

Scientific Information

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1572

Microleakage and Marginal Adaptation of Heated Resin Composites

2 Year Clinical Evaluation of Venus B in Anterior Teeth

of Microhybrid Composite

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Index of Contents

Heraeus Kulzer – Company Profile	4
Preface	5
Restorative Materials	7
▪ Venus	8
▪ Charisma	14
▪ Durafill	15
▪ Experimental Composite	16
Adhesives	19
▪ iBOND Self Etch	20
▪ iBOND GLUMA inside	24
▪ GLUMA Comfort Bond+Desensitizer	27
▪ GLUMA Solid Bond	28
Impression Materials	31
▪ Flexitime	32
Others	35
▪ GLUMA Desensitizer	36
▪ InnoEndo	37
Notes	38

Heraeus Kulzer – Company Profile



Heraeus, the precious metals and technology group headquartered in Hanau, Germany, is a global, private company in the business segments of precious metals, dental health, sensors, quartz glass and specialty lighting sources. With revenues of more than EUR 9 billion and more than 10,600 employees in over 100 companies, Heraeus has stood out for more than 150 years as one of the world's leading companies involved in precious metals and materials technology.

Heraeus Kulzer is a globally established dentistry and dental technology enterprise, comprising a total of 20 companies in Europe, Asia, America, and Australia.

As a dental alloys specialist and provider of systems for the conservation and restoration of natural teeth, Heraeus Kulzer offers a comprehensive range of products for dental laboratories and dental practices – from standard to premium solutions, from fillings, crowns and bridges to total prostheses.

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Preface

Dear reader,

Heraeus Kulzer is pleased to provide you with a summary of the latest and most interesting scientific abstracts being presented at the 85th General Session of the International Association of Dental Research in New Orleans/USA. We are glad that these universities included our products in their research as it is always important for us to have the quality of our products assured by external tests.

We hope that this brochure is an informative tool for you and we are always personally available for any questions or remarks.

Yours sincerely,



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Restorative Materials



0409

Microleakage and Marginal Adaptation of Heated Resin Composites

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Objective: This study evaluated microleakage and marginal adaptation of class V restorations using either heated (600C with Calset Unit) or room temperature (RT) (210C) resin composites (Esthet-X and Venus).

Methods: Eighty extracted molars were prepared for class V (6mmx3mmx2mm) using the proximal surfaces. For each temperature, 20 teeth were restored with one composite on one proximal surface and the other brand on the other proximal surface for a total of four groups. All teeth were restored with 15-sec etch, their respective bonding adhesive, 3-step incremental fill, polymerized and polished. The teeth were stored for 7-days at 370C in 100% humidity and then thermocycled for 2000 cycles (5-55°F). Teeth were sealed and immersed in 0.5% fuschin dye for 18 hours and pumiced. Ten teeth from each group were sectioned to analyze microleakage and the rest were analyzed for marginal adaptation using a 50X microscope. Microleakage was ranked 0=no leakage, 1=dye up to DEJ; 2=dye up to ½ distance between DEJ and axial wall,

3=leakage to axial wall, and 4=leakage along axial wall. For marginal adaptation, the restoration was divided into 10 sections and the adaptation ranked as 1=gap or (0)=no gap.

Results: Data was analyzed using ANOVA on ranks followed by Dunn's test. There was no difference in enamel or dentin microleakage for both composites and temperatures ($p>0.05$) except for dentin microleakage for Esthet-X heated vs (RT) Venus ($p<0.001$). There was a greater marginal gap at the cervical than at the enamel for all materials and temperatures but no statistical difference for any material or temperature when data was analyzed among enamel or dentin groups.

Conclusions: (1) Heating the composite had no effect significant on microleakage and marginal adaptation. (2) The use of heated composites to facilitate placement needs further evaluation.

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1572

Clinical Placement and Blind Evaluation of Microhybrid Composite Resin

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Objective: to evaluate the clinical performance of a posterior composite restorative system Venus microhybrid composite resin (Heraeus Kulzer) and “Gluma comfort Bond” and „I-Bond“ adhesives at 1 year.

Methods: 120 posterior restorations; 72 were class II restorations (2/3 on molar teeth, 1/3 on premolar teeth). Two different bonding systems were randomly utilized, I-Bond or Gluma. Restorations were placed and evaluated by calibrated clinicians. Research subjects returned for evaluation at one week, six month and one year by two blinded pre-calibrated examiners utilizing USPHS criteria.

Results: At 1 year, 43 were missing from analysis leaving 77, 35 restored with Gluma and 42 with I-Bond. Groups were balanced for gender, ethnicity and age. Gluma was used more in Class II restorations than I-Bond. Sensitivity- (24 hours and one week) majority none, and a small number ranked as mild or moderate—after 1 week, there was less sensitivity with I-Bond. Bite and chewing pain-both

showed reduction after a week but with I-Bond slightly less .Color USPHS stability- equal distributions for color ranking were the same for both bonding agents-almost imperceptible; Marginal Discoloration-an equal distribution was found with, slightly less stability for I-Bond; Secondary caries-none for bonding agent; Occlusal wear- none or slight either bonding agent; Marginal Adaptation- equal but slightly less for Gluma; Surface Texture- equal distribution with very slight coarse texture for Gluma‘ Proximal Contact-equal distribution with the majority rated as tight; Functional Occlusion-slight wear on both with a shift from restoration to tooth; Axial Contour-equal; Post-op sensitivity-little difference between agents, but Gluma showed slightly more sensitivity; Restorations all retained; at 1 week, 6 month or 1 year Restoration Fracture-one restoration at 6 month and was withdrawn from the study.

Conclusions: based on 77 restorations recalled at 1 year, there were no differences in the Venus material objective measures between I-Bond and Gluma with superb results.

1573

Clinical Evaluation of Repolishing Venus Composite after 2 Year Recall

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Incorporated glass fillers increase strength, and influence optical characteristics of dental composites but also makes it difficult to polish the composite surface to a high gloss.

Objective: to evaluate surface gloss of Venus composite restorations after two years placement, repolish the restorations to a high surface gloss, then evaluate surface gloss after 3 months.

