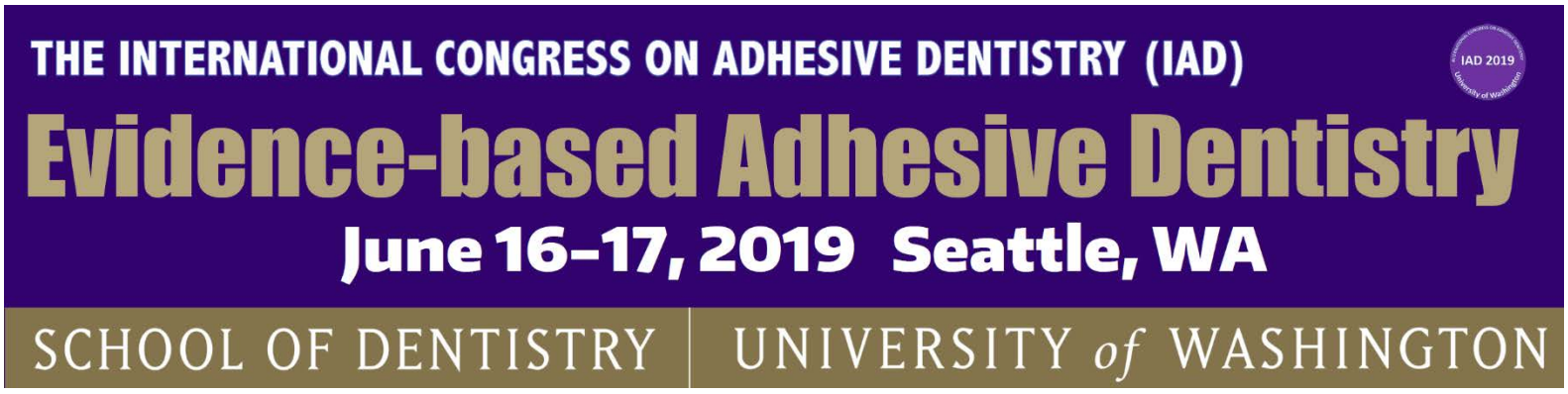
Synopses and Abstracts



UW SOUTH CAMPUS CENTER

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8:20 – 9:15 Keynote Lecture: Junji Tagami (Japan)
9:20 – 10:00 Invited Lecture 1: Bart Van Meerbeek (Belgium)
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10:15 – 10:55 Invited Lecture 2: Jack Ferracane (Portland, OR)
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Daniel C.N. Chan, DMD, MS, DDS, FADM, FICD

Professor and Chair
Department of Restorative Dentistry
University of Washington School of Dentistry, Seattle, WA

Dr. Chan received his D.M.D. (1979) from the University of the Philippines and his M.S. (1984) and D.D.S. (1988) from the University of Iowa. He also received a Certificate in Operative Dentistry from the University of Iowa (1984). Dr Chan is a Fellow of the American Institute for Medical and Biological Engineering, Fellow of the International College of Dentists, the American College of Dentists and the Academy of Dental Materials. He is a Past President of the Academy of Operative Dentistry. He serves on many editorial boards and was the author of several Restorative Dentistry book chapters. Dr Chan has over 100 article publications and 200 meeting abstracts. From 2008 to 2015, Dr. Chan was Associate Dean for Clinical Services at School of Dentistry, University of Washington. He is currently Professor and Chair in Restorative Dentistry and Washington Dental Service Endowed Chair in Dentistry. Dr. Chan received the 2009 University of the Philippines Distinguished Alumni Award in Education and Health. He was a Co-PI on an NIDCR funded project titled “Metal-titanates as Novel Inhibitors of Cariogenic Biofilms at Tooth-Composite Interface”. He holds several provisional patents and patent on restorative materials. Recently, he was involved in the evaluation of first-ever reversible cement developed by CAO Group, Inc that showed great promise for applications in restorative dentistry. He was appointed in 2010 as the Director of the UWSoD International Dentist Program and from 2016-2018 he served as Director of the Operative Dentistry clerkship. In the community, he served as board of director in the Kin On Health Care Center. Dr. Chan lectures on dental materials related topics nationally and internationally. He is an avid stamps and postal history collector and likes to cook to release stress.

Foreword

D.C. Chan

On behalf of the University of Washington, School of Dentistry, Department of Restorative Dentistry, I would like to welcome you to the publication of the 2019 International Congress on Adhesive Dentistry Proceedings. I am especially grateful to the many world-renowned experts who have come to share their knowledge via lecture presentations, discussion and provision of abstracts in the proceeding.

As you may know, the University of Washington, School of Dentistry is among the top dental schools in the States. Our faculty is always searching for new initiatives, novel outreaches and projects that serve to enhance our professional growth. One such shining example is our organizing chair for this event, Dr. Alireza Sadr. I observed first-hand how hard Dr. Sadr and his team worked and prepared for this meeting. I am honored to support him on this project.

My other gratitude goes to our Office of Continued Educations headed by Ms. Sally Gee and the many sponsors who contributed to make this event possible. We look forward to a successful outcome and hope all our participants enjoyed the professional interaction and have a good experience in Seattle.

Thank you.

Daniel C.N. Chan

Junji Tagami DDS PhD

Professor and Chair
Cariology and Operative Dentistry
Vice President
Tokyo Medical and Dental University (Japan)

Prof. Tagami is a well-known figure across the world of adhesive dentistry. His research on dentin characterization, mechanism and structure of caries is believed to have oriented adhesion as a means of achieving minimally invasive dentistry. As the vice president and past dean of Tokyo Medical and Dental University, Prof. Tagami has been a man of great power, influence and potential in academic dentistry.

He has supervised over 180 graduate students and postdoctoral researchers from Japan and around the world in the past 25 years, some of whom have become prominent academicians themselves in Japan, North America, Europe, Asia, South America and Australia.

Because of his contribution in dental research and education, he was awarded Honorary Degrees from King's College of London, UK and Mihidol University, Thailand, and the distinguished scientist award, Wilmer Souder Award 2017, from the International Association for Dental Research (IADR).

Adhesive dentistry: Past 40 years and its future

J. Tagami

The 40 years' history of clinical application of minimally invasive adhesive restorations, its great contribution of the oral health promotion was demonstrated. The recent adhesive and composite resin provided us extremely excellent performances, however, the problems of the restorations, such as the dentin bond stability and control of the contraction shrinkage stress, are still remained. These issues are considered to correlate strongly with the recurrent caries and unfavorable postoperative symptoms. Further development of materials and clinical procedures are required to solve the issues. In the accelerated advanced aged society prevention oriented approaches are becoming more important. The decay of dental hard tissue, not only caries and cervical erosion but also tooth wear and fracture, should be controlled for maintaining the dentition in good functional condition. The root caries is thought to be prevented by chemical and mechanical modifications using fluoride and adhesives, which can be said as the "Super Tooth Therapy". The recent studies using optical coherent tomography(OCT) provided the valuable new findings. It clearly showed the presence of slight surface demineralization at the proximal surface, which could not be detected by bite-wing X-ray images. OCT images even revealed the internal cracks of tooth crown and proximal surface, as well as the separation of cervical enamel at dentino-enamel junction. These faint changes of tooth are believed to be the initiation of fracture, wear, proximal caries and non caries cervical lesion. From the view point above, those initial changes of structure must be diagnosed as diseases of tooth. The therapies for the micro defects are expected to be developed. The similar ideas had been proposed as the micro restoration technique and the resin impregnation technique, however, technology in materials and diagnosis could not support the idea. The adhesive dentistry is expected to contribute to the oral health promotion of people.

Bart Van Meerbeek, DDS, MS, PhD

Head

Biomat

Katholieke Universiteit Leuven (Belgium)

Bart Van Meerbeek obtained his DDS in 1988 and his PhD in 1993 at KU Leuven (University of Leuven) in Belgium. He continued his research activity abroad for one year at the University of Texas Health Science Center at San Antonio, Texas, and later also at the University of Missouri-Kansas City. In 1995, he became Assistant Professor ('Docent') at KU Leuven and since then teaches Dental Biomaterial Sciences. In 1998 and 2002, he was promoted respectively to Associate Professor ('*Hoofddocent*') and Professor ('*Hoogleraar*'), and in 2005 to Full Professor ('*Gewoon Hoogleraar*'). His primary research interest involves studies related to the broad field of *Adhesive Dentistry*, including fundamental as well as clinical research regarding dental adhesive technology in particular. Newer research lines deal with *Dental Ceramics*, *Cariogenicity & Biocompatibility of Dental Materials*, *Bioactive Materials and Pulp-preservation Material Technology*. His research work has been published in more than 400 peer-reviewed journals and has been honoured with awards such as the *1996 triennial Robert Stock Award for best PhD dissertation in Biomedical Sciences*, *Albert Joachim Award* in 1997, *Award in Biomedical Sciences of the Research Council of KU Leuven* in 1998, *IADR Young Research Award* in 2000, *SmithKline Beecham Award* in 2001, *Academy of Operative Dentistry Buonocore Memorial Lecturer* in 2003, *CED-IADR (Continental European Division of IADR) Robert Frank Lecturer* in 2008, *2014 IADR/AADR William J. Gies Award for the best 2014 JDR paper in the Biomaterials & Bioengineering Research category*, and the *2015 IADR Wilmer Souder Award* (IADR Distinguished Scientist award for Dental Materials). In 2003, he became holder of the *Toshio Nakao Chair for Adhesive Dentistry*. He was President of the *Pan-European Federation of IADR* in 2006-2007 and is currently serving as Secretary of the *CED-IADR*. Since 2004, he is Editor-in-Chief of the *Journal of Adhesive Dentistry*.

State of the art adhesive technology

B. Van Meerbeek

Modern dentistry makes use of dental adhesive technology for a wide range of restorative applications. Fundamental research of interfacial biomaterial-hard tissue interactions up to nano-meter level elucidated that both micro-mechanical interlocking and chemical bonding are paramount for efficient and durable bonding. Translation of such fundamental research supplemented with applied laboratory research resulted in advanced adhesives that revealed successful long-term performance in dental clinics. Most recent research and development in dental adhesive technology introduced a new generation of universal adhesives that can be applied in either etch-and-rinse or self-etch mode. A next research challenge is to develop adhesive technology that additionally provides bioactivity. This can be diverse in terms of anti-microbial, anti-enzymatic and/or re-mineralisation potential. The acquired mechanistic knowledge of intermolecular and -atomic interactions occuring at biomaterial-hydroxyapatite-based tissue interfaces has opened perspectives to develop bioactive adhesive technology.

Jack Ferracane, PhD

Professor and Chair
Department of Restorative Dentistry
Oregon Health and Science University, Portland, OR

Jack Ferracane is Professor and Chair of Restorative Dentistry, and Division Director of Biomaterials and Biomechanics at Oregon Health & Science University, Portland, Oregon. Dr. Ferracane earned his Ph.D. in Biological Materials from Northwestern University. He is a founding fellow and past-President of the Academy of Dental Materials. He is a past-President of the American Association for Dental Research. He is the recipient of the Wilmer Souder Award from the Dental Materials Group of the IADR, the Founders Award from the Academy of Dental Materials, and the Hollenback Award from the Academy of Operative Dentistry. He is an honorary member of the American College of Dentists and the Oregon Dental Association. He has authored or co-authored several textbooks on dental materials and operative dentistry, and has published extensively on biomaterials. His research is funded by the NIH/NIDCR as well as private industry. He also is actively involved in the establishment and operation of networks designed to conduct dental clinical research in the private practice setting.

