01. Student Researcher

Nanolayering in Resin-Dentin Interfaces Created by Commercialized 10-MDP-containing Self-etching/Universal Primers

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Purpose: 10-MDP produces nanolayering by self-assembly of the resin monomer, calcium ions, and partially-dissolved apatite into nano-arrays of electron-dense 10-MDP+Ca salt. Because of its hydrolytic stability, 10-MDP+Ca nanolayering has been claimed to render the dentin/adhesive interface more resistant to degradation. Such a notion, however, is founded upon the ubiquity of nanolayered deposits along the resin/dentin interface. The objective of the present study was to determine the extent of nanolayering in resin/dentin interfaces after application of commercialized self-etching adhesives containing 10-MDP, and universal adhesives in the self-etching mode, to human dentin.

Materials and Methods: Seven commercialized adhesives were examined: Clearfil SE Bond 2, Clearfil S3 Bond, Clearfil Universal Bond (all from Kuraray Noritake Dental), Scotchbond Universal (3M ESPE), All-Bond Universal (Bisco), AdheSe Universal (Ivoclar Vivadent), and G-Premio Bond (GC). Each adhesive was applied in the self-etching mode on midcoronal dentin according to the respective manufacturer's instructions. Thin-film x-ray diffraction (XRD) was used to detect the characteristic peaks exhibited by nanolayering (N = 2). Additional bonded dentin specimens (N = 3) were covered with flowable resin composite and processed for transmission electron microscopy without further staining. The control consisted of an experimental self-etching adhesive prepared from 10-MDP (Designer Molecules), ethanol, and water (15:45:40 wt% ratio, with photoinitiators to render it light curable) applied to dentin for 20 s and examined in the same manner.

Results: Profuse nanolayering with highly ordered periodicity (~4 nm wide) was observed adjacent to partially-dissolved apatite crystallites in dentin bonded with the control adhesive. Three peaks in the range of 2.50 degrees (3.53 nm), 4.93 degrees (1.79 nm), and 7.37 degrees (1.20 m) were identified from thin-film XRD. These features were rarely observed in specimens prepared from the commercialized adhesives.

Conclusion: The sparsity of nanolayering in resin/dentin interfaces created by commercialized adhesives challenges its usefulness as a mechanism for improving bond longevity in dentin bonding.

Keywords: methacryloyloxydecyl dihydrogen phosphate, transmission electron microscopy.

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02. Junior Researcher

10-MDP or Its Analog as Self-etching Primers for Dentin Bonding

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Purpose: To test the hypothesis that two phosphate-containing monomethacrylate resin monomers, methacryloyloxidecyl dihydrogen phosphate (10-MDP; Mw: 326 Da) or methacryloyloxipentapropyleneglycol dihydrogen phosphate (analog of 10-MDP; Mw: 456 Da), are equally effective as the sole resin component for formulating self-etching primers for bonding to dentin.

Materials and Methods: Experimental adhesives were formulated by mixing 10-MDP or its analog (both from Designer Molecules), ethanol, and water at a 15:45:40 wt% ratio with photoinitiators added to render the adhesives light curable. Each primer was applied to human midcoronal dentin for 20 s, air dried, and light cured. Contact angles of water on the primed dentin were measured (EasyDrop DSA30). After coupling the primed dentin with a bonding resin and

resin composite, the microtensile bond strength of the bonded dentin was measured and compared with Clearfil SE Bond (Kuraray Noritake Dental). Transmission electron microscopy was used to examine the resin/dentin interface for the presence of nanolayering. Photoinitiator-free primers were dissolved in Tris buffer for size exclusion chromatography, using demineralized bovine dentin powder as the stationary phase, to examine their potential to access the intrafibrillar milieu of collagen.

Results: Static contact angles for smear layer-covered dentin, 10-MDP-, and MDP-analog-primed dentin were 25.1 ± 6.1 degrees, 47.7 ± 7.7 degrees, and 36.4 ± 7.7 degrees, respectively ($p < 0.05$; one-way ANOVA). Microtensile bond strength (in MPa) for 10-MDP-, MDP-analog-, and SE Bond-bonded dentin were 67.7 ± 12.a / 59.9 ± 14.4, and 57.2 ± 10.9, respectively ($p > 0.05$, one-way ANOVA). Nanolayering of resin-Ca salts was only identified in the resin/dentin interface of the 10-MDP-containing adhesive. Both 10-MDP and its analog were capable of accessing intrafibrillar water compartments to infiltrate spaces lost by intrafibrillar apatite demineralization.

Conclusion: When used as sole resin components in self-etching primers, 10-MDP and its analog produce equally strong initial bonds to dentin after forming cross-linked polymer networks with dimethacrylates derived from bonding resin. Absence of nanolayering in resin/dentin interfaces produced by the MDP analog provides a good model for evaluating the contribution of nanolayering to bond degradation.

Keywords: dentin bonding agents, self-etching primer, 10-MDP, chromatography.

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03. Student Researcher

Analysis of Experimental Adhesive System Containing $ZnCl_2$ as MMP Inhibitor

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Purpose: To evaluate the degree of conversion (DC%), water sorption (WS), solubility (SO), and microtensile bond strength (μTBS) stability to the dentin of experimental etch-and-rinse adhesive systems containing 0% (Z0), 2% (Z2), 3.5% (Z3.5) and 5% (Z5) $ZnCl_2$.

Materials and Methods: DC% was measured by FT-IR spectroscopy and WS and SO were calculated based on ISO4049. Fifty human molars were wet ground until occlusal dentin was exposed. The adhesive systems were applied and resin composite buildups were incrementally constructed. After 24 h in distilled water at 37°C, bonded teeth were cut into resin-dentin beams with a cross-sectional area of 1 mm^2. The μTBS was evaluated after 24 h and 12 months of water storage at 37°C. The data were analyzed using ANOVA and Tukey's HSD test.

Results: Z5 and Z3.5 presented the lowest DC% and μTBS ($p < 0.05$) and the highest WS and SO ($p < 0.05$). Z2 and Z0 presented similar WS, SO, DC, and μTBS ($p > 0.05$).

Conclusions: None of the groups maintained μTBS stability after 12 months of water storage. The experimental adhesive systems with higher percentages of $ZnCl_2$ presented the lowest physicochemical properties.

Keywords: adhesive systems, dentin.

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04. Student Researcher

Bond Strength of an Experimental One-Bottle 4-META Adhesive System

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Purpose: To develop an experimental one-bottle total etching adhesive system containing 4-META in different concentrations (12%, 20%, 30%. and 40%) and evaluate bond strength (μTBS) to dentin immediately and after storage for 6 months. The influence of acetone and ethanol as solvents was also evaluated.

Materials and Methods: The Single Bond 2 system was used as the control. The basic composition of the experimental adhesive was: ethanol or acetone (20%), HEMA (30%), TEG-DMA (25%), UDMA (20%), water (4%), camphorquinone

(0.5%), and tertiary amine (0.5%). Different concentrations of 4-META were added to this composition. To evaluate the bond strength to dentin, 63 extracted human molars were used, from which the enamel had been removed to expose the dentin. Restorations with adhesive systems under study and composites were made. The tooth/restoration unit was sliced to obtain sticks, which were stored in distilled water for periods of 24 h and 6 months. After the immersion period, the microtensile test was performed. The pattern of failure was also evaluated. The data were submitted to ANOVA and Tukey's test ($\alpha = 0.05$). In the immediate evaluation and in the evaluation after 6 months of storage was no significant difference between groups (different concentrations and different solvents). All adhesives were able to maintain μTBS after 6 months of storage.

Results: The μTBS (22.55 MPa) of the 12% 4-META/ethanol-solvent group stored for 6 months was significantly lower than the 40% 4-META/acetone-solvent group tested immediately (38.80 MPa) and the 20%-4-META/ethanol-solvent group tested immediately (37.06 MPa). The pattern of failure was predominantly adhesive in all groups.

Keywords: adhesion, microtensile bond strength, 4-META, experimental adhesives.

05. Junior Researcher

Shear Bond Strengths to Dentin of a New Universal Bonding Agent in Multiple Modes

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Purpose: A new universal adhesive (Scotchbond Universal, 3M ESPE; St Paul, MN, USA) was recently introduced to the market accompanied by claims that it can be used with the self-etching, selective-etching, or etch-and-rinse modes. The purpose of this study was to evaluate the dentin shear bond strengths of the new universal adhesive system used in each of the 3 modes.

Materials and Methods: The labial surfaces of 80 bovine teeth were ground up to 600 grit to create flat dentin surfaces. Resin composite (Filtek Z250, A2, 3M ESPE) was bonded to dentin using the new universal self-etching system with three etching techniques: self-etching, selective etching, and etch-and-rinse. The etchant was a 35% phosphoric acid gel. When used in the etch-and-rinse mode, it was applied for 15 s. For selective etching, it was applied to dentin only for 2 s. An etch-and-rinse, two-step adhesive (Adper Single Bond Plus, 3M ESPE) served as control. Following storage in water for 24 h, shear bond strengths were determined using an Instron universal testing machine. The data were subjected to a one-way ANOVA and Duncan's test for multiple comparisons.

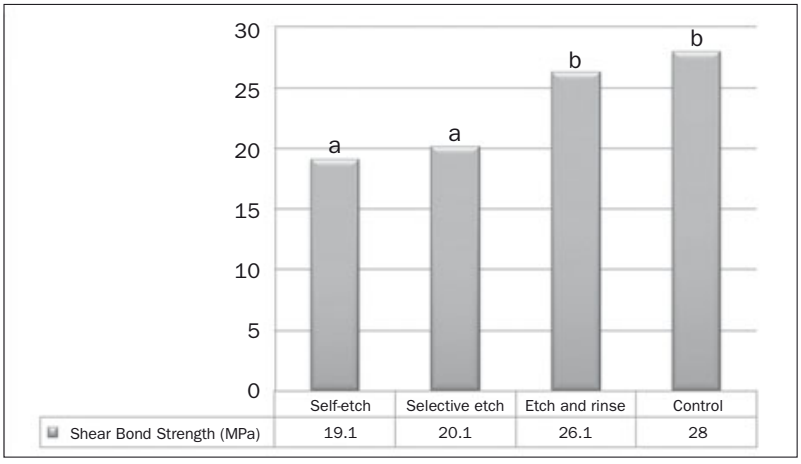

Fig 1 Shear bond strength by technique. Different letters indicate statistically significant differences.

Conclusions: The new universal adhesive had higher dentin bond strengths when used with the etch-and-rinse technique compared to the selective-etching and self-etching modes. The clinical relevance of the slightly lower bond strengths in the self-etching and selective-etching modes is not known.

Keywords: adhesive, resin composite, self-etching, selective etching, etch-and-rinse.

06. Junior Researcher

Influence of Atmospheric Plasma on the Durability of Dentin Adhesion

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Purpose: To investigate the effect of nonthermal atmospheric pressure plasma on dentin bond strength after 24 h and 12 months of water storage.

Materials and Methods: The occlusal enamel was removed from 48 human third molars to fully expose the dentin surface. Dentin was abraded with 600-grit SiC paper under water cooling to standardize the smear layer. Scotchbond Universal (SBU, 3M ESPE) adhesive was used in self-etching (SE) and etch-and-rinse (ER) approaches. Teeth were divided into six groups (n = 8) according to the plasma application for 10 or 30 s, and two control groups, which corresponded the use of SBU according to the manufacturers' recommendations (without plasma): 1. SE control group; 2. plasma 10 s + SE; 3. plasma 30 s + SE; 4. ER control group; 5. ER + plasma 10 s; 6. ER + plasma 30 s. Composite resin blocks were incrementally built up with Filtek Z350 XT (3M ESPE) on bonded dentin surfaces. After 24 h, teeth were vertically and serially sectioned to obtain specimens for microtensile BS, and ten bonded beams were obtained per tooth. Five beams were randomly selected per tooth and tested after 24 h, while the remaining five beams were tested in tension after 12 months of distilled water storage (37°C). Bond strength data were analyzed by two-way ANOVA and Tukey's test (5%).

Results: Bond strength was not improved by plasma application. Control groups and the use of plasma for 10 s kept the bond strength stable for one year. However, bond strength was reduced when the dentin was treated with plasma for 30 s.

Table 1 Mean (SD) microtensile bond strength in MPa to plasma-treated dentin after water storage for 24 h and 12 months

Treatment	24 h	12 months
SE Control	69.6 (7.2)^{Aa}	61.2 (11.4)^{Aa}
SE Plasma 10 s	73.1 (3.4)^{Aa}	70.3 (12.0)^{Aa}
SE Plasma 30 s	78.1 (6.5)^{Aa}	66.4 (4.0)^{Ba}
ER Control	71.2 (5.2)^{Aa}	73.6 (8.4)^{Aa}
ER Plasma 10 s	71.9 (3.4)^{Aa}	67.9(7.9)^{Aa}
ER Plasma 30 s	76.7 (6.2)^{Aa}	69.4 (6.8)^{Ba}

Means followed by different superscript letters (upper case: row, comparing storage times; lower case: column, comparing treatments) indicate significant differences among the groups (Tukey's test, $p \leq 0.05$).

