Air abrasion and metal primers can improve adhesion of resin cements to zirconia ceramics.

**Objective:** To evaluate the effect of different metal primers and surface treatment methods on the bond strength of 2 resin cements to yttrium-stabilized tetragonal zirconia (Y-TZP) ceramic material.

**Methods:** 240 cylindrical dentin specimens were cut from extracted human third molars. The same number of zirconia ceramic (Cercon) plates were made and assigned to 24 groups based on combinations of surface treatment, metal primer, and resin cement. The ceramic plates were treated in 1 of 3 ways: ultrasonic cleaning with isopropyl alcohol (control), air abrasion with 50-μm aluminum oxide particles, or Er:YAG laser irradiation. Each type of surface treatment was followed by Alloy Primer, Metal Primer II, Metaltite, or no coating (control). The dentin cylinders were bonded to the various substrates using either the self-etch cement system Panavia 2.0 or the etch-and-rinse system Calibra. Microshear bond strengths of the bonded specimens were determined using a miniature load testing device.

**Results:** Air abrasion tended to improve bond strengths. Laser irradiation tended to have no effect but did significantly decrease bond strength in one treatment group. Metal primers tended to increase bond strengths. Differences in bond strengths between the 2 types of resin cement were generally not significant.

**Conclusions:** Air abrasion and special functional monomers that chemically bond to zirconia can improve adhesion of resin cements to zirconia ceramics.

**Reviewer's Comments:** Zirconia cannot be etched and silanated in the same way that feldspathic porcelain can, so alternative methods for resin bonding must be determined. A variety of metal primers have been developed in recent years. These contain special monomers including MDP (which has been used in Panavia and Clearfil for many years) that improve bonding of resins to metal alloys. Zirconia, of course, is a metal oxide, so it makes sense to test whether metal primers might improve the bond of resins to zirconia. This study used various combinations of ceramic surface treatment, type of metal primer, and type of resin cement. Thus, it generated a large volume of data that can be difficult to sort through. However, the clinically relevant findings are obvious. First, air abrasion of zirconia ceramic using 50-μm aluminum oxide particles improves adhesion of resin cements. Second, the use of a metal primer might further improve adhesion. (Reviewer-Edward J. Swift, Jr, DMD, MS).

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Keywords: Zirconia, Metal Primers, Bonding

Print Tag: Refer to original journal article
Do Self-Etchings Bond Better to Rough Enamel?

Effects of Surface Texture and Etching Time on Roughness and Bond Strength to Ground Enamel.

Reis AF, Aguiar FHB, et al:

J Contemp Dent Pract 2009; 10 (July 1): 17-25

Some self-etching adhesives might have an acceptable performance on enamel.

Objective: To evaluate the effects of surface roughness on the microtensile bond strength (MTBS) of different adhesives to enamel.

Methods: Enamel blocks were prepared from extracted sound human third molars. Half of the blocks were roughened with 600 silicon carbide paper, and the other half were polished to fine-grit diamond pastes. The blocks were then divided into 5 groups to be treated with one of the following: (1) 35% phosphoric acid gel for 15 seconds; (2) 35% phosphoric acid gel for 60 seconds; (3) Clearfil SE Bond primer (Kuraray) rubbed for 20 seconds; (4) Clearfil SE Bond primer rubbed for 60 seconds; or (5) a combination of 35% phosphoric acid gel for 15 seconds followed by Clearfil SE Bond rubbed for 20 seconds. Phosphoric acid treatment was always followed by rinsing and drying, whereas Clearfil SE Bond primer treatment was always followed by drying. Surface roughness was measured prior to and after the procedures detailed above. Following conditioning, Single Bond (3M ESPE) and Clearfil SE Bond (Kuraray) bonding agents were applied to their respective groups and light-cured. Resin build-ups were made, and the restored enamel blocks were stored in water for 24 hours prior to sectioning and MTBS testing. Scanning electron microscopy was used to evaluate the fractured surfaces and the conditioned enamel surfaces.

Results: The only difference in MTBS was between the 60-second phosphoric acid/Single Bond and the 60-second Clearfil SE Bond primer/Clearfil SE Bond. All other groups had intermediate mean MTBS that did not differ from either one of those groups. No differences in roughness were noticed between initially smooth and rough groups and their respective counterparts after conditioning.

Conclusions: Neither rougher surface nor increased conditioning time produces higher bond strengths.

Reviewer's Comments: Self-etching adhesive systems, especially the ones with mild pH, have been shown to perform poorly on enamel. That is even more evident when bonding to uncut enamel is attempted, which often results in staining at the margins of the restoration. Regardless of the treatment group, results of this study should be interpreted as bonding to cut enamel rather than to uncut enamel. None of the groups had the aprismatic enamel that is present on uncut enamel. Aprismatic enamel appears to negatively affect bonding of self-etching systems when not removed. (Reviewer-Ricardo Walter, DDS).

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Keywords: Bonding, Enamel, Roughness, Self-Etching, Total-Etch

Print Tag: Refer to original journal article
Improving the Bond of Tooth-Colored Inlays to Dentin

The Effects of Three Variables on Shear Bond Strength When Luting a Resin Inlay to Dentin.

Lee J-I, Park S-H:

Oper Dent 2009; 34 (May-June): 288-292

 Objective: To evaluate the effects of immediate dentin sealing, different methods for thinning the adhesive, and light-curing or not on the shear bond strength of composite cemented to human dentin.

 Methods: 90 human premolars extracted for orthodontic reasons were obtained for the study. Dentin slices 2-mm thick were sectioned from the teeth and polished to 600 grit. These were assigned to 6 treatment groups. Dentin surfaces were covered with adhesive tape, leaving two 2.5-mm bonding areas exposed. In half of the groups, a self-etch adhesive, AdheSE, was applied and light-cured. No adhesive was applied in the other groups. To mimic the clinical situation, a PVS impression was made, the surface was covered with a temporary restorative material, and the specimens were stored in 100% humidity for 4 days. Composite cylinders were fabricated from a heat- and light-cured material. AdheSE was applied to dentin and thinned using either heavy or light air pressure, and was either light-cured or not before application of the composite cylinder. These were bonded to dentin using either Filtek Z250 composite or DuoLink resin cement. Shear bond strengths were determined using a universal testing machine.

 Results: The variables in this study were (1) immediate dentin sealing or not; (2) type of air pressure used for thinning the adhesive; (3) light-curing of the adhesive or not before application of the composite cylinders; and (4) type of resin used for cementation. Shear bond strengths were improved by immediate dentin sealing, gentle air drying, and light-curing of the adhesive. The type of resin used for cementation had no effect on bond strengths.

