are transmitted from the ultrasonic device through the tip, which make acoustic streaming and cavitation effect. Previous studies have demonstrated that PUI shows better antibacterial efficacy compared to traditional needle irrigation. Recently, Gallium-aluminum-arsenide (GaAlAs) semiconductor laser has been introduced in endodontic procedure and is known to penetrate into dentinal tubules more deeply up to 1,000  $\mu\text{m}$  with minimizing damage to the surface. Two adjunctive irrigation methods seem to have an effective elimination of irritant and smear layer in C-shaped canals. Complete obturation of root canal systems is one of the main factors for successful endodontic treatment. Recently, alternative new materials like bioceramics or zirconium have been developed and reported as having favorable biocompatibility and antibiotic effects. These newly developed sealers have been reported to have a higher sealing ability due to flowability and can be considered as a proper filling material in C-shaped canals having complex structure.

**Keywords:** C-Shaped canal; Irrigation; Obturation; Treatment protocol

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## OPEN ACCESS

### \*Presenting author

Sumin Lee

Department of Endodontics, University of Pennsylvania School of Dental Medicine, 240 South 40th Street, Philadelphia, PA 19104-6030, USA.

E-mail: [suminlee@upenn.edu](mailto:suminlee@upenn.edu)

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# Update in treatment of immature necrotic permanent teeth: apexification vs. regenerative endodontic procedures

Sumin Lee\*

Department of Endodontics, University of Pennsylvania School of Dental Medicine, Philadelphia, PA, USA

## ABSTRACT

Traumatic injury, pulp exposure with anatomic anomaly such as dens invaginatus or evaginatus, or caries of an immature permanent tooth can cause pulpal necrosis and interrupted root development. The results of arrested root development are a poor crown-root ratio, an open apex, a root with very thin walls, and an increased risk of fracture. Treating an immature tooth with necrotic pulp has been a real challenge to the dentists. The traditional treatment of immature teeth with necrotic pulps relied on apexification procedures involving long-term  $\text{Ca}(\text{OH})_2$ -based intracanal medicament with multiple visits or on one-step apexification placing an apical plug of mineral trioxide aggregate. Even though these treatments have a high success rate of 95% and 94%, respectively, they do not regenerate the physiology of the pulp–dentin complex, nor do they allow for further root formation. A greater alternative in such cases would be performing regenerative endodontic procedures (REP). This therapy involves removal of diseased or necrotic pulp tissue and replace ultimately with healthy pulp tissues to revitalize teeth, which optimally translates to complete restoration of pulpal function and subsequent completion of root development. Since the first REP case was reported in 2001, more than 400 reports have provided evidence of REP-mediated clinical outcomes. However, differences in clinical protocols for the treatment of these teeth and the recent reports of failed cases need clinician's attention. Hence, this presentation will review the perspectives in updated clinical protocols for REPs for favorable outcome.

**Keywords:** Apexification; Immature necrotic tooth; Outcome; Regenerative endodontics; Revascularization

Oral Presentations  
Clinical Case Presentation



# Anticipation to confirmation: redefining outcomes of vital pulp therapy with MTA in young patients

Mathew Varghese Kurichiathu,<sup>1</sup> Prasanth Dhanapal<sup>2</sup>

<sup>1</sup>Department of Conservative Dentistry and Endodontics, Mathews Dental Clinic, Kochi, Kerala, India

<sup>2</sup>Department of Conservative Dentistry and Endodontics, Royal Dental College, Palakkad, Kerala, India



**\*Presenting author**

**Mathew Varghese Kurichiathu**

Department of Conservative Dentistry and Endodontics, Mathews Dental Clinic, Opp KURTC Bus Stand, Pandit Karuppan Road Perumanoor, Thevara, Kochi, Kerala 682015, India.

E-mail: drmathew77@yahoo.com

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## ABSTRACT

**Introduction:** Carious, iatrogenic, or traumatic exposure of the pulp in immature teeth of young children presents a major treatment dilemma to the clinician. Vital pulp therapy involves procedures which allow removal of local irritants and placement of a protective material directly or indirectly over the pulp. Use of mineral trioxide aggregate (MTA), a bioactive silicate cement, to maintain the vitality of pulp and initiate apexogenesis has brought about a paradigm change in treatment outcomes.

**Case:** This paper highlights the treatment outcomes in three cases where vital pulp therapy was initiated for reasons varying from deep caries to trauma and regular follow-up was done to assess the development of root end closure.

**Conclusions:** Follow-up clinical and radiological examinations of the patients discussed herein revealed that the vitality of pulp was preserved, and continued development of the root/tooth with progressive apical closure was also observed. Compared with calcium hydroxide, MTA has a superior long-term sealing ability, can set in a moist environment, and stimulates higher-quality and greater amounts of reparative dentin. To a certain extent, MTA can play a major role in preserving the vitality of many immature permanent teeth with deep carious lesion or traumatic pulp exposure, which otherwise would have been destined for unpredictable endodontic therapy. The remaining tooth structure and durability of the coronal restoration can also affect the long-term success after vital pulp therapy. The development of newer biomaterials has opened avenues for alternative treatment options to conventional endodontic therapy in young children, thereby also improving their quality of life.

**Keywords:** Apexogenesis; Mineral trioxide aggregate; Vital pulp therapy

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## Oral Presentations Clinical Case Presentation



### \*Presenting author

**Divya Sangeetha Rajkumar**

Department of Conservative Dentistry  
and Endodontics, JSS Dental College, JSS  
Academy of Higher Education and Research,  
Bannimantap Road, Sri Shivarathreshwara  
Nagara, Bannimantap A Layout, Bannimantap,  
Mysuru, Karnataka 570015, India.  
E-mail: divs24793@gmail.com

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cited.

# Contemporary management of vertically fractured, endodontically restored teeth: 5 years' evaluation of two cases

**Divya Sangeetha Rajkumar\***

Department of Conservative Dentistry and Endodontics, JSS Dental College, JSS Academy of Higher  
Education and Research, Mysuru, Karnataka, India

## ABSTRACT

**Introduction:** A meticulous restorative strategy is required for endodontically treated teeth since their biomechanics and structural integrity have been altered. Intra-radicular restorations (prefabricated/custom-made cast post) have been proved to restore such weakened teeth to their natural functions. Custom-cast posts and cores are usually recommended for non-circular root canals, with less than 25% of the tooth structure remaining and when the angulation of the crown needs to be changed in relation to the root. A split-cast metal post and core design can be used for additional retention in teeth with divergent roots where the canals do not allow the same path of insertion for the post.

**Case:** Two patients presented to the Department of Conservative Dentistry and Endodontics with vertically fractured mandibular molar teeth restored with class I resin composite after root canal treatment 2 years ago. A mesio-distal transverse, oblique, subgingival but supra-alveolar tooth fracture was noted involving the buccal cusps and composite resin restoration with compromised periodontal health. As much less tooth structure was available, it was decided to restore the tooth with a split-cast post and core. Post space was created in the mesial and distal canals, followed by a silicone impression. The die-and-wax pattern of the post and core was fabricated separately for both the canals and cast. The post was cemented using glass ionomer cement, the crown prepared, impression taken, and metal-ceramic crowns given. After 1, 2, and 5 years of evaluation; the patients were asymptomatic, with no pathological lesions in the supporting tissue and periapical region.

**Conclusions:** A well-planned endodontic post restoration is mandatory for the durability of a tooth. A split-cast metal post and core is a contemporary restorative treatment for the management of transverse intra-alveolar vertical crown-root fractures.

**Keywords:** Endodontically treated teeth; Split post; Vertical fracture

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Oral Presentations  
Clinical Case Presentation



# An innovative method to resolve the esthetic appearance of peg teeth



Wei-Chia Huang,<sup>1\*</sup> Wei-Chen Lu<sup>2</sup>

<sup>1</sup>Academic Department, Taiwan Academy of Operative Dentistry, Taipei City, Taiwan

<sup>2</sup>Q Dental Clinic, Taipei City, Taiwan

**\*Presenting author**

**Wei-Chia Huang**

Academic Department, Taiwan Academy of Operative Dentistry, 13, 17th Floor, No. 50, Section 1, Zhongxiao West Road, Zhongzheng District, Taipei City 10041, Taiwan.  
E-mail: assdert@hotmail.com

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## ABSTRACT

**Introduction:** Peg teeth, a condition in which the upper lateral incisors' shape develops incorrectly, usually involves pointed and small teeth. Upper lateral incisors play an essential role in the esthetics of smiling, and most patients therefore ask for treatments to improve their appearance. Ideally, clinicians use veneers or crowns to change the shape of the teeth, which provides a good long-term prognosis. However, patients who have financial issues may only be able to afford composite resin restoration (COR). Although the direct technique can provide an acceptable result, it is technique-sensitive and shrinkage can cause leakage later. The authors developed an innovative indirect method to fabricate a COR by duplicating the well-shaped wax pattern into COR and delivering it to the patient.

**Case:** A 30-year-old female patient came to our clinic with a peg teeth appearance problem. The patient mentioned that she was not able to afford the common peg teeth treatments of veneers or crowns. After data collection and taking a preliminary impression, we decided to use an indirect COR to change the teeth shape. First of all, we waxed-up the stone in a good shape. Then, we duplicated the wax-up into stone. Second, we fabricated a clear-suck down sheet to make a teeth form shield. In the next appointment, we used the clear shield to fill in the composite resin on the patient's teeth. After curing, we took the restoration down and trimmed the excess resin and polish. Finally, we cemented the restorations back on the lateral peg teeth. Additionally, the clear shield was given to the patient as a night guard.

**Conclusions:** The method described herein provides a straightforward, economical technique with a good prognosis for lateral peg teeth patients. It can be used to achieve a good, esthetically pleasing smile appearance and better margin fitness than traditional direct bonding resin restoration.

**Keywords:** Composite resin; Indirect resin restoration; Operative dentistry; Peg teeth

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## Oral Presentations Clinical Case Presentation



# Metal porcelain crown with a customized post-core in the maxillary first incisor

Dewa Ayu Nyoman Putri Artiningsih,\* Dwi Arniawaty

Department of Conservative Dentistry, Faculty of Dentistry, Universitas Indonesia, Jakarta, Indonesia



### \*Presenting author

Dewa Ayu Nyoman Putri Artiningsih

Department of Conservative Dentistry, Faculty of Dentistry, Universitas Indonesia, Jl. Salemba Raya No. 4, Jakarta 13410, Indonesia.  
E-mail: dewaayunpa@yahoo.co.id

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## ABSTRACT

**Introduction:** In post-endodontic treatment, the restoration should ideally have adequate retention as a final restoration, resistance to fractures, and a coronal seal to prevent reinfection. The preference of specific post-endodontic restorations is affected by the amount of healthy tissue remaining, anatomical position, functional force, and the aesthetic needs of the teeth. Post application in restoration depends on the presence of healthy tissue remnants to support core build-up, as well as the final restoration after caries removal and root canal treatment is completed. If the tooth structure remnants are insufficient for retention and resistance of the core of the crown, then post use is indicated.

**Case:** In this case, a maxillary first incisor with dowel crowns of porcelain fused to metal was unstable, there was plaque retention, and it had subgingival tooth structure. A radiograph showed underfilling of the obturation and apical periodontitis. Root canal re-treatment was carried out, followed by crown lengthening to obtain a ferrule effect. Post-endodontic restoration was conducted using a metal porcelain crown with a customized post core.

**Conclusions:** The treatment was successful, with no subjective complaints or signs of inflammation in the gingival margin of the crown. The patient is satisfied with the clinical appearance of the new restoration.

**Keywords:** Customized post core; Metal porcelain crown; Restoration

Oral Presentations  
Research Presentation



# Comparative antimicrobial activity and stereomicroscopic evaluation of a novel bioactive caries-detecting dye

Shashirekha Govind,<sup>1\*</sup> Amit Jena,<sup>1</sup> Neeta Mohanty,<sup>2</sup> Sushanta Kumar Kamilla<sup>3</sup>

<sup>1</sup>Department of Conservative Dentistry and Endodontics, Institute of Dental Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, Odisha, India

<sup>2</sup>Department of Oral Pathology and Microbiology, Institute of Dental Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, Odisha, India

<sup>3</sup>Physics, Semiconductor Research Laboratory, Institute of Technology and Educational Research, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, Odisha, India



\*Presenting author

Shashirekha Govind

Department of Conservative Dentistry and Endodontics, Institute of Dental Sciences, Siksha 'O' Anusandhan (Deemed to be University), Khandagiri Marg, 2, Sum Hospital Rd, Bhubaneswar, Odisha 751030, India.  
E-mail: shashirekha123@yahoo.com

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## ABSTRACT

**Objectives:** To evaluate the antimicrobial activity of an experimental bioactive caries-detecting (BCD) solution and the Carie Care solvent against *Streptococcus mutans*, *Lactobacillus acidophilus*, and *Candida albicans*, as well as to conduct a stereomicroscopic and scanning electron microscopic (SEM) assessment of the efficiency of caries removal.

**Materials and Methods:** The experimental BCD solution and the Carie Care solvent were subjected to an antimicrobial activity assay and stereomicroscopic study. Standard protocols of antimicrobial activity tests were performed through the blood agar well diffusion method (zone of inhibition), the minimum inhibitory concentration (MIC) and minimal bactericidal concentration (MBC). The stereomicroscopic evaluation ( $\times 8-40$ ) was done on 20 extracted human teeth. Application of solutions: group A (BCD solution,  $n = 10$ ) and group B (Carie Care solution,  $n = 10$ ), was done according to the manufacturer's instruction and evaluated visually and radiographically. After mechanical caries removal teeth were sectioned longitudinally, assessed by 2 observers, and scored according to the modified American Dental Association caries classification. The extent of solutions into the dentinal tubules was observed under SEM. Data were subjected to statistical analysis using the kappa statistic for agreement (0.7 to 0.8;  $p < 0.01$ ), Mann-Whitney test and Wilcoxon signed rank tests ( $p = 0.01$ ).

**Results:** For all tested microorganisms, the experimental BCD solution recorded statistically significant highest zone of inhibition and higher MBC than the MIC as compared to Carie Care. The stereomicroscopic and SEM evaluations showed efficient removal of caries for the experimental BCD, without residual dye in the dentinal tubules.

**Conclusions:** Experimental BCD solution documented positive data regarding antibacterial activity, as well as favorable findings from the stereomicroscopic and SEM analysis, showing its potential for use in the management of dental caries.

**Keywords:** Antimicrobial activity; Caries diagnosis; Experimental bioactive caries detecting (BCD) solution; Stereomicroscope

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Oral Presentations  
Research Presentation



# Occlusion of dentinal tubules with a AlGaAs laser and two different dentrifications: a SEM analysis

Afzal Abdul Salim,\* Rajesh Pillai, Varghese NO, Praveena SV, Shinu Lal, Adarsh Jayan

Department of Conservative Dentistry and Endodontics, PMS College of Dental Science and Research, Thiruvananthapuram, Kerala, India



\*Presenting author

Afzal Abdul Salim

Department of Conservative Dentistry and Endodontics, PMS College of Dental Science and Research, Golden Hills, Vattapara, Venkode, Thiruvananthapuram, Kerala 695028, India.  
E-mail: afzalabdulsalim@gmail.com

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## ABSTRACT

**Objectives:** The purpose of this study was to evaluate the ability of a hydroxyapatite particle-containing desensitizing agent (Aclaim) and Pro-Argin technology (Colgate Sensitive Pro Relief) as compared to laser treatment (gallium-aluminium-arsenide [AlGaAs] diode laser, 810 nm) on dentinal tubule occlusion using scanning electron microscopy (SEM).

**Materials and Methods:** Thirty-two extracted human maxillary premolars devoid of any defects were selected for the study. According to the desensitizing agent used, the specimens were grouped as follows: group I, hydroxyapatite-containing toothpaste (Aclaim); group II, Pro-Argin technology toothpaste; group III, AlGaAs laser (810 nm), and group IV: control group. Teeth were embedded in plaster of Paris molds, and cavities of 4 mm in depth and 3 mm in width were prepared on a buccal surface at the cervical region. The specimens were treated with 17% ethylenediaminetetraacetic acid for 15 minutes. Two specimens remained as controls. Hydroxyapatite-containing dentifrices (Aclaim) and Pro-Argin-containing dentifrices were applied with a cotton applicator tip for a period of 3 minutes twice daily and washed with distilled water ( $n = 10$ ). The procedure was repeated for 7 days. Ten specimens were lased with a diode laser for 10 seconds at 0.5 W in a continuous wave and 3 duty cycles. These specimens were examined under SEM to determine the occluding ability of agents and their efficacy with time.

**Results:** Specimens lased with the AlGaAs diode laser demonstrated more tubule occlusion, followed by the hydroxyapatite-containing (Aclaim) and Pro-Argin technology, and were greater than in the control specimens.

**Conclusions:** Within the limitations of this study, it can be concluded that the diode laser (group III) showed greater efficacy in occluding dentinal tubules than desensitizing toothpastes containing hydroxyapatite (group I) and Pro-Argin (group II).

**Keywords:** Dentin hypersensitivity; Dentinal tubule; Diode laser; Hydroxyapatite; Pro-Argin; Scanning electron microscopy

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**OPEN ACCESS**

**\*Presenting author**

Shalini D Aggarwal

Department of Conservative Dentistry  
and Endodontics, Indian Association of  
Conservative Dentistry and Endodontics, No.  
7, 7th Avenue, Harrington Road, Chetpet,  
Chennai, Tamil Nadu 600031, India.  
E-mail: shalini1972minia@gmail.com

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# Comparison of the desensitizing efficacy of fluoro calcium phosphosilicate, calcium sodium phosphosilicate, and strontium chloride hexahydrate

Shalini D Aggarwal,\* Anamika C Borkar, Nikhil N Borse

Department of Conservative Dentistry and Endodontics, Indian Association of Conservative Dentistry and Endodontics, Chennai, Tamil Nadu, India

## ABSTRACT

**Objectives:** Dentinal hypersensitivity (DH) is a common clinical condition associated with exposed dentin. The objectives of this study (a randomized clinical trial), were to evaluate and compare the clinical effectiveness of dentifrices containing fluoro calcium phosphosilicate, calcium sodium phosphosilicate, and strontium chloride hexahydrate for the treatment of DH when applied twice daily.

**Materials and Methods:** Participants (18 to 50 years) with a history of DH and with a visual analogue scale (VAS) score of  $\geq 5$  in response to a painful test stimulus (dental explorer) in at least one tooth at the qualifying baseline visit were enrolled in this 4-week randomized clinical study. Participants ( $n = 93$ ) were randomly allocated to one of the following groups: group 1, fluoro calcium phosphosilicate (BioMin); group 2, calcium sodium phosphosilicate (NovaMin); group 3, strontium chloride hexahydrate. Clinical effectiveness was assessed over a period of 4 weeks using VAS score, perceived sensation score (verbal rating scale [VRS]), participants' subjective assessment questionnaire (4-item questionnaire), and an oral health-related quality of life questionnaire (Oral Health Impact Profile-14).

**Results:** A significant ( $p < 0.001$ ) reduction in symptoms over a period of 4 weeks (from baseline) was noted in all groups; however, the intergroup difference was not statistically significant. At week 2, the percentage reduction in the VAS (group 1, 58.19%; group 2, 49.18%; group 3, 52.69%) and VRS (group 1, 58.19%; group 2, 47.16%; group 3, 49.05%) scores were higher in group 1 (fluoro calcium phosphosilicate) than in the other groups. Subjective assessment results and oral health-related quality of life were comparable in all 3 groups at the end of 4 weeks.

**Conclusions:** A desensitizing dentifrice treatment, containing fluoro calcium phosphosilicate bioactive glass, may provide better treatment response for the treatment of DH, owing to its early onset of action in relieving sensitivity symptoms compared to other dentifrices.

**Keywords:** Calcium sodium phosphosilicate; Dentifrice; Dentinal hypersensitivity; Fluoro calcium phosphosilicate; Randomized clinical trial; Strontium chloride hexahydrate

Oral Presentations  
Research Presentation



# Effectiveness of simulation training and learning in first-year Doctor of Dental Surgery students

Anu Polster,<sup>1\*</sup> Mario Smith,<sup>1</sup> Brenda Ryan,<sup>1</sup> Michael Wylie,<sup>1</sup> Kwang Meng Cham<sup>2</sup>

<sup>1</sup>Melbourne Dental School, The University of Melbourne, Melbourne, Australia

<sup>2</sup>Department of Optometry and Vision Sciences, The University of Melbourne, Melbourne, Australia



\*Presenting author

Anu Polster

Melbourne Dental School, The University of Melbourne, 720 Swanston Street, Melbourne 3010, Australia.  
E-mail: apolster@unimelb.edu.au

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## ABSTRACT

**Objectives:** This project seeks to evaluate the efficacy of Simodont Dental Haptic Trainers (SDHT) for training of first-year Doctor of Dental Surgery (DDS) students at the University of Melbourne.

**Materials and Methods:** A total of 99 participants attended a lecture and were provided instructional notes and a video link prior to attending the study. They were divided into 2 groups: group 1 ( $n = 50$ ) trained with the SDHT, whereas group 2 ( $n = 49$ ) used standard dental blocks (DB). At the first visit, a 45-minute theoretical and manual dexterity assessment session with both the SDHT and DB were conducted to establish baseline competencies. Six 1-hour sessions were allocated over 4 weeks for students to practice in their assigned training environment. Assessments were conducted on both groups under both training conditions at 2-hour and 4-hour timepoints. Student-perceived proficiency and confidence were evaluated pre- and post-study via surveys and assessment outcomes.

**Results:** All students completed the survey. High internal consistency and reliability of the responses was indicated by a Cronbach's alpha of 0.89. Students in group 1 (SDHT) reported a perceived 20%–30% increase in confidence and proficiency with their clinical skills post-training. The 100% of the students found that the feedback was useful and would change the way they perform the technique. The 90% of the students felt that simulation would improve their visual and motor skills and should be incorporated into future training programs. The reported perceived confidence in group 2 (DB) was similar, albeit lower (10% increment). The 90% mentioned that simulation should also be incorporated into future training programs, even though they were only exposed to simulation during assessments.

**Conclusions:** Preliminary findings suggest that incorporating SDHT into the curriculum may enhance the preclinical training of dentistry students. If well designed and integrated appropriately into the dental program, it will ultimately improve the delivery and structure of the curriculum.

**Keywords:** Dental education; Haptic; Simulation training; Virtual reality

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\*Presenting author

Nameeta Shrestha

Department of Conservative Dentistry and Endodontics, Dental Teaching Hospital, Maharajgunj Medical Campus, Tribhuvan University Institute of Medicine, Maharajgunj Road, Kathmandu 44600, Nepal.  
E-mail: nameetashrestha@gmail.com

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# Effect of early childhood malnutrition on the tooth eruption sequence in Nepalese children

Nameeta Shrestha,<sup>1\*</sup> Jemish Acharya<sup>2</sup>

<sup>1</sup>Department of Conservative Dentistry and Endodontics, Dental Teaching Hospital, Maharajgunj Medical Campus, Tribhuvan University Institute of Medicine, Kathmandu, Nepal

<sup>2</sup>Department of Global Health, Mahidol University, Bangkok, Thailand

## ABSTRACT

**Objectives:** To determine the prevalence of under-nutrition, and to investigate the association between early childhood malnutrition and deciduous tooth eruption in children aged 0–59 months in the Mugu district of Nepal.

**Materials and Methods:** In total, 246 children aged 0–59 months residing in the Mugu district were examined. The weight, height, and length of participants were measured. A structured questionnaire was administered based on the Nepal Demographic and Health Survey 2011 questionnaire and the official Nepalese version was used in the field. Questions 1–6 dealt with religion, caste, maternal education, maternal age, child's age, and child's sex. Questions 7–12 elicited information regarding child size at birth, birth weight, gestational duration, birth interval, and whether child was exclusively breastfed and fed colostrum. Questions 13–17 dealt with child's history of acute illness, immunization status, growth monitoring visits, and antenatal check-up visits by the mother during pregnancy. Question 18 gathered information regarding the participant's diet 1 day before the examination. Questions 19–20 dealt with the household's food security. A dental caries assessment was performed and the eruption sequence was noted.

**Results:** In terms of weight for height, 14.1% were moderately/severely wasted. In terms of height for age, 25.2% were moderately stunted and 36.6% were severely stunted. In terms of weight for age, 30.5% were moderately underweight and 18.3% were severely underweight. A significantly higher proportion of children with wasting presented with a delayed eruption sequence than those without wasting ( $p < 0.05$ ). Furthermore, 25.4% of children who presented with delayed eruption also had at least one decayed tooth ( $p < 0.05$ ).

**Conclusions:** These findings present evidence of an association between tooth eruption patterns and nutritional insufficiency (wasting) throughout childhood. This observed delay in the eruption of primary dentition has practical significance in interpreting age-specific dental caries data from populations with different malnutrition experiences.

**Keywords:** Children; Malnutrition; Tooth decay; Tooth eruption

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The 1st General Meeting of  
the Asian-Oceanian Federation of Conservative Dentistry (AOFCD)

November 8–10, 2019 · Seoul, Korea

Oral Presentations  
Research Presentation



# Marginal and internal fitness of CAD/CAM zirconia copings with different scanners (i3D scanner and 3shape D700)

Zahra Khamverdi,\* Elmira Najafzad

Department of Restorative Dentistry, School of Dentistry, Hamedan University of Medical Sciences, Hamedan, Iran



\*Presenting author

Zahra Khamverdi

Department of Restorative Dentistry, School of Dentistry, Hamedan University of Medical Sciences, Daneshgah-e-Bu Ali Sina, Hamedan 65157838695, Iran.

E-mail: zkhamverdi@yahoo.ca

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## ABSTRACT

**Objectives:** The marginal and internal fitness of a restoration are 2 important clinical factors for assessing the quality and durability of computer-aided design (CAD)/computer-aided manufacturing (CAM) ceramic restorations. The aim of this study was to evaluate the marginal and internal fitness of CAD/CAM zirconia copings fabricated using 2 types of scanners (i3D scanner and 3shape D700).

**Materials and Methods:** Twelve extracted sound human posterior teeth were prepared to receive a full zirconia crown. Two different extraoral scanners (i3D scanner and 3shape D700) were used to digitize the gypsum casts poured from impressions. The crowns were designed using CAD software and milled from presintered monolithic zirconia blocks in a 5-axis dental milling machine. A cement space of 30  $\mu$ m starting 1 mm above the finish lines of the teeth was set in the CAD software. Two zirconia copings were fabricated from each tooth. The replica technique and MIP4 microscopic image analysis software were used to measure the marginal and internal fitness by stereomicroscopy at  $\times 40$  magnification. The data were analyzed by 2-way analysis of variance and the paired Student's *t*-test.

**Results:** The marginal gap was  $203.62 \pm 47.38 \mu$ m in the 3shape D700 group and  $241.07 \pm 36.1 \mu$ m in the i3D scanner group. The internal gap was  $192.30 \pm 32.30 \mu$ m in the 3shape D700 group and  $196.06 \pm 27.44 \mu$ m in the i3D scanner group. The *t*-test showed that there was a statistically significant difference between the 2 scanners in the comparison of marginal fitness, while no statistically significant difference was found in internal fitness ( $p = 0.761$ ).

**Conclusions:** Within the limitations of this study, the results indicated that the type of the studied extraoral scanners (3shape D700 and i3D scanner) affected the marginal fitness of CAD/CAM-made crowns; however, it had no effect on the internal fitness.

**Keywords:** Computer-aided design/computer-aided manufacturing; Internal fitness; Marginal fitness; Scanner

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The 1st General Meeting of  
the Asian-Oceanian Federation of Conservative Dentistry (AOFCD)

November 8–10, 2019 · Seoul, Korea

Oral Presentations  
Research Presentation



# Saliva and serum ferritin levels in relation to caries experience and oral hygiene: an *in vivo* study

Vimala Nilker,\* Sonali Katkar, Leena Padhye

Department of Conservative Dentistry and Endodontics, D. Y. Patil Deemed to be University, School of Dentistry, Navi Mumbai, Maharashtra, India



\*Presenting author

Vimala Nilker

Department of Conservative Dentistry and Endodontics, D. Y. Patil Deemed to be University, School of Dentistry, Sector 7, Highway Road, Dr. D. Y. Patil Vidyanagar, Nerul, Navi Mumbai 400706, Maharashtra, India.  
E-mail: vimala0309@gmail.com

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## ABSTRACT

**Objectives:** Saliva is a complex biological fluid composed of enzymes, hormones, antibacterial constituents, and electrolytes as well as the compounds transported from the blood. Thus, it reflects the physiological state of the body, including hormonal, nutritional, and metabolic disturbances. Ferritin is a major iron storage protein of the body. Reduction of iron content in blood and saliva may also affect dental caries. A cross-sectional study was therefore done to investigate ferritin levels in blood and saliva and its impact on dental caries and oral hygiene status of adults.

**Materials and Methods:** A total of 40 patients in the age group of 35–44 years were divided into group 1 ( $n = 20$ , Decayed, Missing, and Filled Teeth [DMFT] score  $\leq 2$  and Oral Hygiene Index–Simplified [OHI-S] score  $\leq 1$ ) and group 2 ( $n = 20$ , DMFT score  $\geq 8$  and OHI-S score  $\geq 4$ ). Blood and saliva samples from each patient were assessed for ferritin levels using the sandwich enzyme-linked immunosorbent assay test and statistical analysis was conducted.

**Results:** The average age was 39 years. Higher OHI-S scores were associated with higher DMFT scores. The mean ferritin levels in saliva of the subjects in group I and group II were  $0.32 \pm 0.21$  ng/mL and  $0.31 \pm 0.19$  ng/mL and the serum ferritin levels of subjects in group I and group II were  $9.38 \pm 3.05$  ng/mL and  $9.84 \pm 2.56$  ng/mL, respectively. According to the unpaired *t*-test, there was no statistically significant difference in the ferritin levels in saliva and serum between group I and group II. Through Pearson correlation analysis, there was no statistically significant correlation of ferritin levels in blood and saliva with DMFT and OHI-S scores in group I or group II.

**Conclusions:** The results of this study suggest that there is no direct association between salivary ferritin and serum ferritin with dental caries and oral hygiene in adult patients.

**Keywords:** Dental caries; Ferritin; Saliva; Serum

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The 1st General Meeting of  
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November 8–10, 2019 · Seoul, Korea

Oral Presentations  
Research Presentation



# Study of diabetic and hypertensive patients with high caries risk and correlation with blood groups

Monika Mohanty,\* Pratyae Basu, Shashirekha Govind, Amit Jena

Department of Conservative Dentistry and Endodontics, Institute of Dental Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, Odisha, India



\*Presenting author

Monika Mohanty

Department of Conservative Dentistry and Endodontics, Institute of Dental Sciences, Siksha 'O' Anusandhan (Deemed to be University), Khandagiri Marg, 2, Sum Hospital Rd, Bhubaneswar, Odisha 751030, India.  
E-mail: monika.mohanty19@gmail.com

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## ABSTRACT

**Objectives:** This study aimed to investigate the association between blood groups and severity of dental caries in diabetic and hypertensive patients in India.

**Materials and Methods:** In total, 354 patients were screened at the Department of Endocrinology, SUM Hospital and the Institute of Dental Sciences, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, Odisha, India. A detailed case history was recorded, including demographic details, medical history (diabetes and hypertension), blood group, oral health status, and caries assessment. Caries risk was assessed using the International Caries Detection and Assessment System and American Dental Association classification of caries risk. The patients were categorized as diabetic ( $n = 112$ : type I,  $n = 24$ ; type II,  $n = 88$ ), hypertensive ( $n = 144$ ), and both diabetic and hypertensive ( $n = 68$ ) and their blood groups were recorded accordingly. The duration of these conditions, type of diabetes, medication, dietary habits, and related family history were also noted based on the inclusion and exclusion criteria. The observed data were subjected to statistical analysis.

**Results:** The results showed that 45.8% of type I and 53.4% of type II diabetic patients, as well as 57.3% of both diabetic and hypertensive patients, were observed to have high caries risk. Generally, individuals in the B-positive (40%) blood group tended to show a high caries risk. The B-positive blood group was a common finding in diabetic patients (40%) and both diabetic and hypertensive patients (31%). Patients with hypertension most commonly belonged to the O-positive (34.28%) blood group.

**Conclusions:** The present study concludes that type II diabetic patients belonging to the B-positive blood group were more prone to caries. Hypertensive patients with O-positive blood showed a moderate association with caries. Hence, patients with diabetes and hypertension who belong to the B-positive blood group should receive particular caution regarding their oral care and its complications.

**Keywords:** Blood group; Caries risk; Diabetes; Hypertension

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November 8–10, 2019 · Seoul, Korea



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\*Presenting author

Girish Parmar

Department of Endodontics and Conservative Dentistry, Government Dental College and Hospital, Civil Hospital Campus, Civil Hospital Rd, Asarwa, Ahmedabad, Gujarat 380016, India.

E-mail: shandent1@gmail.com

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# Salivary and blood lead levels as biomarkers for dental caries: a cross-sectional study

Girish Parmar\*

Department of Endodontics and Conservative Dentistry, Government Dental College and Hospital, Ahmedabad, Gujarat, India

## ABSTRACT

**Objectives:** This study aimed to estimate blood and salivary lead levels in children with primary dentition, to measure their Decayed, Missing, and Filled Teeth (DMFT) index, and to examine the relationship between those parameters and dental caries

**Materials and Methods:** The present study is a cross-sectional study using a simple sampling method with quantitative data, comprising a control (DMFT = 0) and a study group (DMFT ≥ 5), with a sample size of 100 each. The participants had both vegetarian and non-vegetarian diets, with no frequent snacking habits. The DMFT index of children was recorded according to World Health Organization criteria. Samples of blood and unstimulated saliva were collected from all subjects at fixed times to avoid circadian bias, and lead levels were estimated using the Inductively coupled plasma mass spectrometry method. The unpaired *t*-test (independent *t*-test) was used to assess the data.

**Results:** A significant elevation in the prevalence of dental caries was found ( $p < 0.001$ ) with increased salivary lead levels. Blood lead levels also showed a positive correlation with dental caries. In both samples, the *p* values were found to be  $< 0.05$ . In the control group, the blood and salivary lead levels ranged from 4.06 µg/L to 45.29 µg/L and from 0 to 9.28 µg/L, respectively. In the study group, the blood and salivary lead levels ranged from 11.90 µg/L to 48.55 µg/L and from 2.4 µg/L to 21.6 µg/L, respectively.

**Conclusions:** In this study, increased blood and salivary lead levels showed a significant association with the prevalence of dental caries, enabling us to draw the conclusion that a definite correlation exists between blood and salivary lead levels and dental caries. Therefore, dentists should be aware of environmental pollutants such as lead that can adversely affect general and dental health. Saliva may be a definite biomarker for the recent body lead burden, although blood is the gold-standard method for assessing exposure to inorganic lead.

**Keywords:** Blood lead; Dental caries; Salivary lead

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#### \*Presenting author

Sunil M. Eraly

Department of Conservative Dentistry and  
Endodontics, Malabar Dental College and  
Research Centre, Manoor - Chekanoor Road,  
Manoor, Edappal, Malappuram,  
Kerala 679582, India.  
E-mail: drsunilmeraly@gmail.com

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# Saliva characteristics and oral health status in interventionally and non-interventionally managed cardiac-compromised patients

Sunil M. Eraly\*

Department of Conservative Dentistry and Endodontics, Malabar Dental College and Research Centre, Malappuram, Kerala, India

## ABSTRACT

**Objectives:** To evaluate and compare the following parameters in interventionally and non-interventionally managed cardiac patients: 1) the unstimulated salivary for flow rate, pH, and consistency; 2) the stimulated salivary for flow rate, pH, and buffering capacity; 3) patients' oral health status using the Oral Hygiene Index–Simplified, the Periodontal Index, the Decayed, Missing, and Filled Teeth Index, and the White Spot Lesion Index, and to compare these findings with apparently healthy individuals.

**Materials and Methods:** A total of 300 individuals (group I, healthy individuals, group II, those who underwent interventional management of cardiac disease at the Department of Cardiology, and group III, undergoing non-surgical management of cardiac disease,  $n = 100$ ) were randomly selected. Saliva samples were collected and analyzed using the Saliva-Check BUFFER kit (GC Corp.). An oral health analysis was done after the teeth were isolated with cotton rolls and examined using a mouth mirror and the respective probe under  $\times 2.5$  magnification (Heinz Loupes) and LED light. The obtained data were tabulated and statistically analyzed.

**Results:** The flow rates of unstimulated and stimulated saliva were lower in both cardiac groups than in healthy individuals ( $p < 0.001$ ). The consistency of the unstimulated saliva was altered ( $p < 0.001$ ). The buffering capacity of stimulated saliva was significantly lower in both experimental groups ( $p < 0.001$ ). The pH of unstimulated and stimulated saliva was higher in the interventional group ( $p < 0.001$ ). Oral hygiene, periodontal status, and caries prevalence showed significant deterioration in both study groups when compared with apparently healthy individuals ( $p < 0.001$ ).

**Conclusions:** Patients who had undergone interventional management of cardiac diseases presented better salivary characteristics and oral health status, which they maintained better than the patients undergoing non-interventional management in the time intervals studied. However, these parameters are far below the standards required and hence may complicate these patients' already compromised systemic condition.