Conclusion: The results suggested that the bond strength of SBU used according to the manufacturer's instructions (for SE and ER approaches) or combined with 10 s of plasma did not alter after 12 months of water storage. Conversely, the bond strength of plasma-treated dentin for 30 s decreased after one year.

Keywords: plasma gases, dentin, adhesives, tensile strength.

07. Senior Researcher

Effect of Biosilicate® on Adhesion to Carious Dentin

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Purpose: To evaluate the effect of a bioglass (Biosilicate) on microtensile bond strength (μTBS) of different adhesive systems to sound and carious dentin (natural and artificial caries).

Materials and Methods: Forty molars presenting natural caries and 80 sound molars (40 left sound, 40 with artificial caries) were divided into 4 groups (n = 10) according to the adhesive system: G1: acid etching + Biosilicate + adhesive system; G2: acid etching + adhesive system; G3: self-etching adhesive system + Biosilicate; G4: self-etching adhesive system. Teeth were restored with composite, sectioned into beams (±0.9 mm^2) and submitted to microtensile testing (crosshead speed: 0.5 mm/min). Failures were analyzed by scanning eletronic microscopy. Bond strength data were analyzed statistically by two-way ANOVA and the Bonferroni test ($\alpha = 5\%$).

Results: Biosilicate application increased ($p < 0.05$) bond strength values for all types of dentin. In the groups without Biosilicate, G4 (sound dentin + self-etching adhesive system) exhibited higher μTBS values ($p < 0.05$). For sound dentin, G1 exhibited the highest values of μTBS ($p < 0.05$), followed by G3 and G2. Groups with artificial caries showed higher values ($p < 0.05$) than natural caries. Adhesive failures were predominant in all groups.

Conclusion: The association of an etch-and-rinse adhesive system and Biosilicate provided a positive effect on bond strength to sound and carious dentin.

Keywords: bioglasses, adhesion, dentin.

Acknowledgment: Funded through FAPESP (2013/12215-1), Brazil.

08. Senior Researcher

Biosilicate as Dentin Pretreatment for Etch-and-Rinse and Self-Etching Adhesives

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Purpose: To evaluate the effect of using Biosilicate microparticles prior to the application of etch-and-rinse and self-etching adhesives on dentin microtensile bond strength.

Materials and Methods: The enamel of 40 bovine central incisors was removed using 600-grit SiC disks to expose flat dentin surfaces. Teeth were randomly assigned into 4 groups (n=10), according to the Biosilicate pretreatment and adhesive system: Group 1: 10% Biosilicate suspension prior to etching with 35% phosphoric acid + adhesive Adper Single Bond 2; Group 2: 10% Biosilicate suspension after etching with 35% phosphoric acid + adhesive Adper Single Bond 2; Group 3: 10% Biosilicate suspension prior to self-etching adhesive Adper Easy One; Group 4: 10% Biosilicate suspension after self-etching adhesive Adper Easy One. Composite buildups were made incrementally with Filtek Z350. The specimens were stored in humidity for 24 h at 37°C and sectioned into sticks cross-sectional areas of 1.0 mm^2. Each stick was tested in a universal testing machine (crosshead speed: 0.5 mm/min), and mean microtensile bond strength data (MPa) were analyzed by 2-way ANOVA and Bonferroni's multiple comparisons test ($\alpha = 0.05$).

Results: Group 2 (10% Biosilicate suspension after acid etching with 35% phosphoric acid + adhesive Adper Single Bond 2) showed the highest bond strength values ($p < 0.05$) compared to Groups 1 and 4. Regarding self-etching adhesive, there was no difference ($p > 0.05$) between Groups 3 and 4.

Conclusion: The application of biosilicate microparticle suspension after acid etching positively influenced the bond strength of an etch-and-rinse adhesive to dentin, but it has no significant effect on the bond strength of self-etching adhesive to dentin.

Keywords: bioglasses, biosilicate, microtensile bond strength, dentin.

09. Senior Researcher

Microtensile Bond Strength of Adhesive Systems in Different Regions of Dentin in a Class II Preparation

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Purpose: To evaluate the microtensile bond strength (μTBS) of self-etching and etch-and-rinse adhesives compared on different dentin regions (central or proximal) in a class II preparation.

Materials and Methods: A class II (MOD) preparation measuring 4 mm in width and approximately 3 mm in depth was simulated on 20 extracted human third molars until middle dentin was exposed. Etch-and-rinse adhesives (Scotchbond Multi Purpose [SMP], 3M ESPE, St Paul, MN, USA; Optibond FL [OP], Kerr; Orange, CA, USA) and self-etching adhesives (Clearfil SE Bond [CSE], Kuraray, Osaka, Japan; Optibond XTR [OPX], Kerr) were used according to manufacturer's instructions. Class II restorations were placed using the incremental technique (Filtek Z250, 3M ESPE). Photoactivation was performed on each layer for 20 s using an LED light-curing unit (BluePhase G2, Ivoclar Vivadent, Schaan, Liechtenstein). Samples were sectioned in a beam shape with a maximum 1-mm^2 cross section and dichotomized into central and proximal locations, placed on Geraldeli's device, and submitted to μTBS testing at 0.5 mm/min crosshead speed (OMT-100, Odeme Dental Research; Joacaba, SC, Brazil). Fracture patterns were analyzed with a stereomicroscope (Leica Mz 9.5, Meyer Instruments; Houston, TX, USA) and extra samples were obtained for scanning electron microscope observation (LEO 435 VP, LEO Electron Microscopy; Cambridge, UK). Data were submitted to two-way ANOVA and Tukey's test at a 5% significance level.

Results: There were no statistically significant differences among SMP (30.5 MPa), OP (29.3 MPa), CSE (29.1 MPa), and OPX (29.6 MPa) in central dentin regions ($p > 0.05$). However, in proximal dentin regions, the μTBS values of SMP (23.2 MPa) and OP (22.0 MPa) were lower compared to CSE (27.1 MPa) and OPX (28.1 MPa) ($p < 0.05$). In all groups, mixed failure was the most frequent mode.

Conclusion: Etch-and-rinse and self-etching adhesives did not differ statistically significantly in terms of μTBS on central dentin, while on proximal dentin, etch-and-rinse adhesives produced statistically significantly lower μTBS values than did etch-and-rinse adhesives.

Keywords: adhesive systems, dentin, bond strength.

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10. Senior Researcher

Arginine Incorporated into an Etch-and-Rinse Adhesive System

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Purpose: Arginine metabolism by oral bacteria generates ammonia, which can neutralize glycolytic acids and reduce the risk of secondary caries at the tooth/composite interface. This preliminary study aimed to develop and compare an etch-and-rinse adhesive system containing four different concentrations of arginine for sustainable release without affecting the mechanical properties.

Materials and Methods: The experimental etch-and-rinse two-bottle adhesive was formulated without arginine (control: C) and with different effectively incorporated concentrations of arginine: G2.5%, G5%, G7%, and G10%. A three-point bending flexural strength test (FS) and flexural modulus analysis (FM) were conducted on a total of 40 bar-shaped specimens 10 x 2 x 2 mm ($n = 8$ for each group) according to ISO 4049. A universal testing machine (Instron, Norwood, MA, USA) with a span between supports and a crosshead speed of 0.5 mm/min was used to conduct the tests. FM was calculated using Bluehill 3 software. Data were analyzed by ANOVA and post-hoc Tukey's test. Statistical significance was established at $\alpha = 0.05$.

Results: FS results for each group were as follows: C (10.70 MPa), G2.5% (9.53 MPa), G5% (9.56 MPa), G7% (9.77 MPa), G10% (9.45 MPa). There were no statistically significant differences for FS values between C and G7% ($p > 0.05$) or among G2.5%, G5%, G7%, and G10% ($p > 0.05$). Group C had statistically significantly higher FS values when compared to G2.5%, G5%, and G10% ($p > 0.05$). The FM results were as follows: C (1.24 GPa), G2.5% (1.18 GPa), G5% (1.13 GPa), G7% (1.26 GPa), G10% (1.29 GPa), and no statistically significant difference was found among any of the groups ($p > 0.05$).

Conclusions: The incorporation of arginine at all concentrations tested did not alter the flexural modulus and the incorporation of 7% arginine did not alter the flexural strength of the experimental adhesive as compared to the control. Future study should include testing of other physical and mechanical properties as well as the anti-caries efficacy of this novel arginine-based adhesive.

Keywords: adhesion, microtensile bond strength, nanoleakage, degradation, dentin treatment.

11. Student Researcher

New Strategy in Dentin Treatment Prior to Etch-and-Rinse Adhesive Application

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Purpose: To evaluate the effect of dentin treatment with HEMA-P on the microtensile bond strength (μTBS) and nanoleakage of an etch-and-rinse adhesive system.

Materials and Methods: The occlusal surfaces of human molars were wet ground to expose superficial dentin and assigned to two groups according to the dentin treatment: PA: 37% H_3PO_4 for 15 s; HP: HEMA-P for 15 s. Adper Single Bond 2 was applied to treated dentin surfaces, and resin composite buildups were incrementally constructed over them. After 24 h in artificial saliva at 37°C, bonded teeth were cut into resin-dentin sticks with a cross-sectional area of 1 mm^2 that were submitted to μTBS testing (immediately or after 3 months of storage in artificial saliva at 37°C). The nanoleakage was investigated by SEM/EDS and the interaction between dentin and H_3PO_4 or HEMA-P was analyzed by combining micro-Raman and FT-IR spectroscopy. The data were analyzed by two-way ANOVA and Tukey's HSD post-hoc test ($\alpha = 0.05$).

Results: The HP group presented significantly higher μTBS than did the PA group at both observation times ($p < 0.05$). Both treatments maintained the μTBS stability after 3 months of artificial saliva storage ($p > 0.005$). At both times, the PA group presented higher nanoleakage than did the HP ($p < 0.05$).

Conclusions: HEMA-P maintained the μTBS stability after 3 months of artificial saliva storage. This dentin treatment performs better than the traditional phosphoric-acid etching in terms of nanoleakage.

Keywords: adhesion, microtensile bond strength, nanoleakage, degradation, dentin treatment.

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12. Junior Researcher

Effect of Radiotherapy on the Dentin/Composite Interface

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Purpose: The purpose of this in vitro study was to evaluate the effect of radiotherapy on the dentin/composite interface in human teeth through the microtensile bond strength test (μTBS) with and without doxycycline application.

Materials and Methods: Sixty human third molars were sectioned to expose mid-dentin surfaces and distributed into 3 groups (n = 20) according to the adhesive system (Adper Scotchbond MP and Clearfil SE Bond) applied, doxycycline application (with/without), and exposure or not to 60 Gy total radiation (2 Gy daily doses, 5 days/week, total of 6 weeks). No radiotherapy was performed in the control group (n = 20). Group RtRes (n = 20) was submitted to radiotherapy before the restoration procedure, and group ResRt (n = 20) was submitted to radiotherapy after restoration. Specimens underwent μTBS testing in a universal testing machine (EZ-Test, Shimadzu; Tokyo, Japan). Failure modes were determined with optical microscopy (Leica Mz 9.5; Heerbrugg, Switzerland) and extra samples were analyzed using SEM (LEO 435 VP, Carl Zeiss; Jena, Germany). Data were submitted to two-way ANOVA and Tukey's test ($p < 0.05$).

Results: μTBS values (MPa) for Adper Scotchbond MP (25.5 ± 4.8) and Clearfil SE (27.6 ± 4.2) were not statistically different. The control (30.5 ± 4.9) and ResRt (29.2 ± 4.4) groups presented μTBS values significantly higher than RtRes (23.1 ± 3.2). Doxycycline application (21.7 ± 3.6) significantly reduced μTBS values compared to groups without doxycycline application (33.6 ± 4.2). Dentin cohesive failure mode was predominant for RtRes and mixed failure mode for ResRt. Mixed and adhesive failures were more often observed in control group.

Conclusion: Specimens submitted to radiotherapy before restoration presented significantly lower μTBS values. Specimens submitted to radiotherapy after restoration presented μTBS values similar to those of the control group. The use of doxycycline significantly reduced μTBS values regardless of other test conditions.

Keywords: adhesive, radiation, bond strength, doxycycline.

13. Junior Researcher

Effect of Deproteinization on Dentin Bond Strength in Amelogenesis Imperfecta

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Purpose: To evaluate the effect of different dentin deproteinization procedures on the microtensile bond strength (μTBS) of composite resin to primary dentin affected by hypocalcified amelogenesis imperfecta (AI).