Current and future strategies for bonded composite restorations

J.L. Ferracane

The current state of dental composites presents the practitioner with many material options having a broad range of physical and optical properties, and handling characteristics. The current materials 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. While there is not one material that is considered ideal, dentists are able to use existing products, alone or in combination, to produce restorations that are of high quality and with excellent longevity. In the past, the introduction of new formulations was predominantly focused on materials with 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. Antimicrobial materials, and those capable of repair of internal and external defects are also expected.

Franklin Tay, BDSc (Hons), PhD

Chair and Professor,
Department of Endodontics,
The Dental College of Georgia, Augusta University, Augusta, GA

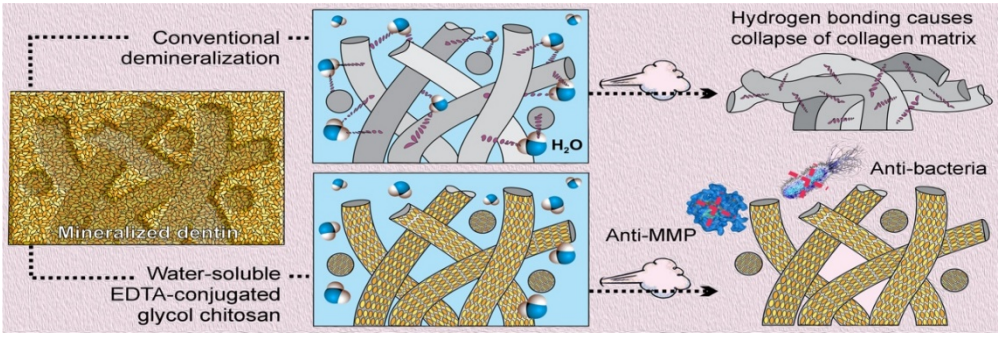
Dr. Franklin Tay received his BDSc with first class honors from the University of Queensland School of Dentistry in Australia in 1981, his Ph.D. from the University of Hong Kong in China in 1997 and his endodontic residency from the Medical College of Georgia, USA in 2007. He is a Diplomate of the American Board of Endodontics. He is currently Professor, and Chair of the Department of Endodontics, College of Dental Medicine, Georgia Regents University.

Dr. Tay serves as Associate Editors for the Journal of Endodontics and Journal of Dentistry. His research interests include biomineralization of collagen scaffolds with apatite and/or silica, remineralization of resin-dentin bonds, antimicrobial sol-gel chemistry, mesoporous silica and endodontic materials. He is a Fellow of the Academy of Dental Materials has published more than 500 papers in peer-reviewed journals.

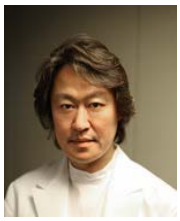
Extrafibrillar demineralization concept for etch-&-rinse dentin bonding

F. Tay

During development of mineralized tissues, intrafibrillar mineralization is achieved by preventing mineralization precursor inhibitors larger than 40 kDa from entering the collagen fibrils. Such a property is incorporated in the design of a calcium chelator for dentin bonding that selectively demineralizes extrafibrillar apatite while leaving the intrafibrillar minerals intact. This strategy prevents the complete demineralization of collagen fibrils which collapse and block resin infiltration on air-drying. Because intrafibrillar endogenous proteases remain fossilized, the strategy also prevents degradation of collagen fibrils that are not completely infiltrated by adhesive resins. In this presentation, a water-soluble glycol chitosan-EDTA (GCE) conditioner will be reported that is synthesized by conjugation of EDTA, an effective calcium chelator, to high molecular weight glycol chitosan, which exhibits weak chelation property. The GCE conjugate is purified, characterized by FTIR, ^{1}H NMR, isothermal titration calorimetry and ICP-AES, and subjected to size exclusion dialysis to recover molecules that are >40 kDa. The optimal concentration and application time for etching dentin is determined by bond strength testing to ensure that the dentin bonding results are comparable to phosphoric acid etching, and maintain equivalent bond strength after air-drying of the conditioned collagen matrix. Extrafibrillar demineralization is validated with transmission electron microscopy. Inhibition of endogenous dentin proteases is confirmed using *in-situ* zymography. The water-soluble GCE dentin conditioner is non-cytotoxic and possesses antibacterial activities against planktonic and single-species biofilms, supporting its ongoing development as a dentin conditioner with air-drying, anti-proteolytic and antibacterial properties to enhance the durability of bonds created using the etch-and-rinse bonding technique.



Masashi Miyazaki, DDS, PhD



Professor and Chairperson
Department of Operative Dentistry
Nihon University School of Dentistry (Japan)

Graduated from Nihon University School of Dentistry in 1987. Received Ph.D. degree in Clinical Sciences from Nihon University Graduate School of Dentistry in 1991. Serves as an editorial member for several dental journals and has published numerous papers in scientific journals on dentin bonding, material science, and operative procedures. Presented nationally and internationally lectures and hands-on courses on topics related to dentin bonding and direct esthetic restorations.

His personal research interests include dental restorative materials, adhesives and bonding and restorative material clinical trials. During his career in the university, he contributed to or was responsible for new dental product introductions with dental companies in Japan. He has been awarded numerous research grants from dental companies as well as Japanese government for evaluating the laboratory performance of dental materials.

Durability of and Clinical Success of Composite Restorations

M. Miyazaki

Development and improvement of resin composites and adhesive systems represent major advancements in restorative treatment. Together with the various types of adhesive systems, resin restoration systems comprise the tooth colored alternatives to metallic restorations. Selection of tooth colored restorative materials that simulate the physical properties and other characteristics of natural teeth, in combination with restorative techniques provide the framework that ensures optimal development of an esthetic restoration.

The most recent advancement in the adhesive technology is the introduction of the universal adhesive, which is distinguished by both its suitability for different types of adherent substrates and for use in total-etch, selective-etch and self-etch modes. The versatility of this adhesive allows clinicians to tailor their approach to the prevailing cavity conditions; variables such as size, depth, location and proportion of the enamel and/or dentin can be considered and optimized. Good marginal adaptation to the entire tooth surface is believed to decrease marginal discoloration and pulpal irritation related to microleakage. System that forms a sufficiently strong bond with a tooth and withstand stresses have long been desired. However, biological and biomechanical degradations invariably result in such restorations deteriorating over time. It is therefore clinically important that the degradation over time of these restorations in intraoral environmental situations should be fully understood.

This presentation will explore the importance of adhesive systems in clinical dentistry and discuss about their bonding durability.

John A. Sorensen, DMD, PhD, FACP

Professor and Director of Research
Department of Restorative Dentistry
University of Washington, Seattle, WA

Dr. Sorensen is Professor, Department of Restorative Dentistry; Director, Biomimetics Biomaterials Biophotonics Biomechanics & Technology Laboratory; Director of Research, Graduate Prosthodontics Program at University of Washington. As Director of B4T his team is actively engaged in research on applied prosthodontic materials and processes, digital technologies and development of digital work flows for implant and conventional prosthodontics. Dr. Sorensen was just awarded the 2018 Clinician-Researcher Award by the American College of Prosthodontists. Previously as founder and director of Pacific Dental Institute in Portland, Oregon, he conducted clinical trials and materials testing, and CE programs. He had a full-time prosthodontic practice and then an implant specialty center for 9 years and is a diplomate of the American Board of Prosthodontics. Dr. Sorensen has published over 85 research articles and chapters as well as over 145 research abstracts.

Predictable Prosthodontic Outcomes Utilizing Digital Workflows For Adhesive Ceramics.

J.A. Sorensen

The development of digital technologies and new materials systems are occurring at an incredible pace. These exciting systems in combination with the principles of biomimetic prosthodontics and adhesive ceramics synergistically work together to produce outstanding clinical outcomes with greater longevity. Sorensen will explore, document and validate the accuracy and limitations of the digital processes such as intraoral scanning, treatment planning, provisional prosthesis design, and CADCAM production of definitive ceramic prostheses. A recent UW clinical trial utilizing a completely digital workflow for posterior adhesive ceramic restorations will be shared. Additionally, clinical analysis using the extraordinary technology of Optical Coherence technology which allows 3D detection and visualization of ceramic restoration cracks and marginal accuracy, as well as interfacial gaps will be demonstrated. He will illuminate how the digital workflow can be integrated into routine practice to increase control, predictability, and clinical efficiency, yet still produce dentistry that is equal or better than conventional prosthodontic methodologies.

Mutlu Özcan, Prof. Dr.med.dent., PhD

Professor and Head
Dental Materials Unit
University of Zurich (Switzerland)

She has authored more than 450 scientific and clinical articles in peer-reviewed journals, is a well-sought lecturer, receiver of several international awards and has held numerous continuing education courses in Europe. She serves also for the editorial boards of several scientific journals. Her clinical expertise is on reconstructive dentistry and her scientific work focuses on translational research.
She has Honorary Professorship positions at various universities some of which are São Paolo State University (Brazil), University of Madrid (Spain), University of Florida (USA) and University of Hong Kong (China).
She is EPA-Recognized Specialist in Prosthodontics, Honorary Secretary of the European Prosthodontic Association (EPA), Past-President of the International Association of Dental Research (IADR) / Dental Materials Group (DMG), Fellow of Academy of Dental Materials (FADM), Fellow of International College of Dentistry (FICD) and Fellow in Dental Surgery of the Royal College of Physicians and Surgeons of Glasgow, FDS RCPS (Glasgow).

She is the recipient of the “2018 IADR Distinguished Scientist Wilmer Souder Award”.

Ahesion to Dental Ceramics: Technical and Clinical Parameters

M. Özcan

Durable adhesion of glassy matrix or oxide-based ceramics is crucial especially for minimally invasive reconstructions. This lecture will highlight the fundamental principles of adhesion to different ceramics, cover current knowledge and the clinical protocols regarding to surface conditioning methods and adhesion promoters to be used in conjunction with different resin-based materials.

Learning objectives:

1- Prerequisites for durable adhesion to different ceramics

2- Surface conditioning methods and working mechanisms

3- Clinical sequence of adhesion protocols for cementation and repair

Yen-Wei Chen, DDS, MSD

Associate Professor
Department of Restorative Dentistry
University of Washington, Seattle, WA

Dr. Yen-Wei Chen holds a Doctor of Dental Surgery degree from Taipei Medical University (1998), a Master of Science in Dentistry degree and Certificate in Prosthodontics from the University of Washington (2008). Dr. Chen's research interests are in the area of all ceramic systems and the application of CAD/CAM technology in the restorative dentistry. Dr. Chen is a member of the American Academy of Fixed Prosthodontics, American College of Prosthodontists, and board-eligible for the American Board of Prosthodontics. Dr. Chen's clinical interests focus on esthetics and implant restorative dentistry. He currently maintains a part-time private practice in Seattle with his wife, Dr. Kanako Nagatomo. Dr. Chen has presented his research and clinical work at several scientific meetings both nationally and internationally. He has authored numerous articles in various peer reviewed journals and coauthored a book chapter. Since 2012, Dr. Chen has been repeatedly acknowledged by the School of Dentistry classes for contributing in teaching at the University of Washington. He is currently pushing for implementation of digital dentistry education for predoctoral students.