 Conclusions: Adhesion of resin inlays to dentin can be maximized by using the immediate dentin sealing technique, gentle air drying, and separate light-curing of the adhesive before the restoration is placed.

 Reviewer’s Comments: The mixture of variables used in this study resulted in a large volume of data, which can make it somewhat confusing for the reader; however, in defense of the authors, they explain the experimental design very clearly. The conclusions as stated summarize their findings well and probably have some clinical relevance. (Reviewer-Edward J. Swift, Jr, DMD, MS).

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Keywords: Resin Inlays, Dentin Bonding

Print Tag: Refer to original journal article
The main failure mode of zirconia-based restorations is through chipping and cracking of the veneering porcelain.

**Background:** Zirconia-based all-ceramic crowns have become very popular in contemporary practice and are often suggested as a replacement for porcelain-fused-to-metal crowns and bridges. The main mode of failure has been through fracture and chipping of the veneering porcelain. To test the fracture resistance, most bench-top studies use flat specimens that do not closely simulate the complex loading encountered during mastication. Anatomically correct crowns and cyclic, complex loading would more closely replicate the oral environment.

**Objective:** To evaluate the fracture resistance of 2 zirconia/porcelain systems under simulated chewing loads using realistically shaped specimens.

**Design:** In vitro study.

**Methods:** A CAD-generated tooth preparation for a lower first molar was created in plastic and placed in an articulator with adjacent and opposing dentition. Impressions were taken, and zirconia cores were fabricated from 2 systems: LAVA (3M/ESPE) and CERCON (Dentsply). The cores were veneered with porcelain, LAVA veneer, and Vita veneer, respectively. Replicas of the tooth preparations were created from resin composite (Z100-3M/ESPE) and subjected to 30 days of water storage to ensure full hydration and dimensional stability. The crowns were cemented to the replicas with RelyX Unicem resin cement (3M/ESPE) and stored in water for 1 week. The specimens were then subjected to step-stress loading; this involves cyclic loading, sliding, and release in an aqueous environment to simulate natural occlusal load. Three step-stress profiles (light, moderate, and aggressive) were utilized. The specimens were evaluated at the end of each cycle with polarized light microscopy for cracks and chips. Failure was defined as chips and/or cracks that extend to the veneer-core interface.

**Results:** The sliding-contact step-stress fatigued specimens of each group demonstrated cohesive failure within the veneering porcelain through cone crack propagation. It was also noted that failure progressed from the zone of contact through the veneering ceramic. No significant difference between the LAVA and CERCON systems was found either in the failure rate or mode.

**Conclusions:** This study demonstrates results in the laboratory that are consistent with the failure mode reported in clinical samples. The primary mode of failure is within the veneering porcelain in both systems, with no significant difference between systems in spite of their differences in material formulation and mode of fabrication.

**Reviewer's Comments:** This study design demonstrates better fidelity between clinical and laboratory results than previous investigations. In this way, it provides a template for future studies. It also suggests the need to refine coping design and/or material formulation in an effort to improve the support of the veneering porcelain and reduce the failure through chipping and cracking. It would be instructive to repeat this study with other zirconia/porcelain systems and particularly with porcelain-fused-to-metal restorations as a comparison. (Reviewer-Daniel E. Wilson, DDS).

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Keywords: Zirconia Step-Stress Loading, Ceramic Cracking

Print Tag: Refer to original journal article
Frameworks from wax-up digitization are no longer necessary for accurate scanning.

**Background:** Use of computer-aided design/computer-aided manufacture allows technicians to handle high-density zirconia-oxide ceramics using automatic fabrication procedures. While this computer-guided fabrication is generally relatively accurate, possible inaccuracies can occur. These inaccuracies can be caused by the scanning process, software design and mechanizing, or the shrinkage effect. This results in marginal discrepancies. Variations in methods of transferring preparation information into digital form include the use of touch-probe scanning (Procera), laser, or white light. Optical scanners allow capture of more complex shapes in their entirety than do touch-probe methods.

**Objective:** To evaluate the influence of the scanning method (wax-up digitization vs direct scanning process) and the preparation finish lines on the vertical fit of zirconia frameworks for 3-unit posterior bridges.

**Methods:** Vertical fit of 2 groups (n=15) of CAD/CAM zirconia frameworks were evaluated as follows: group 1, frameworks derived from wax-up digitization; and group 2, structures designed from direct scanning. Stainless steel master dies were prepared with a buccal shoulder and chamfer on rest of the finish lines. The bridges were made with Cercon Ceramics. Zirconia-oxide ceramic blocks were milled and structured and sintered in a Cercon oven. Frameworks were luted to abutments with zinc-phosphate cement. Marginal discrepancies were evaluated using SEM (x500 magnification).

**Results:** Vertical discrepancies of the waxed framework were significantly greater than for the computer-designed frameworks. The marginal design did not significantly affect the marginal fit. Samples designed by the computer registered better vertical adaptation regardless of the marginal configuration. Adaptation was assessed on the external surfaces only. While this study demonstrates no difference in the marginal adaptation related to marginal design (shoulder vs chamfer), other studies have indicated a better fit with chamfer finish lines. Direct scanning reduces the manual labor of the technician, as well as provides a more accurate fit.

**Conclusions:** Vertical fit of the zirconia frameworks depends on the scanning methods. Marginal designs had no influence on the vertical adaptation. Marginal discrepancy of all groups of frameworks could be considered clinically acceptable.

**Reviewer’s Comments:** The scanners now available for the CAD/CAM fabrication are greatly improved over past iterations. Fit produced by the early CAD/CAM systems was not good. Now the scanning systems and the computer-directed fabrication can provide an accurate fit. New oral scanning systems are very accurate, and the systems allow other fabrication modalities. Some of these methods allow the creation of a die on which other types of restorations using different restorative materials can be used. (Reviewer-Thomas G. Berry, DDS).

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Keywords: CAM vs CAD/CAM Fabricated Restorations, Accuracy

Print Tag: Refer to original journal article
Less Tooth Is Lost With Facial Access for Mandibular Incisors

Labial Access Opening in Mandibular Anterior Teeth-An Alternative Approach to Success.

Logani A, Singh A, et al:

Quintessence Int 2009; 40 (7): 597-602

Improve canal access by moving the endodontic access opening to the facial surface of mandibular incisor teeth.

**Objective:** "To compare the conventional lingual access to labial access preparation in mandibular anterior teeth in terms of achieving a straight-line access to the apex with maximum conservation of coronal tooth structure."