Materials and Methods: Flat dentin surfaces were obtained from extracted hypocalcified AI-affected and noncarious primary molars. The specimens were randomly distributed into 3 groups according to surface conditioning procedures: control, sodium hypochlorite (NaOCl), and chlorine dioxide (ClO_2) groups. A universal testing machine was used to measure μTBS, and data were analyzed using one-way ANOVA and Tukey's test.

Results: μTBS values for all groups in the sound primary teeth were significantly higher than for comparable groups in the hypocalcified-AI primary teeth ($p < 0.05$). For both sound and hypocalcified-AI primary teeth, no significant differences were found between the μTBS values of the control and NaOCl groups ($p > 0.05$); however, μTBS values for the ClO_2 group were significantly higher than for both control and NaOCl groups ($p < 0.05$).

Conclusion: Deproteinization with ClO_2 could be considered effective in enhancing dentin bonding in hypocalcified-AI primary teeth.

Keywords: microtensile bond strength, chlorine dioxide, deproteinization, hypocalcified amelogenesis imperfecta, sodium hypochlorite.

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14. Junior Researcher

Different Adhesives for Immediate Dentin Sealing: Effects on μTBS Durability

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Purpose: To evaluate the effects of using different adhesive systems for immediate dentin sealing (IDS) and three months of water storage on bond strength (μTBS).

Materials and Methods: Dentin/resin/resin interfaces were produced by a self-adhesive cement (RelyX U100, 3M ESPE) and IDS surfaces. For IDS, four adhesives were used: two etch-and-rinse adhesives – a 3-step system [Opti-Bond FL (OB, Kerr)] and a 2-step system [XP Bond (XP, Dentsply)] – and two self-etching adhesives – a 2-step self-etching adhesive [Clearfil SE Bond (SE, Kuraray)] and a single-step adhesive [Xeno V (XV, Dentsply)]. IDS was not performed in the control group, which did not receive any dentin pretreatment. Sixty molars were divided into 5 groups according to adhesive procedures, then subdivided into 2 subgroups according to water-storage time ($n = 6$). Pre-polymerized composite blocks were air abraded, silanized, and cemented according to manufacturer's recommendations. After 7 days of water storage, specimens were sectioned to produce beams of approximately 1 mm^2 cross-sectional area. Half of the beams were tested immediately and the remaining beams were stored in water (37°C) for 3 months prior to testing in tension (1 mm/min). Fracture pattern was determined using an SEM. μTBS data were analyzed by two-way ANOVA and Tukey's test.

Results: No pre-test failures were observed. Results are presented in Table 1. After 7 days, IDS groups presented higher μTBS values than those of the control group, although XP and SE did not differ significantly. However, after 3 months, no significant differences were observed between IDS groups and the control group. XV and OB presented a significant reduction in μTBS values compared to baseline. The majority of failures occurred between cement and dentin, with or without IDS.

Conclusions: IDS was not able to prevent a decrease in μTBS for some materials after 3-month water-storage. The control group did not differ from IDS groups after storage in water.

Table 1 Mean (SD) bond strength values in MPa for the different materials used for immediate dentin sealing after 7 days or 3 months of storage in water

Materials used for IDS		7 days	3 months
1-step self-etching	Xeno V	48.0 (14.1)^{Aa}	18.6 (9.8)^{Ab}
2-step self-etching	Clearfil SE Bond	33.0 (8.4)^{ABa}	25.4 (3.9)^{Aa}
2-step etch-and-rinse	XP Bond	30.8 (14.0)^{ABa}	21.9 (2.5)^{Aa}
3-step etch-and-rinse	OptiBond FL	45.1 (6.0)^{Aa}	28.3 (9.2)^{Ab}
Self-adhesive cement	U100 (control/no IDS)	22.8 (7.7)^{Ba}	23.3 (17.3)^{Aa}

Means followed by different superscript letters (upper case – column; lower case – row) differ at the 95% confidence level (Tukey's test).

Keywords: immediate dentin sealing, self-adhesive resin cement, durability, SEM.

15. Senior Researcher

Immediate Dentin Sealing: A Narrative Review

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Purpose: Preparation of teeth for indirect bonded restorations involves cutting dentin and thus exposure of dentinal tubules. Many approaches have been used to seal exposed dentin tubules. Immediate dentin sealing (IDS) with dentin bonding agents is a new strategy. The aim of this study was to review published studies that evaluated the effectiveness of IDS in restorative dentistry.

Materials and Methods: This report was conducted in accordance with the PRISMA Statement. A literature search was carried out using PubMed Plus, Ovid Medline, Cochrane Library, Web of Science, and Scopus databases in English and without time restrictions. Studies evaluating the effect of IDS were deemed eligible. Case reports or case series, abstracts, short communication, observational studies, review articles/letters, and studies in which the effect of immediate dentin sealing was not determined were excluded. Two reviewers independently selected the studies, extracted the data, and assessed the risk of bias. From 205 potentially eligible studies, 41 were selected for full-text analysis, and 15 were included for review.

Results: The review of the full-text articles confirmed that 8 studies determined bond strength, 2 studies identified interactions between impression materials and dentin bonding agents, 2 articles evaluated the thickness of IDS materials. Cuspal deflection with the fracture resistance of teeth, fluid permeability, postcementation hypersensitivity, and microleakage were investigated in another study. One study examined both microleakage and bond strength. The studies demonstrated that IDS improved bond strength of luting cements to dentin. No change was observed in microleakage values of cemented crowns. Polyether impression materials are not recommended to be used in combination with IDS due to their interaction with dentin bonding agents.

Conclusion: The IDS technique seems to be effective in improving bond strengths and reducing postoperative sensitivity. However, cuspal deflection, fracture resistance, fluid permeability, and microleakage of the restorations are not secured with this strategy.

Keywords: immediate dentin sealing, review.

16. Student Researcher

Shear Bond Strength of Three Adhesive Luting Agents to Bovine Dentin

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Purpose: To compare the shear bond strength (SBS) to dentin of a resin-modified glass-ionomer cement (group A), a self-adhesive resin cement (group B), and an etch-and-rinse adhesive resin cement (group C).

Materials and Methods: A total of 60 bovine teeth were prepared by grinding the buccal surface flat with a carbide disk on a low-speed trimmer and 600-grit carbide paper under continuous water flow. Teeth were randomly assigned to 3 groups of 20 specimens each. All specimens were placed in a thermostatically controlled water bath at constant temperature of 37°C for 24 h. All groups were prepared according to the manufacturer's (all 3M) instructions. 10 specimens per group were thermocycled 1000 times (5°C-55°C) and the other 10 specimens per group spent another 24 h in the 37°C water bath. Shear bond strength values were determined by a Chantillon testing machine. One-way ANOVA and Bonferroni tests were used to determine significant differences ($p < 0.05$) between the material groups.

Results: Pre-test failures were observed. The mean SBS in group A was 4.24 ± 0.87 MPa, in group B 6.59 ± 1.46 MPa, and in group C 9.68 ± 0.76 MPa. Groups A and B ($p = 0.035$), groups A and C ($p = 0.000$), and groups B and C ($p = 0.001$) were found to be statistically significantly different (Bonferroni test).

Conclusions: Statistically significant differences were found between groups A (3M RelyX Luting Plus), B (3M RelyX Unicem 2) and C (3M RelyX Ultimate). The etch-and-rinse system had better retentive properties.

Keywords: resin-modified glass-ionomer cement, self-adhesive resin cement, adhesive resin cement, shear bond strength.

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17. Senior Researcher

Bond Strength of a Newly Developed Luting Resin Composite Cement

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Purpose: To evaluate shear bond strength of a newly developed luting resin composite cement to bovine dentin.

Materials and Methods: Four luting resin cements were tested: Panavia V5 with a self-etching primer (Kuraray Noritake Dental; Tokyo, Japan), RelyX Ultimate with Scotchbond Universal Adhesive (3M ESPE; St Paul, MN, USA), NX3 with Opti-Bond All-In-One (Kerr; Orange, CA, USA) and Panavia F2.0 with ED Primer II (Kuraray Noritake Dental). Bovine mandibular incisors were embedded in a self-curing resin and the labial surfaces were ground with 600-grit SiC paper under running water to obtain flat dentinal surfaces. The surface was then treated with the primer or adhesive, and a resin composite cylinder (2.3 mm diameter, 2.2 mm height, Clearfil AP-X, Kuraray Noritake Dental) was bonded to the surface using the corresponding cement under a pressure of 5 N. Following removal of excess cement, the cement was irradiated according to the manufacturers' instructions. The bonded samples were stored in distilled water at 37ºC for 24 h. Shear bond strengths were measured using a universal testing machine (Instron 4443; Canton, MA, USA) at a crosshead speed of 1.0 mm/min ($n = 10$). Data were statistically analyzed using one-way ANOVA and Tukey's test at $\alpha = 0.05$.

Results: Means and standard deviations of the shear bond strength were 42.3 ± 7.3 MPa for Panavia V5, 14.3 ± 7.2 for RelyX Ultimate, 6.0 ± 1.5 MPa for NX3 and 13.0 ± 6.0 for Panavia F2.0. The bond strength of Panavia V5 was approximately three times greater than that of Panavia F2.0, and was the statistically significantly highest among the four cements.

Conclusion: The newly developed luting composite resin cement (Panavia V5) demonstrated significantly higher bond strength to dentin than the three reference products tested.

Keywords: resin cement, dentin, adhesive.

Acknowledgment: This study was funded by Kuraray Noritake Dental.

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18. Junior Researcher

Influence of Aging Protocol on the Adhesive Interface Using Different Adhesive Systems

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Purpose: To evaluate the influence of different aging protocols on the microtensile bond strength (μTBS) and nanoleakage between bovine dentin and a composite resin using three adhesive systems.

Materials and Methods: The enamel of the vestibular surface of 120 bovine incisors was ground away to expose the dentin. Teeth were randomly distributed into groups according to the adhesive systems (Adper Scotchbond Multipurpose, Clearfil SE bond, Scotchbond Universal Adhesive) and the aging protocols (storage for 24 h, storage for 6 months, mechanical cycling, thermocycling) used in this study, totaling 12 experimental groups (n = 10). After construction of composite blocks, beams were obtained and used for the microtensile and the nanoleakage tests. The percentage of silver nitrate was recorded under energy dispersive spectroscopy. Data were submitted to the Kruskal-Wallis and Mann-Whitney U-tests for post-hoc comparisons (5%).

Results: Thermocycling resulted in lower μTBS values ($p < 0.05$) for Clearfil. The aging protocols had no detrimental effect on the other adhesives. Generally, Scotchbond Multipurpose adhesive showed the highest μTBS values. Clearfil and Universal adhesives yielded more adhesive failures than did Scotchbond Multipurpose, which had more cohesive failures. Storage for 6 months and mechanical cycling resulted in higher nanoleakage ($p < 0.05$) for all adhesives. After mechanical cycling, some significant differences were found (Universal < Scotchbond = Clearfil, $p < 0.05$).

Conclusion: Only thermocycling together with the two-step self-etching adhesive influenced the μTBS. The etch-and-rinse adhesive presented the highest μTBS values. As for nanoleakage, storage for 6 months and mechanical cycling damaged the adhesive interface for all adhesives.

Keywords: aging, self-etching adhesives, bond strength, nanoleakage.

19. Junior Researcher

Effect of Combination of Different Core Buildup Composites/Dual-curing Adhesives on Microtensile Bond Strength to Dentin after Long-term Storage

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Purpose: To evaluate the microtensile bond strength (μTBS) of two core buildup composites (Core.X Flow, Dentsply de Trey and Rebilda, VOCO) combined with two dual-curing adhesive systems (XP Bond+Self Cure Activator, Dentsply and Futurabond DC, VOCO).

Materials and Methods: Twenty sound, freshly extracted human molars were randomly divided into four groups: G1: Futurabond DC/Rebilda (FB+RB); G2: XP Bond+SCA/Rebilda (XP/RB); G3: XP Bond+SCA/Core.X Flow (XP+CF); G4: Futurabond DC/Core.X Flow (FB+CF). Teeth were flattened and dentin was polished down to 600-grit SiC paper. Adhesive systems were applied on dentin surfaces according to manufacturers' recommendations. A metal matrix band was used for constructing a 3-mm high composite buildup, which was then photo-activated (Radii Plus; SDI, output 1411 mW/cm^2) for 40 s. Samples were stored for 24 h or 6 months at 37°C and 100% humidity. The μTBS test was carried out in a universal testing machine operated at a crosshead speed of 1 mm/min. Failure mode was observed under a stereomicroscope. The main factors "combination" and "time" as well as their interactions were tested by 2-way ANOVA ($\alpha = 0.05$).