Bonded CAD/CAM Restoration in Dental Education

Y.W. Chen

The minimally invasive concept has become the main stream of the contemporary dentistry. The use of CAD/CAM technology with advanced adhesive techniques permits efficient workflows, less invasive procedures and better esthetic outcomes. Optimal longevity can be achieved by improving the bonding integrity on the adhesive interfaces through reliable bonding techniques and proper material selection. This presentation provides a systematic and scientific approach for enhancing bonded esthetic restorations based on original research data with special emphasis on clinical applications. The capabilities and the limitations of current intra-oral scanners and chair-side CAD/CAM systems will be discussed. The innovative digital workflow to fabricate ceramic restorations from digital designing, 3-D printed model generation to milling process will be introduced. Based on these considerations, the University of Washington program for implementation of digital dentistry for pre-doctoral training will be discussed.

Alireza Sadr, DDS, PhD

Clinical Associate Professor
Department of Restorative Dentistry
University of Washington, Seattle, WA

Dr. Sadr is a Clinical Associate Professor in the Department of Restorative Dentistry at the University of Washington School of Dentistry and Adjunct Associate Professor of Cariology and Operative Dentistry at Tokyo Medical and Dental University in Japan. He received his DDS degree form the National University of Iran and completed his PhD and advanced training in restorative dentistry from Tokyo Medical and Dental University, mentored by Prof. Junji Tagami in 2008. He has been actively involved in research and development of materials such as self-etching adhesives, adhesive resin cements, novel composites and tooth remineralization agents. He is currently focusing on research towards adoption of advanced technology such as Optical Coherence Tomography (OCT) for non-invasive diagnosis into the clinical practice of dentistry, a clinical research technology that he brought to UW Restorative Dentistry. Dr. Sadr has published over 160 scientific articles with his international colleagues, presented his research and trained many dentists in advanced operative dentistry internationally. Dr. Sadr's research projects have been funded by the government, industry and non-profit organizations in Japan and the United States. He is currently the director of operative dentistry pre-clinical training at UW, mentors pre-doctoral dental students and residents in the B4T research laboratory and practices dentistry at the UW Campus Dental Center in Seattle, WA.

Proof-of-Concept Research for Clinically Successful Bonding

A. Sadr

Over the past two decades dentistry has made important progresses, thanks to advancements in material science, technology and clinical techniques. Dental bonding revolutionized the shape and content of clinical dentistry, presenting a strong and minimally invasive alternative to the traditional materials. Early research in adhesive dentistry was much focused on the bond strength of composite resin to tooth, despite the fact that “sealing” is considered more of a critical issue than “retention” of composite restorations. Polymerization shrinkage of contemporary dental composites still threatens the success of all kinds of adhesive restorations, and is perhaps underestimated from simplified bonding tests. We present a systematic approach for simulation of clinical situation in laboratory research, where the bonded restoration is subject to challenges such as shrinkage stress and fatigue loading. In addition, by real-time imaging using Sadr’s OCT imaging and analytical methodologies, we demonstrate that the integrity of a composite restoration can be visually evaluated and monitored. The visual observations lead to recommendations on clinical procedures for bonding and material selection, leading to a key conclusion; the success of restoring teeth with adhesive technology requires not only an optimal bonding approach, but also a strategy to mitigate the stresses and biomechanically protect the bonded interface and the dental tissue.

Grant Chyz, DDS

Private Practice, Seattle, WA

Dr. Chyz earned his D.D.S. degree in 1983 from the University of Michigan. Dr Chyz has maintained a private practice in downtown Seattle since 1986. He has been involved in various study clubs over the years and lectures on managing incompletely cracked teeth, as well as direct restorative dentistry with composite resin and laminated fiber reinforcement. He has consulted with 3M on many products, but most notably on the development of Filtek Supreme. He serves as an unpaid consultant to Ribbond. Finally, Dr. Chyz first laminated Ribbond to internal tooth structure in 1999 – giving him a unique, long-term perspective on the value of fiber lamination to augment direct restorations.

A New Paradigm for Direct Restorations, Using UHMWPE Fiber

G. Chyz

For an individual tooth, restorative choices are driven by many factors, but more than anything else, it is by the presence or absence of cracks and/or endodontic treatment, and the amount of remaining tooth structure. By incorporating Biomimetic Principles, with the use of composite resin and strategically laminated continuous UHMWPE fiber, we can create a new class of direct restoration that better manages tensile and Poisson's forces, resists and deflects cracks and lessens the effects of polymerization shrinkage on remaining tooth structure. This session will demonstrate clinical applications of UHMWPE fiber lamination.

Dr. Chyz Presentation Handout

Sema Belli, DDS, PhD

Professor
Department of Endodontics
Selcuk University (Turkey)

She graduated from Marmara University, Istanbul, Turkey with DDS, and received her PhD degree in Department of Operative Dentistry from Selçuk University, Konya, Turkey. Dr. Belli held the positions of chair and professor in Department of Endodontics, Selçuk University for 10 years. Her current position is Full-time Professor of Department of Endodontics at the same university. She has published and lectured extensively on dental materials including dental composites, adhesives, glass or polyethylene fibre reinforcement materials, conservative restoration of extensive cavities, restoration of endodontically treated teeth, post and cores, finite elemental analysis, composite polymerization, cuspal deflection, bond strength and leakage tests, biocompatibility of dental materials and cells/dental materials interactions. She is currently a board member of Turkish Endodontic Society and CED/IADR.

Current approaches to post-core restoration requirement: What is the point for making decision?

S. Belli

Post-core restorations are still one of the most commonly used treatment method to form a core structure and to provide a retention to the further prosthetic restoration. Despite significant developments in materials and techniques, problems related to post-core restorations have not been fully resolved. Furthermore, clinical and laboratory studies have shown that post restorations weaken teeth and may cause vertical fractures. Reecnt publications began to draw attention to the issue of the use of post-cores in unnecessary situations. All these signs led us to question ourselves about whether post-core restorations were used where they were really needed. In this conference the failures due to post-core restorations, the solutions for these failures, alternative restoration techniques, clinical applications of these techniques, Current approaches to post-core restoration requirement and the points for making decision will be discussed.

Masatoshi Nakajima, DDS, PhD

Junior Associate Professor

Department of Cariology and Operative Dentistry

Tokyo Medical and Dental University (Japan)

Masatoshi Nakajima is Junior Associate Professor of Cariology and Operative Dentistry, at Tokyo Medical and Dental University, Japan from 2001. He completed his DDS training at Tokyo Medical and Dental University in 1987 and earned his PhD in Restorative Dentistry at Tokyo Medical and Dental University in 1991. He was Assistant Professor at Tokyo Medical and Dental University from 1995-2001. His current research interests are in developing adhesive materials to various dental substrates (enamel, dentin, ceramics and composites) and improving tooth-color matching of resin composite restorations. He is a member of Japanese Society for Adhesive Dentistry and has published over 200 peer-reviewed papers including international leading journals. He also is actively involved in conducting dental clinical training for undergraduate and postgraduate students.

Smear layer-deproteinization; Improving the dentin interface of self-etch adhesives

M. Nakajima

Self-etch adhesives cannot completely remove the smear layer, and remnants of smear debris can form hybridized smear layers on the authentic hybrid layer. The hybridized smear layer formed with self-etch adhesives weakens the physical and chemical properties of the resin-dentin hybridized complex both immediately and over time. In this lecture, I will present a new method of dentin surface pretreatment; smear layer deproteinization for self-etch adhesive systems, particularly in relation to improving bonding to caries-affected dentin. HOCl solution has immediate and highly effective antimicrobial and deproteinizing properties by the oxidizing effect even at lower chlorine concentrations. Moreover, it is also biocompatible and has low cytotoxicity. The application of HOCl solution can dissolve and remove the organic phase on a smear layer-covered dentin surface, leading to thinning of the smear layer and increasing the mineral/organic ratio on the dentin surface. Smear layer deproteinization with HOCl-oxidizing solution can improve the quality of resin-dentin interface of self-etch adhesives through elimination of the hybridized smear layer, development of adhesive monomer infiltration into dentin and enhancement of the chemical interaction of functional monomers with hydroxyapatite. Unfortunately, these positive effects are influenced by the pretreatment time and also depend upon the adhesive materials used because oxidized-byproducts remaining on the dentin surface could compromise the polymerization behavior of the adhesives. However, applying antioxidant/reducing agents can eliminate this problem. Smear layer deproteinization is more effective for improving the bonding efficacy of self-etch adhesives to caries-affected dentin than normal dentin because caries-affected dentin produces a thicker organic-rich smear layer.

David S. Alleman, DDS

Co-director

The Alleman-Deliperi Centers for Biomimetic Dentistry

Private practice, Provo, UT

After undergraduate studies in microbiology at Brigham Young University, I completed my dental degree in 1978 at the University of the Pacific School of Dentistry.

Following graduation, I served in the US Navy dental corps for 3 years. In 1981, I began a private practice in Utah that has continued until the present. After attending a 2 day seminar by Ray Bertolotti in 1995, I began an intense literature review which led to the formulation of new adhesively based restorative principles which I called "Six Lessons".

I have been teaching these principles to other dentists since 2003.

Teaching advanced adhesive dental protocols to practicing dentists: 2003-2019

D. Alleman

After 17 years of practicing traditional dentistry mechanically retained dentistry, I was frustrated with the results and ready to change careers. Fortunately I was introduced to the emerging adhesive dental science that was coming out of Japan by Ray Bertolotti in 1995. That led me to an intense 10 year review of all the literature published in English. This 10,000 hours of research led me to create a new system of restorative dentistry that I called "Dr. Alleman's Six Lessons: The Modern Fundamentals of Advanced Adhesive Dentistry". Since 2003, I have traveled and lectured in the USA and internationally, in an effort to connect with many adhesive researchers and with the many dentists who are interested in learning the published dental literature. In 2007 I travelled to Boston to hear Dr Simone Deliperi at Tufts University. After his lecture we compared our interpretations of the published science and decided to form a partnership to teach and mentor practicing dentists. That partnership continues and has produced of group of over 300 private practice dentists who over the past 15 years have restored an estimated 900,000 structurally compromised teeth without resorting to tooth reduction for full coverage restorations. This presentation will review the "The Alleman-Deliperi Protocols for Biomimetic Restorative Dentistry" that have been published in over 35 articles around the world. The six areas of adhesive science that will be covered are:

1. Using Caries Detecting Dyes and anatomical measurements to find ideal Caries Removal End-points without pulp exposure
2. Using a 4 step risk assessment to predict crack and gap initiation into dentin. Prevention of gap and crack propagation are the goal of biomimetic dentistry
3. Using "gold standard" dentin bonding systems(DBS) to form a biomimetic hybrid layer (HL)
4. Using only stress reducing protocols for the first critical 5-30 minutes of the polymerization reaction of the DBS to insure maximum bond strength of the HL
5. Bonding the enamel replacement of the restoration only after the HL and dentin replacements have matured to their maximum bond strengths
6. Verticalizing occlusal forces for long term stability of the restored teeth

Keiichi Hosaka, DDS, PhD

Assistant Professor
Department of Cariology and Operative Dentistry
Tokyo Medical and Dental University (Japan)

He received his D.D.S. and Ph.D. from TMDU in 2003/2007. In 2005 -2006, he was a visiting scholar at the Department of Oral Biology, School of Dentistry, Medical College of Georgia. His research and clinical work focus on bonding between dental substrates and tooth-colored dental materials. He has published and lectured both nationally and internationally in the field of adhesive dentistry and esthetic dentistry. He is a board-certified specialist of Japanese Society for Adhesive Dentistry, Japan Academy of Esthetic Dentistry, and The Japanese Society of Conservative Dentistry.