**Keywords:** Interventional cardiac treatment; Non-interventional cardiac treatment; Oral health status; Salivary buffering capacity; Salivary flow rate; Salivary pH



Oral Presentations  
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# Prevalence of dental erosion defects in gastroesophageal reflux disease patients at a tertiary hospital

Rajeswari Kalaiselvam,<sup>1\*</sup> Arathi Ganesh,<sup>1</sup> Dakshayani B,<sup>1</sup>  
Deivanayagam Kandaswamy,<sup>1</sup> Major Prasanna Kumar Saravanam,<sup>2</sup> Ganesh P<sup>3</sup>

<sup>1</sup>Department of Conservative Dentistry and Endodontics, Faculty of Dental Sciences, Sri Ramachandra Institute of Higher Education and Research (Deemed to be University), Chennai, Tamil Nadu, India

<sup>2</sup>Department of Ear Nose & Throat, Sri Ramachandra Institute of Higher Education and Research (Deemed to be University), Chennai, Tamil Nadu, India

<sup>3</sup>Department of Gastroenterology, Sri Ramachandra Institute of Higher Education and Research (Deemed to be University), Chennai, Tamil Nadu, India



\*Presenting author

Rajeswari Kalaiselvam

Department of Conservative Dentistry and Endodontics, Faculty of Dental Sciences, Sri Ramachandra Institute of Higher Education and Research (Deemed to be University), No. 1, Ramachandra Nagar, Sri Ramachandra Nagar, Porur, Chennai, Tamil Nadu 600116, India.

E-mail: rajeswarik@sriramachandra.edu.in

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## ABSTRACT

**Objectives:** To investigate the prevalence of dental erosion in gastroesophageal reflux disease (GERD) patients by conducting a cross-sectional pilot study at a tertiary hospital.

**Materials and Methods:** Fifty patients diagnosed with reflux laryngitis due to GERD from the Department of Ear Nose & Throat and Department of Gastroenterology through an established assessment technique comprised the study group, and were recruited for this study following stringent inclusion and exclusion criteria. Ethical approval was obtained from the institutional ethical committee. These patients were subjected to a thorough dental examination at the dental triage station. A structured, closed-ended questionnaire was used to record each patient's medical, medicinal, personal, and dietary details. After completing the questionnaire, they were examined for the presence or absence of dental erosion defects, and the severity of defects was measured using the O'Sullivan index. Data were collected and analyzed using the  $\chi^2$  test.

**Results:** An association was found between dental erosion and GERD. Statistical significance was indicated by  $p$  values < 0.05.

**Conclusions:** The results of this study revealed the possibility of dental erosion in GERD patients, underscoring the importance of an integrated approach of medical and dental specialists to the management of GERD patients.

**Keywords:** Dental erosion; Erosive index; Gastroesophageal reflux disease; Heart burn; Reflux

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\*Presenting author

Jinhee Ha

Department of Conservative Dentistry, Ulsan University Hospital, University of Ulsan College of Medicine, 77 Bangeojinsunhwando-ro, Dong-gu, Ulsan 44033, Korea.  
E-mail: 0732289@uuh.ulsan.kr

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# The association of dental caries with dry powder inhaler use in patients with airway diseases

Jinhee Ha,<sup>1\*</sup> Seungwon Ra,<sup>2</sup> Sungae Son,<sup>3</sup> Jeongkil Park<sup>3</sup>

<sup>1</sup>Department of Conservative Dentistry, Ulsan University Hospital, University of Ulsan College of Medicine, Ulsan, Korea

<sup>2</sup>Department of Pulmonology, Ulsan University Hospital, University of Ulsan College of Medicine, Ulsan, Korea

<sup>3</sup>Department of Conservative Dentistry, Pusan National University Dental Hospital, Yangsan, Korea

## ABSTRACT

**Objectives:** Asthma and chronic pulmonary disease (COPD) are chronic inflammatory diseases of the respiratory tract, and respiratory distress, cough, and various clinical symptoms occur. Drugs are delivered to the airways in the form of metered dose inhaler (MDI) or dry powder inhaler (DPI) formulations, which have anti-inflammatory or bronchodilator effects. Since both drugs are inhaled through the oral cavity, drug deposition occurs in the oral cavity and teeth, leading to oral cavity dryness and decreased saliva flow, which in turn cause side effects such as dental caries. In this study, we hypothesized that lactose monohydrate, which is a drug carrier existing only in DPI, would increase the incidence of caries in comparison with MDI.

**Materials and Methods:** We will compare time to dental caries, hazard ratio (HR), and incidence rate ratio of caries between MDI and DPI using Ulsan University Hospital data from 2010 to 2018. Primary outcome is a HR for dental caries (DPI/MDI) calculated by Cox regression analysis and time to first dental caries (DPI/MDI) calculated by log-rank test during the study period.

**Results:** Our study results showed that DPI use was associated with increased risk of dental caries as compared to using MDI in patients with asthma and COPD. The incidence rate of dental caries per 1,000 person-year was 2.46 *vs.* 1.22, indicating that the use of DPI increased the risk of dental caries during the study period as compared to MDI (HR, 2.10; *p* = 0.028). Time to dental caries was also shorter in DPI use than MDI use (*p* = 0.025 by log-rank test).

**Conclusions:** In patients with having airway disease and high risk of dental caries, we suggest using MDI or lactose-free DPI. If inhalants are used, periodic visits to the dentist will require prevention and early treatment of caries.

**Keywords:** Asthma; COPD; Dental caries; DPI; MDI

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# Antimicrobial efficacy of silver nanoparticles against *Enterococcus faecalis*

Anil Chandra,\* Simith Yadav

Department of Conservative Dentistry and Endodontics, Faculty of Dental Sciences, King George's Medical University, Lucknow, Uttar Pradesh, India



\*Presenting author

Anil Chandra

Department of Conservative Dentistry and Endodontics, Faculty of Dental Sciences, King George's Medical University, Shah Mina Rd, Chowk, Lucknow, Uttar Pradesh 226003, India.  
E-mail: ahanachandra@yahoo.com

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## ABSTRACT

**Objectives:** The aim of the present *ex vivo* study was to investigate the antimicrobial efficacy of silver nanoparticles (SNP) with and without different antimicrobials against *Enterococcus faecalis*.

**Materials and Methods:** In total, 126 recently extracted single-rooted human teeth were contaminated with *E. faecalis*. The teeth were randomly divided into 5 experimental groups ( $n = 21$ ) and 1 control group ( $n = 21$ ). Each group was then exposed to different antimicrobials, namely  $\text{Ca}(\text{OH})_2$  (group 1), 2% chlorhexidine (CHX, group 2), SNP (group 3), SNP with  $\text{Ca}(\text{OH})_2$  (group 4), and SNP with 2% CHX (group 5). In the control group (group 6), saline was used. Cultures were obtained from each group after 24 hours, 7 days, and 14 days, and colony-forming units were counted. The Kruskal-Wallis test was used to compare the study parameters among the groups at 24 hours, 7 days, and 14 days.

**Results:** Significant differences were found in the antimicrobial efficacy of different intracanal medicaments against *E. faecalis* after 24 hours, 7 days, and 14 days. 2% CHX was found to be most effective medicament at 24 hours, 7 days, and 14 days against *E. faecalis*. The combination of SNP with 2% CHX and  $\text{Ca}(\text{OH})_2$  and SNP alone ranked second in antimicrobial efficacy against *E. faecalis* at 24 hours, 7 days, and 14 days, respectively.

**Conclusions:** The 2% CHX was more effective as an intracanal medicament against *E. faecalis* biofilm at both short- and long-term durations (*i.e.*, at 24 hours, 7 days, and 14 days).

**Keywords:** Antimicrobials; *Enterococcus faecalis*; Nano particles

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# Antimicrobial activity of *Citrus limetta* as an intracanal medicament: a comparative study

Sohani Maroli,\* Shamna Muhammed, Srinath Premakumar, Subhash TS,  
Aleem Mohammed, Sowmya S

Department of Conservative Dentistry and Endodontics, Dental Wing, Mysore Medical College and Research Institute, Mysore, Karnataka, India



\*Presenting author

Sohani Maroli

Department of Conservative Dentistry and Endodontics, Dental Wing, Mysore Medical College and Research Institute, Irwin Road, Mysore, Karnataka 570001, India.  
E-mail: sohani\_m@yahoo.com

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## ABSTRACT

**Objectives:** The goals of this study were to study the antimicrobial properties of *Citrus limetta* solution as an intracanal medicament and to compare its antimicrobial properties with those of 5.25% sodium hypochlorite and 2% chlorhexidine.

**Materials and Methods:** Facultative anaerobes (alpha-hemolytic streptococci and *Streptococcus pyogenes*) that are commonly isolated from infected root canals were used. Forty extracted decoronated single-rooted teeth were cleaned, instrumented, and autoclaved. Apical foramina were sealed with composite. Prepared teeth were divided into 2 groups of 20 teeth each according to the bacterium inoculation (group 1, alpha-hemolytic streptococci and group 2, *S. pyogenes*). According to the test medicaments (*C. limetta*, 5.25% sodium hypochlorite, 2% chlorhexidine, or control), each group was divided into 4 subgroups. After irrigation with medicament and incubation, samples were collected from infected root canal and cultured.

**Results:** On alpha-hemolytic streptococci, sodium hypochlorite showed the best results, while *C. limetta* and chlorhexidine were equal in their antimicrobial efficacy. *C. limetta* and sodium hypochlorite exhibited equally effective antimicrobial action against *S. pyogenes*, with chlorhexidine lagging behind.

**Conclusions:** *C. limetta*, a natural medicament, had comparable antibacterial property to 5.25% sodium hypochlorite and 2% chlorhexidine, encouraging its use as intracanal irrigant with less cytotoxic effect.

**Keywords:** Chlorhexidine; *Citrus limetta*; Ethnopharmacology; Intracanal irrigation; Sodium hypochlorite

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Research Presentation



# Coaggregation inhibitors for enhancing the antibacterial effect of irrigants: a myth or reality?

Hannah Rosaline,\* Deivanayagam Kandaswamy

Department of Conservative Dentistry and Endodontics, Sri Ramachandra Institute of Higher Education and Research (Deemed to be University), Chennai, Tamil Nadu, India



\*Presenting author

Hannah Rosaline

Department of Conservative Dentistry and Endodontics, Sri Ramachandra Institute of Higher Education and Research (Deemed to be University), No. 1, Ramachandra Nagar, Sri Ramachandra Nagar, Porur, Chennai, Tamil Nadu 600116, India.

E-mail: hannahrosaline@gmail.com

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## ABSTRACT

**Objectives:** The objective of this study was to investigate the antibacterial efficacy of 3% sodium hypochlorite (NaOCl) and 2% chlorhexidine pretreated with coaggregation inhibitors against a dual-species biofilm of *Enterococcus faecalis* and *Fusobacterium nucleatum* in root canals.

**Materials and Methods:** Dentin samples from human uniradicular teeth were contaminated with *E. faecalis* and *F. nucleatum*. Three hundred samples were pretreated with 100 mM of coaggregation inhibitors (lactose, N-acetyl-D-galactosamine, L-arginine, and L-lysine) and disinfection was done with 3% NaOCl and 2% chlorhexidine. Thirty samples were used as a positive control with dual-species biofilm. The remaining biovolume was analyzed and bacterial quantification was performed using confocal microscopy and a molecular probe assay (reverse transcription polymerase chain reaction; Taqman probe).

**Results:** A significant decrease in the percentage of biovolume and bacterial number after pretreatment was found with 100 mM L-arginine followed by N-acetyl-D-galactosamine before 3% NaOCl disinfection, compared to 3% NaOCl without pretreatment and the positive control (no treatment) ( $p \leq 0.05$ ).

**Conclusions:** Coaggregation inhibitors enhanced the antimicrobial activity of 3% NaOCl and 2% chlorhexidine. L-arginine pretreatment before disinfection with 3% NaOCl showed the lowest percentage of bacterial biovolume and quantification of the dual-species biofilm composed of *E. faecalis* and *F. nucleatum* in the root canal.

**Keywords:** Coaggregation; Coaggregation inhibitors; Dual species biofilm

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# Comparative evaluation of direct pulp capping using PRF, PRP, and MTA: an *in vivo* study

Kavitha Mahendran,\* Shobana Shekar

Department of Conservative Dentistry and Endodontics, Tamil Nadu Government Dental College and Hospital, The Tamil Nadu Dr. M.G.R. Medical University, Chennai, Tamil Nadu, India



\*Presenting author

Kavitha Mahendran

Department of Conservative Dentistry and Endodontics, Tamil Nadu Government Dental College and Hospital, The Tamil Nadu Dr. M.G.R. Medical University, 69, Anna Salai Rd, Little Mount, Guindy, Chennai, Tamil Nadu 600032, India.

E-mail: kavithaendo@yahoo.com

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## ABSTRACT

**Objectives:** The purpose of this study was to assess the effectiveness of platelet-rich plasma (PRP) and platelet-rich fibrin (PRF) *versus* mineral trioxide aggregate (MTA) as direct pulp capping materials in patients with reversible pulpitis. The pulpal response of teeth to direct pulp capping with MTA, PRP, and PRF was evaluated clinically at 3-, 6-, and 12-month intervals. Dentin bridge formation in teeth with direct pulp capping with MTA, PRP, and PRF was assessed using digital radiography at 3-, 6-, and 12-month intervals and using cone-beam computed tomography (CBCT) at the 6th month postoperatively.

**Materials and Methods:** Thirty patients with carious molars and premolars with reversible pulpitis were chosen and randomly allocated into 3 groups according to the material used for direct pulp capping: group 1, MTA; group 2, PRP; group 3, PRF. The treated teeth were restored with glass ionomer cement liner and light-cure composite restoration. Clinical and radiographic assessments were performed at 3, 6, and 12 months and CBCT analysis was done at 6 months. The results were analyzed using Pearson's  $\chi^2$  test and one-way analysis of variance. **Results:** There was no significant difference among the 3 groups with regard to clinical and radiographic outcomes. A total of 26 teeth (87% of the cases) showed a positive response to pulp sensibility testing. There was evidence of dentin bridge formation radiographically at 3-, 6-, and 12-month intervals and in the CBCT assessments at 6 months.

**Conclusions:** The platelet concentrates PRP and PRF are a promising alternative to MTA for direct pulp capping in teeth with reversible pulpitis.

**Keywords:** Direct pulp capping; Mineral trioxide aggregate; Platelet rich fibrin; Platelet rich plasma

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November 8–10, 2019 · Seoul, Korea



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# Antibacterial effect of melittin on *Enterococcus faecalis* biofilm formed on a bovine tooth model

Sujitha Ramaraj,\* Mi-Ah Kim, Kyung-San Min

Department of Conservative Dentistry, School of Dentistry, Chonbuk National University, Jeonju, Korea

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\*Presenting author

Sujitha Ramaraj

Department of Conservative Dentistry, School of Dentistry, Chonbuk National University, 567 Baekje-daero, Deokjin-gu, Jeonju 54896, Korea.

E-mail: sujitharamaraj@yahoo.in

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## ABSTRACT

**Objectives:** The aim of this study was to evaluate the antibacterial and antibiofilm properties of melittin, a cationic antimicrobial peptide derived from honey bee venom, alone or in combination with DNase and sodium hypochlorite, against *Enterococcus faecalis* biofilms formed on a bovine tooth substrate.

**Materials and Methods:** Using broth cultures, colony forming unit (CFU) assays, crystal violet staining assays, eDNA measurements, and field emission-scanning electron microscopy, we examined the effects of melittin on various *E. faecalis* growth parameters and biofilm properties. Confocal laser scanning microscopy (CLSM) was used with Comstat software (Kongens Lyngby) to measure and analyze the bio-volume and thickness of the biofilms.

**Results:** The minimum inhibitory concentration against *E. faecalis* strain ATCC 29212 was determined to be 6 µg/mL. Specimens cultured with DNase for 7 days and then treated with melittin for 1 hour (DNase/melittin) had the lowest number of CFUs and the lowest eDNA levels compared to the specimens treated with DNase or melittin alone. According to CLSM analysis, the bio-volume of bacteria had a similar pattern as the CFU assay. In addition, the combination of DNase/melittin with sodium hypochlorite (NaOCl; 0.5%–5%) enhanced the antibiofilm efficacy significantly.

**Conclusions:** DNase/melittin in combination with NaOCl yielded the greatest reduction in *E. faecalis* biofilms. These results suggest that melittin has potential as an adjunctive endodontic therapeutic agent, since it showed a synergistic effect when used with NaOCl.

**Keywords:** eDNase; *Enterococcus faecalis*; Melittin; Sodium hypochlorite

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**\*Presenting author**

**Rakesh Yadav**

Department of Conservative Dentistry and  
Endodontics, King George's Medical University,  
Shah Mina Rd, Chowk, Lucknow, Uttar Pradesh  
226003, India.  
E-mail: rakeshanita10@yahoo.in

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# Evaluation of temperature increase on the external root surface during laser application in root canals

**Rakesh Yadav\***

Department of Conservative Dentistry and Endodontics, King George's Medical University, Lucknow, Uttar Pradesh, India

## ABSTRACT

**Objectives:** The purpose of this study was to evaluate the temperature increase during the application of neodymium-doped yttrium aluminium garnet (Nd:YAG) and erbium-doped yttrium aluminium garnet (Er:YAG) lasers at different power levels to the external root surface of permanent teeth.

**Materials and Methods:** Sixty mandibular single-rooted pre-molars were selected and prepared chemo-mechanically. Nd:YAG laser-activated irrigation was performed in 30 teeth (group I) and the remaining 30 teeth received Er:YAG laser treatment (group II), at three different power levels (1 W, 1.5 W, and 2.0 W, applied to 10 samples from each group). A type K thermocouple wire, along with a calibrated digital thermometer, was used to measure temperature changes on the external root surface. Data were assessed with the unpaired Student's *t*-test and 2-way analysis of variance.

**Results:** With increasing power levels, the temperature of the external root surface also increased to some extent in both the groups. For the apical third, at power levels of 1.5 W and 2 W, the difference in the mean temperature increase between the 2 groups was found to be significant (6.30°C and 7.75°C; *p* = 0.005 and 9.11°C and 10.05°C; *p* = 0.036, respectively), whereas for the middle third region, it was found that at a power level of 2 W, the difference in mean temperature increase between the 2 groups was significant (6.69°C and 7.91°C; *p* = 0.007).

**Conclusions:** Both Nd:YAG and Er:YAG lasers at various power levels led to increases in temperature on the external root surface, but the temperature changes in all the tested groups remained below the critical threshold.

**Keywords:** Erbium-doped yttrium aluminium garnet laser; Neodymium-doped yttrium aluminium garnet laser; Root canal; Temperature increase

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**\*Presenting author**

**Venkatesh Srinivasan**

Department of Conservative Dentistry and Endodontics, Tamil Nadu Government Dental College and Hospital, The Tamil Nadu Dr. M.G.R. Medical University, 69, Anna Salai Rd, Little Mount, Guindy, Chennai, Tamil Nadu 600032, India.

E-mail: venky08dent@yahoo.co.in

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# Comparative evaluation of the antibacterial properties of glass ionomer cement containing silver zeolite and bioactive glass

**Venkatesh Srinivasan,\* Kavitha Mahendran, Jaikailash Shanmugam**

Department of Conservative Dentistry and Endodontics, Tamil Nadu Government Dental College and Hospital, The Tamil Nadu Dr. M.G.R. Medical University, Chennai, Tamil Nadu, India

## ABSTRACT

**Objectives:** The objective of this study was to conduct an *in vitro* evaluation of the antibacterial properties of glass ionomer cement containing 2% silver zeolite and 2% bioactive glass compared with conventional glass ionomer cement.

**Materials and Methods:** Glass ionomer cement containing silver zeolite was prepared by addition of a 2% weight fraction of silver zeolite to the glass ionomer powder. Similarly, a 2% weight fraction of bioactive glass was added to the glass ionomer powder to produce glass ionomer containing bioactive glass. The test groups considered were group I (glass ionomer cement containing 2% silver zeolite), group II (glass ionomer cement containing 2% bioactive glass), and group III (conventional glass ionomer cement). The direct contact test was used to study the antibacterial properties of the materials. *Enterococcus faecalis* was used as the test organism. Each group was tested for samples aged for 15 days, 7 days, 48 hours, and 24 hours after setting and freshly mixed using 96-well microtiter plates. Data were recorded and statistically analyzed using one-way analysis of variance and Tukey honestly significant difference *post hoc* multiple comparisons.

**Results:** A significant reduction in bacterial growth was found for the freshly set group I samples, and this effect was seen also for the samples set for 15 days, 7 days, 48 hours, and 24 hours. In contrast, group II and group III showed a reduction in bacterial growth only for the freshly set samples, and this effect was not seen in the samples set for 15 days, 7 days, 48 hours, and 24 hours.

**Conclusions:** Adding 2% silver zeolite powder to glass ionomer cement enhanced its antibacterial activity, and this effect was sustained for 15 days. Further studies are required to confirm the effects of adding 2% silver zeolite powder to glass ionomer cement so that the combination can be used as a successful root end filling material.

**Keywords:** Antibacterial glass ionomer cement; Bioactive glass; Root end filling material; Silver zeolite

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**OPEN ACCESS**

**\*Presenting author**

**Vinutha Manjunath**

Department of Conservative Dentistry  
and Endodontics, Indian Association of  
Conservative Dentistry and Endodontics, No.  
7, 7th Avenue, Harrington Road, Chetpet,  
Chennai, Tamil Nadu 600031, India.  
E-mail: vinutha.manjunath2@gmail.com

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# Microtensile bond strength evaluation of Cention compared with other direct restorative materials: an *in vitro* study

**Vinutha Manjunath\***

Department of Conservative Dentistry and Endodontics, Indian Association of Conservative Dentistry and Endodontics, Chennai, Tamil Nadu, India

## ABSTRACT

**Objectives:** The aim of this study was to compare the microtensile bond strength of Cention N without a bonding agent to those of Giomer, resin modified glass ionomer (RMGIC), composite, and Cention N with both 5th-generation and universal bonding agents, and to evaluate the mode of failure using stereomicroscopy.

**Materials and Methods:** In total, 120 premolars extracted for orthodontic purposes were used. Cention N (Alkasite, Ivoclar Vivadent), Tetric N Ceram (composite, Ivoclar Vivadent), Beautifil II (Giomer, Shofu), RMGIC (GC), Tetric N Bond (5th-generation bonding agent) and Tetric N Bond Universal (universal bonding agent, Ivoclar Vivadent). Class I cavities with a one-third intercusp distance and a depth of 0.5 mm into the dentin were prepared. Bonding agents were applied according to the manufacturers' protocols using total-etching technique. Restorative materials were placed and light-cured for 20 seconds using a 1,200 mW/cm<sup>2</sup> (Bluephase C8).

**Results:** Conventional composites gave the highest bond strength values with both the 5th generation and universal bonding agents (23.9 *vs.* 21.2 MPa), in comparison to Giomer (16.7 *vs.* 14.17 MPa) and RMGIC (18.9 *vs.* 16.9 MPa). Cention N without etching and bonding agent application had a lower value (14.9 MPa) than etching with either 5th generation (21.5 MPa) or universal bonding agents (18.48 MPa). The mode of failure was cohesive for the composite group and adhesive for the remaining groups.

**Conclusions:** Cention N had lower bond strength values than conventional composites. Bond strength values with either of the bonding agents were higher than without use of a bonding agent. The lower bond strength values of Giomer and RMGIC were similar to those reported in previous studies. The cohesive mode of failure in the composite group was due to the higher bond strength and the adhesive mode of failure seen with Cention N. The use of Cention N in high-stress-bearing posterior teeth might not be the ideal choice.

**Keywords:** Bonding agent; Cention N; Composite; Microtensile bond strength

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# Silane coupling agent type and application time influences the bond strength of resin-feldspathic CAD/CAM ceramics

Antonio HS Delgado,\* Joao Reis, Anastasia Rita, Ines Caetano Santos, Joao Rua, Luis Proença, José J Mendes

Centro de Investigacao Interdisciplinar Egas Moniz, Instituto Universitario Egas Moniz, Monte da Caparica, Almada, Portugal



\*Presenting author

Antonio HS Delgado

Centro de Investigacao Interdisciplinar Egas Moniz, Instituto Universitario Egas Moniz, Campus Universitario, Quinta da Granja, Monte da Caparica 2829-511, Almada, Portugal.

E-mail: ant.delgado94@gmail.com

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## ABSTRACT

**Objectives:** The aim of this research was to assess the influence of different types of silane coupling agents and their application times on the microtensile bond strength ( $\mu$ TBS) of the resin-ceramic interface.

**Materials and Methods:** Commercial feldspathic computer-aided design/computer-aided manufacturing ceramic blocks (Vitablocs Mark II, VITA) were divided into 3 groups: G1, BIS-Silane (Bisco); G2, ESPE Sil Silane Coupling Agent (3M ESPE AG); G3, Monobond Plus (Ivoclar-Vivadent). Each was then divided into two subgroups, according to the application time: T1 (1 minute) or T2 (5 minutes). Each block was acid etched (9.5% HF, 1 minute), cleaned post-etching (37.5% orthophosphoric acid, 1 minute; ultrasonication, 2 minutes) and silanized. Heat treatment was carried out at 100°C (1 minute). Then, a thin layer of Optibond FL (Kerr) adhesive was applied and each block was adhered to pre-heated resin at 55°C. The samples were light-cured for 40 seconds on each side (1,200 mW/cm<sup>2</sup>). Samples were sectioned into microspecimens ( $1 \pm 0.2$  mm<sup>2</sup>) that were subjected to aging (10,000 thermocycles—5°C and 55°C). The microspecimens ( $n = 50$ ) were tested at a crosshead speed of 0.5 mm/min. Two-way analysis of variance (ANOVA) was carried out at a significance level of 5%.

**Results:** The group Monobond Plus with a longer application time (G3T2) presented a mean  $\mu$ TBS ( $32.4 \pm 19.6$  MPa) significantly higher than in all other groups except G3T1 and G1T2. BIS-Silane at 1 minute registered the lowest mean  $\mu$ TBS (G1T1:  $14.0 \pm 5.5$  MPa). Factorial ANOVA confirmed that the type of silane coupling agent had an influence on  $\mu$ TBS ( $\eta^2 = 0.76$ ,  $p < 0.001$ ), and so did time ( $\eta^2 = 0.43$ ,  $p = 0.001$ ).

**Conclusions:** Two-bottle systems may benefit from extra application time to allow further hydrolysis of the silane coupling agent. The clinician should choose the appropriate silane coupling agent, since a favorable selection optimizes the bond strength of the resulting interface.

**Keywords:** Bond strength; Computer-aided design/computer-aided manufacturing; Silane coupling agent

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Oral Presentations  
Research Presentation



# Detecting subsurface defects of floor de-bonded composite resins from polymerization shrinkage surface displacement

Siti Mariam Ab Ghani,<sup>1\*</sup> Chew HP,<sup>2</sup> Fok AS,<sup>2</sup> Amir Radzi AG,<sup>3</sup> Abdul Halim A,<sup>3</sup> Mohamed Ibrahim AH<sup>1</sup>

<sup>1</sup>Centre for Restorative Dentistry Studies, Faculty of Dentistry, Universiti Teknologi Mara, Selangor, Malaysia

<sup>2</sup>Minnesota Dental Research Center for Biomaterial and Biomechanical, University of Minnesota, Minneapolis, MN, USA

<sup>3</sup>Faculty of Mechanical Engineering, Universiti Teknologi Mara, Selangor, Malaysia



\*Presenting author

Siti Mariam Ab Ghani

Centre for Restorative Dentistry Studies,  
Faculty of Dentistry, Universiti Teknologi Mara,  
47000 Sungai Buloh, Selangor, Malaysia.  
E-mail: sitimariam783@uitm.edu.my

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## ABSTRACT

**Objectives:** Surface displacement during polymerization shrinkage occurs at free/unbonded surfaces. This study compared the distribution of linear and volumetric surface displacements of fully-bonded and floor de-bonded composite restorations.

**Materials and Methods:** Class I cavities  $4 \times 4 \times 4 \text{ mm}^3$  prepared in 10 extracted molars and restored with bulk-fill composite resin: group 1 (G1), bonded at all surfaces ( $n = 5$ ); group 2 (G2), floor de-bonded ( $n = 5$ ). Vaseline applied on the floor to simulate de-bonding condition. Pre- and post-curing micro-computed tomography (micro-CT) scans taken and linear (LDm) and volume (VDm) surface displacement measured. Theoretical linear (LDp) and volume (VDp) surface displacement derived from the pre-cure restoration height. The experiments were simulated using finite element analysis (FEA), in which 3-dimensional (3D) finite-element models of both groups were created.

**Results:** LDm in G1 and G2 were  $62.4 \pm 5.2 \mu\text{m}$  and  $32.8 \pm 4.0 \mu\text{m}$ , respectively, and LDp in G1 and G2 were  $60.1 \pm 7.4 \mu\text{m}$  and  $31.3 \pm 7.5 \mu\text{m}$ , respectively. VDM in G1 and G2 were  $1.22 \pm 0.19 \text{ mm}^3$  and  $0.63 \pm 0.15 \text{ mm}^3$  respectively, and VDP in G1 and G2 were  $1.36 \pm 0.18 \text{ mm}^3$  and  $0.67 \pm 0.16 \text{ mm}^3$ , respectively. No significant difference between the measured and predicted values of LDm and VDM within the same group. Statistically significant differences between group G1 and G2 ( $p < 0.05$ ). In G2, the surface displacement value almost halved the G1 value, proving displacement occurred symmetrically at un-bonded areas (surface and floor). The 3D finite-element analysis exhibited similar patterns to the *in vitro* studies.

**Conclusions:** Measurement of linear and volumetric surface displacements of both groups using micro-CT concurred with those derived theoretically from surface data and confirmed with FEA. Subject to clinical validation, this information may lead to a novel approach to the identification of de-bonded floor in composite resin restorations.

**Keywords:** De-bonded floor; Polymerization displacement; Sub-surface restoration defect

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\*Presenting author

Annapoorna Ballagere Mariswamy

Department of Conservative Dentistry  
and Endodontics, JSS Dental College, JSS  
Academy of Higher Education and Research,  
Bannimantap Road, Sri Shivarathreshwara  
Nagara, Bannimantap A Layout, Bannimantap,  
Mysuru, Karnataka 570015, India.  
E-mail: annapoornabm10@gmail.com

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# Evaluation of herbal etchant and an MMP inhibitor on the microshear bond strength of composite resin

Annapoorna Ballagere Mariswamy\*

Department of Conservative Dentistry and Endodontics, JSS Dental College, JSS Academy of Higher  
Education and Research, Mysuru, Karnataka, India

## ABSTRACT

**Objectives:** The composite resin–dentin bonds created with dentin bonding systems deteriorate over time due to many reasons, including matrix metalloproteinases (MMPs). Chlorhexidine (CHX) is a well-known MMP inhibitor. *Citrus medica* has an acidic pH of 2.3, and synthetic citric acid was found to be an MMP inhibitor. However, the use of citron as an acid etchant and MMP inhibitor on dentin samples has not been reported. The objectives of this study included evaluating and comparing the effect of citron juice as an acid etchant with 37% orthophosphoric acid (OPA) by scanning electron microscopy (SEM) and as an MMP inhibitor with 2% CHX on the microshear bond strength of composite resin.

**Materials and Methods:** Five extracted human teeth were used for the SEM study and one tooth was used for gelatin zymography. Dentin slabs of 3-mm thickness were obtained from 60 extracted human molars and were randomly divided into 5 groups with 10 samples each for the control group and 20 each for the experimental groups. Group 1 specimens were etched with OPA, group 2 with OPA and CHX as an MMP inhibitor, group 3 with citron, and group 4 with OPA and citron as an MMP inhibitor. The groups were restored with standardized composite resin cylinders following bonding protocols. All the specimens were stored in distilled water for 2 weeks, after which they were subjected to microshear bond strength testing.

**Results:** The SEM findings for citron juice were similar to those of self-etch adhesive. Through gelatin zymography in dentin samples, 100% citron extract was identified to inhibit MMP-9 activity. There was no statistically significant difference in the mean values of microshear bond strength between groups 1 and 3 or between groups 2 and 4.

**Conclusions:** Natural citric acid can be effectively used as an alternative acid etchant and MMP inhibitor.

**Keywords:** Bond strength; Citron; Etchant; Matrix metalloproteinase

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# Effects of ozone, photoactivated disinfection, and chlorhexidine on the push-out bond strength of fiber posts

Akriti Goel,\* B Rajkumar, Anil Chandra

Department of Conservative Dentistry and Endodontics, King George's Medical University, Lucknow, Uttar Pradesh, India



\*Presenting author

Akriti Goel

Department of Conservative Dentistry and Endodontics, King George's Medical University, Shah Mina Rd, Chowk, Lucknow, Uttar Pradesh 226003, India.

E-mail: akriti.dentist@gmail.com

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## ABSTRACT

**Objectives:** This study aimed to evaluate the effects of ozone, photoactivated disinfection (PAD), and chlorhexidine gluconate on the push-out bond strengths of fiber posts.

**Materials and Methods:** Sixty freshly extracted, caries-free human permanent mandibular premolars, extracted for orthodontic purposes from patients aged 18 to 25 years, were chosen and randomly assigned to 4 groups: saline, chlorhexidine, ozone, and PAD. The post space was prepared with a Tenax Fiber white post kit (Coltene Whaledent) and immediately treated and restored. Parabond non-rinse conditioner was applied and dried with paper points, followed by application of Parabond adhesive. A Tenax Fiber white post was luted into the post space with Paracore resin luting cement and light-cured. Each specimen was sectioned transversely with a diamond disc into approximately 1-mm-thick sections. The most cervical section of each third was subjected to the push-out test using an Instron universal testing machine with the central 1 mm pin at a 0.5 mm/min cross-head speed. The force in newtons was recorded for each sample (peak load at failure) and the bond strength in megapascals (MPa) was calculated. Groups were compared by 2-factor analysis of variance and the significance of mean differences within and between the groups was evaluated using Tukey's *post hoc* test.

**Results:** No statistically significant differences were found in the push-out bond strength of all the groups. All the tested groups showed higher push-out bond strength in the cervical region than in the middle and the apical thirds, which showed the least bond strength; this difference was statistically significant.

**Conclusions:** PAD showed higher bond strength values than ozone and saline. Significant differences were found among the various regions of the root canal, with cervical areas showing higher bond strength values than middle and apical areas.

**Keywords:** Fiber post; Ozone; Photoactivated disinfection; Push-out bond strength

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# Cyclic fatigue resistance of a virtual rotary file of niobium titanium alloy

Javier Laureano Nino-Barrera,<sup>1\*</sup> Oscar Rodriguez-Montano,<sup>2</sup>  
Carlos Cortes-Rodriguez,<sup>2</sup> Christian Silva-Castellanos,<sup>2</sup> Laura Aldana-Ojeda<sup>1</sup>

<sup>1</sup>Department of Oral Medicine, School of Dentistry, Universidad Nacional de Colombia, Bogota, Colombia

<sup>2</sup>Department of Mechanics and Mechatronics Faculty of Engineering, Universidad Nacional de Colombia, Bogota, Colombia



**\*Presenting author**

Javier Laureano Nino-Barrera

Department of Oral Medicine, School of Dentistry, Universidad Nacional de Colombia, Carrera 45 # 26-85, Edificio. Uriel Gutierrez, Bogota 111321, Colombia.

E-mail: javinino40@gmail.com

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## ABSTRACT

**Objectives:** In order to avoid fractures of endodontic instruments within the root canal, rotary endodontic files have been manufactured using nickel titanium alloy, either conventional or with different thermal treatments. However, fatigue fractures continue to occur, preventing root canal cleaning and shaping. In our research we explored the possibility that titanium niobium alloy could be useful in the manufacture of endodontic rotary files due to its resistance to fatigue fracture.

**Materials and Methods:** Simulations of torsion and bending in wires with the properties of the previously mentioned alloys were conducted using finite element analysis. Then, fatigue failure simulations were conducted and validated experimentally, with similar results. The fatigue module of Ansys Software was used for this purpose. With these findings as a basis and with the same parameters and software, simulations of torsion, bending, and fatigue failure were conducted in models of the F2 rotary file Protaper series with the same mechanical properties tested in the wires of each alloy, but only the rotary files composed of nickel titanium alloy were experimentally validated.

**Results:** It was found that the niobium titanium alloy virtual files were more resistant to fatigue failure than the nickel titanium alloy virtual files.

**Conclusions:** Within the limitations of the present study, it can be concluded that niobium titanium may be an alternative material for the manufacture of endodontic files due its resistance to cyclic fatigue.

**Keywords:** Nickel titanium; Niobium titanium; Rotary files

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# NiTi instrument fracture during root canal treatment and re-treatment

Khalid Alfouzan,\* Ahmed Jamleh

College of Dentistry, King Saud bin Abdulaziz University for Health Sciences, Riyadh, Saudi Arabia



**\*Presenting author**

Khalid Alfouzan

College of Dentistry, King Saud bin Abdulaziz University for Health Sciences, Al Hars Al Watani, Ar Rimayah, Riyadh 14611, Saudi Arabia.

E-mail: kalfouzan@yahoo.com

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## ABSTRACT

**Objectives:** To evaluate retrospectively the incidence of K3 nickel-titanium rotary instrument fracture in referred cases during root canal treatment and re-treatment.

**Materials and Methods:** Clinical and radiographic reports of 12,867 endodontic cases treated at the King Abdulaziz Medical City between January 2010 and November 2015 were reviewed to obtain information on intracanal fractured instruments with respect to the treatment performed, tooth type, and the file size, and at what level the instrument fractured (coronal, middle, or apical). The degree of canal curvature was classified as mild ( $< 10^\circ$ ), moderate ( $10-25^\circ$ ), or severe ( $> 25^\circ$ ). Logistic regression was used to test the incidence of instrument fracture in relation to the root canal treatment performed and tooth type. The  $\chi^2$  test was used to analyze the fracture incidence in the treated teeth in respect to fracture level and fractured file diameter. The level of significance was set at 0.05.

**Results:** Root canal treatment was performed on 8,946 cases, while re-treatment was performed on 3,921 cases. The fracture incidence was higher in re-treatment cases (2.96%) than in primary root canal treatment (0.74%) ( $p < 0.001$ ), with a 1.41% incidence overall. There was a trend for more fractures in maxillary (1.68%) and mandibular (1.35%) molar teeth. Moreover, 56.6% of the instrument fractures occurred in severely curved canals, and the apical third of the root canal was the most common site for instrument fracture (85.7%), followed by the middle (13.2%), and coronal (1.1%) thirds, mostly with file sizes 20 and 25 (59.9% and 25.27%, respectively).