Results: Significant differences were observed for the factors 'combination' and 'time' ($p < 0.05$). However, no significant difference was observed for the interaction between factors. Storage increased the μTBS values after 6 months. The mean μTBS (SD) values in MPa were: G1: 24.3 (5.2)^{B}; G2: 40.2 (14.1)^{A}; G3: 35.9 (8.0)^{A}; G4: 31.2 (7.8)^{AB}. The mean μTBS (SD) values after 24 h and 6 months in MPa were 27.8 (6.4)^{b} and 37.9 (12.0)^{a}, respectively. Different capital superscript letters indicate significant differences between combinations; different small superscript letters indicate significant differences between storage periods. The lowest bond strength values were found in G1. The μTBS values increased after 6 months storage.

Conclusions: The different dual-curing adhesive/core buildup composite combinations did not reduce the μTBS values in comparison with the original, manufacturer-recommended combination.

Keywords: cements, adhesive system, bond strength.

20. Senior Researcher

Effects of In Vivo and In Vitro Aging Protocols on Resin-Dentin Bond Strength

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Purpose: To evaluate the bond strength of in vivo and in vitro restorations under different aging protocols and simulated pulpal pressure.

Materials and Methods: Fifty teeth were divided into five groups (n = 10): G1: in vivo restoration 24 h prior to extraction; G2: in vitro restoration and 24-h storage in deionized water; G3: in vitro restoration and aging with 28 thermal cycles and 666 mechanical cycles; G4: in vitro restoration under simulated pulpal pressure; G5: in vitro restoration under combined simulated pulpal pressure and aging protocols. Standardized cavity preparations were 4 mm long, 5 mm wide, and 2 mm deep in relation to the marginal ridge. The restorative procedure was performed with Single Bond 2 (3M ESPE, Brazil) and resin composite – Grandio (VOCO, Germany) using an incremental technique. A single calibrated operator performed all procedures, including finishing and polishing of the restoratons. Beams with cross sections of approximately 1 mm^2 were obtained and tested for microtensile bond strength using a universal testing machine using 10 kg load and a crosshead speed of 1 mm/min. Fractures were evaluated with stereomicroscopy; only data from adhesive and mixed fractures were evaluated. Data were analyzed with ANOVA and Tukey's test with $\alpha = 0.05$.

Results: Bond strength means and standard deviations in MPa were: G1: 23.2 ± 3.9^{A}; G2: 25.0 ± 3.0^{A}; G3: 24.0 ± 1.8^{A}; G4: 17.4 ± 1.8^{B} ; G5:19.5 ± 1.6^{B}. Significant differences between groups were detected ($p < 0.05$). Tukey's test idenitifed a significant reduction in G4 and G5 compared with the other groups.

Conclusion: Restoration under simulated pulpal pressure resulted in significant bond strength reduction compared to the in vivo control group (G1).

Keywords: microtensile bond strength, aging, simulated pulpal pressure, in vivo, in vitro.

Acknowledgment: Research funded by FAPESP 2014/07047-5.

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21. Senior Researcher

Effect of Fluoride Varnishes on Bond Strength to Enamel

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Purpose: To evaluate the effect of three varnishes containing casein phosphopeptide-amorphous calcium phosphate, tricalcium phosphate, and fluoride on shear bond strength (SBS) of two adhesive systems to enamel.

Materials and Methods: Forty-eight permanent molars were hemi-sectioned buccolingually and embedded in acrylic resin. The outer surfaces of specimens were ground with 600-grit SiC paper to create flat enamel surfaces and randomly distributed into four groups according to the enamel pretreatment agents; control (no treatment, CNT), MI Varnish (MIV), Clinpro White varnish (CWV), and Duraphat varnish (DV). Each group was further divided into two adhesive subgroups (n = 12) as follows: etch-and-rinse (Adper Single Bond, ASB) or self-etching (Clearfil SE Bond, CSE). Enamel surfaces were pretreated with the varnishes and stored in distilled water at 37°C for 24 h. The pretreatment agent residues were then removed with acetone solution (1:1) and a plastic scaler. Cylindrical composite samples (2.3 mm in diameter, 3 mm in height) were bonded to the enamel surfaces with one of the study adhesives. The specimens were stored in distilled water at 37°C for 24 h and then subjected to a SBS test. The data were analyzed by one-way ANOVA and Tukey's test.

Results: For both CSE and ASB, SBS values of the CNT groups were significantly higher than those of other groups ($p < 0.05$). Among the enamel pretreatment groups, SBS values of both adhesive systems were lowest in group MIV, followed by the groups CWV and DV.

Conclusion: Pretreatment of enamel surfaces with fluoride-containing varnishes reduced the bonding performance of adhesive systems to enamel. It seems that MIV application caused greater enamel surface alterations and precipitation, which interfered with the bonding mechanism of the adhesives.

Keywords: casein phosphopeptide-amorphous calcium phosphate, enamel, fluoride, shear strength, varnish.

Mean (MPa) and standard deviations		
Groups	ASB	CSE
CNT	30.49 ± 2.08^{1,A}	29.05 ± 1.66^{1,A}
MIV	18.33 ± 1.87^{1,D}	19.20 ± 2.66^{1,C}
CWV	22.10 ± 2.40^{1,C}	23.70 ± 2.37^{1,B}
DV	24.19 ± 1.96^{1,B}	25.60 ± 1.89^{1,B}

*Different superscript letters and numbers indicate significance within columns and rows ($p < 0.05$).

22. Junior Researcher

Temporal Development of Dentin-Composite Bond Strength During Curing

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Purpose: To determine the time-dependent formation of the dentin-composite bond during light curing and to investigate the effect of composite thickness on its rate of formation.

Materials and Methods: A 0.2-mm-thick layer of uncured composite (Z250, 3M ESPE) was placed between a cured block of the same composite (1.0 or 3.0 mm thick) and a bovine dentin slab with a layer of adhesive (Single Bond, 3M ESPE; output 1200 mW/cm^2) pre-cured on its surface. The assembly was cured through the composite block using a 3M ESPE S-10 curing light modified with a power supply and a digital trigger. The dentin-composite bond strength at 0.5, 1.0, 2.5, 5.0, 7.0, 10, 15, and 20 s was measured by the uniaxial tensile test. Forty specimens were prepared for each thickness, providing 5 measurements per time point. The failure surfaces were examined by SEM to determine the proportions of cohesive and adhesive failure.

Results: Bond strength (S) increased with time (t) according to the equation $S = S_0 (1–e^{–kt})$, where S_0 is the final bond strength and k the rate of formation (Fig 1). The values of S_0 and k were 11.26 MPa, 0.513 s^{-1} and 10.06 MPa, 0.236 s^{-1} for the 1.2-mm-and 3.2-mm-thick specimens, respectively. Initially, only composite and adhesive could be seen on the failure surfaces (Fig 2). With time, an increasing proportion of dentin surfaces could also be seen, which appeared earlier in the thin specimens than in the thick ones.

Conclusion: The time-dependent dentin-composite bond strength follows the equation $S = S_0 (1–e^{–kt})$, with the rate of development being reduced by composite thickness. The predominant mode of failure changed from cohesive in the composite and adhesive at the composite/adhesive interface to adhesive at the adhesive/dentin interface.

Keywords: composite resins, dentin, bond strength.

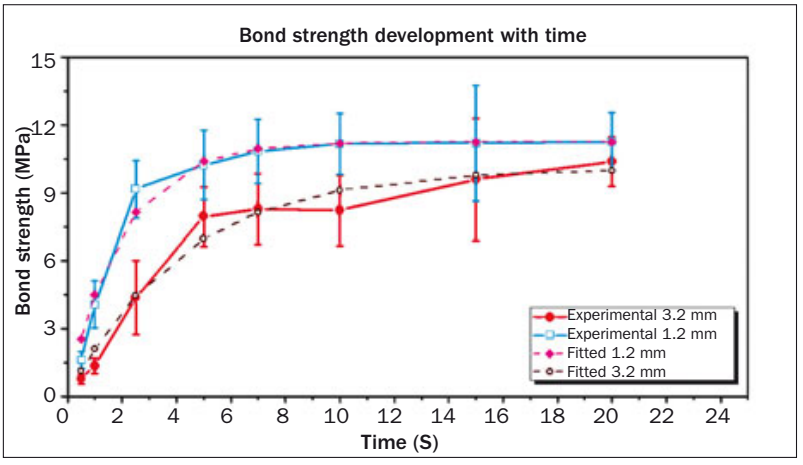
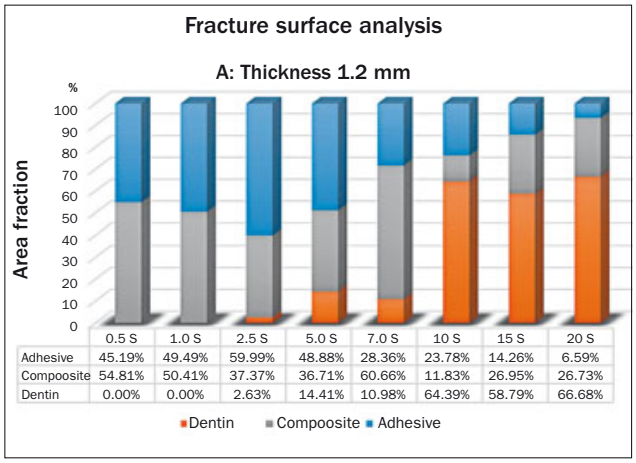


Fig 1 Bond strength development with time.



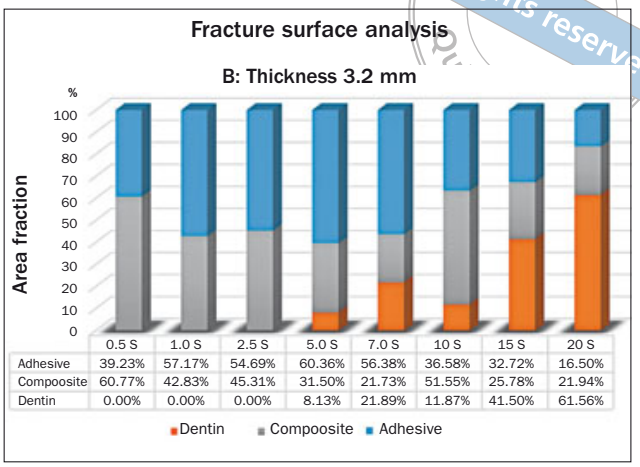


Fig 2 Fracture surface analysis.

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23. Junior Researcher

Evaluation of Dentin Bond Strength by a Thin-film Scratch Test

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Purpose: To evaluate 1) thin-film bond strength between a bonding agent and human dentin using a scratch test, and 2) the characteristics and accuracy of measurement.

Materials and Methods: Four one-step bonding agents (BeautiBond; Bond Force; Adper Easy Bond; Clearfil tri-S Bond) and two two-step bonding agents (Cleafil SE Bond; FL-Bond II) were investigated in this study. Flat dentin surfaces were prepared on extracted human molars. The dentin surfaces were ground and bonding agents were applied and light cured. The thin-film bond strength test of the specimens was evaluated by the critical load at which the coated bonding agent failed and dentin appeared. The scratch-mark sections were then observed under a scanning electron microscope. Indentation hardness was evaluated by the variation in depth under an applied load of 10 gf. Data were compared using one-way ANOVA with the Scheffé's post-hoc multiple comparison test ($p < 0.05$). In addition, thin-film bond strength and indentation hardness were analyzed using analysis of correlation and covariance.

Results: The thin-film bond strength of two-step bonding agents were found to be significantly higher than that of one-step bonding agents with small standard deviations (Table 1). Scratch marks consistently showed adhesive failure in the vicinity of the bonding agent/dentin interface. The indentation hardness showed a trend that two-step bonding agents have greater hardness than one-step bonding agents (Table 2). A moderately significant correlation ($r^2 = 0.31$) was found between thin-film bond strength and indentation hardness.

Conclusion: The thin-film bond strength test is a valid and reliable means of evaluating bond strength in the vicinity of the adhesive interface and is more accurate than other methods currently in use. Further, the thin-film bond strength is influenced by the hardness of the bonding agent.

Keywords: thin-film bond strength, indentation hardness, scratch test, bonding agent.

Table 1 Thin-film bond strength values (in N) for bonding agents to human dentin

Steps	Adhesive	Mean (N)	SD	Group differences*
One	Beauti Bond	5.64	0.94	c
One	Bond Force	7.19	0.92	b
One	Adper Easy Bond	5.81	0.85	c
One	Clearfil Tri S Bond	5.63	0.85	c
Two	Clearfil SE Bond	8.90	0.68	a
Two	FL-Bond II	8.30	0.53	ab

*Groups with different letters are significantly different from each other.