The Power of Direct Composite Restoration - from Crown & Bridge to Occlusal Reconstruction

K. Hosaka

The evolution of adhesive dentistry over the past decades has expanded the range of applications of direct composite restorations and revolutionized modern restorative treatments. Now, direct composite restorations are considered to be available for both functional restorations and esthetic enhancements with minimal invasive costs even for challenging restorations. Recent technology simplifies adhesive systems for speedy treatments, while maintaining the reliable bonding performance. Restorative dentistry can be classified into 4 categories according to Lytle and Skurow. Class I; “Operative Dentistry” requires simple restorative procedures where problems are with individual teeth. Class II; “Crown and Bridge” needs full or partial crown restorations with replacement of any interposed messing teeth. Class III; “Occlusal Reconstruction” requires completed reconstruction with recreation of occlusion. Class IV; Periodontal Prosthesis rewires splinting of the dentition. The presentation will discuss the power of direct composite restorations using reliable materials from clinical and scientific aspects with special focus on Class II and III restorations.

Raymond L. Bertolotti DDS, PhD

Retired Clinical Professor (UCSF)

Private Practice, San Leandro, CA

Raymond L. Bertolotti received his D.D.S. degree from the University of California, San Francisco, after working as a Ph.D. metallurgical and ceramic engineer at Sandia National Laboratories. He is a retired Clinical Professor in Biomaterials Science at the University of California. Perhaps best known for introducing Prof. Takao Fusayama's "total etch" to North America in 1984, he also introduced Caries Detector in 1984, Panavia in 1985, tin plating in 1989 and self-etching primers in 1992. The sectional Contact Matrix system, "Microprime", "Microetcher" sandblasting and intraoral tin-plating are also his innovations. Dr. Bertolotti has published extensively in journals such as the American Dental Association, International Journal of Prosthodontics, Journal of Dental Research and Quintessence International, as well as authoring four dental textbook chapters. He co-authored a new book, *Supra-Gingival Minimally Invasive Dentistry: A Healthier Approach to Esthetic Restorations.* Dr. Bertolotti is a Fellow of the American Academy of Dental Materials, a Fellow of the American College of Dentists, a Fellow of the Pierre Fauchard Academy, an Accredited member of the Academy of Cosmetic Dentistry and recipient of the Lifetime Achievement Award of the Academy of Biomimetic Dentistry. He is a well-known international lecturer, having presented invited lectures in over 30 countries.

Cantilevered Zirconia Adhesion Bridges, A Proven Alternative to Anterior Implants

R.L. Bertolotti

Anterior tooth replacement with minimally invasive adhesion bridges is superior both esthetically and functionally to more conventional implants and tooth destroying bridges. Metal (intra-enamel) adhesion abutments have proven to be highly successful now for over 30 years. The introduction of Y3 zirconia and development of methods to adhere to this non-HF etchable zirconia has changed the paradigm for anterior tooth replacement with a more esthetic material. Cantilever designs have proven to be nearly 100 % successful at 10 years, surpassing the success rates for implants and causing far less complications if failure does occur.

Dr. Bertolotti Presentation Handout

Posters

Poster#	Title	Presenter	Affiliation	Keywords
1	In vitro Study on Crack Extensions and Dentin Permeability of Teeth with Intact Enamel	Minh Luong	*University of Washington, Seattle, WA, USA*	crack, OCT, permeability, chromameter, enamel
2	Silver Diammine Fluoride and Resin Bonding Application Over Carious Dentine	Mark Van Duker	*University of Washington, Seattle, WA, USA*	SDF, KI, Demineralized Dentin, Adhesive Bonding
3	Bond Strength of Universal Adhesives to Enamel and Dentin	Rubens Nazareno Garcia	*University of Joinville Region, Joinville & University of Itajai Valley, Itajai, Brazil*	Composite resins, Dentin, Dentin-bonding agents, Dental enamel, Shear strength
4	The Silane-coupling Effect of a Silane-containing Self-adhesive Composite Cement	Kumiko Yoshihara	*Okayama University Hospital, Okayama, Japan*	Silane, ceramic, cement, bond strength, NMR
5	Internal Defects and Degree of Conversion of New Flash-curing Composite	Juri Hayashi	*University of Washington, Seattle, WA, USA*	Resin Composite; Interfacial gap; Crack; Degree of Conversion
6	Comparison of Material Properties of Flowable and Conventional Resin Composites	Akimasa Tsujimoto	*Nihon University, Tokyo, Japan*	Flowable resin composite, conventional resin composite, mechanical property, curing characteristics
7	Survivability and Fractography of Fatigue Loading Crowns with Different Core Buildup Strategies	Se Won An	*University of Washington, Seattle, WA, USA*	Fiber-Reinforcement, Lithium Disilicate, Ferrule, Fractography, Survivability, Core Buildup, OCT
8	Simulated Localized and Generalized Wear of Indirect Resin Composites	Shunichi Suda	*Nihon University, Tokyo, Japan*	Indirect resin composite, simulated localized wear, simulated generalized wear
9	Influence of Application Time of Universal Adhesives on Dentin Bond	Arisa Imai	*Nihon University, Tokyo, Japan*	Universal adhesive, dentin bond, application time, surface free energy
10	Effect of Acid Erosion on Enamel Bond of Universal Adhesives	Chiaki Yabuki	*Nihon University, Tokyo, Japan*	acid erosion, enamel bond, universal adhesive
11	Role of the MDP in Dentin Bond of Universal Adhesives	Toshiki Takamizawa	*Nihon University, Tokyo, Japan*	MDP, Dentin Bond Durability, Universal adhesive, etching mode
12	Optical Assessment of Horizontal Biofilm Mapping in Resin-dentin Interfacial Gaps	Yuan Zhou	*Shanghai Jiao Tong University, Shanghai, China*	optical coherence tomography, biofilm, gap, Streptococcus mutans

13	Peroxide Penetration on Teeth Restored with Fluoride-containing and Bioactive Materials	Matheus Kury-Rodrigues	*University of Campinas, Piracicaba, SP, Brazil*	Hydrogen Peroxide; Composite Resins; Tooth Bleaching
14	Influence of surface treatments on bond strength of hybrid CAD/CAM materials.	Mayara Zaghi Dal Picolo	*University of Campinas , Piracicaba, SP, Brazil*	shear bond strength; CAD-CAM; Hybrid composites; surface treatments
15	Influence of thickness on Ultimate Fracture Load of CAM-CAM Crowns	Mayara dos Santos Noronha	*University of Campinas , Piracicaba, SP, Brazil*	CAD-CAM, Ceramics, Crowns
16	Real-time Monitoring of Heat Generation in Different Restorative Materials	Turki A Bakhsh	*King Abdulaziz University, Jeddah, Saudi Arabia*	Thermal imaging, resin, composite, heat, polymerization
17	Effect of Staining on Adhesives and Sealants Applied Over Composite	Amanda Willers	*University of Sao Paulo, Sao Paulo, SP, Brazil*	Adhesive, Sealants, Staining
18	Effects of Fiber Reinforcement on Adaptation and Bond Strength of Bulk-fill Composite in Deep Preparations	Behnoush Bakhtiari	*University of Michigan, Ann Arbor, MI, , USA*	Fiber-reinforced composite, Microtensile, Dentin, Bonding, Bulk-Fill.
19	Preliminary Study of Bonding Substrate: Caries Affected Dentin	Shuhei Hoshika	*Hokkaido University, Sapporo, Japan*	Knoop hardness, EPMA, Carious dentin
20	Temporal Analysis of Shrinkage Behavior of Dental Composites	Shu-Fen Chuang	*National Cheng Kung University, Tainan, Taiwan*	Polymerization, optical coherence tomography (OCT), digital image correlation (DIC)
21	Bleaching Diffusion around Restorations and Intrapulpal Concentration of Hydrogen Peroxide	Vanessa Cavalli Gobbo	*University of Campinas, Piracicaba, SP, Brazil*	Hydrogen peroxide, adhesives, diffusion
22	Three-point Bending Test of Composite with and without Polyethylene Leno-woven Fiber	Atef Masak	*University of Washington, Seattle, WA, USA*	Flexural strength, composite, FPD
23	Cold Atmospheric Plasma Based Dry-Bonding Technique Improves the Dentin Bond Strength and Durability *in vitro*	Xiaoqiang Liu	*Peking University, Beijing, China*	cold atmospheric plasma; dry-bonding; bond strength
24	Application of Er:YAG Laser in the Treatment of Dental Caries	Kun-Tsung Denzel Lee	*Kaohsiung Medical University Hospital, Kaohsiung, Taiwan*	ErYAG laser, Cavity preparation, Pain score
25	Biofilm Formation and Contact Angles on Dental Restorative Biomaterials	Daniel Chan	*University of Washington, Seattle, WA, USA*	Contact angle, Wettability, Chemostat, Live and Dead Cell Count

In vitro Study on Crack Extensions and Dentin Permeability of Teeth with Intact Enamel

Minh Luong [a] , Daniel Chan [a] , Alireza Sadr [a]

[a] *Department of Restorative Dentistry, University of Washington, Seattle, WA, USA.*

Objective: Determining the factor affecting the hypersensitivity of caries-free teeth remains a clinical challenge. The present study was aimed to investigate the possible effect of crack on coronal permeability into pulp, which may explain hypersensitivity in visibly sound teeth. OCT was utilized to observe the crack extension in the substrate.
Method: Freshly extracted monoradicular teeth were selected with or without crack (control group). The teeth were imaged on facial, lingual and incisal or occlusal view using 3D SS-OCT (Yoshida) to detect the crack. The crack length was calculated in micrometer using software analysis (Amira). For evaluation of dentin permeability, apical half of the root and the pulp was removed before the root canal was irrigated with 17% EDTA pH = 7.4 for 5 min. Two needles connected with two syringes were inserted into the canal and fixed by cyanoacrylate glue. The specimens were immersed into Evans blue solution for 4 days. The pressure was applied in the first syringe by retracting the second syringe 5 times per day. The Evans blue solution was collected from the pulp on day 4 and was dissolved in 0.2ml of water. L*a*b* of the solution was measured with chromameter (CR-200, Konica Minolta) and the color difference ΔE denoting dentin permeability was assessed.
Results: OCT showed that the cracks were located deeper than visually inspected by transillumination. Cracks displayed with different depth levels at superficial enamel, deep enamel, whole-thickness enamel and dentin. The group with crack exhibited significantly higher value of ΔE and crack length compared to control group ($p<0.05$). Spearman's rank-order correlation showed that dentin permeability was significantly correlated to crack length.
Conclusion: The incidence of enamel surface cracks on a tooth affected coronal permeability and passive fluid infiltration into pulp. These cracks could account for hypersensitivity of a vital tooth.
Funding/conflict of interest: None