**Conclusions:** The fracture incidence of K3 instruments was significantly greater during root canal re-treatment than during root canal treatment, and mainly occurred with small instruments and in the apical third of the canals.

**Keywords:** Canal curvature; Instrument fracture; K3 rotary system; Retrospective study; Root canal re-treatment; Root canal treatment

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# Comparison of working length determination by two apex locators: an *in vivo* study

Reema Joshi\*

Department of Conservative Dentistry and Endodontics, National Academy of Medical Science (NAMS), Bir Hospital, Kathmandu, Nepal



\*Presenting author

Reema Joshi

Department of Conservative Dentistry and Endodontics, National Academy of Medical Science (NAMS), Bir Hospital, Kanti Path, Kathmandu 44600, Nepal.

E-mail: drreemapradhan@gmail.com

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## ABSTRACT

**Objectives:** The aim of this study was to test the efficacy of two new apex locators, Propex Mini and RootZx Mini, in determining the working length *in vivo*.

**Materials and Methods:** Thirty-two single-rooted teeth were selected from patients who were scheduled for extractions. Access cavities were prepared and pulps were extirpated. Both the electronic apex locators were used to measure the working length and noted. With the aid of a stereomicroscope ( $\times 20$ ), each specimen was analyzed for the distance between the tip of each file and the apical foramen. Negative and positive values were attributed to measurements that were short and beyond the apical foramen, respectively.

**Results:** No statistically significant difference was found between the actual length of the canal and that obtained using the RootZx Mini, whereas a significant difference was seen between the results obtained using the Propex Mini electronic apex locator and the actual length. Furthermore, 100% accuracy was seen for the RootZx Mini, whereas 97% accuracy was found for the Propex Mini apex locator within a range of 0.5 mm.

**Conclusions:** The results of this study indicate that the electronic apex locators RootZx Mini and Propex Mini could accurately determine the working length of the tooth, while the RootZx Mini showed higher efficacy.

**Keywords:** Electronic apex locator; Propex Mini; Root Zx Mini; Working length

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\*Presenting author

Meera Acharya

Department of Conservative Dentistry and  
Endodontics, Hamro Aspatal Private Ltd., H08  
Airport Chowk, Biratnagar 56613, Nepal.  
E-mail: itsmeeral@yahoo.com

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# Coronal sealing ability of SDR flowable composite when used as an intra-orifice barrier: an *in vitro* study

Meera Acharya,<sup>1\*</sup> Wen Xia Chen<sup>2</sup>

<sup>1</sup>Department of Conservative Dentistry and Endodontics, Hamro Aspatal Private Ltd., Biratnagar, Nepal

<sup>2</sup>Department of Conservative Dentistry and Endodontics, College and Hospital of Stomatology, Guangxi Medical University, Nanning, China

## ABSTRACT

**Objectives:** To compare the coronal sealing ability of SDR flowable composite with other materials (Filtek Z350 XT and GIC Fuji type II) and to investigate the influence of different adhesive systems (Xeno V and Prime & Bond NT) on the sealing performance of SDR flowable composite when used as an intra-orifice barrier after root canal treatment.

**Materials and Methods:** Fifty-four freshly extracted human mandibular first premolars with a single canal were selected. After root canal treatment, they were divided into experimental and control groups. The experimental group was further divided into 4 sub-groups (XT, SX, SP, and GC), and the control group was divided into the PC and NC groups. The coronal 3.5 mm of gutta percha was removed from all the samples in the experimental group and the cavity was restored with the different restorative materials (*e.g.*, FiltekZ350 XT, SDR flow, and GIC Fuji type II). The samples in the control group were simply left as is with gutta percha up to the coronal orifice. All the samples were then incubated for 1 week, thermocycled for 500 cycles, and finally stained in 1% methylene blue solution for another week in the incubator. The samples were then split longitudinally and the depth of dye penetration was measured under a stereomicroscope.

**Results:** The microleakage index of the SX group was significantly lower than that of the other groups ( $p < 0.05$ ), while the coronal sealing ability of the GC group was significantly lower than that of the other groups ( $p < 0.05$ ) and was not significantly different from the control group ( $p < 0.05$ ).

**Conclusions:** GIC Fuji Type II can be considered unsuitable as an intra-orifice barrier, while SDR flowable composite in combination with Xeno V can be used as an ideal intra-orifice barrier after completion of root canal treatment.

**Keywords:** Intra orifice barrier; Microleakage; SDR flowable composite; Stereomicroscope

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# Apical patency: bane or boon?



**\*Presenting author**

**Snigdha Shubham**

Department of Conservative Dentistry and Endodontics, Universal College of Medical Sciences, Tribhuvan University, Bhairahawa, Nepal.

E-mail: drsnigdhashubham15@gmail.com

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**Snigdha Shubham,\* Manisha Nepal**

Department of Conservative Dentistry and Endodontics, Universal College of Medical Sciences, Tribhuvan University, Bhairahawa, Nepal

## ABSTRACT

**Objectives:** The purpose of this study was to compare the incidence of postoperative pain and swelling in endodontically treated teeth, with and without apical patency, in relation to some diagnostic factors (vitality, presence of preoperative pain, group of treated teeth, and number of visits).

**Materials and Methods:** In total, 160 patients were included in the study. Group A ( $n = 80$ ) contained patients treated at single visit and group B ( $n = 80$ ) contained those treated at multiple visits. Each group included an equal number of patients with apical patency ( $n = 40$ ) and non-apical patency ( $n = 40$ ), including single- and multiple-rooted teeth and vital and non-vital teeth with equal samples. Apical patency was maintained with a size 10 K-file during shaping procedure. Intensity of pain was recorded before treatment and on days 1, 2, and 7 after treatment using a numerical rating scale. Swelling was also recorded on the basis of visual analysis.

**Results:** There was a statistically significant difference in incidence of postoperative pain between the patency group and non-patency group in single-visit root canal treatments. In the multiple-visit root canal treatment group, postoperative pain was also higher in the apical patency group. The incidence of postoperative pain was higher in non-vital teeth than in vital teeth. Swelling was not present in any of the groups.

**Conclusions:** Our study concluded that maintenance of apical patency was not beneficial; instead, it increased postoperative pain and discomfort, which decreases patients' faith in the operating dentist.

**Keywords:** Apical patency; Endodontic pain; Multiple visit; Single visit

Oral Presentations  
Research Presentation



\*Presenting author

**Martha Mozartha**

Department of Dental Material Science,  
Dentistry Study Program, Faculty of Medicine,  
Universitas Sriwijaya, Jl. Raya Palembang  
- Prabumulih Km. 32, Indralaya Ogan Ilir,  
Palembang, Sumatera Selatan 30662,  
Indonesia.

E-mail: Martha.mozartha@gmail.com

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# The effectiveness of *Curcuma zedoaria* extract on the apical third region of root canal cleanliness

Martha Mozartha,<sup>1\*</sup> Vanindya Annisa Adrinanta,<sup>2</sup> Danica Anastasia<sup>3</sup>

<sup>1</sup>Department of Dental Material Science, Dentistry Study Program, Faculty of Medicine, Universitas Sriwijaya, Palembang, Indonesia

<sup>2</sup>Dentistry Study Program, Faculty of Medicine, Universitas Sriwijaya, Palembang, Indonesia

<sup>3</sup>Department of Conservative Dentistry, Dentistry Study Program, Faculty of Medicine, Universitas Sriwijaya, Palembang, Indonesia

## ABSTRACT

**Objectives:** Irrigation solution is necessary for cleaning the root canal of the smear layer that forms during root canal preparation. The smear layer consists of organic and inorganic components, as well as microorganisms, and may cause treatment failure, especially in the apical third of the root canal. There is no single irrigant that qualifies as ideal. The aim of this study was to evaluate the effectiveness of 25% ethanol extract of white turmeric (*Curcuma zedoaria*) as an irrigation solution on cleanliness in the apical third of the root canal.

**Materials and Methods:** A total of 18 samples from mandibular premolars were decoronated. Three groups of root samples were instrumented with ProTaper for hand use and irrigated as follows: group 1 with 25% extract of *C. zedoaria*, group 2 (positive control) with 2.5% NaOCl followed by final irrigation with 17% ethylenediaminetetraacetic acid, and group 3 (negative control) with distilled water. Samples were sectioned longitudinally and the apical third region of root canal was observed by 2 examiners using a microscope at ×50 magnification to measure microstructures. The level of cleanliness of the root canals was analyzed with the kappa, Kruskal-Wallis, and Mann-Whitney tests.

**Results:** The results showed that there was no significant difference in root canal cleanliness between group 1 and group 2.

**Conclusions:** It can be concluded that 25% extract of *C. zedoaria* is effective for cleaning the apical third region of root canals.

**Keywords:** Apical third region; *Curcuma zedoaria* extract; Irrigation solution; Smear layer

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# Comparative evaluation of gloss of aesthetic restorative materials: an *in vitro* study

Priti Desai\*

Department of Conservative Dentistry and Endodontics, Guru Nanak Institute of Dental Science and Research, Kolkata, West Bengal, India



\*Presenting author

Priti Desai

Department of Conservative Dentistry and Endodontics, Guru Nanak Institute of Dental Science and Research, 157/F, Nilgunj Rd, Sahid Colony, Panihati, Kolkata, West Bengal 700114, India.

E-mail: drpriti111@gmail.com

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## ABSTRACT

**Objectives:** To evaluate and compare the gloss of 5 composite resins using a glossmeter after 24 hours.

**Materials and Methods:** Samples of composite resins were fabricated in a plastic mold (6 mm in diameter × 2 mm in height), which was cut out from a polyethylene pipe. After removing samples from the molds and stored in dry, dark containers, at 37°C ± 1°C for 24 hours. The samples were divided into 5 groups ( $n = 10$ ) depending on material used: group I, Tetric N-Ceram; group II, SolarX; group III, Filtek Z350; group IV, NT Premium; group V, Centin N. Gloss was measured with a glossmeter on a scale of 1 to 100 with a square measurement area of 2 × 2 mm and 60° geometry. After one reading was taken, the specimen was rotated 90° to take another reading. The mean of the 2 readings was recorded for each specimen in gloss units (GU). To eliminate the influence of the overhead light, the aperture of the glossmeter and the specimen were covered with a dark box during the gloss evaluation.

**Results:** The gloss of the various composite resins was ranked in the following order: NT Premium (132.3 GU), SolarX (116.7 GU), Filtek Z350 (106.5 GU), Centin N (94.4 GU), and Tetric N-Ceram composite resin (91.2 GU). Analysis of variance showed that there was a significant difference in the mean gloss scores of these composite resin, and Tukey's critical difference showed that the mean gloss of Tetric N-Ceram was significantly lowest and that of NT Premium was significantly highest ( $p < 0.001$ ).

**Conclusions:** The gloss of a composites is important for the surface shine and visual appearance due to light reflection. Materials with a high gloss give a better esthetic appearance to a restoration. In this study, it was found that the nanohybrid NT Premium showed the highest gloss, followed by SolarX, Filtek Z350, and Centin N, and finally, the least gloss was observed with the Tetric N-Ceram composite resin.

**Keywords:** Composite resin; Gloss determination; Gloss meter; 24 hours

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# Effects of daily drinks on the color stability, roughness, and microhardness of nanocomposite

Mohammed Sagir,\* Anusree MP, Dhanya Sagar, Jayakanth K, Sibin P Mathew

Department of Conservative Dentistry and Endodontics, Royal Dental College, Chalissery, Kerala, India



\*Presenting author

Mohammed Sagir

Department of Conservative Dentistry and Endodontics, Royal Dental College, Iron Hills, Chalissery, Palakkad, Kerala 679536, India.  
E-mail: sagirdr@gmail.com

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## ABSTRACT

**Objectives:** To assess the color stability, surface roughness, and microhardness of composite resins exposed to daily beverages.

**Materials and Methods:** A total of 105 samples of composite restorative material measuring 8 mm in diameter and 2 mm in height were prepared using an acrylic mold, placed in sterilized human saliva, and stored at 100% relative humidity at 37°C for 24 hours in an incubator for rehydration. Samples were randomly divided into 7 groups ( $n = 15$ ): stimulated human saliva as control, coffee (group 2, 5 g of coffee + 200 mL of distilled water), coffee with sugar (prepared like group 2 + 10 g of sugar), coffee with milk (prepared like group 2 + 100 mL of milk), black tea (5 g of black tea + 200 mL of water), lime juice, and Coca-Cola. Samples were immersed in all the groups, and incubated at 37°C three times a day for 10 minutes at an interval of 6 hours. The procedure was repeated for 30 days. Color stability, microhardness, and surface roughness were measured before and after immersion in selected media by using the VITA Easy Shade Guide, a Vickers microhardness tester, and scanning electron microscopy.

**Results:** Maximum discoloration was shown in the coffee group, and the maximum reduction in hardness and roughness in the Coca-Cola group.

**Conclusions:** All specimens except the samples placed in saliva and lime juice showed discoloration after the test period. The presence of sugar and milk in coffee decreased the staining. Acidic beverages increased surface roughness and thereby decreased the hardness of nanocomposite, unlike alkaline beverages.

**Keywords:** Discoloration; Microhardness; Nanocomposite; Scanning electron microscopy

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# Clinical analysis of preventive treatment effects in cracked teeth



Reetu Shrestha\*

Department of Conservative Dentistry and Endodontics, National Academy of Medical Sciences, Kathmandu, Nepal

\*Presenting author

Reetu Shrestha

Department of Conservative Dentistry and Endodontics, National Academy of Medical Sciences, Sun Bikram Gyawali Marga, Kathmandu 44600, Nepal.  
E-mail: rreetuz@gmail.com

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## ABSTRACT

**Objectives:** To analyze the effects of the preventive treatment of cracked teeth that are asymptomatic or have symptoms of reversible pulpitis, with the goal of preventing the future possible catastrophic fracture.

**Materials and Methods:** A total of 30 patients with 45 mesio-distally oriented cracked teeth were included in the study. The teeth were classified into 3 groups according to the depth of the prepared cavity: group A, 0.5 to 1 mm into the dentin ( $n = 12$ ), group B, 1.1 to 1.5 mm into the dentin ( $n = 15$ ), and group C, 1.6 to 2 mm into the dentin ( $n = 18$ ). Group C was further sub-divided depending upon the presence (group C-I,  $n = 10$ ) or absence (group C-II,  $n = 8$ ) of a visible crack line at the base of the cavity. All the teeth were restored with light-curing posterior composite resin. Only the teeth in group C-I were lined with light-curing calcium hydroxide lining before restoration. The patients were recalled at 6 months and 12 months. The condition of the restoration and tooth, as well as signs and symptoms, were evaluated and recorded. SPSS version 16 was used for the statistical analysis.

**Results:** A total of 4 cases failed (8.8%). All the failures were in group C-I. However, there was no significant difference ( $p = 0.38$ ) in treatment outcomes according to the presence or absence of a crack line at the base of the cavity depth (deeper than 2 mm into the dentin).

**Conclusions:** Posterior incomplete cracked teeth without caries or previous restoration and with a mesio-distal orientation, regardless of whether they are asymptomatic or have signs and symptoms of reversible pulpitis, can be managed successfully in about 91.2% of cases with a direct composite resin restorative material for at least a period of 12 months.

**Keywords:** Composite resin; Cracked teeth; Cracked tooth syndrome



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\*Presenting author

Chi Hung Chen

School of Dentistry and Graduate Institute of  
Clinical Dentistry, National Taiwan University,  
No. 1, Section 4, Roosevelt Rd, Da'an District,  
Taipei City 10617, Taiwan.

E-mail: rudychen66@gmail.com

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# Bonding mechanism of bioceramic-based sealer to resin cemented glass-fiber posts

Chi Hung Chen,<sup>1\*</sup> Wan-Chuen Liao,<sup>1</sup> Yu-Chih Chiang<sup>1,2</sup>

<sup>1</sup>School of Dentistry and Graduate Institute of Clinical Dentistry, National Taiwan University, Taipei City, Taiwan

<sup>2</sup>Division of Restorative and Esthetic Dentistry, National Taiwan University Hospital, Taipei City, Taiwan

## ABSTRACT

**Objectives:** Endodontically treated tooth sometimes needs a glass-fiber post to provide its favorable mechanical properties. The consequent bonding effect of glass-fiber posts on bioceramic-based sealer (BC sealer, Brasseler) remains unknown. The aim of this research was to explore the bonding mechanism of BC sealer to glass-fiber posts via resin cement.

**Materials and Methods:** First we identified the crystal phase changes of BC sealer using an X-ray powder diffractometer (X'pert Pro, Philips). Thirty-two single-rooted human mandibular premolars and upper central incisors were collected, and after root canal shaping, post cementation were performed with U200 resin cement and glass-fiber posts (3M ESPE). We randomly divided the teeth into 4 groups: sealer, sealer removed, primer (Panavia V5, Clearfil Ceramic Primer, Kuraray Medical Inc.), and control groups. The splitting tensile bond strength ( $\sigma_t$ ) test, fractography analysis by scanning electron microscopy, energy-dispersive X-ray spectroscopy (EDS), and ultra-high speed camera photography were carried out. The data were analyzed using one-way analysis of variance and the *post hoc* Tukey's test ( $\alpha = 0.05$ ).

**Results:** The primer group exhibited a significantly higher  $\sigma_t$  ( $15.9 \pm 2.4$  MPa) than the sealer ( $12.3 \pm 1.9$  MPa) and sealer removed ( $14.0 \pm 2.7$  MPa) groups ( $p < 0.05$ ). The sealer group presented a lower  $\sigma_t$  than the control group ( $14.2 \pm 2.7$  MPa,  $p < 0.05$ ). Adhesion failure mostly occurred between the BC sealer and U200. However, in the primer group only, adhesion failure occurred between the glass-fiber posts and U200. EDS identified that zirconia primarily appeared on the surface of the root canal wall.

**Conclusions:** The BC sealer impaired the resin bonding between the fiber post and root dentin. The zirconia primer of Panavia V5 could improve the bond strength to glass-fiber posts when the root canal was filled with BC sealer. In addition, crystallized BC sealer did not penetrate into dentinal tubules effectively.

**Keywords:** BC sealer; Glass-fiber post; Scanning electron microscopy; Splitting tensile bond strength; Ultra-high speed camera



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# Novel quaternary ammonium and riboflavin (QARF)-modified dentin adhesive in enhancing performance of adhesive restorations

Liang Lin Seow,<sup>1\*</sup> Umer Daood,<sup>1</sup> Hanan Omar,<sup>2</sup> Saad Qasim,<sup>3</sup> Liebert P. Nogueira,<sup>3</sup> Malakarjuna Rao Pichika,<sup>4</sup> Kit-Kay Mak,<sup>4</sup> Liviu Steier,<sup>5</sup> Amr S Fawzy,<sup>6</sup> Yiu CKY<sup>7</sup>

<sup>1</sup>Clinical Dentistry, Restorative Division, School of Dentistry, International Medical University, Kuala Lumpur, Malaysia

<sup>2</sup>Missouri School of Dentistry and Oral Health (MOSDOH) – ATSU, Kirksville, MO, USA

<sup>3</sup>Department of Biomaterials, Institute of Clinical Dentistry, University of Oslo, Oslo, Norway

<sup>4</sup>Department of Pharmaceutical Chemistry, School of Pharmacy, International Medical University, Kuala Lumpur, Malaysia

<sup>5</sup>Post-Graduate Program in Dentistry, Federal University of Rio Grande do Sul, Porto Alegre, Rio Grande do Sul, Brazil

<sup>6</sup>UWA Dental School, University of Western Australia, Nedlands, Australia

<sup>7</sup>Paediatric Dentistry and Orthodontics, Faculty of Dentistry, The University of Hong Kong, Prince Philip Dental Hospital, Hong Kong

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**\*Presenting author**

Liang Lin Seow

Clinical Dentistry, Restorative Division, School of Dentistry, International Medical University, Jln Jalil Perkasa 19, Bukit Jalil, Kuala Lumpur 57000, Malaysia.

E-mail: lianglin\_seow@imu.edu.my

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## ABSTRACT

**Objectives:** This study was conducted to evaluate the cytotoxicity and antimicrobial and anti-proteolytic effects of a quaternary ammonium and riboflavin (QARF)-modified dentin adhesive.

**Materials and Methods:** Dentin discs treated with experimental dentin adhesives containing 0.5%, 1%, and 2% QARF were used for seeding a NIH 3T3 mouse fibroblast cell line on the pulpal side of the discs. The deposition of mineralized nodules on dentin surfaces was evaluated using Alizarin Red staining after 14 days. The anti-proteolytic effect was evaluated using the supernatant of adhesive-treated dentin via enzyme-linked immunosorbent assay for matrix metalloproteinase (MMP)-2 and cathepsin-K. *Streptococcus mutans* was used for single-species biofilm formation and evaluated using confocal laser scanning microscopy. Nodule deposition was analyzed using one-way analysis of variance (ANOVA) to examine the effect of adhesives. Dentinal MMP-2/cathepsin-K and Raman depth analysis were analyzed using one-way ANOVA.

**Results:** The mean percentage of live bacteria in the 1% and 2% QARF groups was significantly lower than in the 0.5% QARF and control groups. Mineralized nodules were significantly increased in the QARF groups, showing a sensitivity of 69.33% and a specificity of 41.5%. The control group showed the highest percentage of live bacteria (99.03% ± 2.4%), followed by 0.5% QARF > 1% QARF = 2% QARF ( $p < 0.05$ ). Mineralized nodule deposition was significantly reduced in the 2% QARF group after 14 days ( $p < 0.05$ ).

**Conclusions:** Incorporation of 1% QARF in the experimental adhesive led to simultaneous antimicrobial and anti-proteolytic effects with no cytotoxic effects.

**Keywords:** Cytotoxic; MMP; Raman; Quaternary ammonium

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Poster Presentations  
Clinical Case Presentation



**\*Presenting author**

**Robin Theruvil**

Department of Conservative Dentistry and  
Endodontics, St Gregorios Dental College,  
Chelad, P.O, Kothamangalam, Ernakulam Dist.,  
Kerala 686681, India.

E-mail: drrobintheruvil@gmail.com

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# Endodontic management of a fused mandibular second and third molar diagnosed with CBCT

Robin Theruvil,<sup>1\*</sup> Prasanth Dhanapal,<sup>2</sup> Ganesh C,<sup>3</sup> Anoj George,<sup>4</sup> Jain Mathew<sup>1</sup>

<sup>1</sup>Department of Conservative Dentistry and Endodontics, St Gregorios Dental College, Kothamangalam, India

<sup>2</sup>Department of Conservative Dentistry and Endodontics, Royal Dental College, Chalicherry, India

<sup>3</sup>Department of Conservative Dentistry and Endodontics, Sri Sankara College, Varkala, India

<sup>4</sup>Department of Periodontics, GSL Dental College, Rajmundry, India

## ABSTRACT

**Introduction:** The glossary of endodontic terms describes fusion as a “double” tooth resulting from the union of two adjacent tooth germs. This article reports an unusual case of fused mandibular second and third molars that was diagnosed with CBCT and successfully managed with non-surgical endodontic therapy.

**Case:** The unpredictable anatomy of the root canal system makes predictable and successful endodontic therapy a challenging task. This is further complicated by the various anatomical anomalies which can occur in the dentition and the limited visualization of the tooth anatomy provided by conventional imaging systems such as radiographs. The diagnostic value of conventional radiography is limited in these cases. With the advent of cone-beam computed tomography (CBCT), a more accurate picture of the root canal anatomy can be visualized at a much lower radiation dosage. This article reports the non-surgical endodontic treatment of a fused mandibular second and third molar, diagnosed with the help of CBCT.

**Conclusion:** Fusion of permanent mandibular molars is a rare occurrence, with very few reports in the literature. Three-dimensional imaging modalities, such as cone-beam volumetric tomography, serve as a valuable adjunct to conventional diagnostic methods to aid in the effective management of such anatomically challenging cases.

**Keywords:** CBCT; Fused molar; Fusion; Mandibular second and third molar

Poster Presentations  
Clinical Case Presentation



## Conservative management of a mandibular molar with a furcation defect: a case report

Ryza Indah Permatasari,\* Putu Ferbika Mitamadella, Dian Agustin Wahjuningrum, Latief Mooduto

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia



**\*Presenting author**

**Ryza Indah Permatasari**

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Campus A UNAIR Jl. Prof. Dr. Moestopo No. 47, Surabaya 60132, Indonesia.  
E-mail: ryzaindahp@gmail.com

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### ABSTRACT

**Introduction:** Modern advanced dentistry makes it possible to preserve functional dentition for a lifetime. Loss of the posterior teeth is damaging, because it often leads to teeth tipping, loss of masticatory function, and loss of arch length, which requires prevention and maintenance measures. Hemisection is an option for preserving posterior teeth. Hemisection refers to the sectioning of a molar tooth, with the removal of an unrestorable root that may be affected by periodontal, endodontic, or carious lesions. The aim of this study was to report hemisection as a treatment for a mandibular molar with a defect on the furcation.

**Case:** This case report describes a procedure of endodontic retreatment and hemisection of the left mandibular second molar with a furcation defect. A 22-year-old man presented with a chief complaint of pain in the lower left mandible for 2 weeks. The patient felt discomfort when biting. The left mandibular second molar had been treated previously, but the restoration came off a few months ago.

**Conclusions:** Hemisection is a viable treatment to preserve an otherwise hopeless tooth with a furcation defect.

**Keywords:** Furcation defect; Hemisection; Preserve tooth

Poster Presentations  
Clinical Case Presentation



# Management of broken instrument in root canals by bypass technique on first lower molar

Kevin Prayogo,\* Michael Golden Kurniawan, Edhie Arief Prasetyo

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia



**\*Presenting author**

Kevin Prayogo

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Campus A UNAIR Jl. Prof. Dr. Moestopo No. 47, Surabaya 60132, Indonesia.

E-mail: kevin\_prayogo92@yahoo.co.id

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## ABSTRACT

**Introduction:** Endodontic file fracture has traditionally been considered an uncommon event. Nonetheless, a fractured instrument represents a complex condition, especially when the file fracture is located near the apex. There is a potential risk of contamination associated with such a situation, which would compromise the healing process. Various devices and techniques have been introduced in endodontics for the retrieval of fractured instruments, including bypass. The bypass technique is a simple and effective technique for the management of a broken instrument in the root canal. The purpose of this case report was to evaluate the efficiency of the bypass technique as a management strategy for retrieval of broken a file.

**Case:** A 13-year-old female patient came with a chief complain of her previously treated first lower left molar (36), which had been previously treated endodontically, without any restoration done. The patient had felt discomfort when biting for a week, and a periapical radiograph examination, showed that there was a broken file located on the apex of the mesio-buccal canal. In endodontic treatment planning, bypass was chosen for the management of the broken file. A C Pilot (VDW) was chosen for creating a bypass through the broken file, using a watch-winding movement. The working length was established using a Root Zx (J. Morita). Preparation of the canals was done using Protaper Next X1-X2 (Dentsply). A crown was chosen for the final restoration with a prefabricated fiber post as the core.

**Conclusions:** If retrieval of a broken instrument fails or cannot be applied, the bypass technique can be considered as a simple and effective method for broken file management.

**Keywords:** Broken file; Bypass; Endodontic failure; Root canal treatment

Poster Presentations  
Clinical Case Presentation



# Management of wide open apices using mineral trioxide aggregate

Setyabudi Goenharto,\* Dian Agustin Wahjuningrum

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia



**\*Presenting author**

Setyabudi Goenharto

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Campus A UNAIR Jl. Prof. Dr. Moestopo No. 47, Surabaya 60132, Indonesia.  
E-mail: setyabudigoenharto@yahoo.com

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## ABSTRACT

**Introduction:** Wide open apices are a major effect caused by trauma in young permanent teeth. The major challenge in performing root canal treatment is to obtain an optimal apical seal. As dentists we need to induce root end barrier formation, through a technique called apexification. Mineral trioxide aggregate (MTA) has been successfully used for one-visit apexification in which the root canal can be obturated immediately. This study was conducted to assess the outcome of apexification using MTA.

**Case:** A 21-year-old woman was referred for management of failed endodontic treatment of the mandibular right canine tooth (tooth #43). However, the tooth had become essentially non-vital as a result of a motor vehicle accident some 4–5 years earlier. Soon after the accident, endodontic treatment was attempted but failed. Radiographic examination revealed a poorly endodontically treated mandibular right canine with a relatively short root and an associated periapical radiolucency roughly 4 mm in diameter. Retreatment with apexification using MTA was chosen for this case. The old gutta-percha filling was easily removed. The working length using was measured with an apex locator, and irrigation continued using sodium hypochlorite, EDTA, hydrogen peroxide, and dressing using Ledermix paste. At the second appointment, apexification was done using calcium hydroxide paste (Pulpdent) and sealed with Cavit G. The next appointment was scheduled 6 months later.

**Conclusions:** This case report confirms that apexification can be performed regardless of previous endodontic or surgical procedures to the tooth or apical tissues.

**Keywords:** Apexification; MTA; Wide open apices

Poster Presentations  
Clinical Case Presentation



**\*Presenting author**

**Nunik Nuraini**

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Campus A UNAIR Jl. Prof. Dr. Moestopo No. 47, Surabaya 60132, Indonesia.  
E-mail: nuraini.nunik@gmail.com

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# Management of a traumatized open apex tooth accompanied by a periapical abscess with MTA apexification and porcelain restoration

**Nunik Nuraini,\* Jayanti Rosha, Kun Ismiyatin, Sukaton Sukaton**

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia

## ABSTRACT

**Introduction:** Trauma to an immature tooth could possibly result in an open apex. An immature open apex presents special challenges for successful treatment. A large open apex, divergent root walls, and thin dentinal walls are susceptible to fracture and frequent apical lesions. Apexification with mineral trioxide aggregate (MTA) is a treatment choice for placing an apical plug in cases of teeth with an open apex. MTA is a biocompatible material that does not require a long treatment duration, has minimal leakage, and has anti-bacterial properties.

**Case:** A 30-year-old female patient presented with the chief complaint of aesthetic problems caused by a fractured left maxillary anterior tooth. The patient felt no pain in tooth 21. The tooth received a traumatic injury when she was 10 years old and was previously untreated. An oral examination revealed a fractured tooth (Ellis class IV), discoloration of the enamel, exposed pulp, no grade of mobility, nonvital pulp, and normal gingiva. A periapical radiograph showed a wide root canal, open apex, and periapical radiolucency. The treatment plan for this patient was apexification. A gentle circumferential preparation technique with a brushing motion for debridement using a #90 H-file was done, and calcium hydroxide was then applied as a dressing. Apexification using MTA was conducted 1 week later. Obturation with the backfill thermoplastic technique was done after a 1-week review with no complaint from the patient. After 1 week, the final restoration was made from a fabricated post core to correct the inclination of the tooth and the entire porcelain crown restoration.

**Conclusions:** The findings of this case report suggest that apexification using MTA could achieve root-end closure in an immature open apex tooth post-traumatic injury and could reduce periapical lesions.

**Keywords:** Apexification; MTA; Non-vital tooth; Open apex; Periapical abscess; Traumatized tooth

Poster Presentations  
Clinical Case Presentation



## Split to save: salvaging mandibular molars with furcation involvement



Amudha Lakshmi Krishnan\*

Department of Conservative Dentistry and Endodontics, Tamilnadu Government Dental College, Chennai, Tamil Nadu, India

\*Presenting author

Amudha Lakshmi Krishnan

Department of Conservative Dentistry and Endodontics, Tamilnadu Government Dental College, Opp Fort Station, Muthusamy Salai, Chennai, Tamil Nadu 600003, India.  
E-mail: lax69sree@gmail.com

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### ABSTRACT

**Introduction:** The loss of molars can result in several undesirable sequelae including shifting of teeth, supra-eruption, loss of alveolar bone, and decrease in chewing ability; therefore, the aim of an endodontist should be to preserve the tooth. A guiding principle for salvaging a tooth with a poor prognosis should be to try to maintain whatever is possible.

**Case:** Treatment strategies for retaining teeth with class 111 furcation involvement and severe bone loss in the furcation area include hemisection, bisection, or bicupidization, followed by rehabilitation and restorative dentistry. This poster presents a case report of class 111 furcation involvement in 2 different mandibular molars and 2 different ways of managing them.

**Conclusions:** Bicuspidation and hemisection should be considered as other treatment options when the choice is made to retain and not remove natural teeth, especially in cases of severe vertical bone loss, bone loss extending through the furcation area, unfavorable proximity of roots, or severe root exposure, as demonstrated in this case.

**Keywords:** Bicuspidisation; Furcation; Hemisection

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November 8–10, 2019 · Seoul, Korea



Poster Presentations  
Clinical Case Presentation



**\*Presenting author**

**Dian Agustin Wahjuningrum**

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Campus A UNAIR Jl. Prof. Dr. Moestopo No. 47, Surabaya 60132, Indonesia.  
E-mail: dianagustin\_fkg@yahoo.co.id

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# Hemisection: a conservative treatment of furcation involvement that provides the opportunity for lifetime tooth preservation

**Dian Agustin Wahjuningrum,\* Setyabudi Goenharto**

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia

## ABSTRACT

**Introduction:** Progress in dentistry gives hope for sufferers to maintain their teeth. Hemisection is a treatment performed to maintain teeth by separating roots with the crown part on multiple-root teeth. This procedure is a conservative form of dentistry, which aims to maintain dental function in the stomatognathic system.

**Case:** A 20-year-old woman with wide carious teeth presented to our dental clinic. The patient wanted to keep her teeth as long as possible. Clinically the presence of very severe caries along with furcation involvement was established. Hemisection was chosen because of the patient's desire to maintain her teeth and keep the teeth still enough to support the alveolar bone. The endodontic treatment procedure was successful. Half of the distal part of the tooth was extracted, and the remaining tooth underwent endodontic treatment and was restored as a premolar, helping to reduce the masticatory load.

**Conclusions:** Hemisection is an effective treatment for keeping teeth as long as possible. This article describes a simple procedure for hemisection of the mandibular molar.

**Keywords:** Furcation involvement; Hemisection; Mandibular molar



Poster Presentations  
Clinical Case Presentation



# Intentional replantation of a maxillary second molar

Joy Lane N. Cuntig,\* Joseph Acosta

Endodontics Department, University of Baguio School of Dentistry, Baguio City, Philippines



**\*Presenting author**

Joy Lane N. Cuntig

Endodontics Department, University of Baguio  
School of Dentistry, General Luna Road,  
Baguio City 2600, Philippines.  
E-mail: cjoylane22@gmail.com

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## ABSTRACT

**Introduction:** Sometimes, the desired surgical endodontic treatment of a tooth may not be feasible for anatomical or other reasons. A planned extraction with repair of the tooth outside the mouth and subsequent replantation, referred to as intentional replantation, may then be the treatment of choice. Intentional replantation may be an option when surgical access is very limited or presents unacceptable risks. Although traditionally viewed as a treatment of last resort, the past several years have seen a renewed interest in intentional replantation, and several authors have reported a reasonably high success rate when a protocol designed to minimize trauma to the periodontal ligament was followed.

**Case:** A 22-year-old female patient came for a consultation due to pain on tooth 17. Based on clinical and radiographic findings, the diagnosis of symptomatic irreversible pulpitis and symptomatic apical periodontitis was established. Because of a limited mouth opening and thick buccal mucosa, conventional root canal treatment may have been impossible due to inadequate access and visibility; thus, intentional replantation was recommended. The tooth was extracted atraumatically, then root canal treatment was done. Next, the tooth was gently replanted back into the socket and a suture was administered. Then, the tooth was restored with glass ionomer cement and a composite filling material. The patient was given post-operative instructions, and recall was done after a week, during which time the patient presented no signs of discomfort, mobility, pain and inflammation. Follow-up check-ups were also advised to the patient for evaluation and monitoring.

**Conclusions:** With appropriate case selection, intentional replantation can be a reliable and predictable procedure. In this case report, short-term successful management of intentional replantation of a maxillary second molar is presented. While the patient was satisfied with the result, she is also receiving long-term follow-up.

**Keywords:** Intentional replantation; Root canal treatment; Surgical endodontics

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November 8–10, 2019 · Seoul, Korea

Poster Presentations  
Clinical Case Presentation



# A case of periradicular surgery: apex resection as a treatment for tooth preservation

Iin Indah Aris Wati,<sup>\*</sup> Latief Mooduto, Dian Agustin Wahjuningrum

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Jawa Timur, Indonesia



**\*Presenting author**

Iin Indah Aris Wati

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Kampus A Unair, Jl. Mayjen Prof. Dr. Moestopo No.47, Pacar Kembang, Kec. Tambaksari, Kota Surabaya, Jawa Timur 60132, Indonesia.  
E-mail: iinindah601@yahoo.com

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## ABSTRACT

**Introduction:** This paper reports a case of periradicular surgery with apex resection. Apex resection is considered as the best attempt to save teeth which cannot be treated with conventional endodontic approach. This is usually necessary when a conventional root canal therapy had failed and a re-treatment was already unsuccessful or is not advised. The main goal of apex resection is to create a barrier between the root-canal system and the periradicular tissues by means of a tight root-end filling, which is placed within the new cavity to close the path of communication the root canal system and periradicular tissue. State of the art procedures use micro-surgical techniques, such as a dental operating microscope, micro-instruments, ultrasonic preparation tips and calcium silicate based filling material.

**Case:** A 35 years old women patient presented with tooth pain on front left upper jaw, the chief complaint was severe pain since last 8 months. Clinically, teeth #21 and #22 were discolored, non-vital, and sensitive to percussion, but periodontal condition was stable with normal mucosa color and no mobility. In addition, there was a radiolucent appearance surrounding teeth #21 and #22. Patient was scheduled for surgical endodontic treatment on teeth #21 and #22 with apex resection.