Materials and Methods: 40 Venus restorations in an on-going clinical study were evaluated at two years recall for surface gloss, repolished to high gloss using a proprietary diamond based polishing system (iPol, Heraeus Kulzer). 35 repolished restorations were evaluated at baseline (2 weeks), and 3 months using a modified USPHS scale.

Results: At baseline all 35 restorations retained high surface gloss, while at 3 months evaluation 5 restorations showed slightly reduced gloss. The following surface gloss (polishability) results are in percentages (%) (PP=Pre Polish, BL=Base Line, 3M=Three Months):

(Polishability)	PP	BL	3M
Alpha	15	100	75
Bravo	75	0	25
Charlie	1	0	0
Delta	0	0	0

Conclusion: At three months recall, Venus restorations repolished after two years recall, showed high retention of surface gloss, and repolishing may be an effective method to extend composite surface gloss.

1575

2 Year Clinical Evaluation of Venus Composite in Anterior Teeth

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Objective: This investigation evaluated the clinical performance of Venus (Heraeus Kulzer) micro-hybrid resin composite for restoration in anterior teeth for a two year period.

Materials and Methods: Gluma Comfort Bond Desensitizer was used as the dental adhesive. Class III, IV, V and veneer restorations were placed in anterior teeth. A total of 53 restorations were placed in 30 patients by two dentists over a 60-day period. Restorations were recalled at 6 mo., 1 Yr, and 2 Yr and evaluated by two examiners for the following variables: Anatomic Form (AF), Color Match (CM), Marginal Adaptation (MA), Retention (RT), Marginal Discoloration (MD), Surface Stain (SS), Secondary caries (SC), Polishability (PL) using a modified USPHS evaluation system.

Results: indicate that all restorations (40) had excellent anatomic form, marginal adaptation, surface staining, and secondary caries. Polishability was one of the most challenging aspects of the study with loss of surface gloss, while still retaining smoothness. The following results are in percentages (%) (BL=Base Line, 2Y = Two Years):

None of the subjects exhibited postoperative sensitivity or exaggerated gingival response. In general, all the restorations were judged to be clinically satisfactory.

Conclusions: Based on the two year findings of this study, Venus nano-hybrid composite is an excellent choice for anterior restorations.

Study supported by Hereaus Kulzer.

	AF		CM		MA		RT		MD		SS		SC		PL	
	BL	2Yr	BL	2Yr	BL	2Yr	BL	2Yr	BL	2Yr	BL	2Yr	BL	2Yr	BL	2Yr
Alpha	100	93	53	83	100	100	100	95	100	93	100	100	100	100	100	15
Bravo	0	7	47	17	0	0	0	0	0	7	0	0	0	0	0	75
Charlie	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
Delta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

1634

Colorimetric data of Opaque and Non-Opaque Shades

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Objective: Aim of the study was to test the null-hypothesis that the colors of opaque-shades do not differ from the corresponding non-opaque-shades of a composite.

Methods: 6 couples for a total of 12 Vita shades of a new composite, Venus (Heraeus Kulzer) were selected: A2, OA2; A3, OA3; A3.5, OA3.5; B2, OB2; C3, OC3; D2, OD2. A reflectance spectrophotometer was used, with a D65 light source with a simultaneous illumination from two sides at 45° and a viewing at 0° (SpectroShade, M.H.T.). The measurement was made on disks of cured material with a thickness of 3mm and a diameter of 10mm, against a black and white back. The CIE-Lab color parameters were determined as average between black and white back data and the translucency was done by the formula $\frac{[(Lw-LB)^2 + (aw-aB)^2 + (bw-bB)^2]^{1/2}}$. Data analysis was performed by ANOVA and Tukey's post-hoc test ($p < 0.05$).

Results: The $L^*a^*b^*T\%$ data for the different shades were reported. The Delta E color difference between opaque and non-opaque shades was found >2 , for the couples A2-OA2 (3.0), A3.5-OA3.5 (4.0), B2-OB2 (2.7), C3-OC3 (4.5), D2-OD2 (4.2) and <2 for A3-OA3 (1.6). Statistical analysis revealed a significant difference ($p < .05$) for the first 5 couples and a not significant difference for the last ($p > .05$). The translucency parameter was significantly lower for the opaque shades. There was a significant difference in translucency between the opaque shades and also between the non-opaque shades.

Conclusion: The null-hypothesis was rejected. The color difference between the opaque and the non-opaque shades was prevalently in the perceptible range that is considered a Delta E >2 . The literature and the results of this study suggest that the need of the clinician for a more opaque material could be connected to a change not only for the translucency, but also for the colorimetric data, in comparison with the same shade in a non-opaque version.

2721

A Comparison in Mechanical Behaviour: Sound vs. Adhesively Restored Premolars

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Objective: Literature has widely demonstrated that root canal treatment weakens the tooth structure, both for chemical and architectural reasons, especially in presence of MOD cavities. Aim of the study was to evaluate, by means of a non-destructive technique, to which extent the tooth is weakened and the contribution of restorative materials in recovering the tooth original stiffness.

Material and Methods: Twenty non-carious maxillary premolars were tested. Teeth were placed in a taylor-made loading cell, where a mechanically controlled loading device applied sequentially known values of axial load (range 98-294 N) on the occlusal surface. Laser sensors registered the amount of deflection. The same teeth were tested in condition of integrity and after endodontic/restorative treatment (MOD cavity). Teeth were split into 4 groups and restored respectively with: A) Dispersalloy (Dentsply); B) Venus (Heraeus-Kulzer); C) TetricEvoCeram (Ivoclar-Vivadent); D) Esthet-X Improved (Dentsply).

Results: The results obtained were analyzed as function of cuspal deflection and average stiffness (i.e. the mean load value needed to cause a 1 μ m cuspal displacement). ANOVA test for repeated measures was performed. Mean structural recovery (assuming as 100% the stiffness of the sound tooth) was calculated: Group A 17%, group B 94%, group C 80% and group D 53%.