**Methods:** 100 extracted mandibular incisors were weighed and radiographed. A single operator who did not know that loss of tooth structure was a key element for the study opened 50 of the teeth from the lingual (traditional) and 50 from the facial. The goal was straight-line access with a #15 file.

**Results:** Labial access resulted in significantly less tooth loss. On the radiographs, projections were traced to determine the long axis of the canals. Only 5 of the 100 teeth were lingually inclined; 24 had both labial and lingual inclinations. The remaining 71 teeth had canals aimed at the facial surface. The authors recommend that, in incisors with significant incisal wear, endodontic access should be through the incisal edge.

**Discussion:** The authors go through a history of why lingual access became the default. Aesthetics, shortest distance to the chamber when foot engines were the power source, and convenience of restoration of the access opening were primary drivers. The number of actual lingual canals (incidence, 22% to 41%) versus insurance data of only 2% treated double canals in mandibular incisors is a flashing light for moving the opening to the labial surface to improve discovery of lingual canals. If resin composite is the final restorative material, then the aesthetic result can certainly be excellent. If a crown is planned, then the enamel lost with a labial access was going away with the crown preparation, while some of the saved cingulum can serve as a source of strength for retaining the crown long term.

**Conclusions:** "A labial access opening for endodontic treatment of mandibular incisors would facilitate straight-line access to canals more consistently and conservatively."

**Reviewer's Comments:** The resistance to change in dentistry is telling when we discuss going away from a lingual access opening for endodontic access. The Western Regional Examining Board requires "straight line" access for the 2 extracted teeth in the endodontic section of the examination. However, points are deducted if the incisal edge is involved with the access opening. The teeth are radiographed from the facial-lingual and mesial-distal, so one can readily see that if the access is not from the labial or through the incisal edge, you will not have straight-line access. My students are encouraged to reject 75% of the teeth in their search for test-worthy extracted teeth because they will lose points if they actually achieve straight-line access. I have found that many mandibular bicuspids offer better straight-line access if the opening is through the buccal cusp tip rather than the central groove. (Reviewer-J.D. Overton, DDS).

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Keywords: Endodontic Access, Facial, Labial

Print Tag: Refer to original journal article
Porcelain Repair--Which Adhesives Work Best?

Effect of Filler Ratio in Adhesive Systems on the Shear Bond Strength of Resin Composite to Porcelains.

Güler AU, Sarikaya IB, et al:

Oper Dent 2009; 34 (May-June): 299-305

Porcelain repair bonds can be improved by using filled adhesives.

Objective: To evaluate the effect of 6 different adhesive systems on shear bond strengths of composite resin to feldspathic and low-fusing porcelains.

Methods: 60 blocks of both low-fusing and regular feldspathic porcelain were fabricated, polished to 1000-grit using silicon carbide abrasive paper, and air-abraded. Surfaces were etched with 9.6% hydrofluoric acid gel and silanated. The specimens were randomly assigned to 6 groups for application of these adhesives: Adper Prompt L-Pop (self-etch adhesive), QuadrantUni 1 Bond (an adhesive containing 4-META), Te-Econom (a bonding agent containing a phosphate monomer), One Step Plus, Prime&Bond NT, and PQ1. These last 3 materials are all combined primer/bonding agent systems. Composite was applied and cured in Teflon molds. After thermocycling, shear bond strengths were determined using a universal testing machine. The porcelain side of the fractured interfaces was examined with an optical microscope to determine the nature of the failure.

Results: 2 of the adhesives tested are not (to my knowledge) available in the United States, so I will not mention results for those. For both porcelain types, the lowest bond strengths were obtained using the self-etch Prompt L-Pop. The highest bond strengths were achieved by PQ1, followed closely by Prime&Bond NT and One Step Plus. Differences between the 2 porcelains were not significant. Failure modes corresponded with the bond strengths, as lower bond strengths were associated with adhesive fractures and higher bond strengths with cohesive fractures.

Conclusions: To improve bond strengths in porcelain repair procedures, an adhesive with a high filler content should be used.

Reviewer’s Comments: Porcelain repairs have always been unpredictable, although we have better materials and techniques now than in the past. However, anything we can do to strengthen the resin-ceramic bond will improve durability of the repair. This study reports that an all-in-one self-etch adhesive is not a good choice. The best results were achieved using “one-bottle” primer/bonding agent systems (the type some people call “fifth generation”), particularly those containing filler particles. The 2 non-U.S. materials tested were unfilled systems and had mediocre results. The 3 adhesives familiar to U.S. clinicians are all filled resins, with PQ1 (Ultradent) having the highest filler content by far, at 40%. (Reviewer-Edward J. Swift, Jr, DMD, MS).

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Keywords: Porcelain Repair, Adhesives

Print Tag: Refer to original journal article
Silorane restorations require a silorane bonding system and are incompatible with other bonding systems.

**Background/Objective:** The organic matrix of Bis/GMA/TEGDMA and urethane dimethacrylate has been used in dentistry since the 1950s. The authors introduce 2 new changes in composite chemistry. The constant shortcoming has been significant polymerization shrinkage. **Discussion:** 3M ESPE currently has Filtek LS Low Shrink on the market, which is a silorane without any methacrylate. This material is hydrophobic and may not have the undesirable hydroscopic expansion of other resin composite formulas. The reported shrinkage is 0.66% to 1.0%, depending on the testing method. That would be one-half to one-third the shrinkage of the commonly used resin composite on the market today. A 1-year clinical trial of 225 teeth in 143 patients had no failures and apparently very good clinical performance. Silorane restorations absolutely require a silorane bonding system and are incompatible with other bonding systems. GC America has a new composite (Kalore) with a reported shrinkage of 1.72%. GC reports that this is the lowest shrinkage of any resin on the market. The company also reports the use of a proprietary chemical link to the strontium glass and fluoro alumina silicate glass filler particles, which also improves the clinical performance. Kalore is compatible with the dentin bonding agents currently in use.

**Conclusions:** The authors suggest that improved laboratory values sound good, but tests in patients need to be completed and long-term clinical evaluation made before dentistry makes wholesale changes. **Reviewer's Comments:** I did my best with an Internet search, and this is what I found. In an extracted tooth study, Miletic et al found that significantly higher temperatures at the dentin interface were generated with Filtek LS than Admira or Herculite XRV. If the remaining dentin thickness is low, that may be a problem. The GC America website has some photographs of clinical cases done with Kalore. I could not find any published studies in the referenced literature on Kalore. On the company's website, there is a chart showing shrinkage stress rankings (not percent setting shrinkage): Kalore <Filtek Silorane<Tetric Evoceram<Filtek Supreme Plus<Esthet X<Venus. The lowest shrink composite in common use is Heliomolar, but that was not evaluated in this table. No statistics are offered with the graph, nor are the units of measure on the chart. My conclusions are that dentistry is indeed interested in resin composites that do not shrink. It is not really clear that Kalore is likely to be a breakthrough change for the profession. The silorane technology needs long-term clinical trials to prove that time in the mouth does not result in a sudden color shift, serious crack propagation, or some other untoward event that would change our mind about the value of the chemistry.  (Reviewer-J.D. Overton, DDS).