**Conclusions:** Apex resection is that treatment choice for tooth preservation.

**Keywords:** Apex resection; Flap; Periapical injury

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The 1st General Meeting of  
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November 8–10, 2019 · Seoul, Korea

Poster Presentations  
Clinical Case Presentation



**\*Presenting author**

**Christine Anastasia Rovani**

Department of Conservative Dentistry,  
Hasanuddin University, Jl. Perintis  
Kemerdekaan Km.10, Makassar 90245,  
Indonesia.

E-mail: ch\_rovani@yahoo.com

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# Direct versus indirect veneer restoration for esthetic rehabilitation: a case report

**Christine Anastasia Rovani\***

Department of Conservative Dentistry, Hasanuddin University, Makassar, Indonesia

## ABSTRACT

**Introduction:** Patients with discolored teeth frequently present to the dentist requesting restorations designed to improve their appearance. For teeth that are sound, this might include the use of a veneer restoration. Minimal-preparation veneers associated with enamel preservation offer predictable results in esthetic dentistry, and indirect additive anterior composite restorations represent a quick, minimally invasive, inexpensive, and repairable option for a smile enhancement treatment plan. One case presented herein involved a minimal intervention for aesthetic rehabilitation of six upper anterior teeth with indirect veneers, while the other case involved aesthetic correction with direct nanohybrid resin composite veneer.

**Case:** Case 1: A 36-year-old female patient presented to the clinic, complaining about discoloration of the restoration of 6 upper anterior teeth. An intraoral examination of the 6 upper anterior teeth revealed a discolored resin composite restoration. The CE test was positive (+), percussion was negative (–), palpation was negative (–), and the teeth were diagnosed with reversible pulpitis. An indirect veneer restoration with ceramic was planned for the patient. Case 2: An 18-year-old female patient presented to the clinic, complaining about discoloration of her central incisor tooth restoration. An intraoral examination of the tooth revealed a discolored resin composite restoration. The CE test was positive (+), percussion was negative (–), palpation was negative (–), and the tooth were diagnosed with reversible pulpitis. Direct veneer restoration with a nanohybrid resin composite was planned for the patient.

**Conclusions:** Direct and indirect veneer restoration are treatments involving minimal interventions that can provide satisfactory results for aesthetic rehabilitation.

**Keywords:** Direct veneer; Indirect veneer; Rehabilitation aesthetic

Poster Presentations  
Clinical Case Presentation



# Metal inlay as one of the best restorations for vital posterior teeth: a case report

Tirta Asprimi Angraeni,<sup>\*</sup> Christine Anastasia Rovani, Mufliha Siri

Department of Conservative Dentistry, Hasanuddin University, Makassar, Indonesia



**\*Presenting author**

**Tirta Asprimi Angraeni**

Department of Conservative Dentistry,  
Hasanuddin University, Jl. Perintis  
Kemerdekaan Km.10, Makassar 90245,  
Indonesia.

E-mail: tirtaasprimi@gmail.com

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## ABSTRACT

**Introduction:** Aesthetic restorations are a major concern for all practitioners in the field of dentistry today. The increased demand for aesthetic fillings by patients has led dentists always to prioritize the selection of restorative materials with natural color, sometimes without considering the indications and contraindications of the material. In restorative dentistry, a metal inlay is still the best choice for posterior teeth with severe occlusion pressure and missing 1 or 2 cusps. Although metal inlays have an aesthetically unfavorable appearance, this problem is not a concern for posterior teeth.

**Case:** A 35-year-old woman presented to the dental hospital of Hasanuddin University in Makassar, complaining about her tooth restoration being repeatedly detached. An intraoral examination of tooth 26 showed proximal caries. The CE test was positive (+), percussion was negative (-), palpation was negative (-), and tooth 26 was diagnosed with reversible pulpitis. A vital indirect inlay restoration with metal material was planned for the patient.

**Conclusions:** A metal inlay provides contact control, superior contour, and high strength. Metal inlay restorations can withstand the heavy occlusal forces of mastication and distribute strength evenly and directly along the axis of the tooth structure, thereby preventing tooth fracture. The inlay also maintains intact enamel and lingual surface structures so as to maintain the health of the surrounding periodontium, thereby contributing to increased restoration endurance.

**Keywords:** Indirect restoration; Metal inlay; Occlusal forces; Vital tooth

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November 8–10, 2019 · Seoul, Korea

Poster Presentations  
Clinical Case Presentation



# Onlay porcelain as an indirect restoration on an endodontically treated mandibular molar

Mufliha Siri,\* Christine Anastasia Rovani, Tirta Asprimi Angraeni

Department of Conservative Dentistry, Hasanuddin University, Makassar, Indonesia



**\*Presenting author**

**Mufliha Siri**

Department of Conservative Dentistry,  
Hasanuddin University, Jl. Perintis  
Kemerdekaan Km.10, Makassar 90245,  
Indonesia.

E-mail: muflihasiri86@gmail.com

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## ABSTRACT

**Introduction:** The post-endodontic restoration greatly influences the success of an endodontic treatment. In posterior teeth, the extent of caries and the large amount of tissue removal during endodontic treatment, especially when opening the pulp access, lead to weakened tooth structure. This condition results in minimal retention and decreased resistance to fracture. Therefore, it is important to ensure cusp coverage on the occlusal surface because it can protect the remaining tooth structure. Dental porcelain is the most commonly used material for partial or total restoration of teeth that are physiologically worn, decayed or fractured. This material has high mechanical resistance to abrasion, low thermal and electrical conduction, chemical stability, and good wear resistance.

**Case:** A 26-year-old male patient came to the dental hospital, was diagnosed with irreversible pulpitis in the mandibular left molar, and received a restoration on the distal aspect. The treatment plan for tooth 36 was endodontic treatment with the crown-down pressureless biomechanical preparation technique and restoration with onlay porcelain. An onlay porcelain restoration was chosen because it could provide cusp coverage for the remaining tooth structure and has excellent resistance to occlusal loads.

**Conclusions:** Onlay porcelain is a choice for post-endodontic restorations on the posterior tooth with sufficient thickness of remaining tooth structure or with 1 or 2 missing cusps. This restoration is not only conservative, but also provides excellent retention and resistance to the posterior tooth and good aesthetic value.

**Keywords:** Cusp coverage; Indirect restoration; Onlay porcelain; Post endodontic treatment

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Poster Presentations  
Clinical Case Presentation



# Endocrowns: stepwise clinical preparation and restoration using CAD-CAM composite and pressed lithium disilicate materials

Noor Aaina Zainon,<sup>1</sup> Zethy Hanum Mohamed Kassim,<sup>1</sup> Abu Razali Saini,<sup>2</sup>  
Tong Wah Lim<sup>1</sup>

<sup>1</sup>Centre for Restorative Dentistry Studies, Faculty of Dentistry, Universiti Teknologi MARA, Sungai Buloh, Selangor, Malaysia

<sup>2</sup>Klinik Pergigian MyDENTIST@Ampang, Ampang Jaya, Selangor, Malaysia



**\*Presenting author**

Noor Aaina Zainon

Centre for Restorative Dentistry Studies,  
Faculty of Dentistry, Universiti Teknologi  
MARA, 47000 Sungai Buloh, Selangor,  
Malaysia.

E-mail: zdaaina85@gmail.com

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## ABSTRACT

**Introduction:** The management for restoration of endodontically treated teeth (ETT) has been widely discussed in the literature. ETT preserve, protect the existing tooth structure and provide a coronal seal, while restoring satisfactory aesthetics, form, and function. The Endocrowns have been used as an alternative to conventional post-core crowns and at the same time able to provide quick, good aesthetics and the predictable alternative treatment option of restoring ETT. Each step of clinical and laboratory procedures has an impact in terms of longevity and esthetic results.

**Case:** Two case series represent the fabrication of Endocrowns, and the aim of this study is to describe in a stepwise manner the rehabilitation of extensively damaged molar teeth using computer aided design-computer aided manufacture (CAD-CAM) composite and Pressed Lithium disilicate materials. Attention will be particularly focused on the surface treatment and cementation procedures when using these materials for restoring ETT.

**Conclusions:** Endocrowns fabricated using CAD-CAM composite and Pressed Lithium disilicate materials can be considered as a reliable option for the restoration of extensively damaged molar teeth. However, long-term follow-up and longitudinal clinical studies are needed to ensure their overall success.

**Keywords:** CAD-CAM system; Endocrown; Endodontically treated tooth; Indirect composite; Lithium disilicate

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Poster Presentations  
Clinical Case Presentation



# Aesthetic rehabilitation with direct composite veneer: a case report

Putu Yuri Divina,\* Latief Mooduto, Dian Agustin Wahjuningrum

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Jawa Timur, Indonesia



**\*Presenting author**

**Putu Yuri Divina**

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Kampus A Unair, Jl. Mayjen Prof. Dr. Moestopo No.47, Pacar Kembang, Kec. Tambaksari, Kota Surabaya, Jawa Timur 60132, Indonesia.  
E-mail: divina.geg@gmail.com

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## ABSTRACT

**Introduction:** Nowadays veneer has become satisfactory restoration to improve aesthetics of smile. Composite veneer can be placed layering the tooth directly or indirectly.

**Case:** A 28 years old female complained about unconfident smile because one of her upper anterior teeth was discolored. The author had performed direct composite veneer on her right upper lateral incisor. Low cost for patient compared with indirect techniques and other prosthetic approaches, short visit, no need for tooth preparation, no need for an additional adhesive cementing system, reversibility, and retreatment are some advantages of this technique.

**Conclusions:** Direct composite veneer can be used to laminate single tooth discoloration. The result of this procedure is an aesthetic anterior tooth within short time.

**Keywords:** Aesthetic treatment; Composite; Veneer



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Clinical Case Presentation



# Esthetic treatment of discolored anterior teeth with indirect porcelain veneer technique

Yashinta Ramadhinta,\* Sukaton, Dian Agustin Wahjungrum

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Jawa Timur, Indonesia



**\*Presenting author**

Yashinta Ramadhinta

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Kampus A Unair, Jl. Mayjen Prof. Dr. Moestopo No.47, Pacar Kembang, Kec. Tambaksari, Kota Surabaya, Jawa Timur 60132, Indonesia.  
E-mail: yramadhinta@gmail.com

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## ABSTRACT

**Introduction:** Esthetic dentistry now needs a combination between function and beauty to restore patient's appearance during smile. Various esthetic materials and techniques were introduced to the dental professionals in the field of conservative and esthetic dentistry. Discoloration of anterior teeth is one of the most frequent reasons why a patient seeks dental care. In the management of patients with discolored teeth, knowledge of the mechanisms behind tooth discoloration is mandatory as it can influence the treatment plan. Veneers are the most frequently prescribed esthetic restorations today. Porcelain veneer is a technique of restoring the appearance of discolored teeth, which provides extremely good esthetic and strength. The aim of this case report is to improve esthetics in discolored upper anterior teeth with porcelain veneers.

**Case:** A 30-year-old female was referred to the Department of Conservative Dentistry at Dental Hospital, Faculty of Dental Medicine, Universitas Airlangga with a chief complaint of discolored anterior teeth. The patient was unhappy with her teeth and restrained herself from smiling and wanted to improve her anterior maxillary teeth. Clinically, there were some opaque, white chalky, and irregularities on the surface of upper anterior teeth. Indirect porcelain veneer had been chosen as a restoration. The patient was satisfied with the enhanced esthetic appearance.

**Conclusions:** Indirect porcelain veneer is an effective treatment for discolored teeth, which can improve patient's smile appearance and self-confidence.

**Keywords:** Discoloration; Esthetic dentistry; Porcelain veneers

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Poster Presentations  
Research Presentation



# Endodontic treatment decision in maxillary molars with sinus involvement



Sanghyun Lee,<sup>1\*</sup> Kyung A Chun,<sup>2</sup> Seung-Ho Baek<sup>1</sup>

<sup>1</sup>Department of Conservative Dentistry, Seoul National University School of Dentistry, Seoul, Korea

<sup>2</sup>Department of Conservative Dentistry, Korea University Anam Hospital, Seoul, Korea

\*Presenting author

Sanghyun Lee

Department of Conservative Dentistry, Seoul National University School of Dentistry, 101 Daehak-ro, Jongno-gu, Seoul 03080, Korea.  
E-mail: leesh014@gmail.com

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## ABSTRACT

**Objectives:** To assess treatment decision tendency in clinic when maxillary molars have endodontic infection with presence of mucosal changes related to maxillary sinus.

**Materials and Methods:** The patients were selected from the clinic of the Department of Conservative Dentistry, Seoul National University Hospital, who had undergone cone beam computed tomography (CBCT) for single tooth in their maxillary molars for endodontic reasons. Among them, patients who had got treatment decision after computed tomography (CT) reading were included and those who had taken CT for follow-up of previous treatment or stopped visiting before or during treatment were excluded. To evaluate mucosal changes related to maxillary sinus, the axial and coronal sections were used. The axial section was determined by apex visualization of interested molar. At that point, coronal section was determined and used to measure the mucosal thickening. The teeth were divided into 2 groups: group 1, 2–5 mm thickness without sinus elevation or perforation due to periapical lesion; group 2, thickness more than 5 mm or sinus with elevation or cortical perforation due to periapical lesion. Treatment tendency was evaluated and categorized as extraction, nonsurgical (re-)endodontic treatment, and surgical endodontic treatment.

**Results:** Two hundred and eighty-seven cases with CBCT of maxillary molars were selected, and total 202 cases were evaluated by inclusion and exclusion criteria. One hundred and twenty-three cases showed sinus mucosal thickening; 40 for group 1 and 83 for group 2. Of all treated teeth (65.7%), non-surgical (re-)endodontic treatment and surgical treatment were 55.0% and 25.0%, respectively in group 1, and 38.6% and 20.5%, respectively in group 2, without significant difference between groups. Group 1 showed less extraction than group 2 (20.0% vs. 41.0%, Pearson's  $r < 0.05$ ).

**Conclusions:** With presence of sinus-involved endodontic problem, more than half of maxillary teeth were treated endodontically, while extraction tendency increased with its severity.

**Keywords:** Maxillary sinus; Mucosal thickening; Treatment plan

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November 8–10, 2019 · Seoul, Korea

Poster Presentations  
Research Presentation



\*Presenting author

Yongmin Kim

Department of Conservative Dentistry, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, 222 Banpo-daero, Seocho-gu, Seoul 06591, Korea.  
E-mail: yongmin32@nate.com

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# Anti-bacterial efficacy between passive ultrasonic irrigation and 980-nm-GaAlAs laser application in two root types

Yongmin Kim,\* Sin-Young Kim, Sung-Eun Yang

Department of Conservative Dentistry, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea

## ABSTRACT

**Objectives:** The purpose of the present study was to investigate the anti-bacterial efficacy of passive ultrasonic irrigation (PUI) and a 980-nm-gallium-aluminum-arsenide (GaAlAs) laser using a real-time DNA-based quantitative polymerase chain reaction (qPCR) assay and scanning electron microscopy (SEM).

**Materials and Methods:** Eighty-six extracted single- and double-rooted human teeth were used in the experiment. The following 4 experimental groups were evaluated, as well as a control group: group 1, single root + PUI ( $n = 20$ ); group 2, single root + laser application ( $n = 20$ ); group 3, double roots + PUI ( $n = 20$ ); group 4, double roots + laser application ( $n = 20$ ); control group ( $n = 6$ ), 3 single roots, 3 double roots. After making working length determination, sample 1 (S1) was obtained to take the bacteria in canals. After usual canal preparation with 2.5% sodium hypochlorite solution irrigation, sample 2 (S2) was obtained. At the second visit, sample 3 (S3) was obtained as described in the initial sampling after final irrigation with 17% ethylenediaminetetraacetic acid and 2.5% sodium hypochlorite. The qPCR assay was performed in three stages to evaluate the efficacy of the adjunctive method against *Enterococcus faecalis* (*E. faecalis*). Also, SEM analysis was used to examine the microstructure of root canal surfaces.

**Results:** The increase in the C(t) (threshold cycle) value from S1 to S2 was highly significant in all groups, and significant increases in the C(t) value from S2 to S3 were found in all experimental groups except group 1 ( $p < 0.05$ ). PUI was significantly more effective in terms of antibacterial efficacy than GaAlAs laser irradiation in single rooted teeth ( $p < 0.05$ ). SEM images showed that cleaning of the root canal surface and reduction of dentin debris were achieved only in single-rooted teeth when using PUI application.

**Conclusions:** Two adjunctive methods were effective in reducing *E. faecalis* in single rooted teeth.

**Keywords:** Cycle threshold value; Gallium-aluminum-arsenide laser; Passive ultrasonic irrigation, Real-time DNA-based quantitative polymerase chain reaction assay; SEM analysis

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# Debris removal efficiency according to different ultrasonic irrigation protocols

Gun Heo,\* Jin-Woo Kim, Kyung-Mo Cho, Se-Hee Park

Department of Conservative Dentistry, Gangneung-Wonju National University, Gangneung, Korea



\*Presenting author

Gun Heo

Department of Conservative Dentistry,  
Gangneung-Wonju National University, 7  
Jukheon-gil, Gangneung 25457, Korea.  
E-mail: rjs1992@naver.com

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## ABSTRACT

**Objectives:** Canal irrigation is an essential part of a root canal treatment as it allows for cleaning beyond the root canal instruments. Many researches mentioned that passive ultrasonic irrigation (PUI) can be more effective for cleaning root canal system, compared with conventional syringe irrigation. The purpose of this study is comparing the efficiency of debris removal of PUI according to different protocols.

**Materials and Methods:** Fifty single-rooted mandibular premolars were randomly divided into 6 groups according to the power of vibration and number of times that PUI used. After canal enlargement, teeth were split longitudinally into 2 halves. On the wall of one half of root canal, three depressions were cut at 1, 3 and 5 mm from the apex and 2 depressions were cut on the other half of root canal at 2, 4 mm from the apex. Each depression was filled with mixture of dentin and 2% sodium hypochlorite (NaOCl). Each tooth was re-assembled using impression putty material. Two percent NaOCl was then delivered into each canal using different protocols PUI. After irrigation, images of the 2 halves of the canal wall were taken, using a microscope and a digital camera. The amount of remaining dentin debris in the depressions was evaluated by using a scoring system between 0–3.

**Results:** Regardless of different protocols used, PUI effectively reduced the debris in the root canal irregularities. There was no significant difference between weak and strong power of vibration groups. The debris score for the groups used once were significantly higher than that of the groups used multiply. However, no significant difference was found between the groups used twice and three times.

**Conclusions:** In mandibular premolars, the power of vibration and number of times PUI used influenced the debris removal efficiency of PUI to remove artificially placed dentin debris.

**Keywords:** Canal irregularity; Canal irrigation; Debris removal efficiency;  
Passive ultrasonic irrigation

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Poster Presentations  
Research Presentation



\*Presenting author

Ja Yeon Lee

Department of Conservative Dentistry,  
Kyungpook National University Dental  
Hospital, 2175 Dalgubeol-daero, Jung-gu,  
Daegu 41940, Korea.

E-mail: naturejy1020@gmail.com

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# Influence of age and different exposure time of final irrigant on root dentin microhardness

Ja Yeon Lee,\* Jung-Hong Ha, Myoung Uk Jin, Young Kyung Kim, Sung Kyo Kim

Department of Conservative Dentistry, Kyungpook National University Dental Hospital, Daegu, Korea

## ABSTRACT

**Objectives:** Previous studies reported that dentin microhardness was significantly reduced with the use of sodium hypochlorite (NaOCl). However, in old versus young dentin, the combined effects of NaOCl + ethylenediaminetetraacetic acid (EDTA) + NaOCl irrigation on mechanical properties are not thoroughly investigated. The purpose of this study was to compare the microhardness in different NaOCl final irrigation time on old and young dentin at coronal, middle and apical levels.

**Materials and Methods:** Eighty root halves were prepared by longitudinal splitting of extracted human premolars and embedded in acrylic resin. The microhardness was measured by using Vickers microhardness tester (HNV-2, Shimadzu) at the coronal, middle and apical levels. The root halves were randomly assigned to 4 groups composed of 20 samples each according to age (< 30 and > 50 years) and time of NaOCl final irrigation (2 minutes of 2.5% NaOCl + 1 minute of 17% EDTA + 1 minute or 10 minutes of 2.5% NaOCl). After surface treatment, dentin microhardness were measured again at close proximity to the initial indentation areas. Experimental data were statistically analyzed by using the *t*-test and one-way analysis of variance, followed by Tukey honestly significant difference test at  $\alpha = 0.05$ .

**Results:** There was a significant difference in microhardness before and after treatment in all groups. At apical level, microhardness of old dentin showed significantly more reduction than young dentin when final irrigation of 2.5% NaOCl was applied for 10 minutes. In the young dentin, there is no significant difference between 1 minute and 10 minutes final irrigation groups.

**Conclusions:** Within the limit of the present study, old dentin may induce more softening effect than young dentin especially at apical level.

**Keywords:** Age; Apical levels; Combined effects; Dentin microhardness; EDTA; NaOCl

Poster Presentations  
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\*Presenting author

Jaeyoung Ryu

Department of Conservative Dentistry, College of Medicine, University of Ulsan, Asan Medical Center, 88 Olympic-ro 43-gil, Songpa-gu, Seoul 05505, Korea.

E-mail: ko4623@naver.com

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# Biocompatibility of double antibiotic paste and enamel matrix derivative as a medicament for regenerative endodontics

Jaeyoung Ryu,\* Hyunjung Ko, Miri Kim

Department of Conservative Dentistry, College of Medicine, University of Ulsan, Asan Medical Center, Seoul, Korea

## ABSTRACT

**Objectives:** The aim of this study was to investigate biocompatibility of different concentrations of double antibiotic paste (DAP) and enamel matrix derivative (EMD) as intracanal medications for regenerative endodontics.

**Materials and Methods:** For solubility and pH tests, each specimen ( $n = 4$ ) was made with 0, 1 mg/mL, 10 mg/mL DAP (1:1, Ciprobay [Bayer] and Flasinyl [CJ]), 200 µg/mL, 400 µg/mL EMD (Emdogain, Straumann), collagen sheets (AteloPlug, Bioland), and MTA (ProRoot MTA, Dentsply). Changes in pH and solubility were obtained after 3 days of immersion in 10 mL of distilled water. For implantation tests, 46 specimens were prepared with dentin disks, collagen sheets soaked with 0 (positive control), 1 mg/mL (DAP1), 10 mg/mL (DAP10), 200 µg/mL EMD (EMD200), 400 µg/mL EMD (EMD400), and MTA. Six dentin disks were implanted for the negative control group. Specimens were inserted subcutaneously into the dorsal connective tissue of 26 BLAB/c mice. After 7 and 28 days, the animals were sacrificed. Tissue samples were sliced in 5 µm thickness and stained with hematoxylin-eosin. A grading system ranging I–IV was used to classify the inflammatory reaction under a light microscope. The Mann-Whitney  $U$  test was used to compare pH, solubility, and the grade of inflammation among the groups.

**Results:** No significant differences were found from solubility tests of all groups. EMD200 and EMD400 groups showed significantly higher pHs than the control group. At 7 days, all groups showed moderate-high inflammatory reactions. Although DAP10 group persistently presented moderate chronic inflammation, inflammatory reactions observed in EMD200, EMD400, and DAP1 groups significantly improved from slight to absent at 28 days.

**Conclusions:** DAP1 group (1 mg/mL) was significantly more biocompatible than DAP10 group (10 mg/mL) at 28 days ( $p < 0.05$ ), while both EMD groups presented good tissue reaction at 28 days.

**Keywords:** Biocompatibility; Double antibiotic paste; Enamel matrix derivative; Regenerative endodontics

Poster Presentations  
Research Presentation



# Effects of xanthone against LPS-induced inflammation in human dental pulp cells

Yu-Seon Kim,<sup>\*</sup> Sung-Hyeon Choi, Bin-Na Lee, Hoon-Sang Chang, Yun-Chan Hwang, In-Nam Hwang, Won-Mann Oh

Department of Conservative Dentistry, Chonnam National University School of Dentistry, Gwangju, Korea



**\*Presenting author**

Yu-Seon Kim

Department of Conservative Dentistry,  
Chonnam National University School of  
Dentistry, 77 Yongbong-ro, Buk-gu,  
Gwangju 61186, Korea.  
E-mail: bogopa903@naver.com

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## ABSTRACT

**Objectives:** Xanthones, secondary metabolites isolated from the pericarp of mangostin, are attributed to the medicinal properties. The most abundant xanthone is alpha-mangostin ( $\alpha$ -MG), which has been reported to possess anti-oxidant, anti-inflammatory, anti-carcinogenic, and anti-microbial activities. Recent studies suggested that  $\alpha$ -MG may have anti-inflammatory potential in lipopolysaccharide (LPS)-induced RAW 264.7 cells by inhibiting the secretion of NO, COX-2, interleukin (IL)-1 $\beta$ , and IL-6. However, the effect of xanthones in LPS-induced human dental pulp cells (hDPCs) has not been studied. Therefore, the aim of this study is to investigate the anti-inflammatory effect of xanthone in LPS-induced hDPCs.

**Materials and Methods:** Cell viability was determined by WST-1 assay. Cells were pretreated with  $\alpha$ -MG (1.5 and 3  $\mu$ g/mL) for 1 hour prior to stimulation with 1  $\mu$ g/mL LPS for 24 hours. Quantitative real-time polymerase chain reaction was used to measure mRNA expression of inflammatory mediators such as IL-1 $\beta$ , IL-6, intercellular adhesion molecule, and vascular cell adhesion molecule as well as western blot analysis to evaluate protein expression of those factors. To examine underlying anti-inflammatory mechanisms, phosphorylation of NF- $\kappa$ B and MAPK was assessed by western blot analysis. One-way analysis of variance followed by Tukey's *post hoc* test was used to determine any statistically significant differences. Differences were considered significant at  $p < 0.05$ .

**Results:** There was no statistically significant difference in 3  $\mu$ g/mL  $\alpha$ -MG treated group compared to the control in cell viability test. Inflammatory mediators were significantly higher in LPS-treated groups compared with control group. The mRNA levels of inflammatory marker genes in  $\alpha$ -MG treated groups were decreased, indicating that  $\alpha$ -MG attenuated the inflammatory response in LPS-stimulated hDPCs.  $\alpha$ -MG significantly inhibited LPS-induced phosphorylation of NF- $\kappa$ B subunits and MAPK. This indicated that  $\alpha$ -MG inhibited LPS-induced inflammation in hDPCs by suppressing NF- $\kappa$ B and MAPK signaling pathway.

**Conclusions:**  $\alpha$ -MG exerts its anti-inflammatory effects in LPS-induced hDPCs by inhibiting the activation of NF- $\kappa$ B and MAPK.

**Keywords:** Alpha-mangostin; Anti-inflammation; hDPCs; NF- $\kappa$ B; Xanthone

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November 8–10, 2019 · Seoul, Korea



Poster Presentations  
Research Presentation



# In vivo study of antibacterial efficacy after root canal preparation and irrigation

Da-Ni Song,\* Sin-Young Kim, Sung-Eun Yang

Department of Conservative Dentistry, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea



\*Presenting author

Da-Ni Song

Department of Conservative Dentistry, Seoul St. Mary's Hospital, College of Medicine, The Catholic University of Korea, 222 Banpo-daero, Seocho-gu, Seoul 06591, Korea.  
E-mail: eksl0104@gmail.com

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## ABSTRACT

**Objectives:** The principal goal of root canal treatment is to reduce the number of bacteria which is pathogen to periapical periodontitis. The purpose of this study was to quantify *Enterococcus faecalis* (*E. faecalis*) during clinical endodontic procedures in primary and secondary infections using a real-time DNA-based polymerase chain reaction assay and to evaluate the effect of clinical manifestations on the antibacterial efficacy.

**Materials and Methods:** Root canal treatment was performed and 29 teeth included for the study were divided into 2 groups: group 1, primary infection with pulp necrosis ( $n = 18$ ), group 2, secondary infection with previously treated root canals ( $n = 11$ ). After making working length determination, sample 1 (S1) was obtained to take the bacteria in canals. Then usual canal preparation performed with 2.5% sodium hypochlorite solution irrigation. After inactivation, sample 2 (S2) was obtained. At the second visit, sample 3 (S3) was obtained as described in the initial sampling after final irrigation with 17% ethylenediaminetetraacetic acid and 2.5% sodium hypochlorite. The samples were treated for DNA extraction and real-time polymerase chain reaction quantification.

**Results:** C(t) (threshold cycle) value of S2 and S3 showed statistically significant difference from S1. There was no statistical difference between groups 1 and 2. Clinical manifestations didn't have any effect on the antibacterial efficacy of root canal treatment procedures.

**Conclusions:**

*E. faecalis* was detected as much in primary infection with necrotic pulp as in secondary infection coming after failed root canal treatment. Presence of clinical symptoms involved before root canal treatment didn't show any difference on antibacterial efficacy based on the level of *E. faecalis*.

**Keywords:** Antibacterial efficacy; Canal irrigation; Canal preparation; Endodontic infection; *Enterococcus faecalis*; Real-time PCR

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Poster Presentations  
Research Presentation



# Cytotoxic effects of different hemostatic agents on human osteoblasts

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**\*Presenting author**

Yae Lim Kim

Department of Conservative Dentistry, Yonsei University College of Dentistry, 50-1 Yonsei-ro, Seodaemun-gu, Seoul 03722, Korea.  
E-mail: ylk001@yuhs.ac

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Yae Lim Kim,\* Dongzi Chen, Sukjoon Lee, Euseong Kim, Sunil Kim

Department of Conservative Dentistry, Yonsei University College of Dentistry, Seoul, Korea

## ABSTRACT

**Objectives:** Adequate hemostasis is essential in apical surgery and various hemostatic agents had been suggested in previous studies. However, direct cytotoxic effects of hemostatic agents on human osteoblasts have not been studied. The purpose of this study was to evaluate cytotoxic effects of Expasyl and Traxodent on human osteoblasts, which might affect bone healing after apical surgery.

**Materials and Methods:** Expasyl and Traxodent were mixed with complete medium under aseptic conditions at the high concentration of 200 mg/mL for observing the short-term effect. Low concentration condition medium of 5 mg/mL was made by diluting high concentration medium to observe the long-term effect. Human osteoblasts were seeded in a 96-well plate at a density of  $1.5 \times 10^4$  cells per well. After 24 hours for cell attachment, the medium was changed to condition medium. Cell viability was tested by Cell Counting Kit-8 according to the manufacturer's instructions. For short-term effect, cell viability was examined at 2 minutes, 10 minutes, and 1 hour. For long-term effect, cell viability was examined at 1 day and 3 days. The plates were read at 450 nm using a spectrophotometer. Differences among groups were analyzed with one-way analysis of variance using the SPSS Statistical Software version 24 (IBM Inc.).  $p < 0.05$  was considered to indicate statistical significance.

**Results:** Osteoblast's cell viability was significantly reduced by being treated with Expasyl or Traxodent in high concentration groups: 2 minutes, 10 minutes, and 1 hour ( $p < 0.05$ ;  $p < 0.001$ ). In low concentration groups, there was no significant difference in cell viability between control, Expasyl, and Traxodent groups.

**Conclusions:** Both Expasyl and Traxodent had cytotoxic effect on human osteoblasts when applied in high concentration (200 mg/mL). This result implies that these hemostatic agents should be removed as completely as possible once hemostasis is achieved during surgery in order to prevent inflammation and delayed bone healing.

**Keywords:** Apical surgery; Expasyl; Hemostatic agent; Human osteoblast; Traxodent

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# *In vitro* study for suppression of osteogenic differentiation of human dental pulp stem cells

Ukseong Kim,\* Sunil Kim, Sumi Kang, Euseong Kim

Department of Conservative Dentistry, Yonsei University Dental Hospital, Seoul, Korea



\*Presenting author

Ukseong Kim

Department of Conservative Dentistry, Yonsei University Dental Hospital, 50-1 Yonsei-ro, Seodaemun-gu, Seoul 03722, Korea.  
E-mail: ukpower@yuhs.ac

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## ABSTRACT

**Objectives:** Intracanal calcifications have been reported in endodontic cases after revascularization. This phenomenon may be due to excessive osteogenic differentiation of dental pulp stem cells and can make nonsurgical root canal treatment challenging when necessary. The present study investigated effect of nicotine amide and garcinol on osteogenic differentiation of human dental pulp stem cells (hDPSCs).

**Materials and Methods:** hDPSCs were cultured with several concentrations of nicotine amide and garcinol in normal media and osteogenic differentiation induction media. Cell viability was evaluated using the Cell Counting Kit-8 assay. The expressions of alkaline phosphatase (ALP), osteocalcin (OCN), and runt-related transcription factor 2 (RUNX2) were analyzed through real-time polymerase chain reaction (PCR). ALP staining and Alizarin Red S (ARS) staining was done. To evaluate stemness change, flow cytometry (FACS) was performed under normal condition and 10  $\mu$ M of garcinol treated condition. Alcian blue staining and Oil-O red staining were used for histologic evaluation of chondrogenic and adipogenic differentiation changes under 10  $\mu$ M of garcinol treatment.

**Results:** Concentrations above 15  $\mu$ M of garcinol and 10 mM of nicotine amide reduced the cell viability of hDPSCs. In ALP and ARS staining, concentrations above 7.5  $\mu$ M of garcinol and 5 mM of nicotine amide seems to suppress osteogenic differentiation. The 10  $\mu$ M of garcinol significantly reduced expression of osteogenic markers (ALP, OCN) in real-time PCR. The 10  $\mu$ M of garcinol treatment not deteriorated stemness of hDPSCs in FACS, rather mild increment was observed.

**Conclusions:** Osteogenic differentiation of hDPSCs was suppressed under 10  $\mu$ M of garcinol treatment in ALP, ARS staining and RNA expression level with no remarkable inhibition of cell viability and stemness.

**Keywords:** Garcinol; Human dental pulp stem cell; Nicotine amide; Osteogenic differentiation

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November 8–10, 2019 · Seoul, Korea

Poster Presentations  
Research Presentation



# Anti-inflammatory effect of bromelain in lipopolysaccharide induced human dental pulp cells

Joo Hyun Hong,\* Sung-Hyeon Choi, Bin-Na Lee, Hoon-Sang Chang,  
Yun-Chan Hwang, In-Nam Hwang, Won-Mann Oh

Department of Conservative Dentistry, School of Dentistry, Chonnam National University, Gwangju, Korea



\*Presenting author

Joo Hyun Hong

Department of Conservative Dentistry, School of Dentistry, Chonnam National University, 77 Yongbong-ro, Buk-gu, Gwangju 61186, Korea.  
E-mail: juile88@naver.com

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## ABSTRACT

**Objectives:** To examine the anti-inflammatory effect of bromelain in lipopolysaccharide (LPS) induced human dental pulp cells (hDPCs).

**Materials and Methods:** The hDPC viability of bromelain was measured using MTT assay. The hDPCs were exposed to LPS, bromelain, and LPS + bromelain. Reverse-transcription polymerase chain and enzyme-linked immunosorbent assay were used to detect interleukin (IL)-1 $\beta$ , IL-6, and IL-8. Western blots were used to detect intercellular adhesion molecule (ICAM) and vascular cell adhesion molecule (VCAM). Immunofluorescence staining and western blots were used to determine anti-inflammation mechanism of bromelain. To evaluate mineralization nodule formation, ALP staining, alizarin red staining were performed. All experiments were performed in triplicate. Statistical significance was determined using analysis of variance test when compared with control. Difference with  $p$  value < 0.05 was considered significant.

**Results:** Bromelain did not significantly affect the viability of hDPCs. LPS induced IL-1 $\beta$ , IL-6, IL-8, ICAM, and VCAM in dental pulp cells. Bromelain significantly inhibited IL-1 $\beta$ , IL-6, IL-8, ICAM, and VCAM in LPS-stimulated dental pulp cells. Bromelain treatment significantly decreased LPS-increased phosphorylation of pp65 level in the cytoplasm and p65 level in the nucleus. The anti-inflammatory effect of bromelain promoted mineralization of LPS-stimulated hDPCs.

**Conclusions:** Bromelain inhibited expression of inflammatory mediators in dental pulp cells stimulated with LPS. The inhibitory effect of bromelain on inflammatory cytokines is associated with inhibition of NF- $\kappa$ B pathway. Therefore, bromelain might be a useful candidate in vital pulp therapy.

**Keywords:** Anti inflammation; Bromelain; Dental pulp stem cell; LPS

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**\*Presenting author**

**Minji Kang**

Department of Conservative Dentistry, Seoul National University School of Dentistry, Dental Research Institute, Seoul National University Dental Hospital, 101 Daehak-ro, Jongno-gu, Seoul 03080, Korea.

E-mail: scarhett@naver.com

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# Effect of plasma treatment on dentin attachment of human dental pulp stem cell

**Minji Kang,<sup>1\*</sup> Kee-Yoen Kum<sup>1,2</sup>**

<sup>1</sup>Department of Conservative Dentistry, Seoul National University School of Dentistry, Dental Research Institute, Seoul National University Dental Hospital, Seoul, Korea

<sup>2</sup>National Dental Care Center for Persons with Special Needs, Seoul National University Dental Hospital for Persons with Special Needs, Seoul, Korea

## ABSTRACT

**Objectives:** To investigate whether plasma treatment of the root dentin surface affected the attachment and viability of human dental pulp stem cells (hDPSCs).

**Materials and Methods:** Decoronated human single-rooted teeth were sliced vertically, then cut horizontally in approximately 3 mm thickness. The dentin slices were randomly assigned to one of the following groups: group 1, plasma + ethylenediaminetetraacetic acid (EDTA) + sodium hypochlorite (NaOCl); group 2, plasma + NaOCl; group 3, EDTA + NaOCl; group 4, NaOCl only. Each specimen was irrigated with NaOCl alone for 5 minutes or with NaOCl and EDTA for 5 minutes respectively with ultrasonic agitation. A floating electrode dielectric barrier discharge jet was used to generate non-thermal atmospheric pressure plasma (NT-APP) onto the root dentin slices. The applied power for generating plasma was lowered to the level of 5.15 W at 15 kHz. The amount of precursor monomers was set at 100 standard cubic centimeters (sccm) and the treatment time was fixed at 1 minute. hDPSCs at passage 4 were seeded onto the dentin slices at a density of  $5.0 \times 10^3$  cells/specimen and incubated for 3 days. Then, MTT assay was done and the spectrophotometrical absorbance was measured at 550 nm with a reference wavelength of 690 nm. Kruskal-Wallis test was performed for statistical analysis. Three dentin specimens from each group were fixed in 2% glutaraldehyde for scanning electron microscope (SEM).