Conclusions: Our research highlighted that direct composite restorations with adhesive techniques and materials afford adequate functional (and aesthetic) recovery in endodontically treated premolars, even in large cavities. The results of this in vitro research should be confirmed in vivo, monitoring the materials behaviour on a long-term basis in the oral environment.

1615

Micro-Hardness Evaluation of a Extra-Light Composite Resin Varying Photocuring Units

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Objective: The aim of this study was to evaluate the superficial micro hardness of a extra-light composite resin Charisma SL (Heraeus Kulzer/Germany) when photocured by four photocuring units: One being halogen based G1 (control group) - Optilux Demetron 401 (SDS Kerr/USA) and three LED units: G2 – L.E.Demetron I (SDS Kerr/USA); G3 – EliparTMFreeLightTM (3MESPE/USA) and G4 – ColtoluxLED (ColtèneWhaledent/Germany).

Methods: Five specimens were made for each evaluated group. The composite resin was photocured in only one increment for 40 seconds. After that, the specimens were stored in the dark for 24 hours. Later, they were evaluated to check the superficial micro hardness (Vickers Hardness – HV) by using the hardness device HMV-2 (Shimadzu) on the top and bottom surfaces.

Results: The results showed in HV: G1- 42.28±1.09; G2 - 41.66±0.93; G3 - 40.54±0.87 and G4 - 37.19±0.85 on the top surface and on the bottom surface the results in HV were: G1 - 33.80±4.58; G2 - 36.81±0.70; G3 - 32.79±0.98 e G4 - 31.40±0.93. Through analysis statistical Analysis of Variance (ANOVA) to 2 criteria and test LSD for multiple comparisons to 5%, it was shown there was differences between the top (40.42±2.19) and the bottom (33.70±3.01) and between the photocuring units with p<0,0001.

Conclusion: It was concluded that there was not statistically significant Vickers micro hardness value only between G1 and G2. In all the groups the values were higher on the top surface.

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0449

Color Stability of Filling Materials after Bleaching, Aging and Staining

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Objective: The aim of this study was to determine the color stability of seven different tooth colored filling materials subject to artificial aging by thermocycling (TC), treatment with 10% carbamide peroxide (CP) and a severe staining challenge with Red Wine.

Methods: 12 specimens of each material (Filtek Supreme[®] (3MEspe), Ecusite[®] (DMG), Filtek Z250[®] (3MEspe), Herculite XR[®] (Kerr), Durafill VS[®] (Heraeus Kulzer), Ketac Fil[®] (3MEspe) and DyractXtra[®] (Dentsply) were identically fabricated and randomly assigned to five groups: group 1 control, group 2 no TC and no CP, group 3 no TC but CP, group 4 5000 TC and no CP, group 5 5000 TC and CP. Groups 2 -5 underwent a wine-water-saliva cycle on seven consecutive days. Specimens were polished with Proxyl[®] (Vivadent) after the last discoloration cycle. Using CIE L*a*b* values, color readings were taken using a small-area colorimeter (ShadeEyeNCC[®], Shofu) after final polishing, to differentiate between extrinsic and intrinsic stain. ΔL , Δa , Δb as well as ΔE values were calculated to

determine the color change. Statistical evaluation (oneway ANOVA, unpaired t-test) was performed using SPSS version 12.0.

Results: Materials in group 1 showed the least change in color. Comparisons between group 2 and 3 (Filtek 4.04±1.5, 2.45±0.8; Ecusit 4.6±0.5, 2.8±1.1; Z250 5.1±1.2, 3.2±0.7; Herculite 3.2±1.1, 3.9±1.8; Durafill 5.5±1, 4.8±0.6) revealed significantly lower ΔE values for the bleached materials. Similar results were obtained between group 4 and 5. In these groups the average values of Ecusit, Z250, Herculite and Durafill were not affected by the CP, while the ΔE values for Filtek (5.6±0.8, 3.32±0.3), Dyract (5.9±1.1, 4.2±0.5) and Ketac (12.5±2.3, 19.4±2.1) differed significantly. TC significantly increased ΔE values for all materials. Groups with CP showed lower ΔE values.

Conclusion: Application of CP is able to reduce staining intensity of toothcolored resin based filling materials.

0126

Marginal adaptation, microhardness of reduced-shrinkage composite cured with different lights

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Objective: To investigate the effect of different light-curing units (LCU) on marginal adaptation (MA) and microhardness (KHN) of a reduced-shrinkage composite (Neun, Heraeus Kulzer).

Methods: Standardized Class II cavities with gingival margins in dentin were prepared on 72 bovine teeth. Specimens were randomly divided into six groups (n=12), each group being restored with a different composite-LCU combination. Composites used were Neun and Venus (Heraeus Kulzer). The LCUs were the Optilux 501 (501, Demetron/Kerr), Translux Power Blue (TPB, Heraeus Kulzer), and Elipar FreeLight 2 (FL2, 3M ESPE). Composites were inserted and cured incrementally (2 mm-40s/increment). After load cycling (100,000x, 2-Hz), epoxy replicas of the proximal surfaces were obtained, and the MA was determined by measuring gingival margin gap width using SEM (500X magnification). Six specimens from each group were randomly selected and sectioned for measurement of the composite subsurface KHN at the occlusal, middle, and gingival thirds. Data were analyzed by ANOVA and Tukey's test.

Results: Mean gap measurements (\pm SD) in microns are shown in the Table. (Same superscript letters indicate $p \geq 0.05$.)

Venus-501	2.6 (1.4)
Venus-TPB	1.7 (0.5)
Venus-FL2	4.7 (2.5)

Neun-501	2.4 (1.2)
Neun-TPB	1.9 (1.1)
Neun-FL2	3.6 (1.9)

No significant MA differences were noted between composites. Among LCUs, TPB resulted in better MA than 501 and FL2. Regarding microhardness, for all groups the occlusal third had the highest and the gingival third had the lowest KHN. When LCUs were compared within each composite, Neun-TPB resulted in the lowest KHN, regardless of location, while Venus-TPB had the lowest KHN at the occlusal third, with no significant differences noted at the other locations.

Conclusions: Marginal adaptation and microhardness were affected by LCU and composite, and the results were LCU- and composite-specific. No significant MA differences were noted between composites. Neun had higher KHN than Venus.