Table 2 Indentation hardness values for bonding agents

Steps	Adhesive	Mean	SD	Group differences*
One	Beauti Bond	14.55	1.75	b
One	Bond Force	7.95	1.35	cd
One	Adper Easy Bond	9.09	1.17	c
One	Clearfil Tri S Bond	6.74	1.44	d
Two	Clearfil SE Bond	13.17	0.63	b
Two	FL-Bond II	20.79	1.09	a

*Groups with different letters are significantly different from each other.
Load: 10 gf for 15 s. Hardness values were calculated as 37.838 x load (gf)/indentation depth(μm)^2

24. Student Researcher

Adhesion of Resin Cement to Zirconia Using Plasma and Primer

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Purpose: To evaluate the effectiveness of nonthermal atmospheric plasma (NTAP) and priming on the shear bond strength of a resin cement to two zirconia ceramics.

Materials and Methods: Sixty Katana zirconia (Kuraray Noritake) and 60 ZirCAD (Ivoclar Vivadent) plates (9 mm x 7 mm x 1 mm) were prepared and randomly divided into 12 groups (n = 10). The zirconia plates were embedded in resin blocks and the exposed surface was submitted to the following treatments: 1) untreated (control); 2) treated with Z-Prime Plus (Bisco) primer; 3) NTAP (model SAP, surface) application for 10 s; 4) NTAP for 30 s; 5) NTAP for 10 s followed by priming; 6) NTAP for 30 s followed by priming. The resin cement (Panavia F2.0, Kuraray Noritake) was manipulated and inserted into two prefabricated matrices (2.37 mm diameter x 1 mm height) positioned on the zirconia surfaces. Specimens were tested after 24 h and 1 year of water storage. A shear load was applied to the base of the resin cement cylinders with a loop wire (0.20 mm diameter) at 0.5 mm/min until failure. Data were analyzed by three-way ANOVA and Tukey's test at $\alpha = 5\%$.

Results: At 24 h, bond strength was higher for ZirCAD in all treatments, except for 30 s of NTAP + primer. For Katana, increasing of NTAP application time followed by priming yielded higher bond strength. After 1 year of storage, there was no significant difference in the bond strength among treatments and zirconias. Bond strength decreased after 1 year of storage, independent of treatment and zirconia ceramic.

Table 1 Mean (SD) bond strength of resin cement to zirconia (in MPa)

Time	Treatment	Zirconia	
		ZirCAD	Katana
24 h	No treatment	*6.9 (1.18) Ad	*3.5 (1.35) Bd
	Primer	*7.6 (2.50) Acd	*4.8 (2.92) Bd
	NTAP 10s	*11.4 (2.21) Aa	*6.9 (2.35) Bc
	NTAP 30s	*8.7 (1.13) Abc	*7.2 (1.56) Bc
	NTAP 10s + Primer	*12.8 (2.74) Aa	*9.5 (3.33) Bb
	NTAP 30s + Primer	*9.6 (3.32) Ab	*11.4 (2.06) Ba
1 year	No treatment	0.0 (0.00) Aa	0.7 (0.55) Aa
	Primer	0.1 (0.20) Aa	0.9 (0.72) Aa
	NTAP 10s	0.0 (0.00) Aa	0.4 (0.44) Aa
	NTAP 30s	0.0 (0.00) Aa	1.0 (0.66) Aa
	NTAP 10s + Primer	0.2 (0.20) Aa	1.3 (0.52) Aa
	NTAP 30s + Primer	0.2 (0.70) Aa	1.2 (0.54) Aa

Means followed by different letters (capital letters compare different zirconia ceramics and lower case letters compare treatments) differ significantly ($p \leq 0.05$). Asterisks show differerences under the same treatment conditions and zirconias after 1 year of storage ($p \leq 0.05$).

Conclusions: NTAP application increases the bond strength of resin cement to zirconia. When followed by priming, it only increased bond strength for Katana zirconia. After 1 year of storage, bond strength decreased dramatically for all groups in both zirconias.

Keywords: zirconia, argon plasma, primer, resin cement, bond strength.

25. Junior Researcher

Effect of Surface Treatment on Bond Strength to Hybrid Ceramic

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Purpose: This study investigated the effect of different surface treatments on the bond strength of two different luting agents to a hybrid ceramic material.

Materials and Methods: A total of 160 specimens (10 x 10 x 2 mm) of a CAD/CAM hybrid ceramic (VITA ENAMIC, Vita Zahnfabrik) were randomly divided into 8 groups ($n = 20$) based on the respective surface treatment: as-milled with Cerec MXCL (Cerec surface, C), Cerec surface + Silane (CS), hydrofluoric acid (HF), HF + silane (HFS), airborne-particle abrasion (AA), AA + silane (AAS), machined (M), and polished (P). Two subgroups of $n = 10$ per group were created by bonding resin composite cylinders (Tetric EvoCeram, shade A2, Ivoclar Vivadent) to the ceramic with two different luting agents: Variolink II (VL, Ivoclar Vivadent) and Rely X Unicem2 (RU, 3M ESPE). Specimens were stored in distilled water at 37°C for 24 h and then subjected to 10,000 thermocycles at 5°C and 55°C. Shear bond strength was tested in a universal testing machine at a crosshead speed of 1 mm/min. Failure modes were investigated with a light microscope at 30X. Data were analyzed with Student's t-test and the Tukey-Kramer test at $\alpha = 0.05$.

Results: As shown in Table 1, pretreatment methods had significant effects on bond strength ($p < 0.001$). Treatments with application of a silane coupling agent revealed significantly higher bond strength values than the ones without ($p < 0.05$). Different adhesive cements had no effect on bond strength ($p > 0.05$). Failure modes were predominantly mixed (adhesive and cohesive combined) for all groups.

Conclusion: Hydrofluoric acid etching and silane application provided the highest bond strength values. Different cements did not affect bond strength.

Table 1 Mean (SD) shear bond strength values in MPa

Group / Cement	C	CS	HF	HFS	AA	AAS	M	P
VL	9.32[a] (5.99)	22.00[b] (8.00)	16.44[b] (2.89)	22.71[b] (5.44)	17.46[b] (4.11)	18.95[b] (2.76)	7.41[a] (4.56)	4.48[a] (2.79)
RU	10.72[df] (4.33)	20.92[c] (3.33)	16.88[cd] (6.62)	16.63[cd] (5.62)	15.94[cde] (4.66)	13.88[def] (5.08)	8.90[f] (3.38)	9.39[ef] (4.28)

Different superscript lower-case letters indicate significant differences within rows. Different cements had no effect on bond strength (columns).

Keywords: resin cements, CAD/CAM, hybrid materials, adhesive luting.

Acknowledgment: All materials used in this study were sponsored by VITA Zahnfabrik, Bad Säckingen, Germany.

26. Senior Researcher

Bond Strength of Different Luting Cements to Metal Alloy Surfaces

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Purpose: To compare shear bond strengths of seven different luting cements to different metal alloy surfaces.

Materials and Methods: Three water-based cements were examined (Durelon carboxylate [DC, 3M ESPE], glass ionomer [GI, Ketac-CEM 3M ESPE], zinc phosphate cement [ZP, Hoffmann's Harmonic Shades]), 2 resin-based cements (RelyX U200 [RX, 3M ESPE], C&B Cement [CB,Bisco]), and 2 temporary cements (RelyX Temp NE [RXT, 3M ESPE], Telio CS Cem Implant [TCS, Ivoclar]). Sixteen square blocks (5 x 5 x 3 mm) were prepared from titanium (T), gold (G) and chrome cobalt (CC) metal alloys for each cement group. The top surfaces of metal blocks were polished with #600 SiC papers. Cylindrical composite samples (2.1 mm in diameter, 3 mm in height) were prepared and bonded to the polished metal surfaces with one of the study cements in a special alignment apparatus, where a load of 10 N was applied for 10 min. The specimens were irradiated for 40 s from three sides for a total of 120 s. The specimens were then stored in deionized water at 37°C for 24 h. Shear bond strengths were determined at a crosshead speed of 0.5 mm/min. Data were analyzed with ANOVA and Tukey's HSD test.

Results: RX showed the highest bond strengths for titanium alloy surfaces. However, GI did not bond to titanium. Bonding performance of temporary cements to metal alloy surfaces was not reliable.

Groups	Means ± SD in MPa		
	T	G	CC
DC	3.75 ± 0.9[d]	4.08 ± 0.4[d]	3.69 ± 0.9[d]
GI	0[a]	1.28 ± 0.1[b]	2.45 ± 0.8[c]
ZP	2.26 ± 0.7[bc]	0.43 ± 0.1[a]	1.84 ± 0.6[bc]
RX	5.71 ± 2.2[e]	2.32 ± 0.6[c]	2.62 ± 0.8[cd]
CB	1.44 ± 0.5[bc]	2.96 ± 0.4[cd]	1.51 ± 0.4[bc]
RXT	0.47 ± 0.1[a]	0.50 ± 0.1[a]	0.50 ± 0.3[a]
TCS	0.75 ± 0.2[ab]	0.44 ± 0.1[a]	0.24 ± 0.1[a]

Same letters indicate statistically similar groups ($p > 0.05$).

Conclusion: The water-based carboxylate cement provided reliable bonding performance to metal alloy surfaces.

27. Senior Researcher

Bond Strength of Multi-Mode Adhesives to Indirect Restorative Materials

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Purpose: To investigate the bond strength performance of two multi-mode adhesives (MMA) to indirect resin composite and lithium disilicate glass ceramic substrates after 24 h or 1 year water storage.

Materials and Methods: Sixty flat, polished plates of indirect resin composite (Epricord, n = 30) and lithium disilicate glass ceramic (IPS e.max Press, n = 30) were prepared. The surfaces were pre-treated using sandblasting for the indirect resin composite or hydrofluoric acid for the glass-based ceramic plates. The specimens were bonded with two MMAs: Scotchbond Universal (SBU), All-Bond Universal (ABU), or ceramic primer and hydrophobic bonding resin (RelyX Ceramic Primer and Adper Scotchbond Multi-Purpose Bond) as a control group. Small resin cement cylinders were also bonded to both substrate surfaces using the respective adhesive manufacturer's instructions. After 24 h or 1 year water storage at 37°C, their bonding performance was measured using the microshear bond strength test. The results were statistically analyzed using two-way ANOVA with Tukey's post-hoc test at a significance level of 0.05.

Results: For the indirect resin composite, there was a significant difference between ABU and SBU, which did not differ from the control after 24 h (ABU > SBU = control). However, no significant difference between groups was observed after 1 year ($p > 0.05$). For the glass-based ceramic, no significant differences in bond strength were observed between SBU and ABU adhesives after 24 h (control = ABU ≥ SBU). After 1-year storage, bond strength for ABU decreased significantly (control > SBU = ABU) ($p < 0.05$).

Conclusions: After aging, the MMAs showed good bonding performance to indirect resin composite, but the use of separate bottles of silane and resin bonding is still recommended for etched-glass-based ceramic substrates.

Keywords: multi-mode adhesives, indirect resin composite, lithium disilicate glass ceramic, bond strength, storage time.

Table 1 Microshear bond strength values in MPa (mean ± standard deviation) of the adhesives tested on an indirect resin composite substrate, after 24-h or 1-year storage

Material	24 h	1 year
Scotchbond Universal	26.6 ± 5.6^{Aa}	20.2 ± 3.1^{Ba}
All-Bond Universal	32.7 ± 3.3^{Ab}	25.1 ± 2.0^{Ba}
RelyX Ceramic Primer and Adper Scotchbond Multi-Purpose Bond	25.5 ± 7.9^{Aa}	22.7 ± 2.7^{Aa}

Two-way ANOVA with post-hoc Tukey's test ($p < 0.05$). Similar capital letters in rows and lower case letters in columns indicate statistical similarity.

Table 2 Microshear bond strength values in MPa (mean ± standard deviation) of the different adhesives tested on lithium disilicate glass ceramic substrate, after 24-h or 1-year storage

Material	24 h	1 year
Scotchbond Universal	23.9 ± 6.1^{Aa}	21.3 ± 5.6^{Aa}
All-Bond Universal	31.5 ± 7.0^{Aab}	16.9 ± 4.4^{Ba}
RelyX Ceramic Primer and Adper Scotchbond Multi-Purpose Bond	35.3 ± 8.5^{Ab}	31.2 ± 5.9^{Ab}

Two-way ANOVA with post-hoc Tukey's test ($p < 0.05$). Similar capital letters in rows and lower case letters in columns indicate statistical similarity.

28. Student Researcher

Acoustic Properties of Interfacial Debonding of Resin Composite Restoration During Curing

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Purpose: To investigate the properties and their correlations of acoustic emissions (AE) of interfacial debonding of composite restoration during curing.