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Keywords: Resin Monomer, Silorane, DX-511, Dupont Molecule, Kalore

Print Tag: Refer to original journal article
Bonding of zirconia ceramics to tooth structure can be improved using agents that contain reactive monomers.

**Objective:** To provide information about yttrium-stabilized tetragonal zirconia (Y-TZP) ceramic, describing structural characteristics, manufacturing procedures, clinical features, and luting procedures. **Summary:** One method of ceramic reinforcement is based on the use of a material that undergoes microstructural changes when subjected to stress. Zirconia transforms from a tetragonal to a monoclinic phase at the tips of cracks, and prevents crack progression except under great tension. Pure zirconia undergoes phase changes with increased temperature, but cooling results in large volumetric shrinkage and cracking that preclude its use. The addition of stabilizing oxides such as yttrium oxide prevents the phase transformations that occur with changes in temperature, resulting in a ceramic material consisting only of the tetragonal phase and referred to as Y-TZP. Dental Y-TZP ceramics have very high flexural strength and fracture resistance; the latter is about twice that of alumina ceramics. Because of its higher mechanical properties, zirconia ceramics can be used for single-unit restorations up to 5-unit fixed partial dentures (FPDs), both anterior and posterior. They can be shaded to simulate natural tooth structure, but are inherently opaque. Frameworks are made using CAD/CAM systems, and specific preparation designs are desirable. Preparations must have at least 1.5-mm occlusal clearance and chamfer or rounded shoulder margins are recommended. For FPDs, connector size is important and must be increased when excessive forces are anticipated. The veneering material plays an important role in the clinical success of zirconia-core restorations. Surface treatments such as air abrasion have been studied extensively, but with conflicting results—some positive and some negative. The best method for promoting a durable bond between zirconia and tooth structure is still unknown. One thing that is known is that conventional hydrofluoric acid etching and silanation are not effective for zirconia. Some evidence suggests that resin cements containing phosphate monomers such as MDP have better bonds to zirconia. Metal alloy primers might also improve resin bonding.

**Conclusions:** Bonding of zirconia ceramics is improved using agents that contain reactive monomers.

**Reviewer’s Comments:** This is an excellent overview of zirconia ceramics in dentistry. I recommend this to anyone wanting to learn more about zirconia. (Reviewer-Edward J. Swift, Jr, DMD, MS).

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Keywords: Zirconia Ceramic, Clinical Application

Print Tag: Refer to original journal article
Polyacrylic acid conditioning allows for the best bond strength of RMGI to dentin.

**Objective:** To evaluate the effects of different surface conditioners on the shear bond strength (SBS) of a resin-modified glass ionomer (RMGI) to dentin.

**Methods:** Extracted human third molars had their occlusal surfaces removed to expose dentin. A hybrid layer was created with 600 silicon carbide paper. Specimens were allocated into 4 groups: (1) 10% polyacrylic acid; (2) 5% NaOCl; (3) 1.1% acidulated phosphate fluoride (APF); and (4) control (no treatment). In group 1, GC Dentin Conditioner (GC) was scrubbed for 20 seconds, rinsed, and gently dried. Specimens in group 2 were acid-etched with 37% phosphoric acid for 15 seconds, rinsed, and gently dried prior to application of 5% NaOCl for 30 seconds. The dentin surface of specimens in group 3 were treated with Phos-Flur fluoride gel (Colgate) for 1 minute, rinsed, and dried. Fuji II LC (GC) was mixed, loaded in a Centrix syringe (Centrix), and applied to the prepared surfaces using a gelatin mold. The RMGI was light-cured for 40 seconds, and the mold was removed and discarded. Specimens were stored in water for 24 hours, thermocycled, and tested in shear.

**Results:** Group 1 showed the highest mean SBS. No difference was found between groups 2 and 3. Group 4 showed the lowest mean SBS.

**Conclusions:** The use of polyacrylic acid as a surface conditioner for RMGI seems to result in the best interaction of dentin/restorative material and, consequently, offers the best outcome.

**Reviewer's Comments:** The results of this study are somewhat expected. Other studies have shown that conditioning with polyacrylic acid, which is normally recommended by the glass ionomer manufacturers, results in the best bond strength to dentin. A more aggressive pretreatment with phosphoric acid removes the smear layer and may consequently result in postoperative sensitivity, with no significant improvement in bond strength. However, phosphoric acid was tested along with NaOCl in the present study. Because of this, few conclusions can be drawn about that conditioning methodology. Advantages of using APF would be the easier application and fluoride in the material. However, APF also resulted in compromised bond strengths compared to polyacrylic acid pretreatment. (Reviewer-Ricardo Walter, DDS).

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Keywords: Bonding, RMGI, Phosphoric Acid, Polyacrylic Acid, APF, NaOCl, Dentin

Print Tag: Refer to original journal article
Stay with the conventional etch and wash sealant because the self-etch sealant appears to be inferior.

**Objective:** "To evaluate and compare shear bone strength and marginal leakage of a new self-etch sealant to enamel of human permanent teeth versus those of a conventional sealant."

**Methods:** 44 extracted premolar teeth were used. In group 1 (control), the teeth were etched with a 37% phosphoric acid and washed with water; next, Clinpro sealant was applied. In group 2, Enamel Loc self-etch sealant was applied for 15 seconds undisturbed. After light curing, bond strength was measured from a flat enamel surface on the lingual. Clinpro shear bond was 6.3 MPa, while Enamel Loc was only 0.5 MPa. The occlusal groove was deepened with a #2 bur, and Clinpro was applied after a routine acid etch. In group 2, Enamel Loc was applied. The resins were light cured, and the teeth were thermocycled 300 times. The teeth were soaked in methylene blue dye for 4 hours, cleaned, rinsed, and sectioned to evaluate leakage.

**Results:** 68% of the conventional sealants had no dye penetration, while only 4% of the self-etch sealants had no leakage.

**Conclusions:** Statistically, the conventional sealant was superior for both bond strength and resistance to leakage compared to a self-etch sealant.