Supported by Heraeus Kulzer.

0412

Shrinkage stress of new experimental low shrinkage resin composites

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Objective: Low shrinkage resin composites are in the focus of research in posterior resin composite restoratives. The aim of this study was to examine the polymerization shrinkage stress of experimental low shrinkage resin composites (K0152/Dentsply, NEUN/Heraeus, Hermes/3M ESPE) in comparison to new and established low shrinkage resin composites (Tetric EvoCeram/Ivoclar Vivadent, QuiXfil/DENTSPLY, Xtrafil/VOCO).

Method: Cylindrical cavities (\varnothing 5mm) in Araldit B epoxide resin plates (40x40x3mm) were pretreated with the Rocatec system to ensure a bonding of the resin composites. The resin composite specimens (n=10) were exposed for 60s with a QTH curing device (Translux Energy, Heraeus Kulzer, Germany). The samples were stored dark and dry (23°C). Polymerization shrinkage stress data [MPa] 5 min and 24 h post exposure were calculated based on the diameter of the isochromatic curves of first order, obtained from the Araldit-plates. Statistical analysis was carried out with the Wilcoxon-test ($p = 0.002$, Bonferroni adjustment).

Results: After 24h the following mean stress values were obtained: 3.7 ± 0.08 MPa for Tetric EvoCeram, 4.7 ± 0.2 MPa for Quixfil, 4.6 ± 0.1 MPa for Xtrafil, 3.8 ± 0.1 MPa for K0152, 3.7 ± 0.05 MPa for NEUN and 2.9 ± 0.3 MPa for Hermes. After 24 h, due to post-exposure shrinkage, significantly higher polymerization stress values ($p < 0.001$) were recorded for all materials, except for Hermes. After 24 h, significant differences ($p < 0.001$, Bonferroni correction) were found between Hermes and all other composites while K0152 and NEUN showed significantly less shrinkage stress compared to QuiXfil and Xtrafil.

Conclusion: New low shrinkage resin composite formulations are able to show a significantly reduced shrinkage stress compared to most of the conventional resin composites investigated. After 24h, the experimental silorane restorative Hermes showed the lowest polymerization shrinkage stress.

This study was supported by DENTSPLY/Konstanz and Heraeus/Hanau.

0374

Hydrophobic coating on simplified self-etching adhesive: in vivo nanoleakage expression

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One-step self-etch adhesives revealed high simplicity and improved user-friendliness, nevertheless they exhibited guarded laboratory and clinical performances when compared with multi-step adhesives. These all-in-one adhesives are prone to degradation due to their high hydrophilic monomer content that expedite water sorption.

Objectives: Aim of the study was to investigate the effects on nanoleakage expression of bonded interfaces when I-Bond New Generation (Heraeus Kulzer) was applied in vivo with or without an hydrophobic layer. Nanoleakage analysis was performed at light microscope level immediately and after 6 months of in vivo use.

Methods: Human molars and premolars scheduled for extractions were selected. Two occlusal cavities were prepared on each tooth. I-Bond New Generation was applied. One restoration was immediately filled with Venus (Heraeus Kulzer), while an additional hydrophobic coating (Bond solution of Scotchbond Multi-Purpose) was added in other restoration before applying composite resin. Four teeth were immediately extracted and analysed, four teeth were extracted after 6 months of clinical function. The

adhesive interface was exposed with low speed diamond saw and specimens were immersed in silver nitrate solution for nanoleakage identification. Adhesive interfaces were processed with standard procedures for light microscopy for investigation of nanoleakage distribution.

Results: The morphological analysis revealed nanoleakage formation after application of dentin bonding systems in all groups. No differences were found regardless to the presence of an hydrophobic coating if teeth were extracted immediately after adhesive application. On the other hand interfaces aged for 6 months of clinical service showed significant nanoleakage reduction if the hydrophobic solution of Scotchbond Multi Purpose was applied onto simplified adhesive layer.

Conclusions: The use of an additional hydrophobic coating on a simplified self-etching adhesive reduces nanoleakage expression and may contribute to increase long term stability of the adhesive interface. How much this coating contributes to improve bond stability should be further investigated.

0927

Mechanical properties of adhesives

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Objective: An important task of dental adhesives is to serve as a “stress breaker” during occlusal loading of adhesive-restored teeth. Aim of this study was to compare different adhesive systems in view of their mechanical properties.

Conclusions: With the limitation of this study, the tested two-steps self-etch adhesives as material class, exhibited significantly lower mechanical properties compared to the other adhesives classes.

Methods: The mechanical properties of 5 one-step self-etch¹, 2 two-steps self-etch² and one two-steps etch-and-rinse adhesives³ (Table) were measured by means of a microhardness indenter (Fischerscope H100C, Fischer, Germany). The Universal hardness was defined as the test force divided by the apparent area of the indentation under the applied test force and was converted in the more familiar Vickers hardness. The indentation modulus was calculated from the slope of the tangent of indentation depth-curve at maximum force. By measuring the change in indentation depth with constant test force, a relative change in indentation depth was calculated (Creep). Additionally the total mechanical work and its components elastical and plastical were calculated (We/Wtot). The adhesives were applied on 1 mm thick dentin disks following the recommendations of the manufacturer. All adhesives were photo-polymerised with the LED curing unit Freelight 2 for 20s, followed by a storing of the samples for 24 h in dest. water.