Silver Diamine Fluoride and Resin Bonding Application over Carious Dentine

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Objectives: To evaluate resin composite micro-tensile bond strength (MTBS) after SDF or SDF-KI application to carious dentine.
Method: Artificial carious dentine was achieved in demineralizing solution (pH 4.5) for 7 days in 30 human molars. 600-grit silicon carbide paper was used for standardized smear layers. Specimens were distributed into 3 groups (n=10). Control: Dentin rinsed with deionized water; SDF: Dentin treated with 38% SDF; and SDF-KI: Dentin treated with SDF and KI. Scotchbond Universal in etch-and-rinse mode was used with composite bonding. Multiple MTBS beams were prepared per specimen after 24 hours and tested. Data was analyzed by one-way ANOVA with Tukey HSD post-hoc test.
Results: MTBS test results ranged from 0 to 40 MPa. The highest values were obtained in the Control and lowest in SDF-KI, where pre-test failures were frequently observed. There was no statistical difference between Control and SDF, but both groups showed higher MTBS compared with SDF-KI.
Conclusion: Resin bonding strength over caries-affected dentine is significantly decreased when treated with SDF-KI. SDF alone did not significantly decrease bonding strength to caries-affected dentine.

Table 1. Micro-tensile Bond Strength (MPa) to Caries-affected Dentin

Group	*Control*	*SDF*	*SDF-KI*
MTBS Mean (SD)	23.5 (10.7)	19.8 (8.4)	7.9 (6.6)*
MTBS Range	12.5 - 40.4	8.1 – 33.8	2.4 – 18.5
MTBS with PTF = 0	21.2 (11.4)	18.5 (9.5)	1.5 (2.6)*
MTBS Range with PTF (PTF beam%)	7.6 - 40.4 (15.5%)	4.1 - 33.8 (10%)	0.0 - 5.9 (77.5%)

* In each MTBS row, values marked by an asterisk are statistically significantly different fror others (one-way ANOVA, p<0.005).

Funding/conflict of interest: Supported by the UW Dental Alumni Association fund.

Bond Strength of Universal Adhesives to Enamel and Dentin

Rubens Nazareno Garcia [a,b], Camila Ribeiro Silva [a], Lissandra Silva Gomes [a], Bruna Duarte Ricardo [b], Renata Bruna de Marco [b], Luiz Carlos Machado Liguel [a], Vitaliano Gomes Araujo Neto [c], Marcelo Giannini [c]

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[b] *University of Vale do Itajai, Itajai, Brazil.*

[c] *University of Campinas, Piracicaba, Brazil.*

Objective: to investigate the bond strength of universal adhesives on ground enamel and medium depth bovine dentin, comparing with a conventional adhesive.
Materials and Methods: Eighty samples of bovine teeth were sectioned to obtain flat surfaces (15 mm x 5 mm x 2 mm thick) - 40 for enamel and 40 for dentin. A conventional adhesive using 37% phosphoric acid (Adper Single Bond Plus, 3M Oral Care) and three universal adhesives were used: Ambar Universal (FGM Prod. Odontol.), Prime&Bond Active (Dentsply Sirona) and Scotchbond Universal (3M Oral Care). The adhesives were applied on enamel and dentin samples and three transparent Tygon cylindrical matrices were positioned over the treated surfaces. A low-viscosity resin was inserted into the matrices and light-cured for 20 seconds. The matrices were removed to expose the specimens (30 per group) and stored in distilled water 37°C for one week. Afterwards, the samples were subjected to the shear bond strength (SBS) test (1.0 mm/min) and analyzed for fracture mode (FM) in scanning electron microscopy. The results were analyzed by two-way Analysis of Variance and Tukey's test ($p<0.05$), while MF data were expressed as percentage.
Results: There was no statistical difference in the enamel SBS among adhesives. For dentin, Prime&Bond Active showed the highest SBS. When comparing the two substrates for the same adhesive, they showed higher SBS to enamel than dentin, except for Prime&Bond Active that showed lower SBS to enamel.
Conclusion: Enamel SBS was not material-dependent, suggesting that the universal adhesives can be used without selective acid etching. SBS to dentin was material-dependent and the composition and bonding mechanism of Prime&Bond Active resulted in the highest SBS, with statistical difference for the substrate enamel. Fracture analysis showed that the failures were mainly adhesive on both substrates.
Funding/conflict of interest: This study was supported by the Project 2134/10182 (UNIVILLE). The authors declare that they have no conflict of interest in this research.

The Silane-coupling Effect of a Silane-containing Self-adhesive Composite Cement

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Objectives: Hydrofluoric-acid etching followed by silanization is a routine clinical protocol to durable bond to glass-ceramics. Although a silane bifunctional monomer is often added to universal adhesives, it is not stable in an acidic solution, by which the separate application of a silane primer remains clinically recommended. Recently, a new silane-containing self-adhesive composite cement, namely Panavia SA Cement Universal ('SAU', Kuraray Noritake), was introduced. To investigate the effectiveness of the incorporated silane coupling agent, shear bond strength (SB), contact angle of water (CA) and Si29 nuclear magnetic resonance (NMR) assessments were conducted.

Materials and Methods: For SB, we prepared 10x10x3-mm IPS Empress CAD (Ivoclar Vivadent) disks. SB to glass-ceramic was measured without ('immediate') and with ('aged') 50K thermocycles upon application of (1) SAU, (2) Panavia SA Cement Plus ('SAP'; Kuraray Noritake), and (3) SAPsil after separate silanization using Clearfil Ceramic Primer Plus (Kuraray Noritake). CA was measured on glass-ceramic exposed to the three luting agents mentioned above, followed by washing with ethanol or acetone. The cement pastes before ('before mixture') and upon mixing ('after mixture') were characterized using 29Si NMR.

Results: Immediate and aged SB of SAU did not significantly differ from that of SAPsil (2-way ANOVA, Tukey's post-hoc tests: $p>0.05$), while it was significantly higher than that of SAP ($p<0.05$). CA of SAU-treated glass-ceramic did not significantly differ from that of SAPsil-treated glass-ceramic (2-way ANOVA, Tukey's post-hoc tests: $p>0.05$), but was significantly higher than CA of SAP-treated glass-ceramic ($p<0.05$). 29Si NMR revealed siloxane bonds after mixture, while only methoxy groups were detected before mixture, indicating that upon cement mixing hydrolysis and condensation of silane monomers occurred.

Conclusion: The novel silane-containing self-adhesive composite cement possessed efficient silane-coupling ability.

Funding/conflict of interest: This study was supported by JSPS KAKENHI [grant number: JP 18K17068]. The authors declare that they have no conflict of interest in this research.

Internal Defects and Degree of Conversion of New Flash-curing Composite

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Objectives: To investigate internal defects (ID) and the degree of conversion (DC) of new flash-curing composite system compared to conventional bulk-fill system by optical coherence tomography (OCT) and micro raman microscopy (mRM).
Method: ID and DC were compared among light-cured bulk-fill composites; Tetric EvoCeram Bulkfill (EP), Tetric EvoFlow Bulkfill (EF), F-Composite 2 (FP, paste-type), Flash Flow (FF, flowable) (Ivoclar Vivadent), using LED Bluephase Style (Ivoclar Vivadent) in either High mode (LED-H: 1200 mW/cm^2, 10 seconds) or Flash mode (LED-F: 3400 mW/cm^2, 3 seconds). The bulk-fill composites were observed during polymerization in a bonded tapered cylindrical composite mold (n=8; 4-mm depth, 3-mm diameter) using Yoshida Dental OCT. Chi-square test was performed for comparison of the ID frequency. 3D OCT datasets were vertically compressed and projected onto 2D images so that calculate ID area percentage (ID-A %). The bottom/top DC ratio (DC-R%) in 4-mm thick discs (n=5) were measured using mRM (Horiba), with DC calculated as the ratio of peak intensities of the aliphatic 1640 cm^{-1} and aromatic 1610 cm^{-1} peaks in cured and uncured composites. Two-way ANOVA followed by multiple comparisons with Bonferroni correction was performed for ID-A% and DC%-R (α=0.05).
Results: ID frequency were different among groups ($p<0.05$). Only FF showed no defect in any specimens (0%). ID-A% were significantly affected by both light-source and composites ($p<0.05$); in all composites LED-F showed the smallest ID-A%. DC-R% was significantly different among composite ($p<0.05$); FF showed the highest and EP showed the lowest DC-R%.
Conclusion: Within the limitations of this study, internal defect and degree of conversion of bulk-fill composites were affected by their composition and light-source. There was a tendency for less defects and better polymerization for flowable bulk-fills. The flash-curing flowable with LED curing in flash-mode showed no defect formation and high degree of polymerization.
Funding source: This research was supported by grants-in-aid for scientific research no. 18K17060 from JSPS. Materials supplied by Ivoclar Vivadent.

Comparison of Material Properties of Flowable and Conventional Resin Composites

Akimasa Tsujimoto [a], Yuko Nagura [a], Yusuke Shimatani [a], Kie Nojiri [a], Toshiki Takamizawa [a], Hidehiko Watanabe [b], Miyazaki Masashi [a], Ko Hinoura [c]

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Objectives: The purpose of this study was to compare flowable and conventional resin composites in terms of physical properties.
Methods: Eleven flowable resin composites (Admira Flow, Beautifil Flow Plus X, G-ænial Flow, G-ænial Flow Universal, Gradio Flow, Herculite Ultra Flow, Parafique Universal Flow, Tetric EvoFlow, Venus Diamond Flow, Venus Flow and X-flow) and five conventional resin composites (Ceram X Universal, Estelite Σ quick, Filteck Surprem XTE, Tetric EvoCeram and Venus Diamond) were used. Flexural strength (FS), flexural modulus (FM), simulated localized wear (volume loss: VL; maximum depth of wear facet: MD), volumetric shrinkage and cuspal deflection were determined.
Results: The flexural strength and flexural modulus of flowable resin composites (FS: 102.4–157.4 MPa; FM: 5.0–10.8 GPa) were similar to those of conventional resin composites (FS: 89.9–167.7 MPa; FM: 7.8–13.1 GPa). On the other hand, the volume loss and maximum depth of simulated localized wear facet of flowable resin composites (VL: 0.025–0.148 mm^3; MX: 98.1–210.6 µm) tended to be lower than that of conventional resin composites (VL: 0.054-0.165 mm^3; MX: 165.7–229.1 µm). The volumetric shrinkage of flowable resin composites (3.7–6.6%) was significantly higher than that of conventional resin composites (2.5–2.9 %). The cuspal deflection of flowable resin composites (10.8–29.1 µm) was similar to that of conventional resin composites (13.1–25.1 µm).
Conclusion: The flexural properties and cuspal deflection of flowable resin composites were comparable to those of conventional resin composites. On the other hand, the simulated localized wear of flowable resin composites appeared superior to those of conventional resin composites, unlike volumetric shrinkage.