Materials and Methods: An AE sensor (Physical Acoustics, USA) was attached to the surface of intact human molars with a Class I composite restoration of 4 x 3 x 2 mm^3 to monitor the interfacial debonding during curing. Background signals were analyzed before curing to determine the threshold amplitude for noise filtering. Three groups of composites were tested: (1) Z100 Restorative, (2) Filtek Z250, and (3) Filtek LS (all 3M ESPE, USA). The restorations in groups (1) and (2) were bonded with Adper Single Bond Plus and those in group (3) with LS System Adhesive from the same manufacturer. All restorations were cured with an LED blue light (3M S-10, output 1200 mW/cm^2) for 40 s. AE signals were recorded continuously for 10 min, and their frequency, amplitude, and duration were analyzed.

Results: 30 dB was chosen as the threshold with the background signals mainly around 25 dB. The cumulative number of AE events was 28, 19, and 5, for Z100, Z250, and LS, respectively (Fig 1), which corresponded to the shrinkage stress. The amplitude of all events lay mainly within the range of 30 to 50 dB, whereas the peak frequency had two main values: 100 to 200 kHz and 700 to 800 kHz. The duration range of 0 to about 200 µs increased with increasing amplitude (Fig 2), but no correlation was found between frequency and the other two parameters.

Conclusion: 30 dB should be used as the amplitude threshold for AE analysis of interfacial debonding. The amount of interfacial debonding increased with the shrinkage stress of a composite. The duration of an AE event increased with its amplitude, but there was no correlation between its frequency and the other two parameters.

Keywords: resin composite restoration, interfacial debonding, acoustic emission.

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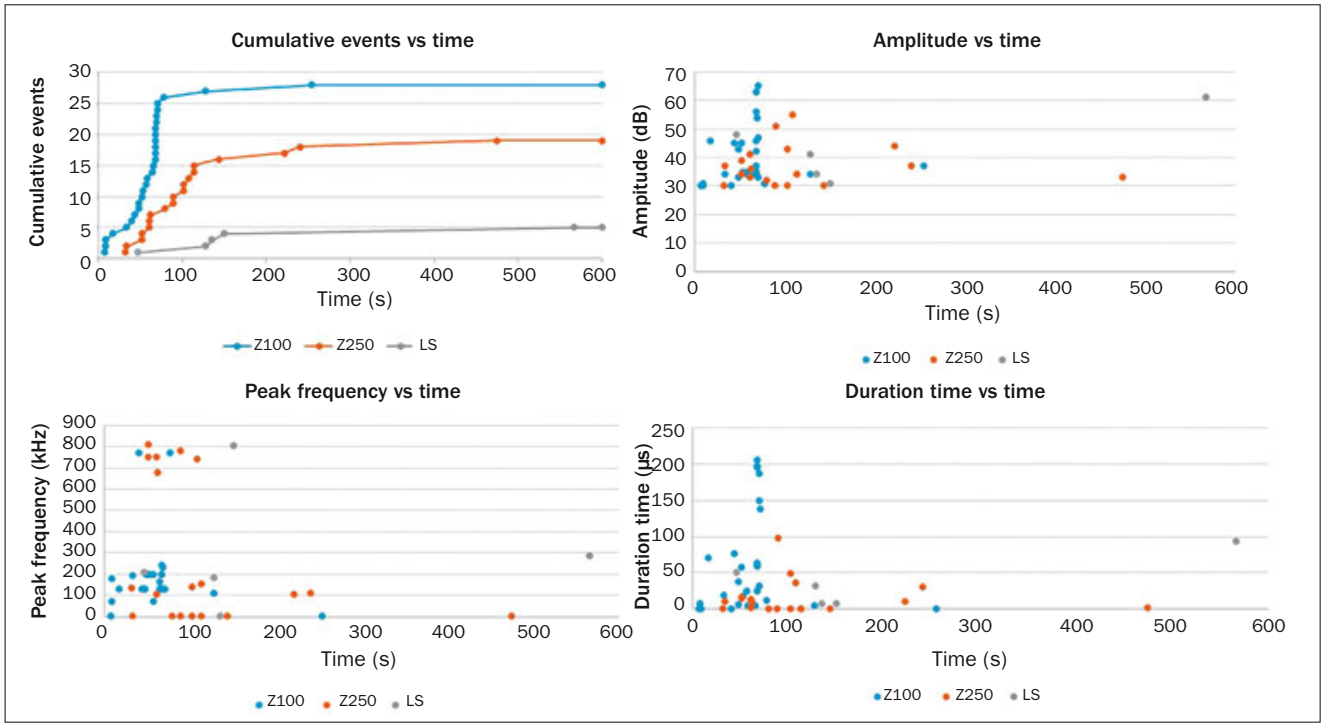

Fig 1 Cumulative events, amplitude, peak frequency, and duration with time.

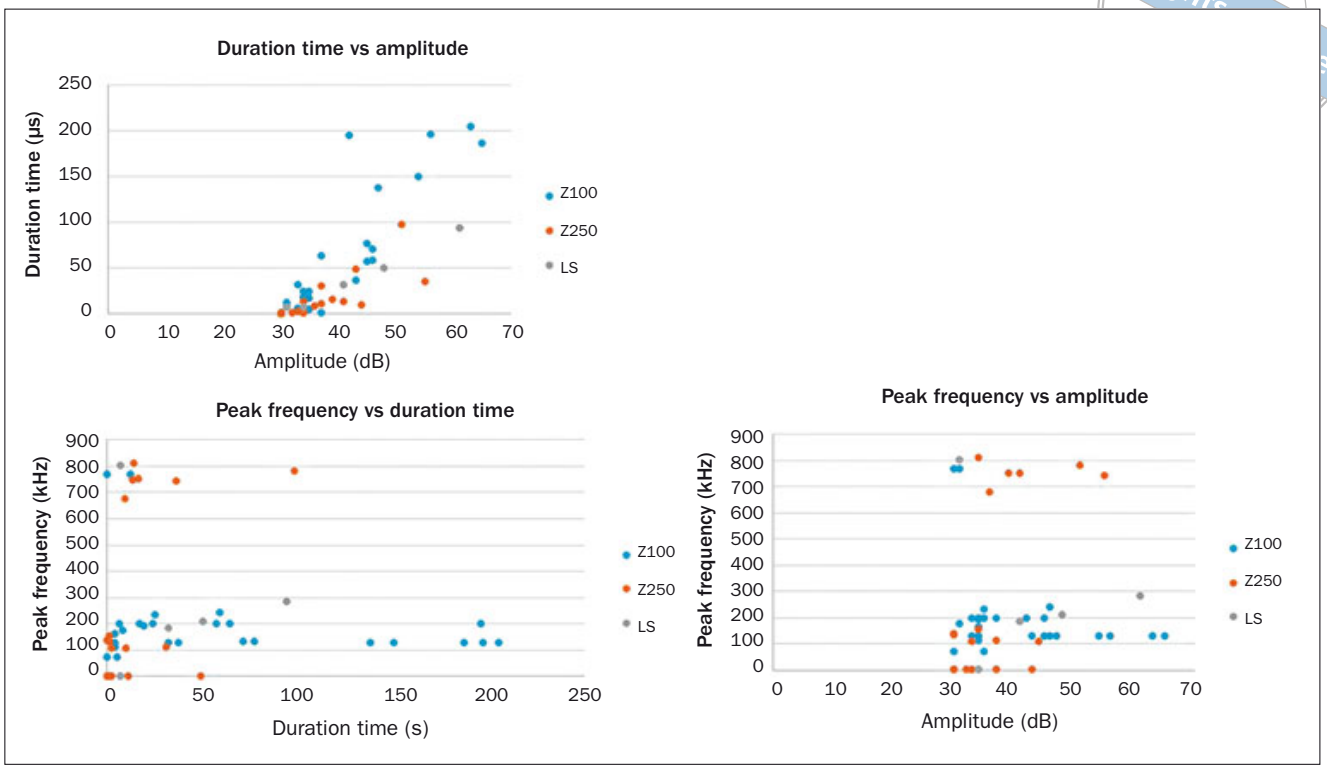

Fig 2 Correlations of AE event properties.

29. Junior Researcher

Internal Adaptation Depending on Resin Polymerization Stress

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Purpose: The first purpose of this study was to compare internal adaptations of different composite resins in cavities of two different depths. The second purpose of this study was to find out the relationship between internal adaptation and polymerization shrinkage stress.

Materials and Methods: One hundred teeth were divided into “deep” and “shallow” groups. The deep group had a cylindrical cavity with a diameter of 3 mm and a depth of 4 mm, whereas the shallow group had a cylindrical cavity with a diameter of 3 mm and a depth of 1 mm. The deep and shallow groups were each divided into 5 subgroups depending on the material used: Filtek supreme (3M), Charisma Diamond (Heraeus Kulzer), Amelogen Plus (Ultradent), Tetric Evoceram Bulk Fill (Ivoclar Vivadent), and Venus Bulk Fill (Heraeus Kulzer). After application of dentin adhesive, composite resin was filled or built up in the same dimension (3 mm diameter, 4 mm height). Thermomechanical cycling was applied, and SS-OCT images were taken to measure internal adaptations. Internal adaptations were compared in two ways: among the different materials and between the two cavity configurations. The polymerization shrinkage stress of resin composite was measured in two ways: the stress under zero-compliance condition and that under compliance-allowed condition. The relationships between internal adaptations and polymerization stress were investigated.

Results: A significant difference was found between internal adaptations of deep and shallow cavities. Statistically significant differences were found among some subgroups of different materials. In shallow cavities, the relationship between the leakage and polymerization stress under the zero-compliance condition ($R^2 = 0.498$) was found to be lower than that under compliance-allowed condition ($R^2 = 0.649$).

Conclusion: Internal adaptation was inferior in the deep cavity group. SS-OCT images showed different internal adaptations depending on the material used. In the shallow cavity group, the relationship between internal adaptation and polymerization stress under zero-compliance conditions were different from that of polymerization stress under compliance-allowed condition.

Keywords: internal adaptation, C-factor, composite resin, polymerization stress, compliance.

30. Student Researcher

Influence of Organic Acids from Oral Biofilm on Resin Composite Properties

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Purpose: To evaluate the repair bond strength after storage in water, lactic and propionic acid for 7 days and 6 months as well as the sorption and solubility of resin composites used.

Materials and Methods: Five cylinders of each resin composite (microhybrid, nanofilled, and silorane-based) were prepared. Specimens were aged by thermocycling (5°C and 55°C) 5000 times. A repair procedure was performed using intraoral sandblasting with 50-µm aluminum oxide, application of an adhesive system, and a cylinder of composite. Specimens were sectioned into beams and stored in three immersion media: water, propionic acid, and lactic acid. The microtensile bond strength was measured after periods of 7 days and 6 months. Sorption and solubility were evaluated using fifteen specimens (Ø = 6 mm; height = 1 mm) of each resin composite, which were prepared and assigned into three groups (n = 5) according to the immersion media. Data were analyzed using one-way/two-way/three-way ANOVA and Tukey's test ($\alpha = 0.05$).

Results: The resin composites, immersion media, and time of immersion did not affect the repair bond strength (microhybrid 38.3 to 40.9 MPa; nanofilled 38.7 to 42.2 MPa; silorane 41.2 to 51.1 MPa). Additionally, the immersion media did not affect the sorption and solubility. The silorane-based composite presented the lowest sorption (10.5 to 12.1 µg/mm^3) and solubility (-2.4 to -2.7 µg/mm^3), while the nanofilled methacrylate-based composite showed the highest sorption (32.1 to 33.6 µg/mm^3). Regarding solubility, the nanofilled and microhybrid methacrylate-based composites did not present statistically significant differences.

Keywords: resin composite, bond strength, sorption, solubility, biofilm.

31. Student Researcher

Influence of PVM/MA Copolymer on Surface Adherence of Streptococcus Mutans

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Purpose: The study investigated 1. the surface roughness of a one-bottle adhesive bonding agent by incorporating a polyvinyl methylether/maleic acid (PVM/MA) copolymer, and 2. its antibacterial activity in preventing colonization of composite surfaces by cariogenic Streptococcus mutans biofilms.

Materials and Methods: Eighteen composite-resin (Estelite Omega, Tokuyama Dental) disks (diameter 8 mm, thickness 2 mm) were made. The adhesive bonding agent Prelude One (PO; Danville Materials) was applied to composite surfaces with or without incorporation of PVM/MA. Composite samples without bonding application were used as controls. The surface roughness of the samples was determined through a stylus profilometer. Bacterial adherence to surfaces was assessed by determining colony-forming units (CFU) and viewed with scanning electron microscopy (SEM). The specimens were sterilized by UV irradiation before incubation with bacteria and immersed in sterilized whole saliva for 2 h, then placed in individual wells containing 1 x 10^8 cells/ml of S. mutans in PBS. Immersed specimens were incubated at 37°C for 4 h and washed with PBS to remove unattached bacteria. Specimens were then placed into tubes containing 1 ml of PBS. Attached bacteria were dispersed by sonication and CFU counts were determined. For SEM analysis, three specimens prepared in the same manner as for counting CFU were immersed in Karnovsky's fixative for 24 h, then coated with gold-palladium. Data were analyzed with ANOVA and Tukey's test.