**Reviewer's Comments:** It does not seem that complex to convert a no-wash bonding agent into a no-wash pit-and-fissure sealant. However, there are clearly problems with this jump because efforts to date have not done well. In children, it would be great to flow something in the fissures, light-cure it, and have it seal the fissure long term. This study showed that Enamel Loc is unlikely to be successful in the clinic. Remember that good performance in the laboratory has been an occasional predictor of good clinical performance. However, results have been much more dependable in the other direction. If a material performs poorly in the laboratory, then it will likely perform poorly in the mouth. (Reviewer-J.D. Overton, DDS).

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Keywords: Sealant, Self-Etch Sealant, Acid Etch

Print Tag: Refer to original journal article
Self-etching, self-adhesive resin cements have questionable conversion levels, particularly in the self-curing mode.

**Background:** Many aesthetic ceramic restorations require resin cement for cementation. In an effort to reduce the technique complexities, a group of self-etching, self-adhesive resin cements have been developed that eliminate any etching and/or priming steps. These materials are also designed to be self-curing or dual-curing to allow use in areas where light-curing is not possible. In addition to reports of varied bonding performance, concerns exist relative to the low degrees of conversion, which could result in poor physical properties.

**Design/Objective:** This in vitro study examines the degree of conversion of 4 self-etching, self-adhesive resin cements and 1 conventional resin cement in both dual-cure and self-cure modes.

**Materials/Methods:** Twelve uniform specimens were prepared from each of the resin cements. Four self-etching, self-adhesive materials (RelyX Unicem™ [3M™ ESPE™], Maxcem™ [Kerr], Biscem™ [Bisco], Multilink Spring® [Ivoclar Vivadent®]), and 1 conventional resin cement (Multilink Automix® [Ivoclar Vivadent®]) were examined. Half of the specimens were light-cured for 20 seconds and then left undisturbed for 5 minutes. The other half were left in dark, dry conditions for 10 minutes. The percentage of conversion was measured for each specimen using a Fourier transform infrared spectrometry (FTIR) spectrometer.

**Results:** The degree of conversion was very low for all cements in the self-curing mode, ranging from 10.82% to 24.93%, with Multilink Sprint having the highest reading. The dual-curing specimens exhibited conversion readings from 26.40% to 41.52% for the self-etching materials and 61.36% for the conventional resin cement. In the dual-curing group, Maxcem had the lowest reading.

**Conclusions:** With the exception of the conventional resin cement in the dual-curing mode, the conversion levels were very low and would suggest that these materials might not be sufficient for use in areas that cannot be light cured. The authors do note that conversion may improve with longer setting times and/or longer light-curing times. They also note that since these materials are indicated for the cementation of fixed prosthodontic restorations, there will almost always be partial or complete attenuation of light during setting.

**Reviewer’s Comments:** On the surface, this study questions the suitability of this class of cements for use in any restoration that will significantly attenuate the light-curing. Although there is not a settled minimum acceptable degree of conversion, the figures demonstrated in this study are significantly lower than those of other resin materials and could potentially compromise the resultant physical properties of these materials. The early strength of cements is quite important relative to stability in the clinical setting. It is important to note that these materials are marketed as “all-around” cements and are suggested for metallic and opaque ceramic restorations, all of which will eliminate the possibility of light curing. Further investigation will be important before these materials can be recommended. (Reviewer-Daniel E. Wilson, DDS).

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Keywords: Resin Cements, Curing Efficiency, Self-Etching

Print Tag: Refer to original journal article
New Concept for Minimally Invasive Restorative Techniques

Benefits in Cost and Reduced Discomfort of New Techniques of Minimally Invasive Cavity Treatment.

Vila Verde A, Ramos MMD, Stoneman AM:


Objectives: To motivate efforts to overcome the remaining obstacles to minimally invasive treatment of dental caries and to reduce costs and discomfort to patients. Summary: The basic principles underlying minimally invasive dentistry include caries prevention, less intrusive treatment for early lesions, and conservation of tooth structure when deeper lesions are restored. This paper focuses on the third principle, describing tools and treatments for deeper lesions and highlighting areas where further development is needed. Tooth conservation during restoration involves the use of adhesive materials rather than amalgam. Data indicate that only 80% of amalgam restorations are in good condition at 10 years, and the percentage is even less for adhesive restorations. Replacement of restorations is a substantial proportion of dental treatment rendered. If the 10-year survival rate could be increased from 80% to 90%, the number of restorations needing replacement over a 30-year period would be substantially reduced. Currently, even minimally invasive methods require removal of healthy tooth structure overlying many lesions. The authors propose an alternative technique that uses a laser to create a small tunnel (0.5 mm in diameter) to access the caries, apply a bactericidal agent through the tunnel, and apply a low-viscosity resin-based material to seal the tunnel. They claim that the necessary technology already exists to treat caries in this way.

Conclusions: Minimally invasive restorative techniques can reduce cost and discomfort to the patient.

Reviewer's Comments: This is an interesting paper that describes a proposed novel method for treating caries. The "tunnel" described in the technique is illustrated for treatment of an occlusal lesion and should not be confused with the "tunnel prep" technique that has been described in the literature for Class II restorations and had been largely discredited. I suppose it is possible that the procedure described in the paper is something that we will be doing in the future. However, I am not convinced that the technology exists today in any realistic sense. For example, do we really have hard tissue lasers that can be used so precisely? Regardless, the paper does raise some interesting questions and presents some interesting thoughts about how we might be treating caries in the future. (Reviewer-Edward J. Swift, Jr, DMD, MS).

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Keywords: Caries Tx, Minimally Invasive Dentistry, Costs, Reduced Discomfort

Print Tag: Refer to original journal article
Pulpal reaction to both self-etch and to total-etch is mild and appears reversible.

**Background:** Deficient bonding of resin composites to tooth structure allows leakage at the margins, which, in turn, can result in hypersensitivity, marginal discoloration, recurrent caries, pulpal damage, and restoration loss. New bonding systems appear to improve this tooth-restoration interface, but some questions do remain about the effects of these bonding systems on the dentin-pulp complex. Pulpal damage caused by adhesive systems has been reported when the adhesive was placed directly on an exposed pulp.

**Objective:** To evaluate the immunochemical, morphologic, and morphometric alterations of pulps when they were capped with self-etching or total-etching adhesive systems to determine if a pulpal reaction would occur.