**Results:** The absorbance was measured highest in the group 1 and followed by the groups 2 and 3. Overall, the group 4 showed the lowest value. However, there was no statistically significant difference in the absorbance between the experimental groups. According to SEM observations, the hDPSCs were attached in multiple layer and had longer cytoplasmic processes in the group 1, while group 4 showed few cells attached on root dentin.

**Conclusions:** The NT-APP failed to improve the attachment of hDPSCs on root dentin.

**Keywords:** Cell attachment; Cell viability; Human dental pulp stem cells; MTT assay; Non-thermal atmospheric pressure plasma; Scanning electron microscope

Poster Presentations  
Research Presentation



\*Presenting author

Seungjae Do

Department of Conservative Dentistry,  
Wonkwang University Daejeon Dental  
Hospital, 77 Dunsan-ro, Seo-gu, Daejeon  
35233, Korea.

E-mail: ehtjdwo823@nate.com

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# The effect of different confluence confirmation strategies on obturation quality in Vertucci type II configuration

Seungjae Do,\* Minseock Seo

Department of Conservative Dentistry, Wonkwang University Daejeon Dental Hospital, Daejeon, Korea

## ABSTRACT

**Objectives:** The present study aimed to compare the obturation quality of 2 confluence confirmation techniques in artificial maxillary first premolars showing Vertucci type II root canal configuration.

**Materials and Methods:** Thirty artificial premolar teeth were divided into 3 groups according to confluence confirmation technique as follows. Thirty artificial premolar teeth were divided into the following 3 groups according to confluence confirmation technique: gutta-percha indentation (GP) group, confluence confirmation using a gutta-percha cone and a K file; electronic apex locator (EAL) group, confluence confirmation using K files and EAL; control group, no confluence confirmation. In the GP group and the EAL group, shaping and obturation were performed with the modified working length. In the control group, shaping was performed without working length adjustment and obturation was carried out with an adjusted master cone. Micro-computed tomography was used before preparation and after obturation to calculate the percentage of gutta-percha occupied volume and the volume increase ( $\Delta\%$ ) in the apical 4 mm. Data were analyzed using one-way analysis of variance and *post hoc* Tukey's test. The significance level was set at 5%.

**Results:** Statistically significant difference was not found in terms of the percentage of gutta-percha occupied volume from the apex to apical 4 mm. However, the control group showed a statistically significant volume increase compared with the EAL group ( $p < 0.05$ ).

**Conclusions:** Confluence confirmation using an EAL in teeth with Vertucci type II configuration allowed more conservative canal shaping compared with no confluence confirmation.

**Keywords:** Artificial teeth; Confluence confirmation; Micro CT; Obturation quality; Vertucci type II

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**\*Presenting author**

Suyeon Ko

Department of Conservative Dentistry, School of Dentistry, Chonbuk National University, 567 Baekje-daero, Deokjin-gu, Jeonju 54896, Korea.

E-mail: tastynice87@gmail.com

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# Effect of gutta-percha cone-mediated ultrasonic activation on accessory canal filling of a premixed bio-ceramic sealer

Suyeon Ko,\* Kwang-Won Lee, Kyung-San Min, Mi-Kyung Yu

Department of Conservative Dentistry, School of Dentistry, Chonbuk National University, Jeonju, Korea

## ABSTRACT

**Objectives:** The aim of this study was to evaluate the effect of gutta-percha cone-mediated ultrasonic activation on accessory canal filling quality of a premixed calcium silicate sealer (EndosealTCS, Maruchi).

**Materials and Methods:** Forty extracted single-rooted human teeth were selected. Canal preparation was performed using NiTi instruments. The canals were irrigated with 5% sodium hypochlorite with passive ultrasonic activation and then treated with ethylenediaminetetraacetic acid. The teeth were randomly assigned as follows ( $n = 10$ ); 1) single-cone with EndosealTCS (SE); 2) single-cone with EndosealTCS + ultrasonic activation (SEU); 3) warm vertical compaction with EndosealTCS (WVE); 4) warm vertical compaction with AHplus, a resin-based sealer (WVA). The teeth were demineralized with a nitric acid solution, cleared in methyl salicylate, and examined under a stereo-microscope. Then, the number and the completeness (partial or complete) of accessory canal filling was recorded. The data were statistically analyzed using one-way analysis of variance and Tukey tests for the number of filled accessory canals, and Pearson's  $\chi^2$  test was used for the completeness of the filling ( $p < 0.05$ ).

**Results:** There were accessory canals in 27 specimens (67.5%) and ranged from 1 to 4 in number. The average number was 1.9 (SE), 2.1 (SEU), 1.1 (WVE) and 1.3 (WVA), and there was no significant difference among the groups. WVA was associated with the highest completeness of the filling (76.9%), followed by WVE (63.6%), SEU (61.9%) and SE (42.1%).

**Conclusions:** There was no difference in the number of filled accessory canals among the groups. Although the use of vertical compaction improves the completeness of the filling in AHplus, no difference was found between the ultrasonic activation and vertical compaction groups when EndosealTCS used.

**Keywords:** Accessory canal; Bioceramic sealer; Clearing technique

Poster Presentations  
Research Presentation



# Micro-CT evaluation of filling quality of single cone technique in oval-shaped root canals

Se Ra Jung,\* Ho Keel Hwang, Hyoung Hoon

Department of Conservative Dentistry, College of Dentistry, Chosun University, Gwangju, Korea



\*Presenting author

Se Ra Jung

Department of Conservative Dentistry, College of Dentistry, Chosun University, 303 Pilmun-daero, Dong-gu, Gwangju 61452, Korea.  
E-mail: sera05@naver.com

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## ABSTRACT

**Objectives:** The aim of this study was to evaluate filling quality in oval-shaped canals filled by modified single cone techniques using micro-computed tomography (micro-CT).

**Materials and Methods:** Twenty-four extracted human single-rooted premolars with oval-shaped root canals were selected. All teeth were decoronated using diamond bur at the level of cemento-enamel junction. All samples were prepared with NiTi rotary instruments and randomly divided into 3 groups ( $n = 8$ ) before canal obturation: group 1, single-cone technique (SC); group 2, single-cone technique with accessory cone (SCA); group 3, single-cone technique with ultrasonic activation (SCU). Before canal obturation, the samples were pre-scanned using a Quantum GX  $\mu$ CT imaging system at Korea Basic Science Institute to measure of void volume of each root canal. After canal obturation, these samples scanned again to measure the mean volume of the root filling materials and voids. Additionally, each sample was divided into 3 regions from the apical end of the root and evaluated separately. Percentage volume ratio was evaluated for each group and regions. The significance of the differences between the groups in the percentage volume of canal filling materials and voids were analyzed by Kruskal-Wallis test ( $p = 0.05$ ).

**Results:** SCU group showed smaller voids than other groups. There were no significant differences in the volume of filling materials among 3 groups. With regards to the 3 regions, coronal thirds showed significantly lower values of filling materials than apical or middle thirds ( $p < 0.05$ ). However, between apical and middle thirds, there were no significant differences in volume of filling materials.

**Conclusions:** The filling quality in oval-shaped root canals filled by modified single cone techniques showed no significant difference in volume of voids among groups. However, coronal thirds showed the highest volumes of voids in all groups. Therefore, clinicians should be careful to use single-cone technique in oval shaped root canals, especially in coronal thirds.

**Keywords:** Endoseal MTA; Oval-shaped canal; Single cone technique; Ultrasonic activation

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**\*Presenting author**

**Mihee Kim**

Department of Conservative Dentistry, Seoul  
National University School of Dentistry, 101  
Daehak-ro, Jongno-gu, Seoul 03080, Korea.  
E-mail: mihee314@hanmail.net

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# Evaluation of quality of root canal obturation with GuttaCore and warm vertical condensation technique

**Mihee Kim,\* Woocheol Lee**

Department of Conservative Dentistry, Seoul National University School of Dentistry, Seoul, Korea

## ABSTRACT

**Objectives:** The purpose of this study was to compare the quality of obturation in oval-shaped canals using GuttaCore obturation system and warm vertical technique with micro-computed tomography (micro-CT).

**Materials and Methods:** Twenty single-rooted premolars were shaped by ProtaperNext (Dentsply Maillefer) X1 to X3 to the working length set from the 1 mm from the apical foramen. Prepared canals were scanned with micro-CT for volume measurement before the obturation procedure. After cleaned with 3.5% sodium hypochlorite and dried with paper-point the canals were obturated with one of the 2 obturation techniques ( $n = 5$ ): GuttaCore (Dentsply Maillefer) technique or warm vertical compaction with gutta-percha using Duo alpha2 and beta system (B&L) without a sealer. Obturated canals were scanned with micro-CT using a voxel size of 14.92  $\mu\text{m}$ ; reconstructed images were analysed for the volumetric percentage of gutta-percha filling area. Data were statistically analyzed with Wilcoxon rank-sum test and significance was set for  $p < 0.05$ .

**Results:** The result of volumetric ratio is 0.800557 for the warm vertical condensation and 0.80528 for the GuttaCore obturation system. Data showed that there was no significant statistical difference between the 2 groups in terms of condensation system employed. In both methods, voids were observed between the wall and the gutta-percha, but voids were hardly observed inside the gutta-percha.

**Conclusions:** The GuttaCore system can make a similar quality of root canal obturation. So, the GuttaCore obturation system is an alternative for obturation of oval-shaped canals.

**Keywords:** GuttaCore; Micro-computed tomography; Warm vertical condensation

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**\*Presenting author**

**Kyung Jae Kim**

Department of Dentistry, Eunpyeong St. Mary's Hospital, College of Medicine, The Catholic University of Korea, 1021 Tongil-ro, Eunpyeong-gu, Seoul 03312, Korea.  
E-mail: roien@catholic.ac.kr

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# Comparison of remaining filling materials after retreatment in the artificial molar teeth with isthmus

**Kyung Jae Kim,<sup>1\*</sup> Dani Song,<sup>2</sup> Sung Eun Yang<sup>2</sup>**

<sup>1</sup>Department of Dentistry, Eunpyeong St. Mary's Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea

<sup>2</sup>Department of Conservative Dentistry, Seoul St. Mary's Dental Hospital, College of Medicine, The Catholic University of Korea, Seoul, Korea

## ABSTRACT

**Objectives:** This study evaluated the presence of residual root canal filling material in the artificial teeth with isthmus after retreatment using micro-computed tomography (micro-CT).

**Materials and Methods:** Artificial mandibular molar teeth with isthmus between the mesio-buccal and mesio-lingual canals ( $n = 45$ ) were prepared with ProFile and randomly assigned to 3 groups. In group 1, teeth were obturated with continuous wave technique with gutta-percha and resin based sealer (AH Plus, Dentsply Maillefer), and in groups 2 and 3, teeth were obturated with single cone technique with gutta-percha and calcium silicate based sealer (EndoSeal MTA, Maruchi). After 15 days, the filling material was removed and root canals were instrumented one size up from the previous master apical file size. In group 3, teeth were additionally irrigated with passive ultrasonic irrigation (PUI). The teeth were scanned using micro-CT before and after retreatment. The percentage of remaining filling material after retreatment was calculated at the coronal, middle, and apical thirds. Data were analyzed using the Kruskal-Wallis test and Mann-Whitney *U* test with Bonferroni *post hoc* correction.

**Results:** The percentage of total remaining filling material was 0.13% in group 1, 0.31% in group 2, and 0.04% in group 3, and there was a statistically significant difference between them. There was no significant difference in the coronal thirds, and there was a significant difference between the groups in the middle and apical thirds.

**Conclusions:** Despite the limitations of *in vitro* studies, EndoSeal MTA, a calcium silicate based sealer in the teeth with isthmus, showed more remaining filling materials than AH Plus, a widely used resin based sealer. It is expected that this will be similar in complex root canal system such as fin, web, or C-shaped root. Residual amounts were significantly decreased when PUI was used. This suggests that careful approach of the clinician should be considered when retreatment.

**Keywords:** Calcibiotic root canal sealer; Micro computed tomography; Root canal filling material; Root canal obturation

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Poster Presentations  
Research Presentation



# Leakage of interfaces between dentin, sealer, and gutta-percha using different type of sealers

Soohyuk Lee,\* Ji-Hyun Jang, Duck-Su Kim, Seokwoo Chang, Kyoung-Kyu Choi

Department of Conservative Dentistry, Kyung Hee University Dental Hospital, Seoul, Korea



\*Presenting author

Soohyuk Lee

Department of Conservative Dentistry,  
Kyung Hee University Dental Hospital, 23  
Kyungheedaero-ro, Dongdaemun-gu, Seoul  
02447, Korea.

E-mail: dltngur0993@gmail.com

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## ABSTRACT

**Objectives:** In endodontic treatments, minimizing leakage between materials and tooth is the key for prognosis of treatment. Sealers and gutta-percha generally are used as filling material for obturating root canal. However, there is still leakage between materials and dentin. The purpose of this study was to figure out which interface is the major cause of leakage and to compare sealing ability of 2 different sealers.

**Materials and Methods:** Eighty Specimens were made by three different methods. The first was material itself (gutta-percha [GP]), AH plus (AH; Dentsply DE Trey), GuttaFlow bioseal (GF; Coltene). The second was made by embedding GP cone in sealers. The last was made by obturating the tooth using continuous wave technique. Each specimen was stored under 100% humidity at room temperature for 2 days. After preparation, every specimen was connected to Nanoflow (IB system). Leakage along the specimens was measured by the movement of an air bubble in capillary connected to Nanoflow under 50 cmH<sub>2</sub>O pressure. Leakage measurement time was 10 minutes. The results were statistically analyzed using 3-way analysis of variance test and independent *t*-test at  $p < 0.05$  level.

**Results:** The leakage between tooth and sealer was significantly higher than the leakage between GP and sealer. GF group showed significantly lower leakage than AH group when it is filled with GP in the tooth ( $p < 0.05$ ).

**Conclusions:** Within the limitation of this study, GF showed that it provides better obturation than AH plus. From the point of view with interfaces, an interface between sealer and tooth was the main cause of leakage in endodontic treatment. It suggested that new sealer which can reduce leakage between dentin and sealer should be invented to get better results in endodontic treatment.

**Keywords:** Interface; Leakage; Sealer

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The 1st General Meeting of  
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November 8–10, 2019 · Seoul, Korea

Poster Presentations  
Research Presentation



\*Presenting author

Hyung-Jong Kim

Department of Conservative Dentistry, Ewha  
Womans University, 52 Ewhayeodae-gil,  
Seodaemun-gu, Seoul 03760, Korea.  
E-mail: blissofangel@hanmail.net

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# Comparison of tooth discoloration by two different calcium silicate based sealers

Hyung-Jong Kim,<sup>1\*</sup> Young-Eun Jang,<sup>1</sup> Yemi Kim,<sup>1</sup> Su-Jung Shin<sup>2</sup>

<sup>1</sup>Department of Conservative Dentistry, Ewha Womans University, Seoul, Korea

<sup>2</sup>Department of Conservative Dentistry, Gangnam Severance Hospital, Yonsei University College of  
Dentistry, Seoul, Korea

## ABSTRACT

**Objectives:** The purpose of this study is to evaluate discoloration of newly developed calcium-silicate based sealers and to compare with the original MTA.

**Materials and Methods:** Forty-three intact human premolars were resected 2 mm apical to the cemento-enamel junction (CEJ). The specimens were divided into 6 groups randomly according to the sealer and timing of core. 1) Positive control, ProRoot MTA (Dentsply) + immediate core, 2) Negative control, composite only, 3) Endoseal MTA (Maruchi) + immediate core, 4) Endoseal MTA + delayed core, 5) Endoseal TCS (Maruchi) + immediate core, and 6) Endoseal TCS + delayed core. First, cement or sealer was filled to 4 mm above CEJ. For the samples in immediate resin core groups, the composite resin (Filtek Z350, 3M) was applied combined with etchant (Ultra-Etch, Ultradent) and bonding system (Single bond 2, 3M) after the remnant of sealer was removed. For delayed resin core, composite was performed after 1 week. The colors (CIE-Lab\*) were measured by a spectrophotometer (Spectroshade, MHT) at baseline, 1, 2, 4, and 8 weeks. The results of color change ( $\Delta E$ ,  $\Delta L$ ) were statistically analyzed by repeated measured analysis of variance and *post hoc* tests were done by Bonferroni method at  $p < 0.05$  level.

**Results:** There were significant differences in  $\Delta L$  among groups depending on the filling materials. However, there were no significant differences between the immediate and delayed core groups. For  $\Delta E$ , group 1 was significantly higher than the rest groups, and Endoseal MTA groups had significant differences with composite group, while Endoseal TCS groups were not significantly different from the composite group.

**Conclusions:** Both Endoseal MTA and Endoseal TCS showed less discoloration than ProRoot MTA. Endoseal MTA demonstrated overall darker shades than the Endoseal TCS due to differences in composition. Both materials showed no significant discoloration over time. There was no difference according to the timing of restoration. Endoseal TCS can be used as a sealer without tooth discoloration.

**Keywords:** Calcium silicate; Discoloration; Endoseal; Root filling material

Poster Presentations  
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# Evaluation of retreatability of calcium silicate based sealer

A-Ra Cho,<sup>\*</sup> Tae-Young Park, Hyoung-Hoon Jo, Ho-Keel Hwang

Department of Conservative Dentistry, Chosun University Dental Hospital, Gwangju, Korea

OPEN ACCESS

**\*Presenting author**

A-Ra Cho

Department of Conservative Dentistry, Chosun University Dental Hospital, 303 Pilmun-daero Dong-gu, Gwangju 61452, Korea.  
E-mail: HROHA@naver.com

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## ABSTRACT

**Objectives:** The aim of this study was to evaluate the retreatability of calcium silicate based sealer (Endoseal, Maruchi) by comparing surface hardness and using NiTi rotary instruments.

**Materials and Methods:** Cylinder-shape specimens were made by calcium silicate based sealer with an internal diameter of 6 mm and height of 0.2 mm, 1 mm, and 2 mm ( $n = 8$ ). Each specimen was stored in 37.5°C during 12 minutes 30 seconds for initial setting. Half specimens of each group were stored in the air and the rest of them were in saline. After one week, surface hardness of each specimen was examined using a universal testing machine. Root canals of 30 extracted anterior teeth were instrumented using NiTi rotary files to an apical size 55. Apical third was obturated with only calcium silicate based sealer and then coronal portion was filled with thermoplasticized gutta percha injection technique. The access cavities were sealed with temporary material. After one week, the specimens were attempted to retreat using NiTi rotary files. After retreatment, the specimens were resected horizontally at apical 1 mm using diamond disc for inspection of resected surface.

**Results:** Group of 2 mm height with or without saline showed higher surface hardness than other groups. Most of the root canals can be retreated with NiTi rotary files and apical patency was archived. Resected root surface revealed that the sealer was removed with instrumentation without sacrificing additional tooth structure.

**Conclusions:** Within limitation of this study, calcium silicate based sealer can be retreated and removed with NiTi rotary system.

**Keywords:** Endoseal; Hardness; MTA; Retreatment

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The 1st General Meeting of  
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Poster Presentations  
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**\*Presenting author**

**Jaeheon Jung**

Department of Conservative Dentistry,  
Gangnam Severance Hospital, Yonsei  
University College of Dentistry, 50-1 Yonsei-ro,  
Seodaemun-gu, Seoul 03722, Korea.  
E-mail: jheon91@gmail.com

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# Retrograde filling quality with a combination of calcium silicate cement and calcium silicate based sealer

**Jaeheon Jung,<sup>1\*</sup> Jeong-Won Park,<sup>1</sup> Kyeol Koh,<sup>1</sup> Sunil Kim,<sup>2</sup> Euseong Kim,<sup>2</sup> Su-Jung Shin<sup>1</sup>**

<sup>1</sup>Department of Conservative Dentistry, Gangnam Severance Hospital, Yonsei University College of Dentistry, Seoul, Korea

<sup>2</sup>Department of Conservative Dentistry and Oral Science Research Center, Yonsei University College of Dentistry, Seoul, Korea

## ABSTRACT

**Objectives:** The aim of this study was to assess the quality of retrograde filling with a combination of calcium silicate cement and calcium silicate based sealer.

**Materials and Methods:** Twenty single-rooted, extracted human teeth were instrumented with nickel-titanium instruments and obturated with gutta-percha cones. Root resection at 3 mm from the apex and root-end preparation were performed. The root-end cavities were filled with two different retrograde filling methods ( $n = 10$ ). In group 1, the root-end cavities were filled with Endocem Zr (Maruchi), while in group 2, the root-end cavities were filled with an approximately 1-mm-thick layer of Endoseal MTA (Maruchi) followed by Endocem Zr. Then, the samples were scanned using micro-computed tomography and three-dimensional images of the samples were reconstructed. The volume of the gap between the tooth structure and the root-end filling materials and the volume of the voids in the filling materials were measured, and the percentages of these volumes were calculated. Data were analyzed using the Mann-Whitney  $U$  test at a significance level of 95% to compare the difference in the volume percentages of voids between the 2 groups. Selected specimens were further observed using a scanning electron microscopy (SEM).

**Results:** No significant difference was found between the 2 groups in the volume percentage of the gaps and internal voids. The SEM examinations showed that the calcium silicate based sealer applied in the retro-prepared cavity demonstrated good adaptation to the cavity wall and the calcium silicate cement.

**Conclusions:** Within the limitations of this study, the quality of retrograde filling with a combination of calcium silicate cement and calcium silicate based sealer showed no statistically significant difference from that of retrograde filling with calcium silicate cement only.

**Keywords:** Calcium silicate based sealer; Calcium silicate cement; Micro-computed tomography; Retrograde filling; Scanning electron microscopy; Void

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Research Presentation



\*Presenting author

Jihyung Kim

Department of Conservative Dentistry, Yonsei University Dental Hospital, 50-1 Yonsei-ro, Seodaemun-gu, Seoul 03722, Korea.  
E-mail: hijee000@yuhs.ac

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# A randomized controlled trial on clinical efficacy of calcium silicate-based sealer in root canal obturation

Jihyung Kim,\* Il-Young Jung

Department of Conservative Dentistry, Yonsei University Dental Hospital, Seoul, Korea

## ABSTRACT

**Objectives:** To assess effect of pain relief and success rate of root canal treatment using calcium silicate-based sealer, 'Maruchi White Endoseal MTA.'

**Materials and Methods:** This is randomized controlled clinical trial based on patients of Yonsei University, Department of Conservative Dentistry who need root canal treatment. Patients were assorted by 2 groups using random number table. Two groups are as below: group 1 (control), root canal treatment with canal obturation using AH plus sealer; group 2 (experimental group), root canal treatment with canal obturation using White Endoseal MTA sealer. The effect of pain relief was reported by patient using wire and wireless communication according to the patients' preference using numeric rating scale for 3 times, which are after 4 hours, 24 hours, and 48 hours from canal obturation. The success rate was evaluated based on the patients' subjective symptom, objective findings, and periapical view. Whether effect of pain relief and the success rate between 2 groups are statistically significant was analyzed by  $\chi^2$  test.

**Results:** The 2 group did not show any statistically significant differences in terms of pain relief and success rate.

**Conclusions:** Calcium silicate-based sealer can be an alternative material to conventional sealer in terms of efficacy of obturation for clinician and healing potential for the patients.

**Keywords:** Calcium silicate-based sealer; Pain relief; Success rate

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### \*Presenting author

Yun Kyung Na

Department of Conservative Dentistry, Seoul  
National University School of Dentistry, 101  
Daehak-ro, Jongno-gu, Seoul 03080, Korea.  
E-mail: sdent0828@naver.com

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# CPNE7 derived novel peptide induces tertiary dentin regeneration in exposed vital pulp

Yun Kyung Na,\* Won Jun Shon

Department of Conservative Dentistry, Seoul National University School of Dentistry, Seoul, Korea

## ABSTRACT

**Objectives:** Vital pulp therapy is a treatment option for preservation and maintenance of pulp vitality which is important for the prognosis of the tooth. Recently, mineral trioxide aggregate was spotlighted as material for a vital pulp therapy, but there are some limitations, such as the formation of irregular tertiary dentin structures. Through previous studies, copine7 (CPNE7) is a master gene of dentin expression and can induce the regeneration of biologic tertiary dentin. This means that CPNE7 might serve as a bioactive dentin-pulp regeneration molecule for vital pulp therapy. Therefore, the purpose of this study is to investigate the possible use of CPNE7 derived peptide for direct pulp capping, through histological observation and micro-computed tomography (CT) imaging.

**Materials and Methods:** Eighteen premolars of three beagles are prepared on cervical area until pin-point pulp exposure was generated. The cavities were divided into 3 groups. Group 1 was received only glass ionomer (GI) cement filling as a control group. Group 2 was sealed with MTA mixed with saline before GI cement filling. Group 3 was sealed with MTA mixed with CPNE7 peptide before GI cement filling. Histological and micro-CT analyses were done after 12 weeks.

**Results:** In histological analysis, comparing to the control group, newly formed tertiary dentin is shown under cavity sites in groups 2 and 3. In group 2, irregular and a tubular features of tertiary dentin were generated. On the other hand, the regenerated dentin in group 3 showed dentinal tubules which are typical characteristics of reactionary dentin. In micro-CT imaging, comparing to control group, newly mineralized tissue was observed under cavity in the group of MTA mixed with CPNE7.

**Conclusions:** These results suggest that CPNE7 derived peptide stimulates odontoblasts to produce tertiary dentin in pulp exposure models. It means that CPNE7 derived peptide might serve as a bioactive dentin-pulp regeneration molecule for direct pulp capping at the exposed vital pulp.

**Keywords:** CPNE7; Direct pulp capping; Novel peptide; Tertiary dentin formation; Vital pulp therapy



Poster Presentations  
Research Presentation



# Quantitative analysis of direct pulp capping on mice using micro-CT

Taeuk Sun,<sup>1\*</sup> Ho-Jin Moon,<sup>1</sup> Yong-Bum Cho,<sup>1</sup> Dong-Hoon Shin,<sup>1</sup> Chan-Ui Hong,<sup>1</sup>  
Jinju Yang,<sup>2</sup> Minju Song<sup>1</sup>



<sup>1</sup>Department of Conservative Dentistry, Dankook University Dental Hospital, Cheonan, Korea

<sup>2</sup>Department of Nanobiomedical Science, Dankook University, Cheonan, Korea

\*Presenting author

Taeuk Sun

Department of Conservative Dentistry,  
Dankook University Dental Hospital, 119  
Dandae-ro, Dongnam-gu, Cheonan 31115,  
Korea.

E-mail: sun31028@naver.com

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## ABSTRACT

**Objectives:** The ability of direct pulp capping with nanocement, a unique cement form made from mesoporous bioactive glass, to form reparative dentin was compared with those with conventional MTA and calcium silicate in mouse pulp tissue.

**Materials and Methods:** Class I cavities were prepared in 40 maxillary first molar from 6-week-old mouse teeth. ProRoot MTA (Dentsply), Theracal LC (Bisco Inc.), and nanocement (mesoporous bioactive glass nanoparticles) were applied on the exposed pulp ( $n = 10$ ) and resin cement was applied to the material. As a negative control group, 10 teeth were applied only resin directly over the pulp without capping material. After 6 weeks, the mice were sacrificed and the teeth were extracted. The volumes of reparative dentin in each sample was analyzed quantitatively using micro-computed tomography and analytical software (Dataviewer64, CTAn64, Bruker). In addition, the materials were applied to the pulp of the unilateral teeth of 2 mice per material. Histological analysis using hematoxylin and eosin staining was performed. The results were statistically analyzed using one-way analysis of variance and Tukey's *post hoc* test.

**Results:** ProRoot MTA and Theracal LC showed higher reparative dentin-forming ability than the control group (composite resin only) ( $p = 0.007$  and  $0.005$ , respectively). Nanocement did not show a significant difference compared to the control ( $p = 0.701$ ). ProRoot MTA and Theracal LC did not show a significant difference compared to nanocement ( $p = 0.095$  and  $0.071$ , respectively), but showed better results. In the histological analysis, except for the composite resin, reparative dentin was formed under the ProRoot MTA, Theracal LC, and nanocement.

**Conclusions:** Nanocement has less reparative dentin-forming ability than ProRoot MTA and Theracal LC.

**Keywords:** Direct pulp capping; Nanocement; ProRoot MTA; Reparative dentin; Theracal LC; Vital pulp therapy

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Poster Presentations  
Research Presentation



# Antimicrobial effect of polyphenon 60 against *Streptococcus mutans* and *Streptococcus sobrinus*

Il Hwa Lee,\* Tae Young Park, Yun Kyong Lim, Joong Ki Kook, Jeong Bum Min

Department of Conservative Dentistry, Chosun University Dental Hospital, Gwangju, Korea



\*Presenting author

Il Hwa Lee

Department of Conservative Dentistry, Chosun University Dental Hospital, 303 Pilmun-daero Dong-gu, Gwangju 61452, Korea.  
E-mail: dentepisod@hanmail.net

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## ABSTRACT

**Objectives:** Polyphenon 60 is a mixture of catechins in green tea. The aim of this study was to investigate the antimicrobial activity of polyphenon 60 against 4 strains of *Streptococcus mutans* (*S. mutans*) and 2 strains of *Streptococcus sobrinus* (*S. sobrinus*).

**Materials and Methods:** The antimicrobial activity of polyphenon 60 were tested against 4 strains of *S. mutans* and 2 strains of *S. sobrinus* which are the major causative bacteria of dental caries. Antimicrobial activity was evaluated through minimum inhibitory concentration and minimum bactericidal concentration (MBC) measurements. Biofilm formation was quantified by measuring the absorbance of the solution at 595 nm in a spectrophotometer.

**Results:** The MBC values of polyphenon 60 for *S. mutans* and *S. sobrinus* were determined and the effect on the inhibition of biofilm formation was evaluated. The MBC values of polyphenon 60 against the bacterial strains were 2.5 mg/mL except one strain, *S. mutans* KCOM 1128 (1.25 mg/mL). The data of biofilm formation inhibition assay showed that polyphenon 60 inhibited above 90% at the 2.5 mg/mL concentration.

**Conclusions:** The results reveal that polyphenon 60 has biofilm formation inhibition activity with bactericidal effect against *S. mutans* and *S. sobrinus*. Therefore, polyphenon 60 could be useful in developing oral hygiene products, toothpaste or gargling solution, as a component for bactericidal agent.

**Keywords:** Bactericidal effect; Cariogenic bacteria; Polyphenon 60

Poster Presentations  
Research Presentation



\*Presenting author

Jae-Young Lee

Department of Preventive and Public Health Dentistry, Seoul National University School of Dentistry, 101 Daehak-ro, Jongno-gu, Seoul 03080, Korea.

E-mail: dentaljy09@snu.ac.kr

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# Changes in quality of life related to the oral health in the disabled through visiting dental care

Jae-Young Lee,<sup>1</sup> Kyung-Cheol Lim,<sup>1</sup> Gyo-Rin Lee,<sup>1</sup> Young-Jae Kim,<sup>2</sup> Bo-Hyoung Jin<sup>1</sup>

<sup>1</sup>Department of Preventive and Public Health Dentistry, Seoul National University School of Dentistry, Seoul, Korea

<sup>2</sup>Department of Pediatric Dentistry, Seoul National University School of Dentistry, Seoul, Korea

## ABSTRACT

**Objectives:** The purpose of this study was to evaluate the change of quality of life related to the oral health of disabled people according to visiting oral health care. We analyzed the factors influencing the oral health-related quality of life and estimated the effects of oral health. We aimed for a basic survey for building direction and system of dental health care services.

**Materials and Methods:** In this study, oral health survey was conducted by a dentist using World Health Organization oral health survey basic methods and oral health-related quality of life of the disabled were evaluated using oral health impact profile 14 through 1:1 interview. An attending dentist and dental hygienist experimentally carried out the visiting dental health care service.

**Results:** Our analysis revealed that the factors influencing oral health-related quality of life included increasing age, type of medical insurance, toothbrushing, dental caries on permanent teeth, kinds of disability, family income, problem-solving ability, and the number of existing teeth. Furthermore, it was found that these factors had a significant influence on oral health-related quality of life.

**Conclusions:** This study shows that continuous oral health management improves the quality of life for disabled persons, and it confirms that oral health can be promoted and maintained by attending dentists and visiting dental healthcare services.

**Keywords:** Disability; Oral health related quality of life; Visiting dental healthcare service

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\*Presenting author

Shinae Lee

Department of Conservative Dentistry,  
Gangnam Severance Hospital, Yonsei  
University, 211 Eonju-ro, Gangnam-gu Seoul  
06273, Korea.  
E-mail: mikablue@yuhs.ac

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# Use of artificial intelligence for the detection of early caries on bitewing radiograph

Shinae Lee,<sup>1\*</sup> Jisoo Keum,<sup>2</sup> Sumi Kang,<sup>3</sup> Yooseok Shin,<sup>3</sup> Sujung Shin,<sup>1</sup>  
Jeoungwon Park<sup>1</sup>

<sup>1</sup>Department of Conservative Dentistry, Gangnam Severance Hospital, Yonsei University, Seoul, Korea

<sup>2</sup>SELVAS, AI Inc., Seoul, Korea

<sup>3</sup>Department of Conservative Dentistry, College of Dentistry, Yonsei University, Seoul, Korea

## ABSTRACT

**Objectives:** In recent years, research has been actively conducted to utilize deep learning using convolutional neural networks (CNN) to process various medical images. In this study, we developed a deep CNN using 1st U-Net model for early dental caries detection on bitewing radiographs and to compare the accuracy of diagnosis with/without artificial intelligence (AI) assistant.

**Materials and Methods:** The radiographs were randomly selected from the bitewing radiograph of the Department of Conservative Dentistry, Yonsei University taken from 2017 to 2018. A total of 304 and 50 bitewing radiographs were used as training and test sets, respectively. The collected training data were transferred to tablet PC and the 2 well-trained observers examined the dental images. The observers drew lines of dental structure, restoration segmentation, and dental caries on the radiographs. The tagged results were used to train the AI model. For the AI model, U-Net model was used, which was proposed by Ronneberger. After training the model, the developed model was used to evaluate the performance of caries diagnosis, compared with 3 observers' independent diagnoses. Three observers tagged the caries without consultation and after a 3-week interval, they were asked to revise their detection by reference to the results of AI model. We compared the diagnosis with and without AI assistant.

**Results:** The deep-learning model showed a good performance in caries detection (recall = 0.934, precision = 0.601, based on 10% overlap ratio of area with the model's and 3 observer's common detection area). When the clinicians detect dental caries with the reference to the AI result, they detected more caries.

**Conclusions:** Our AI model showed quite accurate caries detectability. In addition, when refer to the AI results as a second opinion, clinicians could find more incipient caries on bitewing radiographs.

**Keywords:** Artificial intelligence; Bitewing radiograph; Caries detection; Deep learning model; Dental caries

Poster Presentations  
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\*Presenting author

Widya Saraswati

Departments of Conservative Dentistry,  
Faculty of Dental Medicine, Universitas  
Airlangga, Campus A UNAIR Jl. Prof. Dr.  
Moestopo No. 47, Surabaya 60132, Indonesia.  
E-mail: widya.saraswati@yahoo.com

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# Expression of the inflammasome complex in odontoblast pulp cells induced by resin bonding agent

Widya Saraswati\*

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia

## ABSTRACT

**Objectives:** The inflammasome is an intracellular multimolecular complex that drives the activation of innate immunity in odontoblast pulp cells. A monomer resin, 2-hydroxyethyl methacrylate (HEMA), induced oxidative stress, leading to severe damage through the activation of NOD-like receptor protein 3 (NLRP3), a cytosolic intracellular pattern recognition receptor that controls activation of caspase-1 and regulates the highly pro-inflammatory cytokine interleukin-1 $\beta$  (IL-1 $\beta$ ). The inflammasome can be triggered by infections, tissue damage, and metabolic imbalance. This condition drives the innate immune response towards invading pathogens and cellular damage in the dentin pulp complex, especially in odontoblast pulp cells. However, it is still unclear how the resin monomer HEMA could trigger the inflammasome to activate the innate immune response in the dentin pulp complex. The aim of this study to identify molecular mechanisms of the inflammasome in odontoblast pulp cells induced by the monomer resin HEMA.

**Materials and Methods:** Nine healthy Wistar rat teeth were used for *in vivo* experiments. HEMA liquid (Sigma Aldrich) was applied to the tooth cavities at a concentration of 0.016  $\mu$ g/mL and the cavities were then filled with glass ionomer cement (Fuji IX LC). Teeth were extracted after 24, 48, and 72 hours. The teeth were decalcified using ethylenediaminetetraacetic acid for 8 weeks and paraffin blocks were made after the teeth were cut to 5  $\mu$ m by a microtome. Immunohistochemistry staining was performed, using antibodies against NLRP3, active caspase-1, and IL-1 $\beta$  to investigate the regulation of these molecules in odontoblast cells in the dentin pulp complex. The sample were analyzed statistically using analysis of variance and the Tukey honest significant difference test.

**Results:** HEMA upregulated the activity of NLRP3, active caspase-1, and IL-1 $\beta$  in odontoblast cells of odontoblast pulp cells

**Conclusions:** HEMA induced the innate immune response in odontoblast pulp cells.

**Keywords:** HEMA; Inflammasome; Odontoblast Cells; Innate Immunity

Poster Presentations  
Research Presentation



# Effect of pre-curing of universal adhesives on microshear bond strength of resin cement to zirconia

Ji Hye Sim,<sup>1\*</sup> Tae-Yub Kwon,<sup>2</sup> Jung-Hong Ha,<sup>1</sup> Myoung Uk Jin,<sup>1</sup> Sung Kyo Kim,<sup>1</sup> Young Kyung Kim<sup>1</sup>



<sup>1</sup>Department of Conservative Dentistry, School of Dentistry, Kyungpook National University, Daegu, Korea

<sup>2</sup>Department of Dental Biomaterials, School of Dentistry, Kyungpook National University, Daegu, Korea

\*Presenting author

Ji Hye Sim

Department of Conservative Dentistry, School of Dentistry, Kyungpook National University, 2177 Dalgubeol-daero, Jung-gu, Daegu 41940, Korea.