Results: Integration of PVM/MA into PO increased the surface roughness of the composite surfaces 4.6 fold; however, it decreased colonization of S. mutans biofilms 2.1 fold. SEM images also confirmed these results.

	Control	PO	PVM/MA+PO
Surface roughness (μm)	0.027 ± 0.005^{A}	0.543 ± 0.113^{A}	2.492 ± 0.763^{B}
CFU (10^3 cfu/mm^2)	4.84 ± 1.12^{a}	15.02 ± 2.04^{b}	7.32 ± 1.92^{a}

Means with the same superscript letter are not statistically different from each other ($p > 0.05$).

Conclusions: Integration of PVM/MA into the dentin bonding agent showed an antibacterial effect, which helps to reduce the initial adhesion of bacteria onto the composite surfaces.

Keywords: PVM/MA, antibacterial, bonding.

32. Student Researcher

Push-Out Bond Strength of an Experimental Post in Bovine Root Dentin

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Purpose: To evaluate the bond strength of bovine dentin (experimental) and glass-fiber (control) posts to root canal walls in bovine dentin.

Materials and Methods: Twenty bovine incisor roots were selected to receive experimental (bovine dentin) posts and glass fiber posts ($n = 10$ for each group). After canals were prepared and irrigated (2.5% NaOCl), dentin canal walls and experimental posts were conditioned under the same adhesive protocol (H_3PO_4 37%/15 s + conventional one bottled adhesive). The glass fiber post surfaces were conditioned (24% H_2O_2/5 min), air dried, and silanized. Posts were cemented with a dual-curing resin cement (1200 mW/cm^2 /40 s). In order to evaluate bond strength in different regions (coronal, middle, and apical), the root-post set was sectioned into 1.5-mm-thick disks and submitted to the push-out test in a universal testing machine (1.0 mm/min). After subjecting bond strength data to Levene's test and the sample homoscedasticity was confirmed, data were subjected to two-way ANOVA ($\alpha = 0.05$).

Results: While there was no statistically significant difference ($p > 0.05$) for the "root region" factor or for the interaction, the experimental posts showed statistically significantly higher bond strength values (9.52 ± 1.93 MPa) when compared to glass fiber posts (6.74 ± 3.35 MPa).

Conclusion: Within the limitations of this study, it can be inferred that the experimental post of bovine dentin led to higher bond strength values than did a conventional glass-fiber post.

Keywords: bond strength, bovine dentin, experimental posts, fiber post.

33. Student Researcher

Properties of a Novel Resin-based Pulp Capping Material

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Purpose: To evaluate the physicochemical properties, cytotoxicity, and bioactivity of a novel light-curing pulp capping material composed of resin with antibacterial monomer (MAE-DB) and Portland cement (PC).

Materials and Methods: The experimental material was prepared by mixing PC with a resin containing MAE-DB. Cured pure resin containing MAE-DB served as resin control. ProRoot MTA and Dycal served as commercial controls. The depth of cure, degree of monomer conversion, water absorption, solubility, calcium release, alkalinizing activity, cytotoxicity, and bioactivity were evaluated.

Results: The experimental material had a curing depth of 1.19 mm and a high degree of monomer conversion. Its water absorption was between that of MTA and Dycal, and its solubility was significantly less than that of Dycal. The experimental material exhibited continuous calcium release and an alkalinizing power between those of MTA and Dycal throughout the test period. None of the tested materials showed cytotoxicity. The experimental material, MTA, and Dycal all exhibited the formation of apatite precipitates after immersing in PBS.

Conclusion: The novel material possessed adequate physicochemical properties, low cytotoxicity, and good bioactivity. These properties provide major advantages for a pulp capping material and make it an attractive alternative to conventional pulp capping materials.

Keywords: pulp capping material, quaternary ammonium salt, Portland cement, physicochemical properties, cytotoxicity, bioactivity.

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34. Junior Researcher

N-acetyl Cysteine (NAC)-directed Detoxification of Methacryloxylethyl Cetyl Ammonium Chloride (DMAE-CB)

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Purpose: Methacryloxylethyl cetyl ammonium chloride (DMAE-CB) is a polymerizable antibacterial monomer with reliable bacterial inhibitory effects. The cytotoxicity of DMAE-CB has been attributed to the induction of reactive oxygen species (ROS) with reduced glutathione (GSH). The aim of this study was to investigate the role of adduct formation in N-acetyl cysteine (NAC)-directed detoxification.

Materials and Methods: To this end, the possible formation of NAC-DMAE-CB adduct was investigated by high performance liquid chromatography (HPLC) and liquid chromatography-mass spectrometry (LC-MS). Human dental pulp cells (hDPCs) were exposed to different concentrations of DMAE-CB (0.001 to 0.1 mM), and the cytotoxicity was assessed

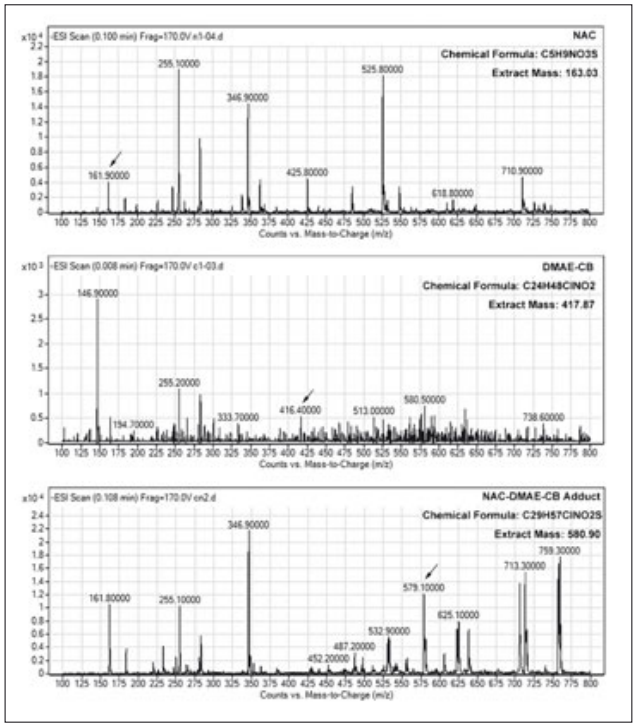

Fig 1 Results of LC-MS.

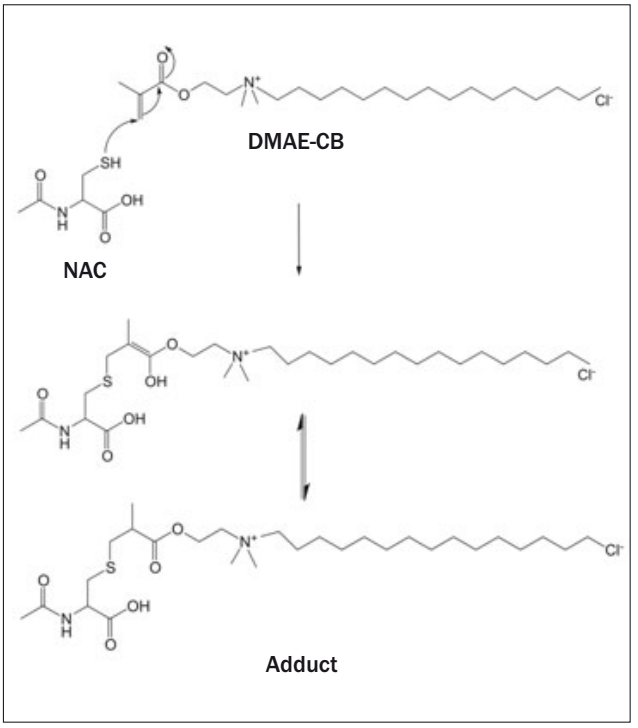

Fig 2 Postulated chemical reaction between NAC and DMAE-CB.

by CCK-8 assay. To investigate the oxidative stress, the contents of ROS and GSH were determined by flow cytometry and microplate reader, respectively. To examine apoptosis, hDPCs treated with the DMAE-CB and the mixtures of NAC and DMAE-CB with 48 h of pre-incubation were analyzed by flow cytometry using Annexin V and propidium iodide staining. Hoechst 33342 staining was also performed to observe the morphological changes of the apoptotic cells. Mitochondrial membrane potential (MMP) and caspase-3 activity were also performed by flow cytometry and microplate reader.

Results: HPLC and LC-MS analysis revealed that chemical binding of NAC and DMAE-CB occurred under neutral conditions after pre-incubation in a time-dependent manner. The amounts of the NAC-DMAE-CB adduct increased with incubation time. DMAE-CB reduced hDPC viability by increasing ROS and reducing the cellular GSH. Flow cytometry indicated that DMAE-CB induced hDPC apoptosis with reduced MMP and increased caspase-3 activity. Typical morphologies of apoptotic cells and morphological hallmarks of chromatin condensation were observed under fluorescence microscopy. However, remarkable protection against DMAE-CB-induced cell death was detected when the mixture was tested after 48 h of pre-incubation.

Conclusion: Our results suggest that the in vitro detoxification ability of NAC against DMAE-CB-induced cell damage might occur through NAC-DMAE-CB adduct formation.

Keywords: DMAE-CB, NAC, ROS, adduct, detoxification.

Acknowledgements: This study was financially supported by grant 81130078 (principal investigator Jihua Chen) and grant 81300927 (principal investigator Sai Ma) from the National Nature Science Foundation of China, and Program No. IRT13051 from the Program for Changjiang Scholars and Innovative Research Team at University (PCSIRT). There is no conflict of interest.

35. Senior Researcher

Canal Irrigants and Coronal Fracture Resistance of Endodontically Treated, Bleached Teeth

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Purpose: Irrigation plays a pivotal role in the success of endodontic treatment. Various single and combined irrigants and irrigation protocols are used during endodontic treatment. The aim of this study was to evaluate the effect of different irrigation regimens on coronal fracture resistance of endodontically treated teeth undergoing bleaching treatment.

Materials and Methods: Access cavities were prepared in 216 maxillary premolars which were divided into 2 groups (n = 108). Group A: non-bleached (NB); group B: bleached (B). Each group was subdivided into 9 subgroups based on irrigation protocol (n = 12). During endodontic treatment, the teeth were irrigated as follows: G1: normal saline (NS); G2: 2.5% NaOCl; G3: 10% citric acid (CA); G4: 2% chlorhexidine (CHX); G5: 17% EDTA; G6: NaOCl plus CHX; G7: NaOCl plus EDTA; G8: NaOCl plus CA, G9: NaOCl plus EDTA plus CHX. In group B, after cervical sealing with light-cured glass ionomer, the teeth were bleached using 38% hydrogen peroxide and 20% carbamide peroxide gels as in-office and at-home bleaching techniques for 3 weeks. All the teeth (NB & B) were restored with composite resin, thermocycled, and incubated for 24 h. The specimens underwent fracture resistance tests. Data were analyzed with ANOVA, Tukey's HSD test, and the t-test ($\alpha = 0.05$).

Results: The t-test showed significant differences between each two corresponding subgroups ($p < 0.0001$). In group A, NS demonstrated significantly higher fracture resistance compared to others, with the least fracture resistance recorded in G2. In group B, the highest fracture resistance was recorded in G1, with the lowest being recorded in G7. Samples irrigated with NaOCl, NaOCl plus CA, and NaOCl plus EDTA exhibited significantly lower fracture resistance compared to NS group ($p < 0.05$).

Conclusion: Within the limitations of this study, it can be concluded that the irrigation regimen used during endodontic treatment with/without bleaching can affect the coronal fracture resistance.

Keywords: bleaching, canal irrigants, coronal fracture resistance, endodontically treated teeth.

36. Junior Researcher

Composite Restorations in Dental Traumatology – From Feasible to (almost) Untreatable

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Background and Purpose: Dental trauma occurs rather frequently in the age group below 35 years. In the permanent dentition, fractures are the most common injuries, and often the maxillary central incisors are affected. The presented clinical cases show how traumatic injuries of the maxillary incisors can be treated with composite restorations in order to preserve healthy tooth structure.

Case Reports: The four clinical cases presented differ in the severity of dental injury. Case 1 shows an enamel-dentin fracture, which was easily treated with composite restorations. In case 2, an enamel-dentin-pulp fracture occurred. Because the tooth fragment was preserved, it was possible to re-attach it by means of standard bonding procedures followed by root canal treatment. The 3rd case was an enamel-dentin-pulp fracture as well, with a subgingival fracture line of the maxillary left lateral incisor and no preserved tooth fragments. Although the defect of this tooth was very deep, it was possible to place a composite restoration with the use of teflon band and a special matrix technique. The 4th case illustrates the application of composite after avulsion of both maxillary central incisors. Because both teeth were missing and therefore not available for replantation, premolars from the maxilla were transplanted to the anterior region. In order to achieve an esthetic appearance, both premolars were reshaped by means of direct partial composite veneers.