**Materials/Methods:** 30 healthy third molars planned for extraction were used in the study. After patients were anesthetized, preparations were cut. Teeth were divided into 2 groups as follows: Group 1 was treated with the total-etch Scotchbond Multipurpose adhesive system using 37% phosphoric acid to etch dentin and enamel; Group 2 was treated with self-etching Clearfil SE Bond. Teeth were then restored with Filtek P60. Teeth were split longitudinally and the pulp removed. Pulp sections were stained, embedded in paraffin, and sectioned serially to determine the presence of any inflammatory lesions. Morphological examination of the pulps evaluated any vascular congestion, dystrophic calcification, hemorrhage, neurosis, and inflammation found to be present.

**Results:** Vascular congestion was found in 60% of Scotchbond 7-day, Scotchbond 30-day, Scotchbond 60-day, and Clearfil 7-day specimens. It was also found in 80% of Clearfil 30-day and Clearfil 60-day specimens. Hemorrhage was present in 80% of Scotchbond 30-day, 60% of Scotchbond 60-day, 20% of Clearfil 7-day, and Clearfil 30-day specimens, and 40% of Clearfil 60-day specimens. Dystrophic calcification was found in 20% of the Clearfil 7-day specimens and swelling of odontoblasts was found in 20% of the Clearfil 30-day and 60-day specimens. Fibrous connective tissue was significantly higher after 30 days and then began to decrease. Congestion was the most frequent pathologic process for both materials.

**Conclusions:** No inflammatory reaction, necrotic areas, or severe immunoreaction for proinflammatory cytokines were found. The results suggest the self-etching and total-etching adhesives are both biocompatible when placed directly on dentin.

**Reviewer’s Comments:** While this study did not show any severe reactions, it is not totally accurate to state that the self-etching and total-etching systems are completely biocompatible. Other agents seem to be more biocompatible. Clinicians should not feel totally comfortable with acid-conditioning and then pulp-capping with dentin bonding agents. Other materials hold promise for more favorable results. More research is needed to determine the best way to preserve pulpal health after exposure. (Reviewer-Thomas G. Berry, DDS).

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The even spacing of the 15 shades in the VITA Bleachedguide 3D-Master makes it the tool of choice for monitoring bleaching effects.

**Summary:** Dr. Snider presents the problems associated with the shade guides in dentistry very well. While it is currently taught that value is the most important thing to match when doing aesthetic restorations, the Vitapan Classical shade guide had 16 shades that were organized into 4 groups of different hues (not value) without any consistency in the changes from one tab to the next. He reports that the 3-D Master Shade Guide (Vident) is scientifically organized with 29 equally distanced shades. The important features of a good shade guide by his estimate are: every step in the shade guide represents the same Delta E (degree of change in value); the adjacent shades are not so close together that one cannot appreciate the change in color; the shades represented should be the actual shades of natural teeth; and the shade guide is arranged by value. For bleaching change evaluation, the 15-shade tab VITA Bleachedguide offers a scientifically smooth transition from one tab to the next, which allows good documentation of bleach effect.

**Reviewer's Comments:** I was trained to remove the necks from the Vitapan Classical (Vident) shade guide tabs. We were to then rank order the 16 tabs by value in the plastic holder. You were to take the guide, squint, and swing the guide past the teeth you wanted to match. In those few seconds, you were to select the color of porcelain to prescribe. Powder blue backgrounds, gray backgrounds, and mid-day natural light with a northern exposure were all given lip service, but most of the time we squinted and gamely made a selection. I do not know if it was true, but I was told that the Classical shade guide was built based on the porcelains available at the time with no consideration of the actual colors of natural teeth. If you look at a scientific plot of the shade guide tabs on a field of the colors of natural teeth, you will quickly conclude that the old Vita shade guide missed a lot of teeth. The university has changed to the 3D-Master Shade Guide, which my students find less complex (even with 29 shades) than the 16-shade Vita Classic. (Reviewer-J.D. Overton, DDS).

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Keywords: Hue, Value, Chroma, Tooth Bleaching, Color Change, Delta E

Print Tag: Refer to original journal article
Clinical Evaluation of Ceramic Inlays Compared to Composite Restorations.

Lange RT, Pfeiffer P:

Oper Dent 2009; 34 (May-June): 263-272

Survival probability of ceramic inlays and direct composite restorations is similar, but most clinical criteria favor the ceramic inlays.

Objective: To compare the clinical performance of ceramic inlays and direct composite restorations. Participants/Methods: Over a 4-year period, 109 patients in a private German dental practice received 264 Evopress ceramic inlays. (Evopress is a glass ceramic material processed using a hot press procedure.) During the same period, 68 patients received 145 posterior composite restorations using Filtek Z250. All of the ceramic inlays were etched with hydrofluoric acid, silanated, and bonded using self-etch adhesive and dual-cure resin cement, usually under rubber dam isolation. Enamel margins were etched with phosphoric acid before the adhesive was applied. For the composite restorations, cavosurface margins were bevelled and etched (dentin was not). Prime & Bond NT was applied and the composite was placed and light-cured in increments. Most of the direct composites were done using cotton roll isolation. All inlay and composite restorations were placed by a single operator, who was not the evaluator. Evaluations were done according to standard United States Public Health Systems criteria for such characteristics as marginal adaptation, recurrent caries, and others.

Results: Of 250 ceramic inlays evaluated at recall, 4 were classified as failures (3 of them because of fractures). Of 135 composite restorations evaluated at recall, 5 were classified as failures (2 because of recurrent caries). In both types of restorations, marginal adaptation of newer ones was better than that of older ones. Inlay margins tended to be better than composite margins. Anatomic form of the ceramic inlays was excellent and did not change with time. Ceramic inlays had better color match and less marginal discoloration than composite restorations. The statistical analysis of survival probability ranked the 2 types of restorations as being similar at up to 57 months of clinical service.

Conclusions: Survival probability of ceramic inlays and direct composite restorations was similar, but most clinical criteria favored the ceramic inlays.

Reviewer’s Comments: This study involved only 1 operator and a limited number of materials, so the results should not be over-extrapolated. With that said, both types of restorations (ceramic inlay and direct posterior composite) performed very well in recalls extending up to 5 years. The ceramic inlays tended to be better than the direct composites. (Reviewer-Erward J. Swift, Jr, DMD, MS).

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Keywords: Ceramic Inlays, Posterior Composites

Print Tag: Refer to original journal article
Gutta-Percha Shows Highest Mean Push-Out Values


De-Deus G, Di Giorgi K, et al:

J Endod 2009; 35 (July): 1048-1050

Despite developments in adhesive dentistry, filling materials still cannot be predictably bonded to root canals.

Objective: To evaluate the bond strength of Epiphany (Pentron) and Epiphany SE (Pentron) to root canal dentin.