Results:

Adhesives	Manufacture	HV	E-Modul	Creep	We/Wtot
Admira Bond ³	VOCO	18.7 (4.1)	4.5 (0.9)	5.9 (0.7)	35.8 (3.2)
Futurabond NR ¹	VOCO	22.8 (2.7)	4.0 (1.0)	5.0 (0.3)	43.7 (5.8)
Solobond Plus ¹	VOCO	24.2 (4.8)	4.6 (1.0)	4.5 (0.5)	44.0 (5.4)
Hybrid Bond ¹	Sun Medical	25.6 (5.6)	5.3 (1.0)	5.2 (0.8)	37.5 (5.3)
Clearfil SE Bond ²	Kuraray Medical Inc.	22.1 (6.1)	4.3 (1.0)	5.6 (0.5)	39.2 (4.2)
Clearfil S ³ Bond ¹	Kuraray Medical Inc.	23.9 (5.9)	4.4 (1.0)	5.4 (1.1)	40.1 (7.8)
Clearfil Protect Bond ²	Kuraray Medical Inc.	17.2 (2.8)	3.6 (0.7)	5.8 (0.8)	37.4 (4.8)
Experimental i-Bond ¹	Heraeus Kulzer	23.4 (5.6)	5.0 (1.4)	5.6 (1.0)	37.4 (5.2)

*ANOVA(a=0.05) and post-hoc Tukey’s test.

1506

Evaluation of Solvent Evaporation Procedure of a New All-in-One Adhesive

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Objective: Aim of this investigation was to evaluate the influence of different solvent evaporation procedures when using experimental iBond (IB+, Heraeus Kulzer), a newly developed experimental self-etching adhesive by determination of the shear bond strength (SBS) to human dentin.

Methods: Under water cooling flat dentin surfaces (n=8) were prepared on SiC paper, grit 80 through 500. One coat of IB+ was applied to the tooth and let dwell for 20s under agitation. During following solvent evaporation distance between tooth surface and air syringe (1cm, 3cm, 5cm), evaporation time (2s, 5s, 10s), and angle between air stream and tooth surface (45°, 90°) were varied. After light curing of adhesive Venus composite (Heraeus Kulzer) was bulk filled in cylindrical plastic molds (Ultradent equipment) and light cured. 20s light activation of both adhesive and composite was done with a LED curing unit (Translux Power Blue, Heraeus Kulzer). SBS was determined after 24h storage of specimens in 37°C tap water. Statistical analysis was done by ANOVA and Bonferroni (p<0.05).

Results: Mean SBS [MPa] without solvent evaporation: 10.8. Mean SBS with solvent evaporation as follows (same capital letters denote no significant differences):

	1cm (90°)	3cm (90°)	5cm (90°)	1cm (45°)
2s	33.3	18.3	12.0	29.7
5s	31.3	25.3	15.1	32.4
10s	37.0	32.1	18.8	35.4

Conclusions: According to this investigation both the evaporation distance and the evaporation time have a strong influence on the performance of IB+. Longer distances and shorter evaporation times lead to significant lower SBS values. At short distances evaporation time has only marginal influence on SBS. When using short distances and longer evaporation times the angle has no influence on the performance of IB+.

1992

SBS comparison of One-Step dentin-bonding-systems on primary tooth dentin

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Objective: To compare shear bond strengths (SBS) of composite materials to primary dentin when used with various One-Step dentin-bonding-agents.

Methods: Extracted primary teeth were divided into 4 groups of 15 specimens each. The teeth were mounted in phenolic rings with acrylic resin and wet-ground so as to expose an experimental dentin testing surface of at least 2.5mm in diameter. The following bonding agents were used in each group: group I (control) - Clearfil SE Bond, group II - Adper Prompt L-Pop, group III - iBond SE, group IV - Clearfil S3. A 2.38mm projection of Herculite XRV Unidose composite was bonded to the dentin surface. After 1000 cycles of 5-55°C thermocycling the specimens were tested in MTS machine with shear force until failure occurred. Load at failure was recorded in Newton and bond strength was calculated into Mega-Pascal. The debonded surfaces were evaluated for cohesive or adhesive failures.

Results: 6 specimens in iBond SE group had cohesive failures in dentin while all the other specimens broke in the bonding interface. Means of SBS (MPa) are listed in the following table with standard deviation in parenthesis. 1-way ANOVA test showed that the bonding agent had a statistically significant influence on SBS.

Clearfil SE Bond	Prompt L-Pop	iBond SE	Clearfil S
17 (10)	12 (6)	29 (6)	24 (6)

Means with the same superscripted letter are not statistically different from each other at $p < 0.05$.

Conclusions: Different dentin bonding agents created different shear bond strengths between the composite and the primary dentin. iBond SE appears to have the highest bonding strength on primary tooth dentin, when taking the cohesive failure into account.

0341

SBS of All-In-One Self-etch Adhesives to Human Dentin

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Single bottle bonding agents claim one step in the bonding procedure.

Objective: to compare an experimental All-in-one self-etch adhesive (Kerr) to four other one-bottle adhesives.

Materials and Methods: the four one-bottle adhesives were Clearfil S3 (Kuraray), G-Bond (GC America), iBond (Heraeus Kulzer), and Xeno IV (Dentsply). Healthy human third molar was embedded in acrylic and the exposed dentin surface was polished with 600 grit SiC paper. Each bonding agent was applied to the tooth surface according to its manufacturer’s instructions and a bonding jig (UITradent) with a cylindrical mold (D=2.38mm) was securely placed on the dentin surface. Herculite XRV (A2 shade, Kerr) was condensed into the jig and light cured for 30 sec. The bonded specimens (n=8) stored in 37°C water for 24 hours before debonding with shear force on an Instron tester at crosshead speed of 1 mm/min.

Results: Three out of the eight specimens in the experimental group and two specimens in Clearfil S3 group had dentin cohesive failure while specimens in the other three groups failed adhesively at the bonding interface. The means of the SBS of tested adhesives to dentin are listed in the following table with standard deviation in parenthesis.

*Means with the same letter are not statistically different from each other at $p < 0.05$. Analysis: 1-way ANOVA reveals that the adhesive had significant influence on SBS on dentin. The experimental adhesive had significantly higher ($p < 0.05$) SBS than G-Bond and i-Bond. The SBS’s of the experimental adhesive, Clearfil S3, and Xeno-IV were not statistically different ($p < 0.05$) from each other.

Conclusion: The experimental adhesive showed higher bond strength than most of the adhesive tested in the study.

This study is partially supported by Kerr.

Bonding agent	Experimental	Clearfil S3	G-Bond	i-Bond	Xeno IV
SBS (MPa)	35.0 (5.6)a	30.4 (7.1)a	10.3 (2.9)c	20.2 (5.5)b	32.2 (8.1)a

0357

Enamel and dentin μ TBS of simplified adhesives

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Dental adhesives have evolved from multi-step etch&rinse systems to all-in-one solutions.