Survivability and Fractography of Fatigue Loading Crowns with Different Core Buildup Strategies

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[c] *Private practice, Seattle, WA, USA.*

Objectives: This study evaluated the survivability of full coverage coronal restorations on structurally compromised teeth with different core buildup strategies under cyclic loading. Internal stress patterns and fractography were analyzed through optical coherence tomography (OCT).

Method: 16 extracted, endodontically treated human premolars were randomly divided into 4 groups to receive core buildups. Group 1: 2mm ferrule/2mm composite core. Group 2: no ferrule/4mm composite core with peripheral reinforcement by continuous fiber. Group 3: no ferrule/4mm composite core. Group 4: no ferrule/fiber post with composite core. Specimens were prepared with 1mm margins and received lithium disilicate crowns. Specimens mounted on a dynamic chewing simulator were incrementally loaded from 10kg with 5kg of weight added every 250,000 cycles until continuous loading with 25kg produced catastrophic failure. OCT imaging was conducted at the conclusion of each set of 250,000 cycles from proximal, buccal, lingual, and occlusal views.

Results: Kaplan-Meier survivability analysis and Log rank (Mantle-Cox) test were performed to check for statistical significance (p-value = 0.003). Specimens without ferrule receiving either composite core or composite core with fiber post performed similarly, with some specimens failing during the incremental warmup stage. Continuous fiber-reinforcement within core buildups provides significantly increased performance compared to fiber posts or composite alone. The conventional ferrule group showed the highest survivability. The fiber-reinforced composite core had the second highest survivability that had similar results as the ferrule group. Catastrophic failures were primarily initiated in the lithium disilicate crown itself or the lingual restorative margin.

Conclusions: Ferrule remains an important factor in increasing the survivability in structurally compromised teeth restored with full coverage crowns. Of the failures observed, these were caused by propagation of microcracks to complete fracture or cement debonding from lingual tensile forces. Continuous fiber reinforcement of the composite core distributes stresses peripherally and may provide a promising alternative restorative option for structurally compromised teeth with inadequate ferrule.

Funding Source: Dr. Douglass L. Morell Dentistry Research Fund. Materials donated by manufacturers.

Simulated Localized and Generalized Wear of Indirect Resin Composites

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Objectives: The purpose of this study was to investigate the simulated localized and generalized wear of indirect resin composites.
Method: Ten indirect resin composites [Ceramage (CM), Experia (EX), Gradia (GD), Gradia Forte (GF), Gradia Plus (GP), Signum ceramis (SC), Solidex (SL), Solidex Hardura (SH), SR Nexco paste (SN), Symphony (SY)] were used. The resin composites subjected to a wear challenge of 400,000 cycles in a Leinfelder-Suzuki (Alabama) wear simulation device. Simulated localized wear was generated using a stainless-steel ball bearing antagonist and generalized wear was generated using a flat-ended stainless-steel cylinder antagonist. Wear testing was performed in a water slurry of polymethyl methacrylate beads. Simulated localized and generalized wear were determined using a Proscan 2100 noncontact profilometer in conjunction with Proscan and AnSur 3D software.
Results: The volume loss, ranging from 0.018 to 0.194 mm^3, and maximum facet depth, ranging from 72.2 to 230.8 µm, of localized wear facets of indirect resin composites were obtained, and these values were material dependent. The volume loss, ranging from 0.129 to 0.608 mm^3, and mean facet depth, ranging from 8.8 to 47.5 µm, of generalized wear facets of indirect resin composites were obtained and they were also material dependent. The rank order of both simulated localized and generalized wear was SN-GP-GF-EX-SY-GD-SH-SL-CS-CM.
Conclusion: Simulated localized and generalized wear of indirect resin composites were material dependent and not influenced by the type of wear simulation. The simulated localized and generalized wear of SN and GP was lower than that of the other indirect resin composites.

Influence of Application Time of Universal Adhesives on Dentin Bond

Arisa Imai [a], Toshiki Takamizawa [a], Ryo Ishii [a], Eizo Hirokane [a], Akimasa Tsujimoto [a], Yuko Nagura [a], Ko Hinoura [a], Masashi Miyazaki [a]

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Objective: The aim of this study was to determine the effect of universal adhesive application time on dentin bond performance in different etching modes through shear bond strength (SBS) tests and surface-free energy (SFE) measurements.
Methods: The five universal adhesives used were: Adhese Universal (AU), Clearfil Universal Bond Quick (CQ), G-Premio Bond (GP), Scotchbond Universal (SU), and Tokuyama Universal Bond (TU). Bovine dentin specimens were divided into four groups of 10 for each adhesive. SBS and SFE were determined after applying the following surface treatments: 1) self-etch (SE) mode with immediate air blowing after adhesive application (IA), 2) SE mode with prolonged application time (PA), 3) Etch-&-rinse (ER) mode with IA, and 4) ER mode with PA. AU and SU are designed for use with PA, while the other three are designed for use with IA. Bonded specimens were subjected to SBS testing. The SFE of adhesive-treated dentin surfaces was measured after rinsing with acetone and water.
Results: AU and SU showed significantly lower SBS values in IA than in PA in both etching modes. However, the other adhesives showed no significant difference between the IA and PA in either etching mode. The total SFE (γ^S) was dependent on the adhesive and etching mode. For all the adhesives, γ^S in SE mode showed significantly higher values than in ER mode, regardless of the application time. In SE mode, almost all universal adhesives tested showed lower γ^Svalues in PA than in IA. For ER mode, most adhesives did not show any significant differences in γ^S values between IA and PA, regardless of etching mode.
Conclusion: The results of this study did not reveal any significant differences in dentin SBS values between IA and PA for universal adhesives designed for IA use, regardless of etching mode.

Effect of Acid Erosion on Enamel Bond of Universal Adhesives

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Objective: The purpose of this study was to investigate the effect of acid erosion on the enamel bond performance of universal adhesives.
Methods: Bovine teeth were cut into enamel slabs and assigned to either the erosion (Er) or the control group. Specimens in the Er group were immersed in citric acid solution (pH 2.1) five times for one min every 12 h and then placed in artificial saliva, while control specimens were simply stored in artificial saliva. After 7 days treatment, three universal adhesives were used to create bonded specimens, and each adhesive was applied to the enamel surface in accordance with the manufacturer's instructions. A Teflon mold (2-mm height, 4-mm diameter) was used to condense a resin composite. The bonded specimens were stored in distilled water at 37°C for 24 h. The shear bond strength test was conducted using universal testing machine at a cross-head speed of 1.0 mm/min.
Results: The SBS values in the control group ranged from 15.6±2.6 to 16.5±2.6 MPa, while that in the Er group ranged from 18.1±4.7 to 18.9±4.7 MPa. Differences in the SBS values between the different surface treatment were greater than expected, even accounting for the effect of differences in the adhesive systems. The Er group mainly exhibited cohesive failure in the enamel, while adhesive failure was more frequent in the control group.
Conclusion: The results in this study indicated that bond strengths of universal adhesive tested were higher with eroded enamel.

Role of the MDP in Dentin Bond of Universal Adhesives

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Objective: The purpose of this study was to determine the role of the functional monomer MDP in dentin bond durability in different etching modes through shear bond strength (SBS) measurement after thermal cycling (TC) or long-term water storage (WS).
Methods: This study used the MDP-containing universal adhesive, Clearfil Universal Bond Quick (CU), and an experimental adhesive (NM) made with the same ingredients as CU, but excluding MDP. Measurements of SBS to bovine dentin were obtained in the etch&rinse (ER) and self-etch (SE) modes. Ten specimens per test group were prepared, and the bonded specimens were divided into three groups: 1) subjected to 5,000; 10,000; 20,000; or 30,000 TC; 2) stored in distilled water for 3 months, 6 months, or 1 year; and 3) stored in distilled water for 24 h, serving as a baseline.
Results: The CU group showed significantly higher dentin SBS values than the NM group, regardless of the etching mode or degradation method. In addition, differences in the SBS values of the CU and NM groups become large with prolonged degradation periods in both TC and WS conditions.
Conclusion: This study indicates that the functional monomer MDP might play a key role in enhancing not only initial dentin bond strength, but also the bonding durability of universal adhesives after TC and WS degradation. Even when dentin surface is etched by phosphoric acid, the MDP containing universal adhesive might create a durable dentin bond.

Optical Assessment of Horizontal Biofilm Mapping in Resin-dentin Interfacial Gaps

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Objective: The main purpose was to compare the horizontal distribution of cariogenic biofilm at different depths of gaps between dentin and resin interfaces using spectral-domain optical coherence tomography (SD-OCT, Thorlabs).
Methods: Twenty cavities (surface diameter: 2.0mm, bottom diameter: 1.0mm, depth: 1.0mm) were prepared on bovine incisor roots and restored by Clearfil SE Bond 2 and Clearfil Majesty ES Flow, containing intentional gaps (average width: 100-200μm) at dentin-adhesive interfaces (DA group) or resin-adhesive interfaces (RA group). *Streptococcus mutans* (ATCC 25175) biofilms were formed after anaerobic incubation (37°C, 7d). Biofilm in gaps was observed by three-dimensional SD-OCT. For analysis, horizontal cross-sectional images at upper layer, middle layer and lower layer (interval: 34.6μm optical depth/layer) of gaps were selected. Gap area and biofilm area were measured by Image J. Percentages of biofilm distribution area (Biofilm-Percent) at three layers were compared by Paired-samples t-test within DA or RA group and compared by Independent-samples t-test between two groups. Correlation between the maximum gap width and Biofilm-Percent were analyzed by Pearson's correlation. All statistics were analyzed at the 95% significant level.
Results: Biofilm in gaps could be detected by SD-OCT. Biofilm-Percent at upper layers was significantly higher than that at lower layers in both DA and RA groups ($p<0.05$). However, Biofilm-Percent at upper and middle layers, or at middle and lower layers did not show significant differences ($p>0.05$). Moreover, there was a significant correlation between the maximum gap width and Biofilm-Percent in DA group ($r=0.575$, $p=0.001$).
Conclusions: SD-OCT can be used as a method for mapping the distribution of cariogenic biofilm in gaps. Biofilm formation in dentin-resin interfaces is affected by the depth of gaps, which infers that upper layers of gaps provide a more beneficial micro-environment for formation of *Streptococcus mutans* biofilms than lower layers of gaps.
Funding source: "Subject-Development-Dental Prevention" from Ninth People's Hospital, Shanghai Jiao Tong University School of Medicine.