E-mail: sbjihye@naver.com

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## ABSTRACT

**Objectives:** Notwithstanding the proven efficacy of universal adhesives as a zirconia primer, instructions for clinical procedures vary depending on the product, especially a need for light-polymerization prior to resin cement application. This study investigated whether pre-curing the universal adhesives affected the resin bonding to zirconia.

**Materials and Methods:** Three commercial universal adhesives (All-Bond Universal [ABU]; Single Bond Universal [SBU]; GLUMA Bond Universal [GBU]) were tested in comparison with a conventional zirconia primer (Z-Prime Plus [ZPP]). Air-abraded 48 zirconia blocks were divided into 8 groups, to which different priming agents were applied with or without photo-polymerization (-LC and -NC). Resin cylinders were bonded on the primed surface using a composite-based resin cement (Duo-Link). For each group, the bonded specimens were stored in water either for 24 hours or for a week with an additional thermocycling 10,000 times before microshear testing ( $n = 12$  per group). Following debonding, the failure modes were evaluated under an optical microscope at  $\times 25$  magnification. Water contact angles for the primed zirconia surfaces were also tested. The data were statistically analyzed using three-way analysis of variance (ANOVA) and Tukey test at  $\alpha = 0.05$ .

**Results:** Three-way ANOVA showed no significant difference for light-curing. After thermocycling, the bond strengths of ABU-LC, SBU-LC, GBU-LC, and SBU-NC groups were significantly decreased ( $p < 0.05$ ). Unlike the universal adhesives, ZPP produced a stable bond regardless of light-curing and thermocycling. Mixed failures were predominant in all test groups. Pre-cured universal adhesives presented significantly higher hydrophobicity than the uncured groups, while no significant difference was found between ZPP-LC and ZPP-NC.

**Conclusions:** Within the limitation of this study, pre-curing of the universal adhesives did not affect the bond strengths of resin cement to zirconia ceramic although it made the primed zirconia surfaces more hydrophobic. ZPP showed better bonding durability compared to the universal adhesives.

**Keywords:** Pre-curing; Universal adhesives; Zirconia; Zirconia primer

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Poster Presentations  
Research Presentation



# Influence of different etch-and-rinse adhesive systems on dentin bond durability

Toshiki Takamizawa,\* Eizo Hirokane, Arisa Imai, Akimasa Tsujimoto, Keiichi Sai, Ko Hinoura, Masashi Miyazaki

Department of Operative Dentistry, Nihon University School of Dentistry, Tokyo, Japan



\*Presenting author

Toshiki Takamizawa

Department of Operative Dentistry, Nihon University School of Dentistry, 1 Chome-8-13 Kanda Surugadai, Chiyoda, Tokyo 101-8310, Japan.

E-mail: takamizawa.toshiki@nihon-u.ac.jp

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## ABSTRACT

**Objectives:** The purpose of this study was to compare dentin bond durability under different degradation conditions between 2 etch-and-rinse (ER) systems and a universal adhesive in ER mode.

**Materials and Methods:** The universal adhesive used was Scotchbond Universal (SU). A 3-step ER adhesive, Scotchbond Multi-Purpose Plus (SM), and a 2-step ER adhesive, Single Bond Plus (SB), were used as comparison adhesives. Bovine incisors were used as substitutes for human teeth. Phosphoric acid (35%) was applied for 15 seconds prior to the application of the primer or adhesive. After phosphoric acid pre-etching, bonding procedures were conducted in accordance with the manufacturer's instructions. There were 3 test groups: 1) subjected to 10,000, 30,000, or 50,000 thermal cycles (TC group); 2) stored in distilled water at 37°C for 3 months, 6 months, or 1 year (WS group); and 3) stored in distilled water for 24 hours, serving as a baseline. After each treatment, shear bond strength tests were conducted in accordance with ISO 29022. Fifteen specimens were prepared for each test group.

**Results:** The three tested adhesives showed different patterns in shear bond strength (SBS) changes in the various degradation conditions. Although the bond strength of SM decreased with an increasing number of TCs, SB did not show any significant differences in SBS values among the tested periods. The TC groups of SU showed significantly higher SBS values than at baseline. For the WS groups, SU showed significantly higher SBS values in the 6-month group than in the 24-hour and 1-year WS groups. However, SM showed decreased SBS values with an increased WS period, and SB did not show any significant differences in SBS among the WS periods.

**Conclusions:** This study indicated that responses to degradation conditions differ among adhesive systems. SB and SU showed more resistance than the 3-step adhesive SM in both TC and WS degradation conditions.

**Keywords:** Degradation; Dentin bond durability; Different adhesive systems; Etch-&-Rinse; Universal adhesive

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Poster Presentations  
Research Presentation



\*Presenting author

Bokyeong Kim

Department of Conservative Dentistry, Kyung Hee University Hospital at Gangdong, 892 Dongnam-ro, Gangdong-gu, Seoul 05278, Korea.

E-mail: culwings@gmail.com

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# Effects of 10-MDP on shear bond strength of adhesives and resin cements to Biodentine

Bokyeong Kim,\* Eun Mi Rhim, Jin-Kyu Yi

Department of Conservative Dentistry, Kyung Hee University Hospital at Gangdong, Seoul, Korea

## ABSTRACT

**Objectives:** The purpose of this study was to determine the effects of 10-methacryloyloxydecyl dihydrogen phosphate (MDP) on shear bond strength (SBS) between Biodentine and composite resin using adhesives and resin cements.

**Materials and Methods:** Seventy cylindrical acrylic blocks with a hole (5 mm in diameter and 2 mm in height) were filled with Biodentine (Septodont). All specimens were stored at 37°C with 100% humidity for 24 hours. The specimens were divided into 5 groups for different adhesives ( $n = 10$ ): group 1, All Bond Universal (Bisco Inc., etch & rinse); group 2, All Bond Universal (1-step self-etch); group 3, Prime & Bond Universal (Dentsply Sirona, etch & rinse); group 4, Prime & Bond Universal (1-step self-etch); group 5, Clearfil SE Bond (Kuraray Noritake, 2-step self-etch). The specimens were allocated into 2 groups for resin cements ( $n = 10$ ): group 6, Panavia F 2.0 (Kuraray Noritake); group 7, Duolink (Bisco Inc.). After the application of adhesives and resin cements, composite resin (Filtek Z350, 3M ESPE) applied over Biodentine. SBSs were measured and the failure modes were examined under a stereomicroscope at a magnification of  $\times 20$ . Scanning electron microscope images of selected samples were evaluated. The data were analyzed using one-way ANOVA and the Tukey's *post hoc* test.

**Results:** The highest and lowest values of SBS were observed for group 2 and group 3, respectively. No significant differences were observed in SBS between adhesives containing 10-MDP and non-containing 10-MDP and between application modes. Most observed modes of failure were cohesive in Biodentine. According to the data, there was no significant difference in SBS between resin cements containing and non-containing 10-MDP.

**Conclusions:** The monomer 10-MDP of adhesives and resin cements did not significantly improve SBS to Biodentine. Also, similar SBS values were found for the adhesives regardless of their application modes.

**Keywords:** 10-MDP; Adhesive system; Biodentine; Functional monomer; Shear bond strength



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# Comparison of adhesive strength of resinous tooth splinting materials according to enamel surface treatment

Yerim Lee,\* Jinwoo Kim, Sehee Park, Kyungmo Cho

Dental Materials (including Biomaterials), Department of Conservative Dentistry, College of Dentistry, Gangneung-Wonju National University, Gangneung, Korea



\*Presenting author

Yerim Lee

Dental Materials (including Biomaterials),  
Department of Conservative Dentistry, College  
of Dentistry, Gangneung-Wonju National  
University, 7 Jukheon-gil, Gangneung 25457,  
Korea.

E-mail: 01072115622@naver.com

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## ABSTRACT

**Objectives:** The purpose of this study is to compare and analyze the shear bond strength and fracture pattern in different enamel tooth surface treatments for resin splinting materials.

**Materials and Methods:** G-FIX (GC) and LightFix (Sun Medical) were used as tooth splinting materials. Twenty bovine mandibular incisors were used for preparation of specimens. The exposed enamel surface was separated into 4 parts. Each tooth was treated with 37% phosphoric acid, 37% phosphoric acid + adhesive resin, 37% phosphoric acid + G-premio bond (GC), and G-premio bond for each fraction. Shear bond strength was measured using a universal testing machine. After measuring the shear bond strength, the fractured surface of the specimen was magnified with a microscope to observe the fracture pattern. Two-way analysis of variance (ANOVA) was used to verify the interaction between the material and the surface treatment method. One-way ANOVA was used for comparison between the surface treatment methods of each material and *post hoc* test was conducted with Scheffe's test. An independent *t*-test was conducted to compare shear bond strengths between materials in each surface treatment method. All statistics were conducted at 95% significance level.

**Results:** G-FIX, a tooth splinting resin, showed similar shear bonding strength when additional adhesive resins were used when material was applied after only acid etching, and LightFix showed the highest shear bonding strength when additional adhesive resins were used after the acid etching. In addition, both G-FIX and LightFix showed the lowest shear bond strength when only self-etching adhesive was applied without additional acid etching. Verification of interactions observed interconnection between resins and surface treatment methods. Most of the mixed failure was observed in all counties.

**Conclusions:** When using G-FIX and LightFix, which are tooth-splinting materials, it is considered that sufficient adhesion will be achieved even after applying only acid etching as instructed by the manufacturer.

**Keywords:** Enamel; Shear bond strength; Splinting; Surface treatment; Tooth mobility

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Research Presentation



# The effect of C-factor and adhesives on bonding of a dual-cure resin composite

Na-Ri Shin,<sup>1\*</sup> Ji-Hyun Jang,<sup>1</sup> Duck-Su Kim,<sup>1</sup> Al-Abdulwahed May Mohammed,<sup>2</sup>  
Seok-Woo Chang,<sup>1</sup> Kyoung-Kyu Choi<sup>1</sup>



<sup>1</sup>Department of Conservative Dentistry, Kyung Hee University Dental Hospital, Seoul, Korea

<sup>2</sup>Department of Conservative Dentistry, Graduate School, Kyung Hee University, Seoul, Korea

**\*Presenting author**

**Na-Ri Shin**

Department of Conservative Dentistry,  
Kyung Hee University Dental Hospital, 23  
Kyungheedaero-ro, Dongdaemun-gu, Seoul  
02447, Korea.

E-mail: ete8681@gmail.com

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## ABSTRACT

**Objectives:** The aim of this study is to compare the micro-tensile bond strengths of a dual-cure resin composite under different C-factors and adhesives protocols.

**Materials and Methods:** Fifty-four extracted caries-free molars were divided into 3 experimental groups with different cavity configurations (C-factors); group 1 (C-factor = 0.29), group 2 (C-factor = 3.4), group 3 (C-factor = 5.8). Each of these groups was divided into 3 sub-groups according to different adhesives: All Bond Universal (ABU; Bisco), Prime & Bond Universal (PBU; Dentsply), Prime & Bond universal with self-cure activator (Dentsply). As a dual-cure resin composite, CompCore-AF (Premier Dental) was used. Composite-dentin beams with 1 × 1 mm<sup>2</sup> were produced with high-speed diamond saw (ISOMET 5000, Buehler). Half of the beams were undergone thermal cycling (5,000 cycles between 5°C and 55°C for 15 seconds). Micro-tensile bond strength (μTBS) was measured with universal testing machine (AGS-X, Shimadzu) and compared. The data was statistically analyzed by 3-way analysis of variance, Bonferroni test at  $p < 0.05$  level

**Results:** After thermocycling, μTBS of all groups decreased regardless of adhesive protocols ( $p < 0.05$ ). The μTBS of group 3 was significantly lower than that of groups 1 and 2 ( $p < 0.05$ ). High C-factor negatively affected μTBS. The μTBS of ABU groups were significantly higher than that of PBU groups ( $p < 0.05$ ). There were no significant differences in μTBS between ABU and PBU with self-cure activator groups.

**Conclusions:** Different C-factor and adhesive protocols may influence the adhesion of the dual-cure composite resin.

**Keywords:** Adhesives; C-factor; Dual cure resin composite

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# Effect of adhesive application method on composite repair bond strength

Hee Kyeong Oh,\* Dong Hoon Shin

Department of Conservative Dentistry, College of Dentistry, Dankook University, Cheonan, Korea



\*Presenting author

Hee Kyeong Oh

Department of Conservative Dentistry, College of Dentistry, Dankook University, 119 Dandae-ro, Dongnam-gu, Cheonan 31116, Korea.  
E-mail: 00609@naver.com

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## ABSTRACT

**Objectives:** The purpose of this *in vitro* study was to evaluate the effect of application method of universal adhesives on the shear bond strength (SBS) between aged and new composite resins applied with different thickness that were cured or left uncured when new composite was placed.

**Materials and Methods:** A total of 78 composite specimens (Filtek Z350 XT) were prepared, stored in distilled water for a week followed by thermocycling (5,000 cycles, 5°C to 55°C), and served as substrates. They were mechanically roughened using 400-grit silicon carbide sandpapers and etched with phosphoric acid. After surface treatment, samples were equally divided into 2 groups: group 1, Single Bond Universal (SBU), and group 2, Prime & Bond Universal (PBU). Each group was subdivided into 3 subgroups ( $n = 13$ ) according to the application methods: 1) 1 coat + curing; 2) 1 coat + uncuring; 3) 3 coats + curing. They were repaired using the same composite resin. After storage for 24 hours in distilled water, specimens were subjected to a SBS test and the data were statistically analyzed. Specimens were examined with a stereomicroscope to analyze fracture mode and scanning electron microscopy to observe the interface.

**Results:** Bonding agent was significant factor (2-way analysis of variance,  $p < 0.05$ ). Bond strengths achieved with SBU were higher than with PBU. The highest mean SBS values were obtained by 1-coat application of SBU followed by curing. Multi-layer application resulted in an increase in adhesive layer thickness, as observed in scanning electron microscope but there is no significant difference in SBS values. Failure mode was predominantly cohesive in old composites.

**Conclusions:** Application of an adequate bonding system played a key role in achieving reliable repair bond strengths. Groups with SBU showed higher SBS than groups with PBU and application of additional layers increased the adhesive layer thickness but do not significantly affect SBS.

**Keywords:** Composite repair bond strength; Curing; Multi-layer; Single Bond Universal

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Poster Presentations  
Research Presentation



# Effect of etching procedure on the bond strength of biofilm coated dentin

Bo-Kyung Jeon,\* Sun-Young Kim

Department of Conservative Dentistry, Seoul National University Dental Hospital, Seoul, Korea



\*Presenting author

Bo-Kyung Jeon

Department of Conservative Dentistry, Seoul National University Dental Hospital, 101 Daehak-ro, Jongno-gu, Seoul 03080, Korea.  
E-mail: bk910901@naver.com

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## ABSTRACT

**Objectives:** To investigate how the etching procedure affects the removal of biofilm on dentin and the bond strength of biofilm-coated dentin.

**Materials and Methods:** Twenty extracted human third molars were sectioned to have dentin slices of 500  $\mu$ m thickness using a low-speed diamond saw. Dentin slices were autoclaved to remove any microorganism. For biofilm removal test, dentin slices were assigned 5 groups ( $n = 5$ ) according to biofilm formation and surface treatment: NC, no treatment (negative control); BF, biofilm formation; BF-E, BF + 37% phosphoric acid etching for 15 seconds; BF-EC, BF-E + chlorhexidine soaking for 5 minutes; BF-RE, BF + rubbing with rubber cup and pumice for 15 seconds + 37% phosphoric acid etching for 15 seconds. Biofilm was formed by inoculation of *Streptococcus mutans* (*S. mutans*) for 3 days. The specimens were examined by confocal laser fluorescence microscope and scanning electron microscope. Thirty extracted human molars were cut to obtain flat dentin surface. The procedures for bond strength test with adhesives (Single Bond Universal, 3M ESPE) and composite resin (Z-250, 3M ESPE) were performed following same surface treatment with biofilm removal test: NC, BF-E, BF-EC, BF-RE ( $n = 10$ ). Tygon tube of 0.8 mm diameter was used as a mold for composite resin application. Shear bond strength test was performed in a universal test machine at a crosshead speed of 0.5 mm/min.

**Results:** Significantly less amount of biofilm was observed in BF-E, BF-EC and BF-RE compared to BF. The highest population of dead *S. mutans* was shown in BF-EC. BF-E and BF-EC showed no significant difference in between but significantly lower bond strength than NC ( $p < 0.05$ ). More adhesive failure modes were exhibited in BF-E, BF-EC and BF-RE than NC.

**Conclusions:** Biofilm on dentin might not be removed completely by 37% phosphoric acid etching during adhesive procedure and lead to lower bond strength of dentin to composite resin.

**Keywords:** Biofilm; Bond strength; CLSM; Etching; Micro shear bond strength test; SEM

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Poster Presentations  
Research Presentation



# Effect of exclusive primer and adhesive on bond strength of self-adhesive resin cement to dentin

Bitna Kim,\* Sung-Ae Son, Jeong-Kil Park

Department of Conservative Dentistry, School of Dentistry, Pusan National University, Yangsan, Korea



\*Presenting author

Bitna Kim

Department of Conservative Dentistry, School of Dentistry, Pusan National University, 20 Geumo-ro, Yangsan 50612, Korea.  
E-mail: 1004sjbn@hanmail.net

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## ABSTRACT

**Objectives:** The aim of this study was to investigate the effect of G-Cem One Primer and self-etching adhesive on the microtensile bond strength ( $\mu$ TBS) between G-Cem One cement and dentin.

**Materials and Methods:** Teeth were sectioned to expose flat coronal dentin surface and randomly assigned into 5 groups ( $n = 15$ ) according to the dentin surface treatment: 1) no surface treatment (control); 2) G-Cem One Primer (GCOP); 3) All Bond Universal (ABU); 4) G-Cem One Primer was applied onto the dentin surface followed by All Bond Universal (GCOP/ABU); 5) All Bond Universal was applied onto the dentin surface followed by G-Cem One Primer (ABU/GCOP). The composite resin blocks were luted to the dentin surface using self-adhesive cement (G-Cem One). All specimens were stored in distilled water at 21°C for 24 hours, sectioned into stick ( $1.0 \times 10.0$  mm). Then, the tension of the sticks was tested until failure. The mean values of  $\mu$ TBS were statistically analyzed by 1-way analysis of variance and Tukey's *post hoc* test. After debonding, failure mode was examined under a dental microscope.

**Results:** GCOP group exhibited the highest  $\mu$ TBS value followed by GCOP/ABU, ABU/GCOP, ABU, and control group. There were no significant differences observed between GCOP, GCOP/ABU, ABU/GCOP group. Moreover, there were no significant differences between ABU/GCOP and ABU group. Cohesive failure was predominant in the GCOP group. All group specimens failed mainly at the interface of the dentin and the resin block except for the GCOP group.

**Conclusions:** The use of GCOP to bond indirect restorations with G-Cem One cement results in the improved  $\mu$ TBS between G-Cem One cement and dentin. Using only GCOP with G-Cem One for cementation of indirect restoration is extremely simple and increases bonding effect.

**Keywords:** Exclusive primer; Micro-tensile bond strength; Self-adhesive resin cement

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November 8–10, 2019 · Seoul, Korea

Poster Presentations  
Research Presentation



# Effect of saliva contamination and cleaning methods on bond strength of resin cement to lithium disilicate CAD/CAM blocks

Kyung-Won Jun,\* Minju Song, Yong-Bum Cho, Dong-Hoon Shin, Chan-Ui Hong, Ho-Jin Moon

Department of Conservative Dentistry, College of Dentistry, Dankook University, Cheonan, Korea



\*Presenting author

Kyung-Won Jun

Department of Conservative Dentistry, College of Dentistry, Dankook university, 119 Dandae-ro, Dongnam-gu, Cheonan 31116, Korea.  
E-mail: kwjun10@gmail.com

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## ABSTRACT

**Objectives:** Recently, Lithium disilicate glass ceramics have widely used in indirect dental restorations. When we try in restorations, saliva control has to be handled with care for successful adhesion of ceramic restorations. The aim of this study is to investigate the effect of saliva contamination and cleaning procedures on the shear bond strength of Lithium disilicate CAD/CAM blocks to resin cement.

**Materials and Methods:** A total of 36 ceramic specimens (Celtra DUO, Dentsply Degudent) were fabricated and embedded with acrylic resin. The specimens were randomly divided into 3 groups: group 1, saliva contamination + hydrofluoric (HF) acid etching for 30 seconds + silane (Monobond N, Ivoclar Vivadent) for 1 minute; group 2, HF acid etching for 30 seconds + saliva contamination + rinsed with water and air syringe + silane (Monobond N) for 1 minute; group 3, HF acid etching for 30 seconds + saliva contamination + ultrasonic cleansing with 70% alcohol + silane (Monobond N) for 1 minute. All of the ceramic specimens were bonded with self-adhesive resin cement (RelyX U200, 3M ESPE). After bonding procedures, samples were stored in distilled water for 24 hours, and then submitted to the shear bond testing machine (Shear Bond Tester, Bisco Inc.)

**Results:** The result of shear bond strength test showed that saliva contamination had negative effect on bonding procedures. Even between groups 2 and 3, there was no significant difference in shear bond strength.

**Conclusions:** Within the limitation of this study, cleaning contaminated ceramic surfaces by water spray or ultrasonic cleansing is insufficient.

**Keywords:** Bonding strength; Lithium disilicate; Saliva contamination

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Poster Presentations  
Research Presentation



\*Presenting author

Saori Kimura

Department of Operative Dentistry, Tsurumi University School of Dental Medicine, 2-1-3 Tsurumi, Tsurumi-ku, Yokohama 230-8501, Japan.

E-mail: kimura-s@tsurumi-u.ac.jp

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# Changes in residual stresses on the surface of ceramic restorations luted with resin cements

Saori Kimura,<sup>1\*</sup> Saki Fukai,<sup>1</sup> Wataru Saito,<sup>1</sup> Masao Hanabusa,<sup>1</sup> Jack L. Ferracane,<sup>2</sup> Takatsugu Yamamoto<sup>1</sup>

<sup>1</sup>Department of Operative Dentistry, Tsurumi University School of Dental Medicine, Yokohama, Japan

<sup>2</sup>Department of Restorative Dentistry, School of Dentistry, Oregon Health & Science University, Portland, OR, United States

## ABSTRACT

**Objectives:** To assess the influence of water sorption on residual stresses on the surface of ceramic restorations luted with a self-adhesive resin cement or a conventional resin composite cement.

**Materials and Methods:** Ring specimens having a small flat plane in their outer curve were processed using a leucite-reinforced ceramic ( $K_c = 1.58 \text{ MPa} \cdot \text{m}^{0.5}$ ,  $E = 70 \text{ GPa}$ ), which simulated an all-ceramic crown. The rings were luted to ceramic cylinders (6.0-mm diameter, 5.0-mm height) that simulated an abutment, using a self-adhesive resin cement (SA Luting Plus [SA], Kuraray Noritake Dental) or a conventional resin composite cement (Panavia V5 [V5], Kuraray Noritake Dental). The cements were light-cured or self-cured, and the luted specimens were immersed in 37°C distilled water for 4 weeks. Indentation cracks were introduced on the flat planes of the rings at 1 hour after immersion and their lengths were measured. The crack measurement was repeated 1, 3, 7, 14, and 28 days after the immersion started. Residual stresses were calculated from the incremental crack lengths and the  $K_c$  of the ceramic.

**Results:** The ranges of the means ( $\pm$  standard deviations) of the residual stresses (MPa) from 1 hour to 4 weeks were from  $7.9 \pm 8.4$  to  $0.0 \pm 8.5$  for light-cured SA, from  $4.4 \pm 8.1$  to  $-4.5 \pm 7.9$  for self-cured SA, from  $11.1 \pm 3.7$  to  $4.6 \pm 3.5$  for light-cured V5, and from  $4.3 \pm 3.6$  to  $0.3 \pm 6.5$  for self-cured V5. The minus sign indicates tensile stress. Analysis of variance revealed that three factors (material, curing method, and time) were significant, without statistical interactions ( $p < 0.05$ ).

**Conclusions:** Compressive stresses were generated on the surface of ceramic restorations by polymerization contraction of resin cements, and were decreased by water sorption of the cements as the immersion time was extended. The self-cured self-adhesive cement was the only one to generate tensile stresses during the time frame of the study.

**Keywords:** Residual stress; Water sorption; Self-adhesive resin cement; Crack analysis, Polymerization



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**\*Presenting author**

**Ting-An Chen**

Department of Dentistry, School of Dentistry,  
National Taiwan University and National  
Taiwan University Hospital, No. 1, Changde St.,  
Zhongzheng Dist., Taipei City 100, Taiwan.  
E-mail: b02402013@g.ntu.edu.tw

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# Can light-cured bulk-fill composite serve as a luting cement for lithium disilicate based ceramics?

Ting-An Chen,<sup>1\*</sup> Pei-Ying Lu,<sup>2</sup> Yu-Hsin Huang,<sup>1</sup> Hon Yin Cheng,<sup>1</sup> Yu-Chih Chiang<sup>2</sup>

<sup>1</sup>Department of Dentistry, School of Dentistry, National Taiwan University and National Taiwan University Hospital, Taipei City, Taiwan

<sup>2</sup>Graduate Institute of Clinical Dentistry, School of Dentistry, National Taiwan University and National University Hospital, Taipei City, Taiwan

## ABSTRACT

**Objectives:** Light-cured bulk-fill composites were designed to increase the depth of curing. We hypothesized that bulk-fill composites could be applied as light-cured cements under lithium disilicate based ceramics.

**Materials and Methods:** Two flowable bulk-fill composites (Tetric N Flow Bulk-Fill; Ivoclar-Vivadent and x-tra base; VOCO GmbH), a dual-cured (Multilink N; Ivoclar-Vivadent) and a conventional composite (Tetric N Flow [Ivoclar-Vivadent]), were used to test the hypothesis. We set up a 1-mm cement space using a customized glass mold. We prepared 1- and 2-mm-thick, high- and low-translucency (HT- and LT-) lithium disilicate discs (IPS e.Max press; Ivoclar-Vivadent) to serve as ceramic restorations. The control group involved direct curing of the composite cement without passing through the ceramic discs. Two curing times, 20 and 40 seconds, were also implemented for each test group. The surface and bottom of the cured cements were measured by Vickers microhardness (VMH) testing (Shimadzu HMV-2) to evaluate the efficacy of light-curing. Fourier transform infrared (FTIR) spectroscopy (JASCO FT/IR-4200 spectrometer) was conducted to measure the degree of conversion (DC). We tested the DC immediately after curing, at 1 and 24 hours post-curing, and after complete curing.

**Results:** In terms of VMH values, Multilink N and x-tra base ( $28.1 \pm 1.8$  and  $24.4 \pm 1.8$  HV) outperformed the others (VMH < 15 HV) at 20 seconds in the 2-mm thickness, LT-ceramic, and surface-cement condition ( $p < 0.05$ ). Thickened ceramic and less curing time decreased the resulting hardness of the test cements significantly ( $p < 0.05$ ). Translucency of the ceramic did not impair the hardness in all conditions. FTIR tests supported the findings of VMH.

**Conclusions:** We concluded that bulk-fill composite could serve as a luting cement in a product-dependent fashion. The curing time is a crucial factor influencing the setting efficacy, even with dual-cured resin cement. Conventional light-cured composite may not be suitable as luting cement due to its low curing efficacy under ceramic restorations.

**Keywords:** Bulk-fill composite; Dual-cured resin cement; FTIR; Light-cured composite; Lithium disilicate ceramic; Vickers microhardness test

Poster Presentations  
Research Presentation



# A preliminary investigation of a novel CAD-CAM polymer crown

Muhammad Syafiq Alauddin,<sup>1\*</sup> Sami Alduwayhi,<sup>2</sup> Nicolas Martin<sup>3</sup>

<sup>1</sup>Department of Conservative Dentistry and Prosthodontics, Universiti Sains Islam Malaysia, Kuala Lumpur, Malaysia

<sup>2</sup>Department of Prosthodontics, College of Dental Sciences, Majmaah University, Al-Majmaah, Saudi Arabia

<sup>3</sup>Academic Unit of Restorative Dentistry, University of Sheffield, Sheffield, United Kingdom



**\*Presenting author**

**Muhammad Syafiq Alauddin**

Department of Conservative Dentistry  
and Prosthodontics, Universiti Sains Islam  
Malaysia, Jalan Pandan Utama, Pandan Indah,  
Kuala Lumpur 56100, Malaysia.  
E-mail: syafiq.alauddin@gmail.com

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## ABSTRACT

**Objectives:** To use mechanical static and dynamic testing to investigate the structural integrity of a novel PEEK polymer crown on posterior teeth.

**Materials and Methods:** IPS e.max computer-aided design (CAD) and PEEK by Juvora and Vita Enamic were used with 30 samples from each group and prepared according to the manufacturer's guidelines. An upper right premolar duplicated in a polyurethane resin (AlphaDie) and identical full-coverage crowns were fabricated on a crown preparation. The periodontal ligament was simulated by using a light body silicone impression material. CAD was implemented by using the InEos (Sirona Dental Systems GmbH) system and CEREC inLab software version 3.60. The scanned crown preparations utilized computer-aided manufacturing (CAM) with a dental milling machine (Roland DWX-50 5-Axis). A custom-made tensometer (Lloyds Instrument Model LRX) was used to obtain a constant force throughout the cementation procedure, simulating finger pressure. A universal testing machine (Lloyds Instrument Model LRX) was used as a static compression axial load indenter and a chewing simulator machine with a water bath environment was used as a dynamic testing method.

**Results:** There was significant difference in the mean fracture load and Burke's fracture mode analysis of PEEK crowns compared to the other groups ( $p = 0.0000$ ). The PEEK crowns showed an exceptionally high fatigue limit, with up to 11 kg (930 N) and 5,000 cycles, and an excellent fatigue life, lasting for roughly 1,250,000 cycles (corresponding to an estimation of 5 years of continuous chewing). A fractographic assessment by stereomicroscopy showed catastrophic failure of PEEK crowns, while the digital subtraction technique in a 3-dimensional analysis showed a deformation area on occlusal regions and the walls of crowns.

**Conclusions:** Fracture strength, fatigue life, and fatigue limit testing among all groups revealed that the PEEK crown scored the highest; however, at the peak fracture point, catastrophic deformation failures occurred.

**Keywords:** Dynamic testing; Fracture strength; Full coverage crown; Static testing; Structural integrity

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\*Presenting author

Wonhuy Choi

Department of Conservative Dentistry, Yonsei University Dental Hospital, 50-1 Yonsei-ro, Seodaemun-gu, Seoul 03722, Korea.  
E-mail: wonhuy@yuhs.ac

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# Two-year clinical evaluation and comparison of bulk-fill and micro-hybrid composite resin

Wonhuy Choi,\* Yooseok Shin, Byoung-Duck Roh

Department of Conservative Dentistry, Yonsei University Dental Hospital, Seoul, Korea

## ABSTRACT

**Objectives:** Bulk-fill composite resins have been released for substitutes of conventional composite resin. However, bulk-fill composite resins also have limitations in terms of shade and translucency because of their chemical compositions. And questions still remain regarding clinical performance due to lack of clinical trials. There are only a small number of clinical studies in European populations only. The purpose of this clinical trial is to compare the performance of bulk-fill composite resin with micro-hybrid composite resin in Korean population.

**Materials and Methods:** Micro-hybrid composite resin, Filtek Z250 and Adper single bond 2 system (3M ESPE) and bulk-fill composite resin, Tetric N-Ceram Bulk-fill and N-bond self-etch system (Ivoclar) were used in this study. Micro-hybrid composite resin was used incrementally, each one being light-cured for 20 seconds (increments less than 2.0 mm). Bulk-fill composite resin was used in bulk-fill cavities, each one being light-cured for 10 seconds (less than 4.0 mm), and 20 seconds (more than 4.0 mm). The restorations were finished and polished immediately. The restorations were evaluated by the FDI criteria at baseline and after 6 months, 1 year, 2 years of clinical service by 2 evaluators. Pearson's  $\chi^2$  test, and the Friedman repeated measured analysis was used to compare the changes across different time points within each groups ( $\alpha = 0.05$ ).

**Results:** At 6 months, 1 year, and 2 years, the recall rates were 79%, 56%, 36%, respectively. For the anatomical contour of class II restoration at 6-month recall, micro-hybrid group had significantly more deficiency on the restoration ( $p < 0.05$ ). There was no significant difference on the scores of other esthetic, functional, and biological properties.

**Conclusions:** No significant differences were observed on the properties between bulk-fill and micro-hybrid composite resin except the anatomical contour of class II restoration. Within the limitation of this study, bulk-fill composite resin has a similar clinical performance to micro-hybrid composite resin.

**Keywords:** Bulk-fill composite resin; Clinical trial; FDI criteria; Korean population; Micro-hybrid composite resin

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# Color stability of esthetic composite resins with different polishing systems



Bora Song,\* Jung-Hong Ha, Young Kyoung Kim, Sung Kyo Kim, Myoung Uk Jin

Department of Conservative Dentistry, School of Dentistry, Kyungpook National University, Daegu, Korea

\*Presenting author

Bora Song

Department of Conservative Dentistry, School of Dentistry, Kyungpook National University, 2177 Dalgubeol-daero, Jung-gu, Daegu 41940, Korea.

E-mail: roseluv65@hanmail.net

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## ABSTRACT

**Objectives:** The purpose of this study is to evaluate the influence of polishing methods on the color stability of esthetic composite resins.

**Materials and Methods:** Two esthetic composite resins (Filtek Z350 XT Universal A2 shade, 3M ESPE; Gradia Direct A2 shade, GC Corporation) were used. One hundred and ninety-two resin specimens were prepared using cylindrical molds (6 mm in diameter, 2 mm in thickness). The specimens were randomly divided into 4 subgroups according to different finishing and polishing systems: group 1, no polishing; group 2, Sof-Lex Spiral Wheels (3M ESPE); group 3, Enhance & Enhance PoGo (Dentsply); group 4, Jota Professional & Easy (JOTA). After finishing and polishing, the specimens were stored in distilled water at 37°C for 24 hours. A spectrophotometer (CM-3500d, Minolta) was used to determine the color value according to the CIE L\*a\*b\* color space. After the baseline color measurement, half of the specimens remained in distilled water and the other half were immersed in coffee solution 20 min/day and remained in distilled water. Color value evaluation was repeated after 1 and 4 weeks. The results were analyzed by analysis of variance and the Tukey's *post hoc* test.

**Results:** Effect of coffee on color differences ( $\Delta E$ ) was greater than that of distilled water ( $p < 0.05$ ). In distilled water, there was no significant difference between the types of composite resins and polishing methods. In coffee, Filtek Z350 XT universal showed the higher  $\Delta E$  values than Gradia direct ( $p < 0.05$ ). Among the polishing system, group 4 (JOTA) showed the lowest  $\Delta E$  values regardless of the type of composite resins.

**Conclusions:** Within the limitation of this study, microhybrid resin composite (Gradia direct) showed higher color stability after immersion in coffee than nanofilled resin composite (Filtek Z350 XT). JOTA polishing system showed highest color stability after immersion in coffee regardless of the type of composite resins.

**Keywords:** Color stability; Esthetic composite resin; Polishing system

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# Color stability of esthetic restorative materials after application of fluoride varnishes

Chul Hoon Jang,\* Sung-Hyeon Choi, Bin-Na Lee, Hoon-Sang Chang,  
Yun-Chan Hwang, Won-Mann Oh, In-Nam Hwang

Department of Conservative Dentistry, School of Dentistry, Chonnam National University, Gwangju, Korea



\*Presenting author

Chul Hoon Jang

Department of Conservative Dentistry, School of Dentistry, Chonnam National University, 77 Yongbong-ro, Buk-gu, Gwangju 61186, Korea.  
E-mail: vanguards@naver.com

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## ABSTRACT

**Objectives:** The objective of present study was to compare the color stability of esthetic materials after application of fluoride varnishes.

**Materials and Methods:** Esthetic restorative materials used were Filtek Z350 XT (Composite resin, 3M ESPE), Fuji II LC (RMGI, GC Co.), and Beautifil Flow Plus F00 (Giomer, Shofu Inc.). Fluoride Varnish used were Cavity Shield (3M ESPE), V-varnish premium (Vericom). Thirty samples of each restorative materials were prepared, which were divided into 3 groups ( $n = 10$ ). Group 1 specimens were stored in distilled water without varnish application, which were used as control, group 2 specimens were applied with Cavity Shield and group 3 specimens were with V-varnish premium. All specimens were stored in the distilled water at 60°C for 30 days for the accelerated test. Samples were then subjected to colorimetric analysis. Data was statistically analyzed using one-way analysis of variance and Tukey's *post hoc* test.

**Results:** The color change between before and after application of varnish was the highest in all experimental groups. The color change according to the accelerated test showed no significant difference in the varnish application group and the control group. Fluoride varnish caused significant increase in color change of RMGI ( $p < 0.05$ ). The color change of Giomer and RMGI were not significantly different between Cavity Shield and V-varnish application groups.

**Conclusions:** Present study concludes that color stability of esthetic restoration materials can be affected by application of fluoride varnish. Especially, RMGI shows a large color change compared to the composite resin and Giomer, so it is suggested that careful attention should be paid to clinical application.