Objective: Compare the μ TBS of an experimental all-in-one adhesive with four commercially available all-in-one adhesives using an etch&rinse adhesive as control.

Methods: 42 extracted third molars were randomly assigned to one of 7 groups: Clearfil S3 Bond (CS3, Kuraray); EXL 683 (3M ESPE) with 20s agitation (EXA); EXL 683 without agitation (EXNA); G-Bond (GB, GC America); iBond (iB, Heraeus Kulzer); Xeno IV (XE, Dentsply Caulk). Adper Single Bond Plus (SB, 3M ESPE) was used as control. For ground enamel, the proximal surfaces of 21 teeth was roughened with a diamond bur for 5s, bonded, and restored with Filtek Z250 (3M ESPE). Teeth were sectioned in X/Y directions to obtain sticks with a cross-sectional area of $0.8 \pm 0.2 \text{ mm}^2$. For dentin, occlusal middle dentin was bonded in 21 teeth and crowns restored with Filtek Z250. Teeth were sectioned in X/Y directions to obtain sticks with a cross section of $0.7 \pm 0.2 \text{ mm}^2$. All sticks were fractured in tension (Instron 4204) at a crosshead speed of 1mm/min. Statistical analysis for each substrate: 1-way ANOVA and Duncan's, $P < 0.05$ (for each column, superscript letters indicate significance).

Conclusion: The control group resulted in statistically higher μ TBS than the all-in-one adhesives tested. For the all-in-one adhesives, EXL683 (without agitation) on dentin and Clearfil S3 Bond on ground enamel resulted in the highest μ TBS. Supported by 3M ESPE.

Results: (Mean \pm SD in MPa; PTF = pre-testing failures, 0 MPa):

Dentin			Ground Enamel			
Mean \pm SD	PTF	N	Adhesive	N	PTF	Mean \pm SD
35.2 \pm 14.8	2	87	CS3	56	0	29.2 \pm 10.9
52.8 \pm 19.6	0	114	EXNA	59	1	23.0 \pm 10.7
44.9 \pm 21.3	2	97	EXA	60	3	20.6 \pm 10.1
23.0 \pm 13.5	14	108	GB	53	7	18.9 \pm 10.3
28.6 \pm 16.1	9	119	iB	47	6	17.7 \pm 10.7
45.4 \pm 23.0	7	101	XE	41	2	20.2 \pm 9.6
76.3 \pm 19.3	0	82	SB	65	0	35.2 \pm 9.5

0846

Longevity of Single Bottle Dentin Adhesives

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Objective: Dentin adhesives have evolved to the point where etch, primer, adhesive resin are now available in All-in-One formulations. The purpose of this study is to examine the effect of long term storage on the shear bond strength of several of these All-in One adhesives and one two bottle self-etch dental adhesive.

Methods: & Materials: 96 human molars were ground exposing dentin then sectioned to create 192 dentin specimens. These were placed into 1 inch methylmethacrylate cylinders. Test samples were ground flat & polished with 320 grit wet-dry emery cloth. Samples were aged in water at 37 degrees C for 2 months prior to testing. Samples were separated into 8 groups.

Adhesives selected for testing - G-Bond™ (GC America); iBond™ (Heraeus Kulzer); Adper Prompt-L-Pop™ (3M ESPE); Xeno IV™ (L.D.Caulk); Futura Bond™ (Voco); Clearfil S3™ (Kuraray); LC Etchbond™ (S&C Polymer); Simplicity™ (Apex Dental) 2 bottle system as a control. Adhesives were applied as instructed. 2.38mm diameter X 1.5mm high composite posts, Z-100™ (3M), were placed and polymerized using a 700mW/cm² FlashLite 1401™

(Discus Dental) for 40 seconds. Samples were stored in water at 37 degrees C, stressed to fracture using a Universal Testing machine, notched blade apparatus, with a crosshead speed of 1mm per minute. 12 specimens of each of the 8 adhesives were tested after 24 hours, and 12 of each at 10 months.

Results: Averaged (std dev) were as follows: 24 Hours 10 months G-Bond - 17.10MPa (2.67) 24.65MPa (6.79) iBond - 25.30MPa (2.31) 29.48MPa (6.45) Adper PLP - 19.80MPa (7.77) 26.98MPa (7.43) Xeno IV - 25.70MPa (3.01) 43.96MPa (5.83) FuturaBond - 16.20MPa (3.33) 45.03MPa (4.97) Clearfil S3- 31.10MPa (3.21) 26.40MPa (3.57) LC Etchbond- 12.80MPa (6.54) 21.84MPa (8.67) Simplicity - 43.84MPa (2.99) 48.71MPa (3.91)

Conclusions: This in-vitro testing suggests that the adhesives tested maintain stable bond strengths following long term storage and most actually increase in bond strength over time.

0898

Self Etch Adhesive in deciduous teeth – 12-month results

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Objective: The aim of this study was to compare the clinical performance of adhesive Class I- and II resin composite restorations using a self etching and an “etch & rinse” adhesive, according to the Ryge/CDA-criteria in primary teeth.

Method: In a split-mouth design, the children (mean age: 52 ±15.5 months) received 62 pairs of comparable Class I or II restorations using a self etching (iBond GI, Heraeus Kulzer, Hanau, Germany) and an “etch & rinse” adhesive (Gluma Comfort Bond + Desensitizer, Heraeus Kulzer, Hanau, Germany). The two adhesives were randomly assigned to cavities. To ensure the comparability, Venus SB1 was used for all restorations and VL-curing was conducted incrementally for 20s each. 32 restorations were placed in a university dental clinic and 30 restorations in a private practice. Statistical evaluation was performed using Wilcoxon signed rank and Mann-Whitney tests.