Materials/Methods: Human upper canines were used in this study. Root canals were accessed and prepared to 1 mm of the apex. After preparation with rotary instruments, the canals were rinsed with 17% ethylenediaminetetraacetic acid (EDTA) for 3 minutes, followed by distilled water. Roots were then divided into 3 groups to be sealed with (1) gutta-percha (Diadent) and AH Plus sealer (Dentsply Maillefer), (2) Epiphany after application of Epiphany primer with a microbrush, and (3) Epiphany SE. Gutta-percha and Epiphany cones were inserted to full working length and lateral condensation was accomplished using 5 accessory cones. The excess material was removed and the filling vertically condensed. Specimens in groups #2 and #3 were light-cured for 40 seconds and all filled roots were stored at 37°C in 100% humidity for 14 days prior to testing. Roots were then serially cut into 1-mm thick slices resulting in 4 slices, from different thirds, per root. The push-out test was conducted using a universal testing machine.

Results: Differences among root canal thirds were not significant. Gutta-percha showed the highest mean push-out values. No difference was found between Epiphany and Epiphany SE.

Conclusions: Nonbonding root filling materials may still be the more reliable choice for root canal treatments.

Reviewer's Comments: It is well known that root canals are not favorable substrates for bonding. With that said, it is not surprising that the Epiphany materials, which are bonded to root canals, performed poorly. Important to point out is the differences in elastic modulus among the materials tested. That may have influenced the results and was not taken into consideration. Moreover, more important than the bond strength of root canal filling materials to root canals may be the leakage allowed by those. A correlation between those is probable and the polymerization shrinkage of the Epiphany materials may be considered a potential limitation. That is likely to have been one of the reasons for the poor performance of the Epiphany materials in the present study. (Reviewer-Ricardo Walter, DDS).

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Keywords: Root Canal, Bonding, Epiphany, Gutta-Percha

Print Tag: Refer to original journal article
Gingival Margin--Weakest Link of Class II Composite Restorations

The Effect of Flowable Materials on the Microleakage of Class II Composite Restorations That Extend Apical to the Cemento-Enamel Junction.

Sadeghi M, Lynch CD:

Oper Dent 2009; 34 (May-June): 306-311

Flowable liners might reduce microleakage at the gingival margin of a Class II composite restoration below the CEJ.

Objective: To evaluate the effect of a thin layer of flowable composite or compomer on microleakage of Class II restorations with packable and nanofilled composite extending apical to the cemento-enamel junction (CEJ) and cured using either a light-emitting diode (LED) or a quartz tungsten halogen (QTH) light.

Materials/Methods: 72 intact maxillary first premolars extracted for orthodontic reasons were obtained for the study. Standardized mesio-occlusal (MO) and disto-occlusal (DO) restorations were prepared in each tooth. The gingival margins were located 1 mm apical to the CEJ. The preparations were restored using Single Bond etch-and-rinse adhesive and either packable (Filtek P60) or nanofilled Universal (Filtek Supreme) composite. Restorations were placed using the restorative material alone or preceded by a thin layer (1 mm) of flowable composite (flowable Supreme) or compomer (Dyract Flow). (Compomer refers to polyacid-modified composite resins, which have modifications based on glass ionomer chemistry.) The various combinations of materials were cured using either a QTH or halogen device. After thermocycling, the specimens were immersed in dye, sectioned, and examined under 10 X magnification to evaluate microleakage. Leakage was scored along a 0 to 3 scale.

Results: For both restorative materials, leakage was reduced by application of a flowable liner. There were no significant differences in leakage between the 2 types of liners or the 2 curing lights.

Conclusions: The use of a flowable composite or compomer liner might reduce microleakage at the gingival margin of a Class II composite restoration extending apical to the CEJ.

Reviewer's Comments: The weak link of the Class II composite restoration is the gingival margin, particularly when that margin is on dentin or cementum. Not surprisingly, researchers are constantly looking for methods to improve the seal of the gingival margin. This is just the most recent of many studies that have evaluated the effects of flowable liners on leakage of Class II composite restorations. Although the research in this area is not unanimous, much of it suggests that flowable liners can help to reduce leakage. It is important to remember that flowable resin-based materials have greater shrinkage than more highly filled restorative materials and thus should be applied only in thin layers. (Reviewer-Edward J. Swift, Jr, DMD, MS).

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Keywords: Posterior Composites, Leakage, Flowable Materials

Print Tag: Refer to original journal article
Rocatec of the intaglio surface does not really help retention of zirconia crowns.

**Objective:** To determine what can be predicted about different brands of cement retention of zirconia crowns cemented to extracted teeth?

**Materials/Methods:** 160 molars were prepared with 10° taper, 3-mm high walls. Zirconia crowns were fabricated and cemented with different brands of cements. The intaglio surface of the zirconia was treated with Rocatec-Pre and then some of the intaglio surfaces in some test groups had additional chemical treatments. The cemented restorations were thermocycled and tested or thermocycled, aged in water for a year, and tested. The crowns were then removed in the long axis of the path of draw with a testing machine.

**Results:** The standard deviations were very large, so the applied statistics were a sum of the tests, which is more difficult for me to evaluate. Maxcem performed worse than any of the other tested cements. Unicem performed well. Rocatec of the intaglio surface of the zirconia did not have a significant positive effect on retention. When stressed on the long axis of the path of draw, aging the samples in water had no noted effect on resistance to displacement.

**Reviewer’s Comments:** Zirconia crowns are conventionally cemented (nonresin cements) at our university. By wild guess statistics, we have a number of them that have walls <3 mm tall, >10° of taper, and more cementation failures than we see with gold crowns, which readily accept grooves and boxes to correct for anatomic deficiencies. That this paper showed that RelyX Unicem was as retentive as the multistep bonding cements is probably a reason to consider RelyX Unicem more favorably than Maxcem, which did less well. By statistics, Fujicem performed similarly to the resin cements, but the authors admit they had difficulty defining a "clinically significant" distribution. It is certain that taffy candy (pull in the long axis) is not the major way that cementation efforts fail. Cementation efforts fail by repeated small and large loads placed in every axis on the crown depending on the degrees of freedom controlled by the walls and quality of fit of the casting to the preparation. This real world failure method was not tested in this research project. (Reviewer-J.D. Overton, DDS).
Etch-and-rinse resin luting agents provide more reliable bonding of indirect restorations to dentin.

**Objective:** To evaluate the effects of 4 types of dual-cure luting systems on the bond strength of composite and ceramic blocks to dentin.