**Keywords:** Color stability; Esthetic restorative materials; Fluoride varnishes

Poster Presentations  
Research Presentation



# Color stability of conventional resin composite cements and self-adhesive cements immersed in 37°C water

Ayaka Hori,\* Yuka Ogawa, Daichi Aizawa, Nana Sakaeda, Kaoru Ohmori,  
Masao Hanabusa, Takatsugu Yamamoto

Department of Operative Dentistry, Tsurumi University School of Dental Medicine, Yokohama, Japan



\*Presenting author

Ayaka Hori

Department of Operative Dentistry, Tsurumi University School of Dental Medicine, 2-1-3 Tsurumi, Tsurumi-ku, Yokohama 230-8501, Japan.

E-mail: hori-a@tsurumi-u.ac.jp

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## ABSTRACT

**Objectives:** The purpose of this study was to evaluate the color stability of conventional resin composite cements and self-adhesive cements immersed in 37°C water for 21 days. The hypothesis tested was that conventional resin composite cements and self-adhesive cements would demonstrate similar discoloration through water immersion.

**Materials and Methods:** Three conventional resin composite cements (PANAVIA V5, Rely X Ultimate, and Variolink Esthetic DC) and 3 self-adhesive cements (SA Luting Multi, Rely X Unicem 2 and Speed CEM Plus) were evaluated in this study. The cements were mixed using mixing tips, and then packed in aluminum molds ( $\phi$  15.0 mm  $\times$  1.0 mm). The mixtures were irradiated with a LED curing device as per ISO standards. Hand-mixed specimens were added for SA Luting Multi. The disk specimens were immersed in 37°C water for up to 21 days. The colors (CIELAB) of the specimens were measured at the center of the disk using a spectrophotometer, before immersion and at 1-, 7-, 14-, and 21-day intervals after immersion ( $n = 5$ ). The color difference between before and after immersion ( $\Delta E$ ) was calculated from the measured  $L^*a^*b^*$  values, and statistical analysis was performed using analysis of variance (ANOVA) at  $\alpha = 0.05$ .

**Results:** All of the cements demonstrated discoloration during water immersion. The mean values of  $\Delta E$  ranged from 0.43 (SA Luting Multi at 1 day) to 3.28 (SA Luting Multi hand-mixed at 21 days). Three-way ANOVA revealed that three factors (conventional/self-adhesive, cement brand, and immersion period) significantly affected  $\Delta E$ . The statistical interactions were also significant between cement type (conventional/self-adhesive) and immersion period, as well as between cement brand and immersion period.

**Conclusions:** Discoloration of the resin cements was induced by 37°C water immersion. The degree of discoloration varied among the cements, irrespective of whether they were of the conventional type or the self-adhesive type.

**Keywords:** Color stability; Discoloration; Resin cement; Self-adhesive cement; Water immersion

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Poster Presentations  
Research Presentation



# Anti-cariogenic biofilm effect of zinc glass-containing glass ionomer cement after long-term water immersion using *in vitro* minimal residual disease flow cell study

Traithawit Naksagoon,\* Tatsuya Ohsumi, Shoji Takenaka, Taisuke Hasegawa, Yuichiro Noiri

Department of Cariology, Operative Dentistry and Endodontics, Graduate School of Medical and Dental Sciences, Niigata University, Niigata, Japan



\*Presenting author

Traithawit Naksagoon

Department of Cariology, Operative Dentistry and Endodontics, Graduate School of Medical and Dental Sciences, Niigata University, 2-5274, Gakkocho-dori, Chuo-ku, Niigata 951-8514, Japan.

E-mail: naksagoon-ttw@dent.niigata-u.ac.jp

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## ABSTRACT

**Objectives:** The aim of this study was to assess the effect of long-term water exposure to zinc glass-containing glass ionomer cement restoration on anti-cariogenic biofilm properties

**Materials and Methods:** After 21 days of submersion under sterile distilled water, 10 disks of Careclyn Restore (CD; GC Corporation) and Fuji VII (FJ; GC Corporation) were used as *Streptococcus mutans* biofilm construction surfaces with a modified Robbins device flow-cell system and incubated in a 37°C chamber for 24 hours. Biofilm structure and morphology were assessed by confocal laser scanning microscopy (CLSM) and scanning electron microscopy (SEM). Colony-forming unit (CFU) counts were also made to assess the vitality of bacterial cells. To determine fluoride uptake and release ability, the liquid was collected after 1 hour of immersion, then once every week, and analyzed for mineral contents.

**Results:** There was no significant difference between the CD and FJ groups in the viable cell count analysis: CD group,  $7.19 \pm 0.16$  (control) and  $7.61 \pm 0.29$  (21-day water exposure group) log CFU/mm<sup>2</sup>; FJ group,  $7.54 \pm 0.75$  and  $7.53 \pm 0.27$  log CFU/mm<sup>2</sup> ( $p > 0.05$ ). The SEM and CLSM analyses distinctly revealed that all the CD groups' surfaces had lower amounts of biofilm than the FJ groups, showing thinner layers and dispersing small bacterial clusters. While water immersion diminished the physical properties of both glass ionomer cements, the antibiofilm effect was slightly affected in the CD group.

**Conclusions:** The new zinc glass-containing glass ionomer cement has an anti-cariogenic effect on biofilms by interrupting the adhesion of bacterial cells to the restoration surface although long-term contact with moisture. However, no bactericidal effect was shown in either group.

**Keywords:** Antibiofilm; Glass ionomer cement; Oral biofilm; *Streptococcus mutans*; Zinc

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**\*Presenting author**

**Hyoeun Kim**

Department of Conservative Dentistry, School of Dentistry, Chonbuk National University, 567 Baekje-daero, Deokjin-gu, Jeonju 54896, Korea.

E-mail: hwa3106@naver.com

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# The effect of concentration and temperature of hydrofluoric acid etching on the shear bond strength to Y-TZP

Hyoeun Kim,<sup>\*</sup> Kyung-San Min, Mi-Kyung Yu, Kwang-Won Lee

Department of Conservative Dentistry, School of Dentistry, Chonbuk National University, Jeonju, Korea

## ABSTRACT

**Objectives:** This study was to investigate to the effect of changes in concentration and temperature of hydrofluoric acid etching on the shear bond strength (SBS) between resin cement and yttria-stabilized tetragonal zirconia polycrystal ceramic (Y-TZP).

**Materials and Methods:** Sintered Y-TZP specimens and resin cement blocks were prepared for SBS test. The bonding surface of Y-TZP specimens was etched for 10 minutes with hydrofluoric acid under different conditions: temperature conditions (room temperature, 70°C–80°C) and concentration conditions (5%, 10%, 20%, and 40%). The zirconia primer (Z-prime plus, Bisco Inc.) was applied to the etched surface of Y-TZP. MDP-containing resin cement (G-CEM LinkAce, GC Inc.) was applied on the bonding surface of Y-TZP. SBS test was conducted with universal testing machine at crosshead speed of 0.5 mm/min. The surface morphology was observed with scanning electron microscope and surface roughness was calculated with atomic force microscope. Two-way analysis of variance was performed to compare the difference of SBS values between the groups ( $\alpha = 0.05$ ).

**Results:** At the same temperature condition, the higher the concentration of hydrofluoric acid (HF) solution, the higher the SBS values were measured. When etched with 40% HF solution, the highest SBS value was measured. Under room temperature condition, the SBS value of 40% HF etching was significantly higher than the other subgroups. Under the 70°C–80°C condition, the SBS values of 20% and 40% HF etching were significantly higher than the other subgroups. However, there was no significant difference in the SBS values of 40% HF etching between at room temperature and 70°C–80°C.

**Conclusions:** Etching with a 40% HF solution at room temperature is recommended as a Y-TZP surface treatment for improving the bonding strength.

**Keywords:** Hot acid etching; Hydrofluoric acid; Y-TZP

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\*Presenting author

Sooyoung Yu

Department of Conservative Dentistry, Seoul  
National University Dental Hospital, 101  
Daehak-ro, Jongno-gu, Seoul 03080, Korea.  
E-mail: dentalsy90@gmail.com

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# Effect of air-plasma treatment on shear bond strength of resin cement to zirconia surface

Sooyoung Yu,\* Byeong-Hoon Cho

Department of Conservative Dentistry, Seoul National University Dental Hospital, Seoul, Korea

## ABSTRACT

**Objectives:** Sandblasting for the zirconia may induce micro-cracks on the surface of zirconia substrate. In order to prevent such defects, this study applied plasma to the zirconia surface rather than sandblasting, evaluated the effect of plasma treatment on the bond strength between zirconia and resin cement, and to compare its effect with contemporary Al<sub>2</sub>O<sub>3</sub> sandblasting by comparing shear bond strengths.

**Materials and Methods:** A total of 60 zirconia specimens, which were polished and then sintered, were randomly divided into 6 groups ( $n = 10$ ) according to surface treatments using air-plasma (non-thermal atmospheric pressure plasma) and zirconia primer (ZP; Z-Prime Plus, Bisco) before applying resin cement (Rely X Ultimate, 3M ESPE): group 1, ZP application only (negative control); group 2, 1 minute plasma bombardment + ZP; group 3, 10 minutes plasma bombardment + ZP; group 4, ZP + 1 minute plasma bombardment; group 5, ZP + 1 minute plasma bombardment + ZP; group 6, sandblast + ZP (positive control). Resin cement was built in an iris for shear bond strength testing. Data were statistically analyzed with 1-way analysis of variance test and Tukey's *post hoc* test at a significance level of  $p < 0.05$ .

**Results:** The shear bond strength of the sandblast group ( $19.3 \pm 2.6$  MPa [mean  $\pm$  standard deviation]) was significantly higher than that of the negative-control group (no previous treatment,  $11.5 \pm 3.0$  MPa). However, the plasma treated groups (group 2,  $15.0 \pm 5.6$  MPa; group 3,  $14.0 \pm 5.0$  MPa; group 4:  $12.3 \pm 4.3$  MPa; group 5,  $15.4 \pm 5.3$  MPa) did not show statistical differences from positive and negative control groups. There were no statistical differences among the plasma treated groups.

**Conclusions:** Even with the air plasma, the bond strength of resin cement to plasma treated zirconia surface did not approach the contemporary sandblasting technique.

**Keywords:** Adhesion; Plasma; Shear bond strength; Zirconia bonding

Poster Presentations  
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# Effect of cementation protocols, curing mode, and thermocycling on push-out bond strength of fiber post

Haseon Lo,\* Ji-Hyun Jang, Seok Woo Chang, Kyoung-Kyu Choi, Duck-Su Kim

Department of Conservative Dentistry, Kyung Hee University Dental Hospital, Seoul, Korea



\*Presenting author

Haseon Lo

Department of Conservative Dentistry,  
Kyung Hee University Dental Hospital, 23  
Kyungheedaero-ro, Dongdaemun-gu, Seoul  
02447, Korea.

E-mail: hsglitter@naver.com

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cited.

## ABSTRACT

**Objectives:** The aims of this study were to evaluate the effect of a cementation protocols, curing mode, and thermocycling on push-out bond strength of fiber post to different root regions.

**Materials and Methods:** The coronal portions of 64 extracted human lower premolar teeth with single canal were sectioned at 4 mm above the cemento-enamel junction. Root canal treatment was performed. The specimens were divided randomly into 4 groups, 16 teeth were assigned to each group. Group 1, All-bond Universal (BISCO) + Duo-link Universal (BISCO); group 2, Single-bond Universal (3M ESPE) + RelyX Ultimate (3M ESPE); group 3, Universal Primer (BISCO) + Duo-link Universal; group 4, RelyX U200 (3M ESPE). Each group was divided into 8 subgroups according to curing mode (dual-cure or self-cure), artificial aging (immediate or thermocycled), and different root regions (coronal third or middle third). D.T light post (BISCO) was cemented according to manufacturer's instructions. Artificial aging group were subjected to thermocycling (5°C–55°C, 5,000 cycles). Each tooth was transversely sectioned and 3 discs with thickness of 1 mm were produced in each of coronal and middle third, respectively. Push-out bond strength test was performed. Data were analyzed using Student's *t*-test, 4-way analysis of variance and Bonferroni test at  $p < 0.05$  level.

**Results:** In immediate groups, dual-cure showed significant higher bond strength than self-cure ( $p < 0.05$ ). In most subgroups, coronal showed higher bond strength than middle, but it was not statistically significant. In aged groups, dual-cure showed no significant difference from self-cure in all cementation protocols. Coronal showed significant higher bond strength than middle in groups 1, 2, and 4, except group 3 ( $p < 0.05$ ).

**Conclusions:** Push-out bond strength of fiber post is affected by various factors used in this study. Dual-cure mode is recommended in all the cementation protocols.

**Keywords:** Bonding strength; Cementation; Curing mode; Post; Resin cement; Thermocycling

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Research Presentation



# The effect of silver coating on the mechanical properties of L605 cobalt chromium

Widowati Siswomihardjo,<sup>1\*</sup> Bonifasius Primario Wicaksono,<sup>2</sup>  
Muhammad Kusumawan Herliansyah<sup>3</sup>

<sup>1</sup>Department of Dental Biomaterials, Faculty of Dentistry, Universitas Gadjah Mada, Yogyakarta, Indonesia

<sup>2</sup>Department of Biomedical Engineering, Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia

<sup>3</sup>Department of Mechanical and Industrial Engineering, Faculty of Engineering, Universitas Gadjah Mada, Yogyakarta, Indonesia



**\*Presenting author**

**Widowati Siswomihardjo**

Department of Dental Biomaterials,  
Universitas Gadjah Mada, Bulaksumur,  
Yogyakarta 55281, Indonesia.  
E-mail: widowati@ugm.ac.id

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## ABSTRACT

**Objectives:** Cobalt chromium (CoCr) L605 is a metal alloy used in dentistry with good mechanical properties. However, it has a tendency to release chromium ions into the oral environment, which might cause an adverse reaction. Silver coating is a method for preventing the release of chromium. Clinically, materials are subjected to stresses from mastication actions in the oral environment that can initiate deformations. Hardness tests evaluate the surface characteristics of a material in terms of deformation. The aim of this study was to determine the effect of silver coating thickness on the hardness of L605 cobalt chromium alloy.

**Materials and Methods:** Sixteen metal plates of CoCr L605 (Remanium GM 800; Dentaaurum) were divided into 4 groups: control, and silver coating groups of 1 µm, 5 µm, and 10 µm thickness. The silver coating was performed using electroplating. After 14 days, the concentration of chromium ions was measured using atomic absorption spectrophotometry, and followed by hardness testing, using a Vickers hardness testing machine (Iqualitrol).

**Results:** One-way analysis of variance showed a significant effect ( $p < 0.05$ ) of silver coating thickness on the concentration of chromium ion release. The *post hoc* test showed there was no significant difference ( $p > 0.05$ ) between the 5 µm and 10 µm silver coating thickness groups.

**Conclusions:** It can be concluded that the thickness of the silver coating influenced the concentration of released chromium ions, but the coating did not have a significant effect on the hardness of the CoCr alloy.

**Keywords:** Cobalt chromium alloys; Hardness; Silver coating

Poster Presentations  
Research Presentation



# A randomized controlled trial of bleaching toothpaste with two different concentration of hydrogen peroxide

Jei Kim,<sup>1\*</sup> Hyun-Jung Kim,<sup>1</sup> Seok Woo Chang,<sup>2</sup> Kyoung-Kyu Choi,<sup>2</sup> Duck-Su Kim,<sup>2</sup> Ji-Hyun Jang<sup>2</sup>

<sup>1</sup>Department of Conservative Dentistry, Graduate School, Kyung Hee University, Seoul, Korea

<sup>2</sup>Department Of Conservative Dentistry, School of Dentistry, Kyung Hee University, Seoul, Korea



\*Presenting author

Jei Kim

Department of Conservative Dentistry,  
Graduate School, Kyung Hee University, 26  
Kyungheedaero-ro, Dongdaemun-gu, Seoul  
02447, Korea.

E-mail: woldji0202@gmail.com

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## ABSTRACT

**Objectives:** The aim of this study is to evaluate the clinical efficacy of the bleaching toothpaste with 2 different concentration of hydrogen peroxide in a randomized controlled trial.

**Materials and Methods:** Subjects were randomly allocated to 3 experimental groups: Toothhole white (TW,  $n = 17$ ), Vussen 7 (VL,  $n = 15$ ), Vussen 28 (VH,  $n = 17$ ). The experimental materials were the 3 bleaching tooth pastes containing 2 different concentration of hydrogen peroxide (TW 0.75%, VL 0.75%, VH 2.8%). Patients were instructed to use the toothpaste for 12 weeks. We recorded the color of the cervical, middle, and incisal parts of the teeth #11 and #13 at the baseline appointment, 4 weeks, 12 weeks by using color measuring device, spectrophotometer (Vita Easyshade), to determine the color change (CIE LAB,  $\Delta E$ ). At each check day, patients answered the question about the occurrence of sensitivity.

**Results:** All experimental group showed the bleaching effects in the early stage (4 weeks). At 12 weeks,  $\Delta E$  values of all groups went beyond 3.3. VH showed the most whitening effect on both teeth #13 and #11. There was no significant difference between TW and VL. VH had the highest incidence of tooth sensitivity during treatment.

**Conclusions:** Toothpaste with higher concentration of hydrogen peroxide had more tooth bleaching efficacy and increased the risk of tooth sensitivity.

**Keywords:** Bleaching toothpaste; Hydrogen peroxide; Randomized controlled trial; Spectrophotometer; Tooth sensitivity

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# Homogeneity of dental curing light beam profile

Hyoungeok Ko,\* Ji Yoon Hong, Dohyun Kim, Sung-Ho Park

Department of Conservative Dentistry, Yonsei University College of Dentistry, Seoul, Korea



\*Presenting author

Hyoungeok Ko

Department of Conservative Dentistry, Yonsei University College of Dentistry, 50-1 Yonsei-ro, Seodaemun-gu, Seoul 03722, Korea.  
E-mail: fluori2@yuhs.ac

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## ABSTRACT

**Objectives:** To analyze factors affecting inhomogeneity of the light on dental curing light.

**Materials and Methods:** Eight dental curing lights were investigated via following sequences:

1) Radiant emittance and spectrum were examined; 2) Spectrum of the light which went through neutral-density (ND) filter were analyzed. Each dental curing light was tested with ND filters with 5 different optical density (OD) values (0.1, 0.2, 0.5, 1.0, and 2.0); 3) Beam profile of each dental curing light was inspected with camera. Light was attenuated with ND filter in order not to exceed camera's limit. When distortion of beam profile occurred, holographic filter was applied. Procedures 1) and 2) were repeated 5 times each.

**Results:** From 8 dental curing units, 3 units emitted polywave light and 5 units emitted monowave light. Radiant emittance varied from 420.2 to 2,326.4 mW/cm<sup>2</sup>. Spectral distribution of each dental curing units was uniformly decreased after passing through ND filter with higher OD value. Each curing lights lost its homogeneity after attenuated with ND filters with different OD values (4.2–5.1).

**Conclusions:** Within the limitations, light from dental curing units is homogeneous unless the light is heavily attenuated.

**Keywords:** Beam profile; Dental curing light; Dental materials



Poster Presentations  
Research Presentation



# The effect of desensitizers on the dentinal tubule occlusion

Sang-Su Lee,\* Yoorina Choi, Seok-Ryun Lee, Su-Jung Park

Department of Conservative Dentistry, Wonkwang University Dental Hospital, Iksan, Korea



\*Presenting author

Sang-Su Lee

Department of Conservative Dentistry,  
Wonkwang University Dental Hospital, 77  
Dunsan-ro, Seo-gu, Iksan 35233, Korea.  
E-mail: consben17@gmail.com

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## ABSTRACT

**Objectives:** The purpose of this study is to evaluate products which are included in different categories such as re-mineralizing paste, desensitizer, fluoride varnish, but known as they can be used to treat dentin hypersensitivity by occluding dentinal tubules.

**Materials and Methods:** Twenty extracted sound human third molars were mesiodistally sectioned into 2 parts and trimmed to expose flat surface of dentin on the occlusal surface. They were embedded in acrylic resin. A total of 40 specimens were randomly divided into 4 groups ( $n = 10$ ): group 1, control; group 2, Apapro (Sangi) containing nanohydroxyapatite particles; group 3, Superseal Desensitizer (Phoenix Dental) containing oxalic acid and potassium salt; group 4, 3M Clinpro White Varnish (3M ESPE) containing 5% sodium fluoride. All products were applied on the exposed occlusal dentin surface under instructions of the manufacturers and stored in a 100% relative humid container at 37°C. The protocol was daily carried out for 1 week. Occlusal dentin surface of each specimen was examined using a field emission scanning electron microscope (SUPRA40VP, Carl Zeiss) at  $\times 1,500$  and  $\times 15,000$  magnification.

**Results:** Group 1 (control) images showed round-shaped, open dentinal tubules and sound intertubular dentin. In group 2, small crystals deposited along the rim of the tubules and on the occlusal surface of dentin were observed and diameter of the tubule decreased due to the depositions. In group 3, relatively large cubic-shaped crystals deposited on the occlusal surface of dentin filled dentinal tubules. Unlike the other 2 groups, group 4 showed varnish-like surface and a large and round-shaped lump or lid that covered the tubule opening.

**Conclusions:** Within the limitations of this study, in all experimental groups, dentinal tubules changed in such a way that their diameter was reduced, tubules were filled with depositions, or tubular openings were covered with varnish.

**Keywords:** Dentin; Desensitizer; Fluoride varnish; Scanning electron microscope; Nano-hydroxyapatite

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The 1st General Meeting of  
the Asian-Oceanian Federation of Conservative Dentistry (AOFCD)

November 8–10, 2019 · Seoul, Korea



Poster Presentations  
Research Presentation



# Antibacterial efficacy of *Garcinia indica*, *Cinnamomum cassia*, and *Azadirachta indica* against *Enterococcus faecalis*

Karthick Soundararajan,\* Hannah Rosaline, Deivanayagam Kandasawamy, Arathi Ganesh

Department of Conservative Dentistry and Endodontics, Sri Ramachandra Institute of Higher Education and Research, Chennai, Tamil Nadu, India



\*Presenting author

Karthick Soundararajan

Department of Conservative Dentistry and Endodontics, Sri Ramachandra Institute of Higher Education and Research, No.1, Ramachandra Nagar, Sri Ramachandra Nagar, Porur, Chennai, Tamil Nadu 600116, India.  
E-mail: skarthick@sriramachandra.edu.in

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## ABSTRACT

**Objectives:** The aim of this study was to assess the efficacy of the antimicrobial activity of *Garcinia indica*, *Cinnamomum cassia*, and *Azadirachta indica* against *Enterococcus faecalis* compared with 2% chlorhexidine using real-time polymerase chain reaction (PCR).

**Materials and Methods:** Ninety-six single-rooted mandibular premolar human teeth were used for the study, and were decoronated 5 mm below the cemento-enamel junction to obtain 6 mm of the middle third of the root. The internal diameter was standardized using a No. 3 Gates Glidden drill. Organic and inorganic debris was removed with 17% ethylenediaminetetraacetic acid for 5 minutes followed by 5% NaOCl for 5 minutes. Each block was rinsed with distilled water for 5 minutes and sterilized in an autoclave at 121°C. Contamination of the blocks was performed with isolated 24-hour colonies of pure cultures of *E. faecalis* (ATCC 29212). The dentin blocks were transferred to individual centrifuge tubes containing 1 mL of inoculum in 1 mL of brain heart infusion broth. For the antimicrobial assessment, after the incubation period, the blocks were irrigated with 5 mL of sterile saline to remove the incubation broth. The dentin blocks were assigned to the following groups ( $n = 12$ ) for each day. The minimum inhibitory concentration of *G. indica*, *C. cassia*, *A. indica*, and 2% chlorhexidine in methylcellulose was 0.06 mg. Antimicrobial assessment was performed at the end of the first and fifth days, and the content was evaluated by real-time PCR.

**Results:** This study showed that *G. indica* and *A. indica* had significantly higher antibacterial activity on day 1 ( $p < 0.05$ ) than the other 2 groups. On the fifth day, the antibacterial activity of chlorhexidine was higher than that of the other groups ( $p < 0.05$ ).

**Conclusions:** The results of the present study indicate that *G. indica* and *A. indica*, herbal intracanal medicaments, had higher antibacterial activity on day 1. Furthermore, 2% chlorhexidine and *A. indica* maintained substantial effects until day 5.

**Keywords:** Antimicrobial; *Enterococcus faecalis*; Intracanal medicament

**ConsAsia** 2019

The 1st General Meeting of  
the Asian-Oceanian Federation of Conservative Dentistry (AOFCD)

November 8–10, 2019 · Seoul, Korea

Poster Presentations  
Research Presentation



**\*Presenting author**

**Sukatton Sukatton**

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Campus A UNAIR Jl. Prof. Dr. Moestopo No. 47, Surabaya 60132, Indonesia.  
E-mail: sukatondrg@yahoo.com

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# Inhibition of glucan formation by *Lactobacillus acidophilus* by a calcium hydroxide and propolis combination

**Sukatton Sukatton,<sup>1\*</sup> Gracia Imanuella<sup>2</sup>**

<sup>1</sup>Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia

<sup>2</sup>Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia

## ABSTRACT

**Objectives:** The presence of glucans promotes selective attachment of oral bacteria that colonize human teeth and play a role in plaque accumulation, which can develop into caries. Caries that have reached the dentin and roof of the pulp chamber need pulp capping treatment using calcium hydroxide. The disadvantages of calcium hydroxide have caused many researchers to explore alternative ingredients, one of which uses propolis. Propolis has an active ingredient that can inhibit the enzyme glucosyltransferase. The addition of propolis extract to calcium hydroxide is expected to improve the function of calcium hydroxide. This study was conducted to determine whether maximal inhibition of the combination of calcium hydroxide and propolis was achieved at a ratio of 1:1; 1:1.5; or 1:2 against glucans produced by *Lactobacillus acidophilus*.

**Materials and Methods:** The study used four treatment groups with each group consisting of 6 replications. Group 1 was a combination of calcium hydroxide and propolis with a ratio of 1:1, Group 2 used a ratio of 1:1.5, Group 3 used a ratio of 1:2, and a positive control group used calcium hydroxide and sterile Aqua Dest. Then, a solution of *L. acidophilus* and each treatment group was added into a different tube containing sucrose and phosphate buffer. The tube was tilted 300 times for 18 hours and then vortexed. The absorbance value of colonization of *L. acidophilus* was measured using a spectrophotometer.

**Results:** Glucan levels were measured from the absorbance value of *L. acidophilus* colonization. The absorbance value of *L. acidophilus* colonization was inversely proportional to the increase in the combination of calcium hydroxide and propolis.

**Conclusions:** The combination of calcium hydroxide and propolis with a ratio of 1:2 inhibited glucan formation by *L. acidophilus* more effectively than combinations of calcium hydroxide and propolis at ratios of 1:1 and 1:1.5.

**Keywords:** Combination of calcium hydroxide and propolis; Glucan; Inhibition; *Lactobacillus acidophilus*

Poster Presentations  
Research Presentation



# Effective dose of combined calcium hydroxide-propolis to inhibit *Aggregatibacter actinomycetemcomitans* biofilms

Ira Widjiastuti,<sup>1\*</sup> Nancy C. Sudiartha,<sup>2</sup> Mochammad Mudjiono,<sup>1</sup> Nirawati Pribadi<sup>1</sup>

<sup>1</sup>Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia

<sup>2</sup>Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia



\*Presenting author

Ira Widjiastuti

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Campus A UNAIR Jl. Prof. Dr. Moestopo No. 47, Surabaya 60132, Indonesia.

E-mail: ira-w@fkg.unair.ac.id

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## ABSTRACT

**Objectives:** Calcium hydroxide is often used as a pulp-capping material, but disadvantage is resistant by some microorganisms, including *Aggregatibacter actinomycetemcomitans*. Due to this disadvantage, many researchers have sought alternative natural ingredients, such as propolis. Propolis has long been known for its efficacy and has been used in the field of dentistry because of its antibacterial activity. Combining calcium hydroxide and propolis is expected to overcome its disadvantages. The purpose of this research was to determine the effectiveness of the combination of calcium hydroxide and propolis in inhibiting *A. actinomycetemcomitans* biofilms.

**Materials and Methods:** Samples were divided into 5 treatment groups, with each group consisting of 5 replications. Group 1 corresponded to a combination of calcium hydroxide and propolis at a ratio of 1:1, group 2 had a ratio of 1:1.5, group 3 had a ratio of 1:2, the positive control was a combination of calcium hydroxide with sterile Aqua Dest, and the negative control was *A. actinomycetemcomitans* bacteria. Wells that contained a combination of calcium hydroxide and propolis and an *A. actinomycetemcomitans* bacterial suspension were incubated for 2 × 24 hours, then washed using phosphate-buffered saline 3 times. Next, staining with 0.1% crystal violet was performed, and the samples were covered with aluminum foil and incubated for 15 minutes. Isopropanol (200 µL) was added, followed by measurements of optical density (OD) with an ELISA reader. OD values were calculated using the inhibition biofilm formula.

**Results:** Group 2 had the largest mean inhibition (76%).

**Conclusions:** The combination of calcium hydroxide and propolis at a ratio of 1:1.5 was more effective than ratios of 1:1 or 1:2 for inhibiting an *A. actinomycetemcomitans* biofilm.

**Keywords:** *Aggregatibacter actinomycetemcomitans*; Biofilm; Calcium hydroxide; Propolis

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the Asian-Oceanian Federation of Conservative Dentistry (AOFCD)

November 8–10, 2019 · Seoul, Korea

Poster Presentations  
Research Presentation



# Inhibitory effect of exposure to a combination of calcium hydroxide and propolis against *Lactobacillus acidophilus* biofilm formation

Nirawati Pribadi,<sup>1\*</sup> Dida Devina,<sup>2</sup> Ira Widjiastuti,<sup>1</sup> Nanik Zubaidah<sup>1</sup>

<sup>1</sup>Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia

<sup>2</sup>Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia



\*Presenting author

Nirawati Pribadi

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Campus A UNAIR Jl. Prof. Dr. Moestopo No. 47, Surabaya 60132, Indonesia.

E-mail: nirawatipribadi@fkg.unair.ac.id

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## ABSTRACT

**Objectives:** Calcium hydroxide is currently used as a major material for pulp capping. Among 540 direct pulp capping cases with calcium hydroxide, 339 (62.8%) were categorized as failures. A disadvantage of calcium hydroxide is that it dissolves easily; therefore, the bacterial seal is low, which has caused researchers to seek alternative materials, especially those derived from nature. Propolis has long been used in dentistry because it contains various beneficial active compounds, such as tannin, which can inhibit the production of the glucosyltransferase enzymes that are needed by bacteria to form biofilms by decreasing their attachment. The addition of propolis extract to calcium hydroxide is expected to increase and complement the function of calcium hydroxide, which was previously claimed to be the gold-standard therapy for pulp capping. This study was conducted to determine the effect of exposure to a combination of calcium hydroxide and propolis on the inhibition of *Lactobacillus acidophilus* biofilm formation.

**Materials and Methods:** Samples were divided into two treatment groups with 8 replications. Group 1 (treatment) comprised a combination of calcium hydroxide-propolis at a ratio of 1:2 and *L. acidophilus*, while group 2 (control) contained solely *L. acidophilus*. A combination of calcium hydroxide and propolis was added to a well microtiter plate that already contained a suspension of *L. acidophilus*, incubated for 24 hours, and then washed with phosphate-buffered saline (PBS). Crystal violet was added, followed by incubation for 15 minutes, washing with PBS to remove the crystal violet, and reincubation for 24 hours. Then, optical density (OD) was measured by adding isopropanol to each well and reading with an ELISA reader.

**Results:** The OD value in the remaining colony in the well in group 1 was 41.45%, meaning that the inhibitory power of the combination in group 1 was 58.55%.

**Conclusions:** The combination of calcium hydroxide and propolis can inhibit *L. acidophilus* biofilm formation.

**Keywords:** Biofilm; Combination of calcium hydroxide-propolis; *Lactobacillus acidophilus*

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The 1st General Meeting of  
the Asian-Oceanian Federation of Conservative Dentistry (AOFCD)

November 8–10, 2019 · Seoul, Korea

Poster Presentations  
Research Presentation



# Comparison of antibacterial efficacy of red pomegranate extract (*Punica granatum*) and 2.5% sodium hypochlorite against *Enterococcus faecalis*

Olivia Vivian Widjaja,\* Mandojo Rukmo, Nanik Zubaidah, Kun Ismiyatin

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Jawa Timur, Indonesia



\*Presenting author

Olivia Vivian Widjaja

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Kampus A Unair, Jl. Mayjen Prof. Dr. Moestopo No.47, Pacar Kembang, Kec. Tambaksari, Kota Surabaya, Jawa Timur 60132, Indonesia.  
E-mail: widjaja.olivia@rocketmail.com

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## ABSTRACT

### Objectives:

*Enterococcus faecalis* (*E. faecalis*) is often found in persistent endodontic infection. It is due to virulence of these bacteria. Sodium hypochlorite (NaOCl) 2.5% is commonly used as irrigation material, but it has toxicity and can irritate periapical tissues. Therefore, some studies to find natural materials that have antibacterial properties as alternative root canal medicaments need to be done. Pomegranate (*Punica granatum*) was proven in the preliminary study that the minimum inhibitory concentration was 35% and minimum bactericidal concentration was 40%. The aim of this study was to compare the effectiveness of antibacterial activity of the Pomegranate extract than 2.5% NaOCl against *E. faecalis*.

**Materials and Methods:** This study is a laboratory experiment with only control group using *E. faecalis* ATCC 29212. Agar diffusion test was used to check the antimicrobial activity of pomegranate extract and 2.5% NaOCl by measuring the inhibition zone diameter of each treatment.

**Results:** Diameter of bacterial inhibition zone formed pomegranate extract was greater than that of 2.5% NaOCl.

**Conclusions:** Antibacterial activity of pomegranate extract was greater than that of 2.5% NaOCl against *E. faecalis*.

**Keywords:** *Enterococcus faecalis*; NaOCl; Pomegranate extract (*Punica granatum*)

Poster Presentations  
Research Presentation



\*Presenting author

Vinisha Pandey

Department of Conservative Dentistry and Endodontics, Institute of Dental Studies & Technologies, Delhi-Meerut Road, NH-58, Kadrabad, Modinagar, Uttar Pradesh 201201, India.

E-mail: vinisha9@gmail.com

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The 1st General Meeting of  
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# Comparison and evaluation of the efficiency of different irrigation systems at the apical third of the root canal

Vinisha Pandey,\* Nidhin Narayan

Department of Conservative Dentistry and Endodontics, Institute of Dental Studies & Technologies, Modinagar, Uttar Pradesh, India

## ABSTRACT

**Objectives:** This study was conducted to compare the efficiency of various irrigation activation systems, such as EndoActivator, ultrasonic systems, diode laser, and conventional needles; to evaluate the removal of the smear layer by various irrigation activation systems; and to evaluate the efficiency of ethylenediaminetetraacetic acid (EDTA) for smear layer removal.

**Materials and Methods:** Sixty mandibular premolars were decoronated to a working length of 12 mm and prepared with ProTaper rotary files up to size F3 and divided into six groups ( $n = 10$ ). The group I (control) canals were irrigated with a final flush of 1 mL of 3% NaOCl for 1 minute followed by 1 mL of 17% EDTA using a conventional needle and syringe. The group II canals were irrigated with 1 mL of EDTA and activated with EndoActivator. The group III canals were irrigated with 1 mL of EDTA with passive ultrasonic activation. The group IV canals were initially irrigated with 0.8 mL of 17% EDTA, the remaining 0.2 mL was used to fill the root canals, and diode laser application was done. In group V, 1 mL of EDTA was activated using a Neoendo finishing file. In group VI, irrigant activation was done with an XP Endo finisher file. Scanning electron microscope examinations of the canals were for the remaining smear layer at the apical third level.

**Results:** All samples showed the presence of a smear layer at the apical third. The remaining smear layer was highest for control group, followed by passive ultrasonic, XP Endo finishing file, Neoendo finishing file, and EndoActivator groups. The least smear layer was present in the diode laser group.

**Conclusions:** Diode laser activation along with EDTA as the irrigant was more efficient than other systems in removing the smear layer at the apical third of root canals.

**Keywords:** Diode laser; Endoactivator; Root canal irrigation; Scanning electron microscopy; Smear layer; XP endo finisher



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#### \*Presenting author

Ahmed Elsheikh

Department of Endodontics, Private, Cairo, Egypt.

E-mail: DrAhmedElsheikh@Outlook.com

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# Push-out bond strength of a glass ionomer-impregnated gutta percha/glass ionomer sealer system

Ahmed Elsheikh\*

Department of Endodontics, Private Practice, Cairo, Egypt

## ABSTRACT

**Objectives:** The present study evaluated the push-out bond strength of the Active GP system *versus* gutta percha (GP)/AH Plus sealer using different irrigants. Fifty-six human single-rooted teeth were instrumented with a crown-down technique using the EndoSequence rotary Ni-Ti file system.

**Materials and Methods:** The teeth were equally divided into 2 main groups and 8 subgroups according to the final irrigant: NaOCl, ethylenediaminetetraacetic acid (EDTA), citric acid, and MTAD (Dentsply). Obturation was done using the single-cone technique with the Active GP system, and with lateral compaction in the GP/AH Plus group. Each obturated tooth was embedded in an epoxy cylinder, where three 2-mm sections were made using an Isomet saw. The push-out bond strength was measured using a universal testing machine at a speed of 0.5 mm/min. Data were analyzed using one-way analysis of variance followed by the Newman-Keuls *post hoc* test. Stereomicroscopic examination was used to determine the type of bond failure.