Results: After up to 4.5 years of observation, teeth which were treated with composite restorations after experiencing a dental trauma showed excellent esthetic results and a healthy gingival environment.

Conclusion: Depending on the severity of the dental injury after a trauma, composite restorations are the treatment of choice. Even difficult cases which push the limits of current bonding strategies can be treated with composite, if the appropriate techniques for creating sufficiently dry conditions are used.

Keywords: composite resins, tooth fractures, dental bonding, dental esthetics.

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37. Student Researcher

Maxillary Arch Rehabilitation Using Telescopic Copings and Adhesive Technology

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Purpose: To rehabilitate a maxillary arch using adhesion and telescopic gold copings and show how five abutment teeth can be restored with adhesion technology, composite core buildups, and metal ceramic FDPs.

Case Report:

- Records appointment: Face bow, CR, CO, protrusive, diagnostic images, radiographs, comprehensive perio exam (Fig 1).
- Diagnostic wax up.
- Removed existing provisional bis-GMA restoration (abutments: 17, 13, 23, 24, 27 [FDI]); fabrication of new PMMA provisional with Ribbond reinforcement to refine margins, OHI.
- Adhesively bonded core buildups on teeth 17, 13, 23, 24, 27 (FDI) using Renamel Posterior Composite (Cosmedent), Renamel De-Mark Flowable Composite (Cosmedent) and Clearfil SE Bond (Kuraray Dental) (Fig 2).
- New PMMA provisional fabricated with Ribbond reinforcement; occlusion adjusted (patient with new provisional for approximately 4 months).
- Scan of all prepared teeth and opposing mandibular arch using iTero Intraoral Digital Scanner (Align Technology).
- Fabrication of cast gold telescopic copings with Paul Westbrook, CDT (Westbrook Dental Lab).
- Adhesive bonding of cast gold telescopic copings with RelyX Unicem self-adhesive universal resin cement (3M ESPE).
- Scan of cast gold telescopic copings using iTero Intraoral Digital Scanner.
- Custom gingival shade selection (Paul Westbrook, CDT) and tooth shade using Vita 3D Master Shade Guide.

Fig 1 (left) Diagnostic view of existing maxillary abutment teeth.

Fig 2 (right) Adhesively bonded abutment teeth with provisional crowns on teeth 17 and 27 (FDI) to maintain occlusal vertical dimension.

- Framework try in.
- Bisque bake try in and adjustment of occlusion.
- Delivery of maxillary FDP.
- Bonding of maxillary FDP using RelyX luting cement (3M ESPE).

Results: The maxillary arch was rehabilitated using adhesion technology, cast gold telescopic copings, and metal ceramic FDP.

Discussion: An alternative approach has been presented for rehabilitating a partially edentulous arch without the use of endosseous dental implants. Conventional prosthodontics and occlusion principles were followed and confirmed with provisional prostheses.

Conclusion: Within the limits of this clinical report, it is possible to rehabilitate a patient with adhesive technology and telescopic copings.

Keywords: adhesion, telescopic copings, maxillary arch rehabilitation.

38. Junior Researcher

Interdisciplinary Approach to Improve Esthetics in the Anterior Maxilla

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Purpose: To improve the esthetics of the anterior maxilla of a patient with peg-shaped maxillary lateral incisors.

Case Report: A 26-year-old female patient with peg-shaped maxillary lateral incisors was evaluated at the School of Dentistry of the University of North Carolina, and treated with an interdisciplinary (orthodontic, periodontic, and restorative) approach to improve esthetics.

Results: The orthodontic treatment helped to obtain space between anterior maxillary teeth. Enough space was obtained for the placement of porcelain veneers. Crown lengthening for the maxillary anterior teeth was performed to obtain esthetic harmony of gingival margins. Four porcelain veneers were fabricated and placed on central and lateral maxillary incisors.

Conclusion: This clinical report shows the importance of an interdisciplinary approach to improve the esthetics of the anterior maxilla.

Fig 1 Before.

Fig 2 After.

39. Junior Researcher

A Novel Solution for Anterior Implant Restoration

Yen Jung Lai

Hualien Tzu Chi Medical Center, Taiwan.

Purpose: To present a novel solution for both optimal esthetics and long-term maintenance in anterior implant restorations.

Case Report: A patient with two implants at positions 12 and 21 was planned to be restored as a 12X21 bridge. The screw access of each implant was palatal to the incisal edge by about 0.7 to 1 mm. According to the diagnostic wax-up, customized zirconia abutments were made by CAD/CAM and cemented to titanium bases. The framework design of a 12X21 bridge is a monolithic block with cut-backs at 12 and 21 for bonded veneers and at 11 for veneering porcelain. The bridge and the veneers were made of lithium disilicate (Fig 1). The bridge and veneers were bonded by resin cement after surface treatment using HF and silane (Fig 2). After cementation, part of the veneer near the screw access was removed for retrievability. After extra-oral polishing and finishing, the bridge was placed and the screw access was sealed by teflon tape and composite resin.

Results: The definitive restoration displayed optimal function and esthetics. The restoration has been in place for 20 months without complications.

Conclusion: Screw retention is recommended for implant-supported prostheses because they offer more reliable retrievability, and no cement cleanup is necessary, resulting in healthier soft tissues. However, the oro-facial implant axis may not be ideal for screw-retained restorations, due to the bone volume and ridge alignment in some cases. With the high-strength lithium disilicate veneer and the adhesive combination with a framework, it is possible to obtain more screw-access freedom for screw-retained restorations.

Keywords: implant-supported prosthesis, adhesion, lithium disilicate, zirconia ceramic, retrievability.

Fig 1 Bridge and veneers made of lithium disilicate.

Fig 2 Bridge and veneers bonded in place.

40. Student Researcher

The Natural Restoration: Adhesive Reattachment of a Tooth Fragment Retrieved From Lip

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Purpose: To describe a case of traumatic crown fracture of a maxillary incisor, with successful adhesive reattachment of the tooth fragment after retrieving it from the upper lip.

Case Report: A 24-year-old male, who fell from a skateboard and sustained a complicated crown fracture in his maxillary right central incisor (tooth 11, FDI), associated with a laceration wound in the upper lip showing local edema, reported to our department in the post-graduate operative dentistry clinic (Fig 1a). After comprehensive evaluation followed by periapical radiographs of the fractured tooth and injured upper lip, we found the remaining tooth fragment in the upper lip. The lip was opened with a small incision and the tooth fragment was found; the laceration was closed with chromic gut sutures. A triage provisional filling (FUJI II resin-modified glass ionomer) was placed on the fracture

site. The remaining tooth fragment was placed in distilled water for 2 weeks. Two weeks later, a new periapical radiograph was taken and evaluated apically within normal limit. Cold tests were positive. Endodontic examination showed the the tooth was vital; however, it is possible that root canal treatment might be necessary at some point, and there may be risk of an abscess in the future.

Treatment was performed under rubber-dam isolation (Fig 2). The existing composite restoration in tooth 11 was removed, and the outer enamel surface was roughened with a diamond bur at slow speed, avoiding contact with the dentin. The tooth fragment was tried in and adjusted as needed until fully seated. The preparation was cleaned with Consepsis (2.0% chlorhexidine gluconate solution), rinsed, and gently air dried. Tooth fragment preparation: the fragment was washed and cleaned, then etched with 35% phosphoric acid for 15 s and rinsed (Fig 3). Optibond FL (primer and bond 4th generation) were applied and dried.

Washing, cleaning, and Consepsis (2.0% chlorhexidine gluconate solution) application, then rinsing and gentle air drying (Fig 1c). The adjacent teeth were protected with a teflon tab. Etching was performed with 35% phosphoric acid for 15 s, then rinsed. Optibond FL (primer and 4th generation bond) were applied and cured for 10 s. Flowable composite shade A2 was applied, the fragment was attached, and excess composite was removed. Light curing was performed for 40 s while air cooling. Occlusion and contacts were checked and adjusted as needed. After two weeks, the previously chipped incisor was restored with composite, and the restoration was finished and polished using diamond finishing burs and Diacomp composite polishing kit.

Results: At the follow-up 9 months later, the vitality test (including periapical radiograph) showed the teeth to be vital and neither of the two traumatized teeth showed any sign of discoloration; esthetics and function were satisfactory (Fig 1b).

Keywords: tooth fragment, reattachment, adhesion, adhesive dentistry.

Fig 1 a) Patient before treatment; b) patient after treatment; c) prepared tooth; d) fragment bonded to tooth.

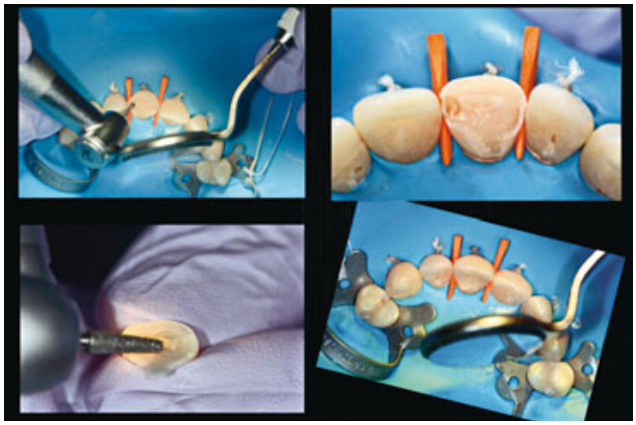

Fig 2 Treatment performed under rubber-dam isolation.

Fig 3 Tooth fragment.

41. Student Researcher

Diastema Closure Using Prefabricated Composite Veneers

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Purpose: The concept of one-visit prefabricated resin-based veneers was introduced in the early 1980s. Taking advantage of a modern technology that enables the production of a resistant, inorganic glossy surface, prefabricated composite veneers recently revitalized this concept. This poster presents the use of prefabricated composite veneers to enhance the anterior esthetics of a patient with several diastemas and poor tooth anatomy. This technique is considered a more affordable, alternative esthetic solution than traditional porcelain veneers.

Case Report: A young male patient presented to the post-graduate operative clinic after completion of orthodontic treatment. Several diastemas between the anterior teeth, peg-shaped lateral incisors, and poor anatomy and contour of the anterior teeth were present. Facial and smile analysis were an integral part of treatment planning, assisted by the use of the DSD (Digital Smile Design) concept. Teeth 13, 12, 11, 21, 22, 23 (FDI) were successfully restored using the layering technique and microhybrid direct composite Vita-l-escence (Ultradent, South Jordan, UT, USA) in association with the Edeweiss system (Ultradent), which contains thin prepolymerized hybrid composite shells. Finishing and polishing were accomplished with silicone tips, brushes, and disks.

Conclusion: Conservative treatment, natural-looking restorations in the esthetic zone with control of color, morphology, and high patient satisfaction were achieved. This technique can be used to restore function and esthetics in one office visit. However, it does not replace conventional custom-made ceramic veneers, but offers the clinician a one-visit, cost-effective alternative.

Keywords: veneers, composite, esthetic.

42. Student Researcher

Reproducing Anatomy and Esthetics in Direct Composite Restorations

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Purpose: One of the clinician's main concerns when using composites is the difficulty of obtaining good anatomy, proper proximal contact, and the time spent on finishing and polishing. The fabrication of a clear custom index prior to tooth preparation has been suggested as a promising technique to be used in many clinical situations. This technique permits the final composite restoration to reproduce the original anatomy and occlusion, requires minimal finishing and polishing, and reduces the incidence of voids at the occlusal surface. This poster presents a technique that uses a clear custom index to restore Class I and Class V cavities and re-establishes the original anatomy with minimal finishing and polishing time. For the Class I restoration, a clinical case was selected.

Case Report: Tooth 46 (FDI) had advanced hidden caries and intact occlusal anatomy. For the Class V restoration, a clinical case of a patient with multiple noncarious cervical lesions was selected and a diagnostic wax-up was used to restore form and function of the cervical area. For both cases, the technique consisted of fabricating an index using a clear silicone bite registration (Blu-Bite clear, Henry Schein; Melville, NY, USA). The silicone was applied onto the occlusal surface of the tooth prior to preparation. After the material was set, the bite registration was trimmed to include at least one tooth anterior and posterior to the working area. The layering technique using composite resin Vit-l-escence (Ultradent; South Jordan, UT, US). After the last increment, the clear index was applied under finger pressure and light curing. The same steps were followed for the restoration of the Class V preparations, except the silicone was applied onto the facial surface of the waxed model. Often, if the index is placed properly, the restoration needs only minimal finishing and polishing and minimal occlusal facial adjustments.

Keywords: esthetic, composites.