Peroxide Penetration on Teeth restored with Fluoride-containing and Bioactive materials

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Objective: The aim of this study was to evaluate the concentration of hydrogen peroxide in the pulp chamber of teeth restored with fluoride-containing and bioactive materials.
Material and Methods:
Standard cavities (4 mm in diameter and 3mm-deep) were prepared on the buccal surface of fifty bovine incisor crowns. The prepared crowns were randomly restored with (n=10): resin-modified glass-ionomer (Riva Self-Cure, SDI – positive control), fluoride-containing resin (Beautiful II, Shofu), bioactive composite (Activa BioActive, Pulpdent) and two negative controls - non-fluoridated bulk-fill composite (Filtek Bulkfill Posterior, 3M Oral Care) and a non-fluoridated conventional composite (Filtek Z350 XT, 3m Oral Care). The surface was submitted to in-office bleaching with 37.5% hydrogen peroxide (Pola Office, SDI) for 4 sessions. At the 4th appointment, acetate buffer was inserted in the pulp chamber and removed at the end of the bleaching procedure. Leucocrystal violet (0.5 mg/µL) and horseardish peroxidase (1 mg/mL) were added to the tube and the optical density of this solution was spectrophotometrically analysed, providing the concentration of hydrogen peroxide (mg/µL). Data was submited to one-way ANOVA and Tukey test ($\alpha = 0.05$).
Results: No diferences were observed in the intrapulpal concentration of hydrogen peroxide, regardless the fluoride-containg or the bioactive composite used (p=0.123). Even though resin-modified glass-ionomer promoted the lowest HP mean concentration, it was not statistically different from the conventional composite (p=0.196), which exhibited the greatest hydrogen peroxide mean concentration.
Conclusion: The intrapulpal concentration of hydrogen peroxide after in-office bleaching was not different among teeth restored with non-fluoridated and bioactive composites and the non-fluoridated systems.
The authors declare no conflict of interest.

Influence of Surface Treatments on Bond Strength of Hybrid CAD/CAM Materials

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Objectives: This study evaluated shear bond strength (μSBS) and failure mode of CAD-CAM resin nanoceramic (RNC- Lava Ultimate) and polymer-infiltrated ceramic-network (PICN - Vita Enamic) submitted to different surface treatments immediate and after storage for one year.
Method: Forty blocks of each material were obtained and submitted to (n=10): (Sand) Sandblasting with 50-μm Al_2O_3; (Ac5%) 5% hydrofluoric acid etching; (Ac10%) 10% hydrofluoric acid etching; (Sand/Sil) Sandblasting with 50-μm Al_2O_3 and silanization. A multimode adhesive (Scotchbond Universal) was applied on the surface of all specimens and four cylinders (2-mm height and 1.2-mm diameter) of resin cement (Rely X Ultimate) were bonded to the treated surface. Two cylinders were submitted to μSBS test 24 h after the restorative procedure, and the remaining two cylinders were stored in water for one year. Data were evaluated by two-way repeated measures ANOVA and Tukey test (α= 0.05). Failure mode was observed under scanning electron microscopy (SEM).
Results: Immediate μSBS of RNC and PICN was greater when treated with Sand, Ac5% and Ac10% ($p<0.05$). At the same time point, Ac5% and Ac10% treatments promoted higher μSBS for PICN ($p<0.05$). After storage, μSBS of PICN decreased for all surface treatments ($p<0.05$) and only after Ac5% treatment for RNC. After 24 h, failure mode was predominantly mixed (61.6%), and mostly adhesive (65.9%) after storage.
Conclusion: Sandblasting and acid etching (5% or 10%) promoted greater immediate μSBS for both RNC and PICN. Water storage decreased μSBS of PICN, regardless the surface treatment performed.

Influence of Thickness on Ultimate Fracture Load of CAM-CAM Crowns

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Objective: This study evaluated the effect of thicknesses (thin and thick) of 3 types of posterior CAD-CAM crowns on ultimate fracture load (UFL) and failure pattern (FP).
Methods: Thirty human molars were prepared to receive prosthetic full crowns. Three types of CAD-CAM materials were tested (e-MaxCAD/Ivoclar, Enamic/Vita and InCoris TZI/Sirona) using two different thicknesses of 0.5 (thin) and 1.5 (thick) mm (n=5). CAD-CAM blocks were milled with CEREC MCXL (Sirona). Final processing and surface intaglio treatment occurred according to manufacturer's instructions. Crowns were placed using a resin cement Panavia V5 (Kuraray Noritake) and tested after 24h in a universal testing machine (Instron). Teeth were submitted to axial loading until failure using a stainless-steel sphere (3mm diameter), in order to determine the UFL. Afterwards, specimens were classified in failure modes, such as: adhesive, cohesive at prosthetic piece, cohesive in dentin and catastrophic. Data of UFL were expressed in Newton (N) and analyzed by two-way ANOVA e Tukey test (pre-set alpha=5%).
Results: Thin groups did not show differences in UFL values among materials. Thick crowns of InCoris TZI showed higher values ($p<0.0001$) than e-MaxCAD and Enamic. The thickness affected the results for all materials ($p<0.0001$). Regarding FP, thin groups of e-MaxCAD and Enamic showed 75% of adhesive failures and only e-MaxCAD had catastrophic failures (25%). FP of thick groups showed 25% of adhesive failures combined with cohesive fracture within dentin for e-MaxCAD and 25% of adhesive failure for Enamic. Catastrophic failures were found in 75% of e-MaxCAD and Enamic crowns. Thin and thick InCoris TZI groups showed 40% of adhesive and catastrophic failures and 20% of the specimens did not fracture under UFL. Thickness and CAD-CAM material significantly influenced UFL results ($p <0.0001$)
Conclusion: Thick crowns resulted in significantly greater UFL than thin crowns ones, for all materials. Different FP was also observed according to the thickness.

Real-time Monitoring of Heat Generation in Different Restorative Materials

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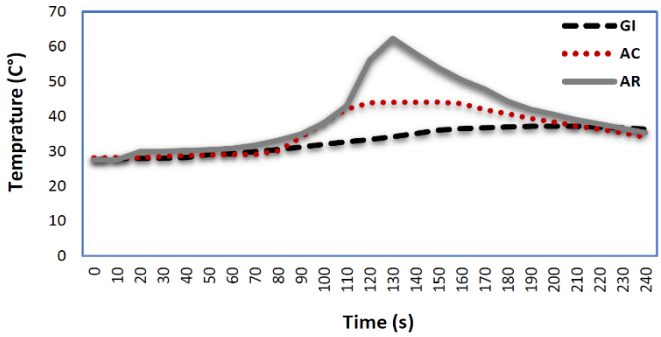
Objective: The objective of this study was to monitor and compare heat generation in different restorative materials using a thermal imaging system.
Materials and Methods: A glass ionomer luting cement (GI; Fuji I, GC, Japan) and 2 different self-cure provisional restorative materials were used in the study; Acrylic resin (AR; Unifast III powder and liquid, GC, Japan) and acrylic composite (AC; Protemp 4, 3M ESPE). Before imaging the samples, the thermal imaging camera (FLIR, USA) was validated with a conventional mercury bar thermometer in hot/iced water bath. Eighteen clear celluloid crown formers for mandibular lateral incisors (Strip-Crown Form - Pedo, 3M ESPE) were used in this study and divided into 3 groups (N=6); GI, AR, AC. Sample preparation was carried out while the room temperature was set at 25 C°. The crown formers were held vertically on non-conductive custom-made mold and each group was filled completely with one of the restorative materials. The thermal imaging camera was positioned perpendicularly over each sample during filling the crown formers to monitor the generated heat during setting reaction for 4 min.
Results: By monitoring the rise in temperature, the highest mean maximum temperature was seen in AR (62.33±0.14 C°) followed by AC (44.1±0.13 C°) and GI (37.22±0.1 C°). One-Way ANOVA with least significant difference (LSD) showed statistically significant differences between the tested groups (P<0.001).
Conclusion: Thermal imaging tool is a useful tool that can noninvasively quantify generated heat. It is recommended to limit the usage of acrylic-based provisional restorations to indirect technique.
The author declares no conflict of interest.



Effect of Staining on Adhesives and Sealants Applied Over Composite

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Objectives: To investigate the roughness (Ra), surface topography (SEM), and color change of different materials (adhesive systems and surface sealants) applied over a resin-based composite, after immersion in wine.

Methods: Ninety composite specimens (5 x 5 x 3 mm) were obtained using Z350 XT (3M Oral Care), and were stored in distilled water during 24 hours at 37°C. The specimens were subsequently polished and received a thin layer of the following materials over their surface: CTRL- only polishing; SB- Adper Single Bond II (3M Oral Care); 3) US- Single Bond Universal (3M Oral Care); CF- Clearfil SE "Bond" (Kuraray); APS- Ambar APS (FGM); BF- Bioforty (Biodinamica); FF- Fortify (Bisco); PS- PermaSeal (Ultradent); GC- G-CoatPlus (GC). Ra was analyzed using an optical profilometer and color change by means of a spectrophotometer (n=10) before and after 24, 72 and 168 hours of immersion in red wine (RW). Topography analysis of representative specimens with no staining and after 168 hours of immersion in RW was done. Data were statistically tested with two-way ANOVA and Tukey´s Test. In addition, a Pearson correlation was performed among the variable responses. A 5% level of significance was used.

Results: The lowest color change was detected for BF, FF and PS sealants and SB adhesive in 24h, with no statistical difference to CTRL ($p \geq 0.05$). In all times of observation, APS adhesive presented the highest color change (p<0.05). The most intense color change was observed within 72h, stabilizing mostly in 168 hours. The sealants and the APS adhesive system showed the lowest Ra (p<0.05), immediately after application. Topographical degradation of the materials was mainly seen after 168 hours of immersion in RW.

Conclusions: Tested materials´ surface degraded and their roughness increased under staining with RW. Color change was present in all the materials, including the resin-based composite without covering layer.

Effects of Fiber Reinforcement on Adaptation and Bond Strength of Bulk-fill Composite in Deep Preparations

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Objectives: This study investigated the effect of plasma-treated leno weaved ultra-high-molecular-weight polyethylene fiber placement on adaptation and microtensile bond strength (MTBS) of bulk-fill composite to deep cavity.

Method: Tapered cylindrical composite cavities (4mm depth, 3mm diameter) were treated with Clearfil SE Bond 2 (SE) and filled in 3 placement techniques: 1) Surefil SDR flow (SDR) placed in bulk (BLK), 2)SDR placed in two unequal increments (INC) and 3)SDR placed after an increment of SDR placed with wetted fiber (Ribbond Ultra) at the cavity floor (FRC). As a control group, the cavities were bulk-filled with SDR and no bonding agent(n=12). All the specimens were subjected to 3D imaging by Optical Coherence Tomography (Santec) to calculate the total volume of gap formed (mm ^{3}) at the cavity floor and between the composite increments. For MTBS, the occlusal cavities (3 x 3 x 4 mm^3) were prepared on intact molars with above-mentioned 3 placement techniques. After 24 hours 37°C water storage, specimens were sectioned using a diamond saw to create 0.7 x 0.7mm^2 beams for MTBS, and subjected to bond test at the crosshead speed of 1 mm/min. Data were analyzed by one-way ANOVA and multiple-comparisons with Bonferroni correction (significance level = 0.05).