**Results:** In the Active GP group, the NaOCl-treated subgroup had the highest mean bond strength ( $6.98 \pm 1.9$  MPa), followed by the citric acid subgroup ( $5.40 \pm 1.1$  MPa) and the MTAD subgroup ( $4.71 \pm 0.7$  MPa), while the EDTA subgroup recorded the lowest value ( $4.14 \pm 1.4$  MPa). However, these differences were statistically nonsignificant. In the GP/AH Plus group, the EDTA-treated subgroup showed a significantly higher mean bond strength ( $5.9 \pm 0.7$  MPa) than the other groups, followed by the NaOCl subgroup ( $5.40 \pm 1.1$  MPa) and the citric acid subgroup ( $4.6 \pm 0.6$  MPa), while the MTAD subgroup recorded the lowest value ( $3.5 \pm 0.1$  MPa).

**Conclusions:** Failure in the Active GP group was mainly cohesive in the GP, while the GP/AH Plus group mainly showed adhesive failure of AH Plus sealer with GP.

**Keywords:** Bond strength; Glass ionomer; Push out

**ConsAsia** 2019

The 1st General Meeting of  
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November 8–10, 2019 · Seoul, Korea



Poster Presentations  
Research Presentation



\*Presenting author

Kun Ismiyatin

Department of Conservative dentistry, Faculty of Dental Medicine, Universitas Airlangga, Campus A UNAIR Jl. Prof. Dr. Moestopo No. 47, Surabaya 60132, Indonesia.  
E-mail: kun-is@fkg.unair.ac.id

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# Extracellular polymeric substance degradation of *Streptococcus mutans* biofilm by irradiation with a 405 nm laser diode

Kun Ismiyatin,\* Sri Kunarti, Irmasmitha Tasniadara

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia

## ABSTRACT

**Objectives:** *Streptococcus mutans* is a major cause of dental caries induced by biofilm formation. These bacteria are able to form an exopolysaccharide matrix in dental biofilms. A biofilm is a group of microorganisms that are attached to a surface and covered with extracellular polymeric substance (EPS). Photodynamic therapy is an alternative for eliminating the EPS of bacterial biofilms.

**Materials and Methods:** A total of 30 *S. mutans* biofilms were divided into 6 groups and analyzed. Group 1 (control) consisted of *S. mutans* biofilm, treated neither with chlorophyll nor with a laser. Group 2 consisted of *S. mutans* biofilm with chlorophyll without irradiation by a 405 nm laser diode. Groups 3, 4, 5, and 6 consisted of *S. mutans* biofilms that were treated with a chlorophyll photosensitizer and 75 seconds irradiation with a 405 nm laser diode for group 3, 90 seconds irradiation with a 405 nm laser diode for group 4, 105 seconds irradiation with a 405 nm laser diode for group 5, and 120 seconds irradiation with a 405 nm laser diode for group 6. The degradation of the EPS of the *S. mutans* biofilms was assessed using confocal laser scanning microscopy.

**Results:** Irradiation with a 405 nm laser diode affected the degradation of the EPS of the *S. mutans* biofilm. Irradiation with a 405 nm laser diode led to significant EPS degradation of the *S. mutans* biofilm compared to the control group and the group that only received chlorophyll. Differences in the irradiation times resulted in significant differences in EPS degradation. Chlorophyll with 120 seconds of laser diode irradiation showed significantly greater degradation of the EPS of the *S. mutans* biofilms than other groups ( $p < 0.05$ ).

**Conclusions:** Photodynamic therapy for degradation of the EPS of *S. mutans* biofilms using a 405 nm laser diode and a chlorophyll photosensitizer with 120 seconds of laser diode irradiation could degrade the EPS of *S. mutans* by up to 85%.

**Keywords:** Chlorophyll; EPS; Laser diode; Photodynamic therapy; *Streptococcus mutans*

Poster Presentations  
Research Presentation



# Effective concentration of calcium hydroxide-propolis against *Lactobacillus acidophilus*

Edward Irwantoro,\* Leviena Merlynike Leo, Ira Widjiastuti, Ari Subiyanto

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Jawa Timur, Indonesia



**\*Presenting author**

Edward Irwantoro

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Kampus A Unair, Jl. Mayjen Prof. Dr. Moestopo No.47, Pacar Kembang, Kec. Tambaksari, Kota Surabaya, Jawa Timur 60132, Indonesia.  
E-mail: edwardentist@gmail.com

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## ABSTRACT

**Objectives:** Calcium hydroxide ( $\text{Ca}(\text{OH})_2$ ) has been considered as the ‘gold standard’ of direct pulp-capping materials for several decades. The success rate of direct pulp capping with  $\text{Ca}(\text{OH})_2$  was only 36.70% from 30 cases. That causes many researchers looking for alternative materials derived from nature. Propolis in dentistry has long been used because it has anti-inflammatory, anti-microbial, and anti-fungal effects, and can cure scars. The addition of propolis extract is expected to improve the function of  $\text{Ca}(\text{OH})_2$ . This study aimed to evaluate the effect of  $\text{Ca}(\text{OH})_2$ -propolis combination against the bacterial colonization of *Lactobacillus acidophilus* (*L. acidophilus*).

**Materials and Methods:** The combination ratio of  $\text{Ca}(\text{OH})_2$ -propolis were 1:1 in group 1, 1:1.5 in group 2, and 1:2 in group 3, and positive control group was a combination of  $\text{Ca}(\text{OH})_2$  and sterile aqua distillata. Each sample was immersed in saliva for 1 hour, and then washed with Brain phosphate-buffered saline. Samples were inserted into *L. acidophilus* suspension, grown for 24 hours, sequentially put into Brain Heart Infusion Broth medium, and vortex for 1 minute. A total of 0.1 mL of suspension *L. acidophilus* was put in to Mueller Hinton Agar, grown for 24 hours, and then, the number of colonies was calculated.

**Results:** There was less bacterial colonization in group 3 containing the highest amount of propolis extract than in group 2, which followed by group 1 and control group.

**Conclusions:** The combination of  $\text{Ca}(\text{OH})_2$ -propolis with a ratio of 1:2 was the most effective in inhibiting colonization of *L. acidophilus*.

**Keywords:** Combination of calcium hydroxide-propolis; *Lactobacillus acidophilus*; Pulp capping material

**ConsAsia** 2019

The 1st General Meeting of  
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November 8–10, 2019 · Seoul, Korea

Poster Presentations  
Research Presentation



\*Presenting author

Vialyne Dinata

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Kampus A Unair, Jl. Mayjen Prof. Dr. Moestopo No.47, Pacar Kembang, Kec. Tambaksari, Kota Surabaya, Jawa Timur 60132, Indonesia.  
E-mail: vialyne\_t1@yahoo.com

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# The difference in antibacterial effect between ethanol extracts of *Citrus aurantifolia* and *Citrus limon* against *Streptococcus mutans*: an *in vitro* study

Vialyne Dinata,<sup>1\*</sup> Sanarto Santoso,<sup>2</sup> Yuliana Ratna Kumala,<sup>3</sup> Setyabudi<sup>1</sup>

<sup>1</sup>Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Jawa Timur, Indonesia

<sup>2</sup>Department of Microbiology, Faculty of Medicine, Universitas Brawijaya, Malang, Jawa Timur, Indonesia

<sup>3</sup>Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Brawijaya, Malang, Jawa Timur, Indonesia

## ABSTRACT

**Objectives:** The prevalence of dental caries in Indonesia tends to increase every year. One of the main causes of dental caries is *Streptococcus mutans* (*S. mutans*). *S. mutans* is one of normal bacterial flora in the oral cavity, but this will be pathogenic and cause caries if the number continues to increase. Herbs that contain antibacterial ingredients are lime peel and lemon peel. The antibacterial components that they contain are saponin, minyak atsiri, fenol, alkaloid, tanin, and flavonoid. The aim of this study was to compare the antibacterial activity between ethanol extracts of lime peels and lemon peels against *S. mutans* in *in vitro* study.

**Materials and Methods:** This was an experimental laboratory study using well diffusion method to get inhibition zone. The concentration of ethanol extracts of lime peels and lemon peels used were 0%, 3.125%, 6.25%, 12.5%, 25%, 50%, and 100%. The inhibition zones were compared by 1-way analysis of variance, Pearson correlation test, regression test, and unpaired *t*-test.

**Results:** The inhibition zones on the lime peels were formed at concentrations of 6.25%, 12.5%, 25%, 50%, and 100%, those on the lemon peels were formed at concentrations of 50% and 100%. There was a difference in the inhibition zones between the ethanol extract of lime peel and lemon peels against *S. mutans* inhibition zone.

**Conclusions:** Antibacterial activity of ethanol extract of lime peel was stronger than that of lemon peel on the growth of *S. mutans* in *in vitro* study.

**Keywords:** Antibacterial activity; Ethanol extract; Inhibition zone; Lemon peels; Lime peels; *Streptococcus mutans*

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#### \*Presenting author

##### Soegeng Wahluyo

Department of Pediatric Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Campus A UNAIR Jl. Prof. Dr. Moestopo No. 47, Surabaya 60132, Indonesia.

E-mail: waluyosoegeng@yahoo.com

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# Fluoride-induced expression of the amelogenin protein in amelogenesis and density of enamel

Soegeng Wahluyo\*

Department of Pediatric Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia

## ABSTRACT

**Objectives:** Amelogenin is a major protein that plays an important role in the amelogenesis. One of the factors that influence enamel quality is fluoride which contributes to the development of tooth enamel. Sodium fluoride (NaF) an important form of fluoride is found in groundwater. Normally, in the process of amelogenesis, amelogenin is degraded by the activity of matrix-metalloproteinase-20 (MMP-20), is replaced by minerals.

**Materials and Methods:** The study used a model of Rat-norvegicus (Wistar) strain which was divided to 2 group, the treatment group that was induced with NaF and the control received Aqua Dest for 28 days. The sample unit was the rat mandibular incisor. Protein was studied using immunohistochemical analysis, it enamel was investigated using electron microscopy.

**Results:** The results showed that there was no decrease in amelogenin protein expression NaF group while significant, enamel density changes found their NaF treated teeth compared to control group ( $\alpha = 0.01$ ).

**Conclusions:** It was concluded that fluoride promotes amelogenin ion because it induced a change in enamel; so, meaning would reduce the quality of tooth enamel.

**Keywords:** Amelogenesis; Amelogenin; Enamel density; Fluoride

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# Staining over non-cavitated enamel after application of silver diamine fluoride: a case series

Hui-Chen Chan,<sup>1,2,3\*</sup> Yu-Chih Chiang,<sup>4</sup> Yiu-Hsiang Chang,<sup>5,6</sup> Tzong-Ping Tsai<sup>2,3,7</sup>

<sup>1</sup>Department of Pediatric Dentistry, Taipei Medical University Hospital, Taipei City, Taiwan

<sup>2</sup>Division of Pediatric Dentistry, Taipei Veteran General Hospital, Taipei City, Taiwan

<sup>3</sup>Department of Pediatric Dentistry, Wan Fan Medical Center, Taipei City, Taiwan

<sup>4</sup>Department of Restorative and Esthetic Dentistry, National Taiwan University and National Taiwan University Hospital, Taipei City, Taiwan

<sup>5</sup>Mechanical and Mechatronics System Research Labs, Industrial Technology Research Institute, Taipei City, Taiwan

<sup>6</sup>Department of Chemical Engineering, National Tsing Hua University, Tsing Hua, Taiwan

<sup>7</sup>Department of Pediatric Dentistry, National Taiwan University Children's Hospital, Taipei City, Taiwan



\*Presenting author

Hui-Chen Chan

Department of Pediatric Dentistry, Taipei Medical University Hospital, Division of Pediatric Dentistry, Taipei Veteran General Hospital, and Department of Pediatric Dentistry, Wan Fan Medical Center, Taipei City, Taiwan.

E-mail: tsaiapd@gmail.com

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## ABSTRACT

**Objectives:** The aim of this study was to report staining outcomes after silver diamine fluoride (SDF) application over clinically healthy enamel, and to address the interpretation of these outcomes and their potential clinical implications for caries risk assessment.

**Materials and Methods:** Chart review was performed for patients who received 38% SDF (Advantage Arrest) between March 2018 and March 2019 at a private pediatric dental clinic in Taipei, Taiwan. The protocol of the clinic for SDF application involved the following steps in sequence: a clinical examination, photos, toothbrush, prophylaxis, SDF application, and fluoride varnish. Parents were advised to watch for staining in the following days. If staining was noted, they were encouraged to take photos with a mobile phone. Clinical photos were then taken at the next visit.

**Results:** In total, 178 subjects who received SDF application were identified. The inclusion criteria of this survey were as follows: healthy Taiwanese children under the age of 36 months, with no clinical signs of decalcification upon examination, with clinical photos of pre- and post- SDF applications that clearly showed the child's front teeth. Of the 178 subjects, 61 patients satisfied these criteria. After SDF application, the staining results could be classified into 3 groups—group 1: no stain was present on the teeth after SDF application ( $n = 20$ ); group 2: the stain on the teeth could be removed with a toothbrush by parents and no stain was present at the recall visit ( $n = 19$ ); group 3: the stain on the teeth could not be removed with a toothbrush and was present at the recall visit ( $n = 22$ ).

**Conclusions:** It is proposed that the staining outcome after SDF on clinically healthy enamel may provide a useful indicator for assessing caries risk.

**Keywords:** Caries; Caries risk assessment; Silver diamine fluoride

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# Minimal-intervention dentistry: an eye towards the future



Ahana Chandra,\* Neelam Mittal, Barnwal HC

Department of Conservative Dentistry and Endodontics, Faculty of Dental Sciences, Institute of Medical Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India

**\*Presenting author**

**Ahana Chandra**

Department of Conservative Dentistry and Endodontics, Faculty of Dental Sciences, Institute of Medical Sciences, Banaras Hindu University, Bhagwanpur, Varanasi, Uttar Pradesh 221005, India.  
E-mail: chandraahana@gmail.com

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## ABSTRACT

**Objectives:** This poster is being presented to shed light on current trends in the field of preventive dentistry with the aim of conserving tooth structure.

**Materials and Methods:** Minimally invasive procedures are the new paradigm in health care. Everything from heart bypass procedures to gall bladder surgery is being performed with these dynamic new techniques. Dentistry is also joining this exciting revolution. Minimally invasive dentistry adopts a philosophy that integrates prevention, remineralization, and minimal intervention for the placement and replacement of restorations. Minimally invasive dentistry achieves the goals of treatment using the least invasive surgical approach possible, with the removal of the minimal amount of healthy tissue. This poster reviews in brief the concept of minimal interventions in dentistry.

**Results:** The results of the review show a healthy trend towards minimal surgical interventions with maximum conservation.

**Conclusions:** With advancements in the field of minimally invasive dentistry, the future belongs to longevity of the tooth rather than the longevity of restorations.

**Keywords:** Minimal intervention dentistry; Remineralization; Restoration

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**\*Presenting author**

**Rahmi Amran**

Department of Conservative Dentistry, Faculty of Dentistry, Universitas Padjadjaran, Jalan Tubagus Ismail Dalam No.16, Lebakgede, Coblong, Lebakgede, Kecamatan Coblong, Bandung 40132, Indonesia.  
E-mail: rahmi.amran@gmail.com

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# The status of dental fitness of Indonesian soldiers based on antemortem data from 2016 to 2018

**Rahmi Amran\***

Department of Conservative Dentistry, Faculty of Dentistry, Universitas Padjadjaran, Bandung, Indonesia

## ABSTRACT

**Objectives:** Dental fitness is part of a soldier's oral health condition, which is assessed before a soldier can be assigned to duty. A dental fitness check-up must be carried out, especially for soldiers who would be assigned to locations far from adequate health facilities, limiting their ability to receive dental treatment while on duty. Poor dental health conditions could cause pain and interfere with a soldier's daily activities.

**Materials and Methods:** The purpose of this study was to determine the status and classification of soldiers' dental fitness in 2016–2018. The research method used was descriptive research with a stratified random sampling technique. This study used antemortem data from 65 Indonesian soldiers in Ladokgi R.E. Martadinata Jakarta who had been assigned in the 2016–2018 period. The dental fitness classification was adjusted to the NATO STANAG 2466 classification.

**Results:** The results showed that from 65 samples, 55% of soldiers had class 3 dental fitness, followed by class 2 (28%), and class 1 (17%). There were no instances of class 4 in the sample.

**Conclusions:** Based on antemortem data, Indonesian soldiers' dental fitness Ladokgi TNI-AL R.E. Martadinata in the 2016–2018 period was most likely to be classified as class 3 on average.

**Keywords:** Antemortem data; Classification of dental fitness; Indonesian soldiers



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**\*Presenting author**

**Adioro Soetojo**

Department of Conservative Dentistry,  
Universitas Airlangga, Campus A UNAIR JL.  
Prof. Dr. Moestopo No. 47, Surabaya 60132,  
Indonesia.  
E-mail: adioros@yahoo.com

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# Total MMP-1 and TGF- $\beta$ 1 expression after the application of MMA and 4-META

**Adioro Soetojo,\* Sumitro Hatmojo, Bintang Widjaja**

Department of Conservative Dentistry, Universitas Airlangga, Surabaya, Indonesia

## ABSTRACT

**Objectives:** In a cavity dominated by dentin surfaces, a dentin-bonding adhesive material is needed to attach a composite resin. Methyl methacrylate (MMA) and 4-methacryloxyethyl trimellitic anhydride (4-META) are widely used as dentin-bonding materials. Nevertheless, their monomers diffuse into the pulp through dentinal tubules, which can affect odontoblasts. This research aimed to analyze the expression of matrix metalloproteinase 1 (MMP-1) and transforming growth factor beta1 (TGF- $\beta$ 1) in the dentin of Wistar rats given pure MMA and pure 4-META. This study constituted laboratory research with a post-test-only control group design.

**Materials and Methods:** Twenty-seven Wistar rat maxillary first molars were prepared in a cavity and equally divided into three groups ( $n = 9$ ): no treatment for the control group (C); the application of 4-META for the first treatment group (T1), and the application of MMA for the second treatment group (T2), before being filled with glass ionomer cement. On day 3, the subjects were euthanized, and the upper jaw resected prior to decapitation of the molar crown. Hematoxylin-eosin staining and immunohistochemistry staining were subsequently performed. The results were statistically analyzed using one-way analysis of variance, followed by the Tukey honest significant difference test ( $p < 0.05$ ).

**Results:** The amount of MMP-1 expression in both treatment groups (T1, T2) was significantly higher than in the C group, with the T2 group showing the highest expression level. On the contrary, the highest level of expression of TGF- $\beta$ 1 was found in the C group, while the lowest level of expression was found in the T2 group.

**Conclusions:** The 4-META dentin-bonding is better than MMA dentin-bonding based on its response involving inflammatory processes, as indicated by the expression of MMP-1 and TGF- $\beta$ 1.

**Keywords:** 4-Methacryloxyethyltrimellitic anhydride; Matrix metalloproteinase-1; Methylmethacrylate; Transforming growth factor beta1

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\*Presenting author

Kyunga Bae

Department of Conservative Dentistry, Yonsei University College of Dentistry, 50-1 Yonsei-ro, Seodaemun-gu, Seoul 03722, Korea.  
E-mail: borumi2016@gmail.com

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# Effect of surface treatment with self-etching ceramic primer on repair bond strength of aged resin

Dohyun Kim, Kyunga Bae,\* Dasun Lee, Yooseok Shin

Department of Conservative Dentistry, Yonsei University College of Dentistry, Seoul, Korea

## ABSTRACT

**Objectives:** To examine the effect of surface treatment with self-etching ceramic primer on the repair bond strength of aged resin-based composite (RBC).

**Materials and Methods:** Fifty disc-shape specimens were prepared with an RBC material (Tetric N-Ceram, Ivoclar Vivadent). The specimens were polished with 1,200-grit silicon carbide paper and stored in distilled water at 37°C for a month. After the period, the specimens were randomly divided into 5 groups and received different surface treatments: group SB, sandblasting (3 bar, 50  $\mu$ m Al<sub>2</sub>O<sub>3</sub> particles, 10 seconds); group SBSI, sandblasting (10 seconds) + silane (Monobond Plus, Ivoclar Vivadent, 60 seconds); group HF, hydrofluoric acid (HF, 60 seconds); group HFSl, HF (60 seconds) + silane (60 seconds); group SCP, self-etching ceramic primer (Monobond Etch & Prime, Ivoclar Vivadent, 60 seconds). After the surface treatment, bonding agent (Heliobond, Ivoclar Vivadent) was applied and light cured for 20 seconds. Then, new RBC material was applied on the specimen using a Teflon mold (2 mm in diameter and 2 mm in thickness) and light cured for 40 seconds. After 24-hour storage in distilled water, shear bond strength (SBS) of each specimen was measured using a bond strength tester (Bisco) running at a crosshead speed of 1.0 mm/min. The SBS values of different groups were compared using one-way analysis of variance followed by Tukey's *post hoc* test.

**Results:** There were significant differences in the SBS among the groups ( $p < 0.05$ ). Group SBSI demonstrated the highest SBS (86.8 MPa), while group SB showed the lowest (52.4 MPa). The SBS of group HF was the second lowest (62.0 MPa). There were no significant differences in the SBS among groups SBSI (86.8 MPa), SCP (77.9 MPa), and HFSl (73.9 MPa).

**Conclusions:** Within the limitations of this study, the self-etching ceramic primer showed comparable repair bond strength on aged resin with conventional surface treatment methods. It is considered that the self-etching ceramic primer can be used as a surface treatment strategy when an aged RBC restoration need to be repaired.

**Keywords:** Aged resin-based composite; Repair bond strength; Self-etching ceramic primer, Surface treatment

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\*Presenting author

Siti Sunarintyas

Department of Dental Biomaterial, Universitas  
Gadjah Mada, Bulaksumur, Caturtunggal, Kec.  
Depok, Kabupaten Sleman, Daerah Istimewa,  
Yogyakarta 55281, Indonesia.  
E-mail: sunarintyassiti@ugm.ac.id

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# Evaluation of biofilm growth on a new matrix system for fiber-reinforced composite resin

Siti Sunarintyas,<sup>1\*</sup> Widowati Siswomihardjo,<sup>1</sup> Jukka Pekka Matinlinna<sup>2</sup>

<sup>1</sup>Department of Dental Biomaterial, Universitas Gadjah Mada, Yogyakarta, Indonesia

<sup>2</sup>Department of Dental Material Science, The Hong Kong University, Hong Kong

## ABSTRACT

**Objectives:** E-glass fiber-reinforced composite (FRC) resin has become popular for use in bridgework in dentistry. Novel materials provide a different environment for oral microorganisms to grow. The objective of the current research was to determine the effect of a proposed novel resin matrix system for dental FRC bridgework on biofilm growth, including *Streptococcus mutans* and *Candida albicans* growth.

**Materials and Methods:** The materials used were bis-GMA (Sigma-Aldrich, USA), MMA (ProSciTech), 1,6-hexanediol dimethacrylate (HDDMA), CQ, CEMA (Esstech), E-glass fibers (Ahlstrom), BHI, Sabourauds agar, and MHA (Sigma-Aldrich). Two compositions of an HDDMA-based resin matrix systems (exp-1, exp-2) and a control group (bis-GMA-based) were evaluated for *S. mutans* and *C. albicans* growth.

**Results:** Significant differences were found in *S. mutans* growth among the tested groups ( $p < 0.05$ ): control group ( $7.6667 \times 10^4 \pm 0.5774 \times 10^4$  CFU/mL) > exp-2 group ( $7.5467 \times 10^4 \pm 0.2145 \times 10^4$  CFU/mL) > exp-1 group ( $7.3334 \times 10^4 \pm 0.5275 \times 10^4$  CFU/mL). The growth of *C. albicans* was significantly different among the tested groups ( $p < 0.05$ ): control group ( $10.3334 \times 10^4 \pm 0.5774 \times 10^4$  CFU/mL) > exp-2 group ( $10.3240 \times 10^4 \pm 0.9841 \times 10^4$  CFU/mL) > exp-1 group ( $10.1344 \times 10^4 \pm 0.6585 \times 10^4$  CFU/mL).

**Conclusions:** It was concluded that the resin matrix systems influenced the biofilm growth, including *S. mutans* and *C. albicans* growth on E-glass FRC. The novel resin matrix system based on HDDMA resulted in less biofilm growth than bis-GMA on an E-glass FRC surface.

**Keywords:** *Candida albicans*; FRC; HDDMA-based matrix; *Streptococcus mutans*

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### \*Presenting author

Dini Khalidja

Department of Conservative Dentistry, Faculty of Dentistry, Universitas Padjadjaran, Jalan Tubagus Ismail Dalam No.16, Lebakgede, Coblong, Lebakgede, Kecamatan Coblong, Bandung 40132, Indonesia.  
E-mail: dinikhalidja@gmail.com

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# Hardness difference between packable composite and bulk fill composite

Dini Khalidja,\* Irmaleny Satifil, Taofik Hidayat

Department of Conservative Dentistry, Faculty of Dentistry, Universitas Padjadjaran, Bandung, Indonesia

## ABSTRACT

**Objectives:** The aim of this study was to analyze the difference between packable composite and bulk fill composite.

**Materials and Methods:** Both composites were cured on an acrylic mold, using 20 packable composites (Filtek P60 Posterior Restorative) with a thickness of 4 mm for the horizontal incremental technique and 20 bulk fill composites (Filtek Bulk Fill Posterior Restorative) with a thickness of 4 mm for the bulk technique. Both composite types were cured for 20 seconds and tested for hardness using a Vickers microhardness tester with a load of 100 g for 20 seconds. The data were analyzed statistically using one-way analysis of variance and the *post hoc t*-test ( $\alpha = 0.05$ ).

**Results:** A significant difference in hardness was found between the packable composite and bulk fill composite with an average hardness value of the packable composite on the upper surface of  $81.3 \pm 3.4$  VHN and  $80.1 \pm 3.5$  VHN on the bottom surface. That of bulk fill composite on the upper surface was  $65.3 \pm 0.6$  VHN, and on the bottom surface it was  $63.4 \pm 2.1$  VHN.

**Conclusions:** There was a significant difference in hardness between packable composite and bulk fill composite. Packable composite had a higher hardness value than bulk fill composite.

**Keywords:** Bulk fill; Hardness; Packable

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### \*Presenting author

Yovita Yonas

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Kampus A Unair, Jl. Mayjen Prof. Dr. Moestopo No.47, Pacar Kembang, Kec. Tambaksari, Kota Surabaya, Jawa Timur 60132, Indonesia.  
E-mail: yovita.yonas@gmail.com

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# Comparison of microleakage between self-adhering flowable composite and conventional flowable composite after citric acid immersion

Yovita Yonas,<sup>1\*</sup> Sekar Firdhea Rizkifa Soetanto,<sup>2</sup> Adioro Soetojo,<sup>1</sup> Widya Saraswati<sup>1</sup>

<sup>1</sup>Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Jawa Timur, Indonesia

<sup>2</sup>Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Jawa Timur, Indonesia

## ABSTRACT

**Objectives:** Conventional flowable composite (CFC) is a composite that has low viscosity so that it can flow to the cavity. It is used with a relevant bonding system. Self-adhering flowable composite (SAC) is a type of flowable composite which is applied without the stages of etching and bonding because it has an acidic monomer. Exposure to acidic fluid and changes in temperature result in microleakage between the restoration and the cavity wall which may cause secondary caries and hypersensitivity. Microleakage was compared between SAC and CFC after immersion in citric acid.

**Materials and Methods:** Twenty-eight bovine incisors were divided randomly into 4 groups: groups 1 and 2, SAC and CFC restorations were treated by thermocycling from 5°C and 55°C for 120 cycles and immersed in 3,364 ppm citric acid for 24 hours, respectively. Groups 3 and 4, SAC and CFC materials were used as control groups, respectively. All groups were immersed in 2% methylene blue for 24 hours. Microleakage was evaluated by ×40 magnification digital microscope. Data were analyzed using the Kruskal-Wallis and Mann-Whitney *U* test.

**Results:** Significant differences were found between SAC and CFC ( $p < 0.05$ ). Significant differences were also obtained from SAC compared with the SAC control group ( $p < 0.05$ ). Whereas in the comparison between CFC and CFC control groups no differences were found.

**Conclusions:** Microleakage of SAC was bigger than those of CFC and SAC control groups, but CFC had no difference with CFC control group.

**Keywords:** Citric acid; Flowable composite; Microleakage; Self-adhering flowable composite

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### \*Presenting author

**Nanik Zubaidah**

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Campus A UNAIR Jl. Prof. Dr. Moestopo No. 47, Surabaya 60132, Indonesia.  
E-mail: nanik-z@fkg.unair.ac.id

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# The roughness of microhybrid composite resin surfaces after polishing with diamond paste and aluminum paste

**Nanik Zubaidah,\* Saifuddin Zuhri, Nirawati Pribadi, Mochammad Mudjiono**

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Surabaya, Indonesia

## ABSTRACT

**Objectives:** The use of composite resins, especially microhybrid composite resins, in dentistry is well accepted for restoring anterior and posterior teeth. Proper finishing and polishing are important steps in clinical restorative dentistry that enhance both the esthetics and longevity of restorations. The 2 kinds of polishing paste materials (diamond paste [DP] and aluminum oxide paste [AOP]) may have different effects based on their characteristics. This study was conducted to determine the differences in the surface roughness (Ra) of microhybrid composite resins after a polishing procedure using 2 different materials (DP and AOP).

**Materials and Methods:** In this experimental study, the samples were 28 microhybrid composite resin blocks that met the criteria of the sample. The samples were divided into 4 groups: 1) without finishing and polishing, 2) finishing using a diamond bur, 3) finishing then polishing using DP, and 4) finishing then polishing using AOP. Average Ra was measured with a Ra tester (Mitutoyo Surftest SJ-301).

**Results:** Significant differences in the Ra of composite resins were found between groups: 1.820 (DP) versus 1.413 (AOP)  $\mu\text{m}$ , compared to the measurement of 2.673  $\mu\text{m}$  in the control group ( $p = 0.00$ ). A significant difference was found between the methods.

**Conclusions:** Differences were found in the Ra of microhybrid composite resins after a polishing procedure using diamond paste and aluminum oxide paste. Finishing and polishing with AOP yielded finer roughness than DP.

**Keywords:** Composite resin; Polishing paste; Teeth surface roughness

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# Effect of polishing materials on the surface roughness of resin composites



Pipop Saikaew,\* Vanthana Sattabannasuk, Pisol Senawongse

Department of Operative Dentistry and Endodontics, Mahidol University Faculty of Dentistry, Bangkok, Thailand

\*Presenting author

Pipop Saikaew

Department of Operative Dentistry and Endodontics, Mahidol University Faculty of Dentistry, No. 6, Yothi Road, Ratchathewi District, Bangkok 10400, Thailand.  
E-mail: pipop045@gmail.com

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## ABSTRACT

**Objectives:** To evaluate the surface roughness (Sa) of resin composites after polishing with different polishing materials.

**Materials and Methods:** Four resin composites were used in this study: Filtek Z250, Filtek Z250XT, Filtek Z350, and Estelite Sigma Quick. A total of 60 cylindrical-shaped specimens were prepared and divided into 5 subgroups ( $n = 12$ ). The control group was left unpolished as the surface was photo-polymerized under a plastic strip. The remaining four groups were assigned to different polishing systems: Astropol, HiLuster, Sof-Lex discs, and Sof-Lex Spiral. All systems were operated as per the manufacturers' instructions. A 3-dimensional profilometer (Talyscan150; Taylor Hobson) was used to assess Sa. Data were analyzed using 2-way analysis of variance and Dunnett's T3 test.

**Results:** The smoothest surface was detected in the control group. The highest Sa was obtained from Sof-Lex Spiral with Z250 and Z250XT. Astropol and HiLuster produced smoother surfaces, and no significant difference was detected between them. Filtek Z250 showed greater roughness than other composites.

**Conclusions:** The type of composite and polishing system contributes to the Sa. Proper restorations come from an appropriate selection of composites and polishing armamentariums.

**Keywords:** Polishing system; Resin composite; Surface roughness



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# Prolonged silicon and sodium release from dental resin composites

Madeline Yon,\* James Tsoi, Chun Hung Chu

Faculty of Dentistry, The University of Hong Kong, Hong Kong



\*Presenting author

Madeline Yon

Faculty of Dentistry, The University of Hong Kong, Pokfulam, Hong Kong, Hong Kong.  
E-mail: yonjunyu@hku.hk

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## ABSTRACT

**Objectives:** To investigate the release profiles (as elements) of silicon and sodium from tooth-colored resin-based restorative materials at different shades over a prolonged period of time.

**Materials and Methods:** Specimens from 5 different shades of a resin composite (A1B, A2B, A3B, A3.5B, A4B, Filtek Supreme XT Restorative; 3M ESPE) (total  $n = 25$ ) were prepared ( $\varnothing 3.0 \text{ mm} \times 6.2 \text{ mm}$ ) and light-cured, immersed in 2.00 mL of deionized water (Milli-Q) and stored in closed plastic containers at 37°C/99% RH. Then, 0.40 mL of liquid was quenched and made up to 5.00 mL at 4 prolonged timepoints (48, 216, 384 and 720 hours). Elemental concentration of Si and Na were determined by ion coupled plasma-optical emission spectrometry (ICP-OES; SPECTRO ARCOS). Statistical analysis was performed by analysis of covariance (SPSS Statistics v. 25, SPSS Inc.) on the regression lines of release profiles (ppm vs. time).

**Results:** Si and Na were found to be released continuously over 30 days. The rate of Si and Na release were similar regardless of the shade of the dental resin composite.

**Conclusions:** Si and Na may be leached from resin composite after placement of the filling material. Prolonged disintegration of resin composite after curing may continue to occur in a wet environment, such as the oral cavity.

**Keywords:** Disintegration; Resin composite; Shade; Silicon; Sodium

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# Remineralization potential of fluoride to GIC compared with RMGIC of enamel lesions

Sri Kunarti,\* Ira Widjiastuti, Stephanie Setjadinigrat

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Rumah Sakit Gigi dan Mulut (RSGM), Surabaya, Indonesia



\*Presenting author

Sri Kunarti

Department of Conservative Dentistry, Faculty of Dental Medicine, Universitas Airlangga, Rumah Sakit Gigi dan Mulut (RSGM), Campus A UNAIR Jl. Prof. Dr. Moestopo No. 47, Surabaya 60132, Indonesia.  
E-mail: sri-k@fkg.unair.ac.id

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## ABSTRACT

**Objectives:** The oral cavity is constantly exposed to demineralization and remineralization. The best strategy for caries management is to focus on methods of improving the remineralization process. Various materials combining fluoride with restorative materials exist to combat demineralization. Glass ionomer cement (GIC) and resin-modified glass ionomer cement (RMGIC) are remineralizing agents containing fluoride, which can promote remineralization. The purpose of this study was to determine the remineralization potential of GIC and RMGIC on enamel demineralization lesions.

**Materials and Methods:** Class V restorations were made in 24 bovine teeth, which included 6 groups with 4 teeth in each group. After the restorative procedures, the restorations underwent demineralization or remineralization cycling for 14 days. Sections of the teeth were examined under scanning electron microscopy after undergoing pH cycling. The data were analyzed using analysis of variance, the Tukey test, and Pearson correlations ( $p < 0.05$ ).

**Results:** GIC showed a reduction in lesion demineralization of the enamel and had a higher fluoride content than RMGIC. Fluoride levels had a relationship with the depth of the demineralization lesions, as higher levels of fluoride were associated with deeper lesion demineralization.

**Conclusions:** GIC has a greater potential for mineralization than RMGIC. The release of fluoride from GIC is greater than from RMGIC. A relationship was found between the depth of demineralization lesions and fluoride levels.

**Keywords:** Demineralized; Fluoride; Glass ionomer cement; Remineralized; Resin modified glass ionomer cement

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**\*Presenting author**

**Choltacha Harnirattisai**

Department of Operative Dentistry and  
Endodontics, Faculty of Dentistry, Mahidol  
University, 6 Yothi Alley, Thung Phaya Thai,  
Ratchathewi, Bangkok 10400, Thailand.  
E-mail: Dtchndent@gmail.com

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# Penetration of hydrogen peroxide through bovine teeth and color change after using different bleaching agents

**Munin Chaichalothorn, Pisol Senawongse, Choltacha Harnirattisai\***

Department of Operative Dentistry and Endodontics, Faculty of Dentistry, Mahidol University, Bangkok, Thailand

## ABSTRACT

**Objectives:** To evaluate the amount of hydrogen peroxide penetration through bovine tooth discs into artificial pulp chambers and the degree of color change after bleaching with three different bleaching agents.

**Materials and Methods:** Bovine tooth discs with a thickness of 3.2 mm were prepared and placed into a modified artificial pulp chamber filled with acetate buffer solution. The specimens were divided into 3 groups and bleached with one of following bleaching agents—group 1: 40% Opalescence Boost (hydrogen peroxide), group 2: 20% Opalescence PF (carbamide peroxide), and group 3: 10% Opalescence PF (carbamide peroxide). The amount of peroxide that penetrated into the artificial pulp chamber was evaluated using a microplate spectrophotometer after bleaching. The degree of color difference ( $\Delta E^*$ ) before and after bleaching was measured using a SpectroShade spectrophotometer.

**Results:** An increase in the amount of hydrogen peroxide penetration corresponded to an increase in the concentration of bleaching products and a longer bleaching time. When compared at 1 hour, the greatest amount of hydrogen peroxide was found in group 1 (0.1080 mg/mL) and the smallest amount was observed in group 3 (0.0107 mg/mL). The highest  $\Delta E^*$  was observed in group 3 after a 2-week application period (9.0). In group 1, in which an office bleaching agent was used, the  $\Delta E^*$  after a 1-hour application time was not the highest value (7.41). Moreover, the lowest  $\Delta E^*$  was found in group 2 between the 1- and 2-week application periods (1.48). A significant change in  $a^*$  and  $b^*$  took place after bleaching for all concentrations of bleaching agents.

**Conclusions:** The amount of hydrogen peroxide penetration was impacted by the concentration of bleaching products and the application time. The degree of tooth color change was not only affected by the concentration of bleaching agent, but also by the extension of bleaching time, predominantly by altering the  $a^*$  and  $b^*$  parameters.

**Keywords:** Artificial pulp chamber; Bleaching agent; Bovine tooth; Color change; Penetration of hydrogen peroxide