Results: After 12 months, the results [in %] of the Ryge/CDA-evaluation for both groups (Gluma Comfort Bond+Desensitizer / iBond) were: marginal adaptation: Alfa: 38/54, Bravo: 62/46, Charlie:0/0, Delta: 0/0; anatomic form: Alfa: 83/86, Bravo: 17/12, Charlie 0/2; secondary caries: Alfa: 100/93, Bravo: 0/7; marginal discoloration: Alfa: 40/62, Bravo: 55/31, Charlie: 5/7; surface: Romeo: 88/92, Sierra: 12/8, Tango: 0/0, Victor: 0/0; color match: Oscar: 57/67, Alfa: 38/28, Bravo: 5/5, Charlie: 0/0; postoperative sensitivity: Alfa 1: 93/93, Alfa 2: 2/0, Bravo: 5/7, Charlie: 0/0, Delta: 0/0; integrity of tooth: Alfa 1: 88/83, Alfa 2: 12/17, Bravo: 0/0, Charlie: 0/0, Delta: 0/0. Except for secondary caries and postoperative sensitivity, all differences after 12 months were statistically significant in comparison to baseline. However, the differences between the study groups were not significant.

Conclusion: After 12 months, the clinical performances of both adhesives were comparable.
This study was supported by Heraeus Kulzer, Hanau, Germany.

0899

3-Year Clinical Evaluation of an All-In-One Self-Etching Dental Adhesive

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Objective: The purpose of this randomized clinical trial was to evaluate the clinical performance of an all-in-one self-etching dental adhesive (iBond, Heraeus Kulzer) versus that of a multi-step total-etch dental adhesive (Gluma Solid Bond, Heraeus Kulzer) when used to restore non-carious cervical lesions.

Methods: Lesions were characterized preoperatively relative to height, width, depth, percent of margin in enamel, internal angle, and degree of sclerosis. Fifty-five non-carious cervical lesions were randomly assigned to two treatment groups according to the adhesive used: iBond (n=28) or Gluma Solid Bond (n=27). The exposed walls of the lesion were roughened with a diamond instrument. No retentive grooves or bevels were used. Lesions were restored with Durafill VS (Heraeus Kulzer). Adhesives and composite were applied according to manufacturer's directions and light-cured using Translux Energy (Heraeus Kulzer). The restorations were evaluated at baseline, 6 and 18 months, and 3 years post-insertion for retention, secondary caries, marginal adaptation/integrity, and marginal discoloration using modified USPHS criteria for clinical

evaluation of dental restorations. Data were analyzed using Fisher's Exact Test ($p=0.05$) for significant differences between treatments.

Results: Overall lesion characteristics were similar for both treatment groups, and all baseline scores were alpha for restorations in both treatment groups. The 6-month, 18-month and 3-year recall rates were 100%, 95% and 86%, respectively. No retention failures or secondary caries were observed at any of the evaluation visits. No significant differences were detected between iBond and Gluma Solid Bond regarding marginal adaptation/integrity ($p=0.09$). iBond had significantly more marginal discoloration than Gluma Solid Bond at 18 months and 3 years ($p=0.003$).

Conclusions: The all-in-one self-etching dental adhesive had a higher incidence of marginal discoloration than the total-etch dental adhesive at 18 months and 3 years post-insertion. No clinical failures were observed as determined by modified USPHS criteria.
Supported by Heraeus Kulzer.
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1993

In-vitro bond strength testing – human vs bovine primary teeth

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Objective: This in vitro study assessed bovine primary teeth as a replacement for human primary teeth in shear bond strength testing of adhesive luting agents to dentin and enamel of human and bovine origin teeth.

Methods: Shear bond strength and fracture modes of extracted human (n=88) and bovine (n=88) primary teeth were determined after 24 h storage in aqua dest for Syntac Assortment (SY), Adaper Prompt L-Pop (PLP), iBond Gluma inside (IB) and Clearfil Protect Bond (PB) together with the composite Clearfil AP-X. Eleven replicate tests were performed for each group. The data were statistically analysed with the Mann Whitney U-test, the Error Rates Method (ERM with $\alpha=0.05$) and the fracture modes were analysed with the Fishers exact test.

Results: Shear bond strength in MPa (medians and 25-75% quartiles, n = 11)

Bond strength data for dentin of both human and bovine primary teeth were, in general, statistically different from those of enamel (ERM). Bond strength and fracture modes of human primary teeth were, in general, not statistically different from those of bovine primary teeth (ERM). On enamel SY and PB yielded significantly higher shear bond values than other materials, on dentin IB and PB.

Conclusion: Bovine teeth may be considered a suitable alternative to human teeth for bond strength tests of primary teeth dentin and enamel.

	Human primary teeth		Bovine primary teeth	
	enamel	dentin	enamel	dentin
SY	42.3 (41.2/51.5)	27.8 (25.9/36.4)	46.0 (38.6/48.5)	33.5 (30.4/45.4)
PLP	30.9 (27.4/33.5)	29.5 (19.0/32.0)	34.9 (33.1/37.5)	30.3 (18.2/34.4)
IB	29.5 (26.4/31.9)	40.1 (32.7/48.2)	27.4 (24.3/28.8)	31.0 (29.4/40.3)
PB	39.5 (35.9/41.2)	29.9 (24.7/32.7)	41.1 (38.3/44.6)	37.6 (34.0/41.0)

2640

Effect of Bleaching on Shear-bond-strength of Composite to Enamel

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Objective: Carbamide peroxide bleaching has been implicated in adversely affecting the bond strength of composite to enamel. This in vitro study evaluated the effect of a total etch dentin bonding agent, Scotchbond Multipurpose(3M St. Paul, MN, USA) and two self-etch ones, Prompt L-Pop(3M /ESPE, Seefeld, Germany) and i-bond (Heraeus, kulzer, Germany) on the shear- bond-strength of composite to bleached enamel.

Methods: Seventy two intact human molar teeth randomly assigned to 3 control and 3 experimental groups. Experimental groups were subjected to a %15 carbamide peroxide bleaching system (Opalescence, Ultradent Product Inc, USA). Then, the buccal enamel of all control and experimental groups were bonded with cylinders of composite (Filtek Z250, 3M, USA), using three dental bonding agents. After Thermo cycling, shear- bond- strengths were determined by a universal testing machine.