**Materials/Methods:** Flat occlusal dentin surfaces were created in extracted human molars and polished to 180-grit. Forty teeth were divided into groups of 5. Twenty composite blocks were fabricated by curing a microhybrid material in cylindrical molds. The composite was polished to 600-grit and was air-abraded using 50-μm aluminum oxide particles. Twenty glass ceramic blocks were fabricated and polished to 600-grit also. They were etched with 9.5% hydrofluoric acid and silanated. Both types of restorative material were bonded to dentin using 4 resin cements. The cements were CoreXFlow (which uses the etch-and-rinse adhesive XPBond), Enacem HF (which also appears to be an etch-and-rinse system), Panavia F2.0 (which includes a self-etch primer), and RelyX Unicem (a self-adhesive cement). The bonded specimens were sectioned for microtensile bond strength (MTBS) testing, which was accomplished using a universal testing machine. Failure modes were examined using scanning electron microscopy (SEM).

**Results:** Bond strengths for the composite material were much higher than for the ceramic. For the composite, the mean values were 30 to 31 MPa for the etch-and-rinse systems, but only 18 to 19 MPa for the self-etch systems. Mean values for the ceramic were approximately 5 to 7 MPa and did not vary much by cement, although RelyX Unicem did have the highest bond strength. Most failures in the ceramic groups were at the cement-ceramic interface, while most failures in the composite groups occurred at the dentin interface.

**Conclusions:** Of the materials tested, the etch-and-rinse luting agents provide more reliable bonding of indirect restorations to dentin.

**Reviewer's Comments:** The one big surprise in this study was the composite material bonded to dentin better than the ceramic material did. This makes no sense until you look at the fracture sites, which were primarily between cement and ceramic. This is an unusual finding, because the bond of resin materials to etched ceramic is extremely strong. Although the ceramic material was etched and silanated, it had not been air-abraded first. This probably accounts for the low bond strengths and is a flaw in the experimental design. (Reviewer: Edward J. Swift, Jr, DMD, MS).

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Keywords: Resin Cements, Bond Strength, Luting Systems

Print Tag: Refer to original journal article
**Background:** Zirconia-based all-ceramic restorations have provided improved aesthetics as compared to porcelain-fused-to-metal restorations. Although the strength of the zirconia substructure is very high, concerns exist relative to the adhesion of zirconia to resin cements. Zirconia is resistant to HF acid etching and silane application; therefore, a strong chemical bond has proven elusive. Aggressive mechanical surface treatments can increase adhesion, but may induce surface flaws that compromise strength. Air abrasion with silica particles (silica-coating) followed by silane has shown some promise. Research continues to find a practical means to improve bonding to zirconia.

**Design/Objective:** The aim of this in-vitro study was to evaluate a novel surface treatment, molecular vapor disposition, to allow conventional silanation and adhesive cementation of high strength zirconia ceramics.

**Methods:** Zirconia blocks (ZirCAD) and leucite-filled porcelain blocks ProCad (Ivoclar) were obtained and composite resin blocks fabricated in a corresponding size. The surfaces of each block were polished with 1200-grit paper and air-abraded. There were 5 tested groups. The ProCad blocks were HF acid-etched, silanated, and bonded with a resin cement system (C&B Cement, Bisco). The zirconia blocks were bonded with silane only (silica-coated) (CoJet, 3M-ESPE) and treated with 2 different "seed" thicknesses (2.6 nm and 23 nm) of SiCl₄ deposited by a vapor disposition process. Silane application and bonding to the composite blocks followed. After 24 hours of water storage, the specimens were subjected to microtensile bond strength (MTBS) testing. Scanning electron microscopy was used to evaluate the mode of failure.

**Results:** The untreated zirconia samples had the lowest strengths and often failed adhesively during the specimen preparation. The 2.6-nm seed thickness of vapor-deposited silica samples demonstrated similar MTBSs to the control group (porcelain with HF etching and silanation). This group also demonstrated a failure mode, primarily in the composite. The tribochemical silica-coated group showed better performance than the untreated zirconia and the 23-nm thickness of the vapor-deposited silica, but lower than the control and thin thickness specimens.

**Conclusions:** The MTBS testing demonstrates that the use of a gas-phase chloro-silane pretreatment in 2.6 nm layers offers the possibility of robust bonding to zirconia surfaces using traditional silanation and bonding procedures. The chemical bonding appears to be better than with silica-coating.

**Reviewer’s Comments:** This technique is not yet commercially available, but shows promise as a means to adhesively cement zirconia based restorations. Currently, the lack of robust bonding limits zirconia use to clinical situations that allow generation of a tooth preparation with sufficient retention and resistance form. This class of restorations could be significantly more versatile if a practical means of true adhesive cementation is realized. This procedure shows promise. (Reviewer-Daniel E. Wilson, DDS).

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Keywords: Zirconia, Adhesion, Molecular Vapor Disposition

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Differences in coronal and radicular dentin might signify different bond strengths to those substrates.

**Objective:** To compare the hardness of coronal and radicular intertubular dentin. 

**Materials/Methods:** Bovine teeth were used in the study. Three-mm thick dentin slabs were cut parallel to the long axis of the teeth. Those were sectioned into coronal and radicular dentin and each section was embedded in epoxy resin. The specimens were then polished to fine diamond pastes and the smear layer formed was ultrasonically removed. Hardness and Young's modulus of pre-established areas of the coronal and radicular dentin were measured. Those areas were 1.5 mm midway from the dentoenamel junction to the pulp chamber, 1.5 mm midway from the outer surface, and 4 mm below the cementoenamel junction (CEJ). After those, the indentations were observed using scanning electron microscopy and the elemental composition of the area (calcium [Ca], phosphorus [P], and magnesium [Mg] concentrations, and Ca/P ratio) was determined using an energy dispersive x-ray spectrooscope.

**Results:** Hardness and Young's modulus of coronal intertubular dentin was higher than radicular intertubular dentin. Ca content and Ca/P ratio of coronal intertubular dentin were higher than radicular dentin. There was no difference in P content, while Mg content was higher in radicular intertubular dentin.

**Conclusions:** Hardness and Young's modulus of intertubular dentin are affected by tooth region/location. 

**Reviewer's Comments:** Hardness and Young's modulus determine the resistance of a material to deformation. The results of those tests along with the elemental composition measurements confirmed that the mineral content contributes to the hardness of dentin. As discussed in the manuscript, the use of bovine teeth should be taken into consideration even though the results of this study are somewhat in accordance with the current literature. The results might explain the differences in bond strength reported in previous studies. (Reviewer-Ricardo Walter, DDS).

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Keywords: Hardness, Young's Modulus, Intertubular Dentin, Radicular, Coronal

Print Tag: Refer to original journal article