Results: The placement technique was significant ($p<0.05$) in total gap volume. The largest gap was observed in the control group and all other groups showed a degree of gap formation at the cavity floor except FRC, where the cavity floor was gap-free in all specimens but some separation was observed between the two increments. MTBS values were 13.8±7.6, 31.7±12.5 and 28.3±8.5 (mean±SD) for BLK, INC and FRC groups. While there was no significant difference between FRC and INC, both were different from BLK ($p<0.05$).

Conclusions: Adaptation of composite improved with the placement of a fiber-reinforced increment at the base of deep cavity. The fiber-reinforced layer may act as a composite shrinkage stress breaker and protect the bonded interface at deep dentin.

Funding/conflict of interest: Materials donated by the manufacturers.

Preliminary study of bonding substrate: caries affected dentin

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Objectives: The purpose of this study was to investigate and analyze the various characteristics of carious dentin.
Materials and methods: Extracted human carious teeth were used. Teeth were cut perpendicularly to tooth axis through center area of caries, then polished and accordingly made 200μm thickness specimens. Using those specimens, Knoop hardness test and element analysis by Electron Probe Micro Analyzer (EPMA) were carried out. The region of the dentin that was studied located between the surface of softened dentin and pulp chamber. The relationship between Knoop hardness test and element analysis were collected and compared in detail.
Results: The hardness-depth curve and Ca, P concentration-depth curve of carious dentin did not always show the same tendencies, that is, in many cases the Ca, P concentration began to decrease at the more superficial region of the cavity compared with the softening dentin front. It was suggested this phenomenon was caused by alternating demineralization and remineralization of decalcified dentin occurring within the broad areas of carious dentin.
Conclusions: The hardness-depth curve and Ca, P concentration-depth curve of caries affected dentin showed respective tendencies.
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Funding source: The author declares no conflicts of interest associated with this research.

Temporal analysis of shrinkage behavior of dental composites

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Objective: Polymerization shrinkage of light-curable resin composites is unfavorable on integrity of restoration-cavity interface. Optical coherence tomography (OCT) is a diagnostic imaging technique that provides necessary information on materials defects. Digital image correlation (DIC) is used to determine in-plane displacement field by matching two characterized pictures. The purpose was to examine temporal shrinkage behavior of different composites by combining OCT-DIC analysis.
Materials & Methods: Three composites (Filtek Z350XT Universal, Z350; Filtek Z350XT Flowable, Z350F; Bulkfill Posterior, Bulkfill) were chosen to examine. Each composite was filled into a cylindrical cavity (3mm in diameter and 1mm deep) on human incisors with flatten labial surfaces without adhesive treatments. During 20-s light curing, OCT scanned the restoration to obtain series of images. The shrinkage behaviors of restorations were analyzed by DIC software based on OCT images. The maximal vertical displacements at the top surface and average displacements at the bottom was recorded in regards of curing time.
Results: For the top surface, the shrinkage began at about 0.4-0.6 second, and gradually increased. The top surface displacements of Z350 directed inward, but the direction reversed at 8.8 second. For its bottom surface, the displacement also moved upward concurrently. Z350F showed the largest top surface displacement among groups, and became stabilized at 5.7 second. Bulkfill has the similar pattern, and its top displacement stabilized at 5.6 second. Z350 showed larger bottom maximal displacement, while Z350F and Bulkfill had similar bottom displacement.
Conclusion: Z350 had the highest bottom surface displacements in the study, possibly due to the thermal expansion and higher stiffness. Low modulus resin (Z350F and Bulkfill) had higher top surface displacements but less bottom displacements, and presented a smooth shrinkage throughout the curing.

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Bleaching Diffusion around Restorations and Intrapulpal Concentration of Hydrogen Peroxide

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Objectives: This study evaluated the diffusion of home-applied bleaching agents around adhesive restorations and intrapulpal concentration of hydrogen peroxide (HP).
Method: Bovine incisors crowns (80) were selected and randomly divided into two groups according to enamel treatment (n=40): (1) enamel without restoration (control); (2) enamel cavities restored with multimode adhesive system and conventional composite resin. The restorations were submitted to 5,000 thermocycles and both groups were treated with (n=10): 6% HP, 10% carbamide peroxide (CP), 15% CP and 20% CP. Bleaching agents were applied once for 6 h on enamel surface and acetate buffer was introduced into the pulp chamber before bleaching. After bleaching, the buffer was collected and the concentration of HP in the solution was determined by the spectrophotometric method. Data were evaluated by two-way ANOVA and Tukey test (α = 5%). Additional samples were immersed in rodhamine B solution and the bleaching agent was applied on enamel with or without restorations. After bleaching, samples were prepared and the inner interface was observed in confocal microscopy.
Results: No significant differences were found in HP intrapulpal concentration after 10% CP treatment on enamel with or without restorations ($p>0.05$). In the presence of adhesive restorations, HP intrapulpal concentration increased after bleaching with 6% HP, 15% and 20% CP ($p<0.05$), except for 10% CP, which promoted the lowest HP intrapulpal concentration. Confocal microscopy exhibited HP diffusion through the adhesive interface and along the enamel prisms; however, diffusion was lower for 10% CP-bleached group.
Conclusion: The intrapulpal concentration of HP increased in the presence of enamel restorations, except for the 10% CP groups.

Three-point Bending Test of Composite with and without Polyethylene Leno-woven Fiber

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Objective: Fracture of conservative resin-based bonded bridges is of concern. This study aimed to determine whether the flexural strength composite resin blocks would be affected by addition of one or two layers of polyethylene fiber on the tension side.
Method: 30 specimens were prepared for the flexural strength test. The specimens (4X4X30 mm) were divided into 3 groups with and without addition of one full length of plasma-treated woven polyethylene fiber (3-mm Ribbond Ultra, Seattle, WA) or double full lengths. Composite without fibers was used as a control. The fiber was impregnated in unfilled wetting resin. A thin layer of composite was placed between the two fibers in group with double fiber. The universal composite used was Estelite Sigma Quick (Tokuyama Dental, Tokyo, Japan). The specimens were tested using Universal Testing Machine (Model 5500—Instron Engineering Corp., Canton, MA) in compression mode with a customized jig at a cross-head speed of 5 mm/min. The mean flexural strength (N) were compared by One-way analysis of variance, followed by the Tukey standardized range test (alpha=.05).
Results: The flexural strength average ranged from 135 to 250 N for three groups. All fiber reinforcements showed a significant increase (P<.0001) in mean flexural strength over unreinforced controls. Double full lengths was significantly stronger than all other groups evaluated (P<.01). Control composite group showed clean total fractures while the reinforced types showed incomplete cracks.
Conclusion: Reinforcement of composite blocks with one or two layers of wetted fiber on the tension side of the specimen improved the overall strength of a hybrid composite. When restorative material fracture is a concern and space allows, placement of the fiber layer(s) may contribute to longevity of the restoration under mechanical stress.
Funding/conflict of interest: Materials for this study were donated by the manufacturer.

Cold Atmospheric Plasma Based Dry-Bonding Technique Improves the Dentin Bond Strength and Durability *in vitro*

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Objectives: To investigate the influence of a modified cold atmospheric plasma (CAP) treatment on demineralized dentin collagen morphology, the quality of the hybrid layer, and the immediate and delayed microtensile bond strength.
Method: The study protocol was approved by the Peking University School of Stomatology Institutional Review Board (PKUSSIRB-201522043). Acid-etched mid-coronal dentin surfaces were treated with a novel CAP jet, which was at a gas temperature of 4°C, for 0s, 15s, 30s, or 45s. The micro-morphological appearance of the dentin surfaces and bond interfaces were viewed by scanning electron microscopy (SEM). The microtensile bond strength was tested immediately, after a 10,000-cycle thermocycling process or after 1 year of 37 °C water storage, and the fracture modes were analyzed under stereo microscope.
Results: The demineralized dentin collagen, that was dehydrated by CAP, maintained an uncollapsed three-dimensional structure. When compared with the traditional wet-bonding technique, the CAP-based dry-bonding technique resulted: (1) a thicker hybrid layer and longer resin tags; (2) a significant improvement in the immediate bond strength; (3) well preservation of bond strength after the aging of thermalcycling or 1-year storage.
Conclusion: CAP preserves the dehydrated dentin collagen network and improves the mechanical properties of resin-dentin bonding.
Funding source: Supported by the National Nature Science Foundation of China grant 81701003.

Application of Er:YAG Laser in the Treatment of dental caries

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Objectives: To compare the pain score with two rating scale during cavity preparation for dental caries between Er:YAG laser irradiation and high-speed handpiece.
Method: The study used Er:YAG laser irradiation (wavelength: 2940 nm, energy density: 21.2 J/cm^2) and high-speed handpiece to prepare a cavity over two carious teeth, one was for laser irradiation and the other one was for high-speed handpiece, in the same subject. All 12 subjects were collected in Dentistry department of Kaohsiung Medical University Hospital, Taiwan. The pain score of record for subjects were used Numeric rating scale and facial rating scale during the preparation procedure. All data were used Mann-Whitney U Test for statistical analysis.
Results: The value mean ± SD of numeric rating scale was 1.75 ± 1.91 in laser irradiation group and 3.25 ± 2.52 in high-speed group. For facial rating scale, the value of mean ± SD was 1.17 ± 1.8 in laser irradiation group and 2.67 ± 2.74 in high-speed group. of laser irradiation group.
Conclusion: The statistical analysis of results p-value: 0.128 in numeric rating scale and 0.114 in facial rating scale) showed no significant difference between these two groups. To use laser irradiation for cavity preparation might not reduce the discomfort for patients.
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Biofilm formation and contact angles on dental restorative biomaterials

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Objectives: To investigate biofilm formation on various dental restorative biomaterials by using newly developed model.
Method: Eight biomaterials, human dentin, and Teflon were selected and disk specimens were fabricated. A microbial mixed culture comprised of 5 oral species were grown continuously in a Chemostat provided a system with a constant species distribution and overall growth activity. The condition set up is close to the real situation where it is under constant temp, pressure and wet. The bacteria were analyzed fluorescently using conjugated antibodies and confocal laser scanning microscopy. Number of live and dead cells were counted after 48-hour. Sessile drop contact angle was also measured for each of the materials to correlate with wettability and the biofilm formation.
Results: Gold casting alloy, amalgam, and zirconia materials harbored low number both in live and dead cells. Based-metal alloy, resin composite, and lithium desilicated glass-ceramic surfaces retained significantly higher number of dead compared to the controls (dentin and Teflon). For biofilm formation, glazed porcelain, glass ionomer, Teflon, and human dentin surface consist of significantly higher bacterial growth.
Conclusion: The techniques described are feasible and quick to study biofilm formation on biomaterials.

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Our industry sponsors, all at the forefront of research and development of adhesive dentistry have played a major role in the success of this effort. Thank you and please keep up the great job!

Finally, I close my statement with appreciation and acknowledgment of:

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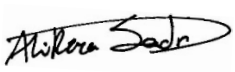

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