Results: Scotchbond Multipurpose aided bond strengths were 19.52 5.21 MPa to unbleached and 7.95 4.16 MPa to bleached enamel. For Prompt L-Pop, bleached enamel exhibited bond strength of 5.39 0.66 MPa and unbleached enamel exhibited 9.66 2.89 MPa. The composite bond strengths for i-bond were 11.46 4.31 MPa to unbleached and 6.41 2.01 MPa to bleached enamel. One way ANOVA showed significant statistical differences between the shear bond strengths of control and experimental groups of three dental bonding agents ($P<0.001$).

Conclusion: Shear- bond- strength of composite to enamel bleached with %15 carbamide peroxide used in this study decreased and was not dependent on the bonding agents used.

Impression Materials



1621

Initial Water and Saliva Wettability of Elastomeric Impression Materials

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Abstract:

Purpose: The purpose of this study was to validate the effectiveness of clinical findings with early caries diagnostic/detection devices.

Objectives: Usually, wettability studies of unset impression materials are performed with water drops placed on thin material films. Clinically, however, the impression materials will contact physiological solutions, e.g. saliva. This study focuses on whether water is a proper model liquid instead of physiological solutions for hydrophilicity studies, especially for the clinically relevant “initial hydrophilicity”.

Methods: Three additional curing silicones (Affinis, Flexitime, Panasil Contact Plus) and one polyether (Impregum L Duosoft Quick) were studied 30s, 60s and 90s after mixing by high resolution drop shape analysis for initial contact angles of 1/25s and 1s old drops of pure water and modified Fusayama saliva containing bovine serum albumin. Each measurement was repeated fivefold and the mean contact angles of water and saliva were tested for statistically significant differences (t-test, $p < 0.05$).

Results: All materials showed 30 s after mixing for both drop times analyzed (1/25s and 1s) no statistically significant differences between water and saliva mean contact angles ($p > 0.05$). The mean difference (standard deviation) between water and saliva of all measurements was 0.7° (4.2°) for 1/25s old drops and 0.7° (2.7°) for the 1s drops and thus being small compared to the measurement accuracy (mean standard deviation of 6.3° for repeated measurements). The 95% confidence interval of all differences of 1/25s old drops ranges from -2.0° to 3.4° and of 1s old drops from -1.1° to 2.4° .

Conclusion: Based on this study, pure water is suitable for hydrophilicity studies during the setting time of impression materials. Since water contact angle data are comparable to those of saliva used here and lead to the same results in the evaluation of materials, water can be used as a model liquid simulating physiological wetting conditions.

Financial support of 3M ESPE, Germany, is gratefully acknowledged

2705

Compressive Strength Analysis: Precision Milling of Unsupported vs. Supported Y-TZP

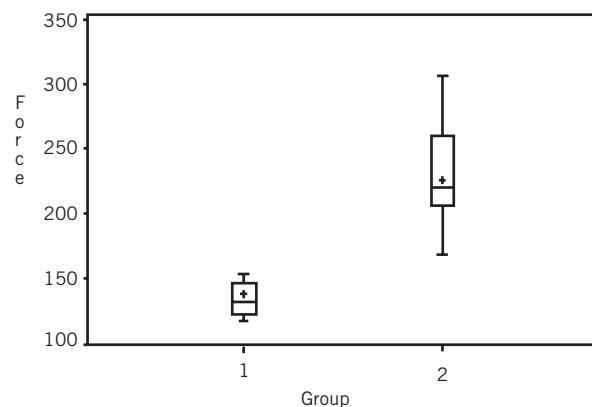
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Most CAD/CAM Y-TZP (zirconia) restorations are milled in an Unsupported mechanism requiring thicker coping designs for stability followed by manual finishing to render cores 0.3mm thick. Supported mechanism milling systems are the minority; machine to 0.3mm without hand-manipulation.

Objective: To compare compressive strength of Unsupported (Lava, 3M-ESPE) vs. Supported (Everest, KaVo) 0.3mm zirconia cores post-sintering.

Methods: Dentoform premolar was prepared using standardized zirconia guidelines. Light/heavy-body impression (Flexitime, Heraeus Kulzer) was made to fabricate master die (Type 4 Scanning Stone, KaVo). Master die was scanned with each milling center's proprietary software (Everest Scan Pro, KaVo/Lava CAD, 3M-ESPE) and used to fabricate cores with 35 μ gapping. Titanium die with occlusal channel (2mm-W x 2mm-D) cut mesially/distally was created to support cores on Instron. Cores were fabricated: (Group1) N=15 from authorized 3M ESPE Lava Milling Center machined to 0.4mm thickness per manufacturer instructions and hand-finished to 0.3mm; (Group 2) N=15 from authorized KaVo Everest Milling Center machined directly to 0.3mm thickness. Cores checked for marginal integrity/fit. Cores subjected to compressive force at crosshead speed of 0.5mm/min. Load at failure recorded in Newtons.

Results: Force required for fracture of 13 Unsupported and 15 Supported cores was assessed. Supported cores (Group 2) fractured at mean (SD) force of 225.94 (37.5). Unsupported cores (Group 1) fractured at mean (SD) of 132.78 (12.5). Using two-sample t-test, this difference was highly statistically significant ($p < 0.0001$).



Conclusion: Study results imply that Group 2 cores fractured at statistically significantly higher load than Group 1 and Unsupported milling of Y-TZP renders cores more vulnerable to compressive strength than Supported milling. (Study supported in part by KaVo.)

Others



0015

Influence of Desensitizers and Adhesives on Dentin Demineralization in Situ

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Objectives: The objective of this study was to evaluate the influence of five bonding agents and desensitizers on dentin demineralization in situ.

Methods: The root surfaces of 60 freshly extracted human molars were thoroughly cleaned, thereby removing the cementum. From each tooth root dentin specimens were prepared. 120 specimens were distributed among the following experimental groups: A: Syntac, B: Xeno III, C: Admira Protect, D: Gluma Desensitizer, E: Hyposen, F: control group, untreated. Two dentin specimens of each group were inserted into two buccal aspects of ten intra-oral mandibular appliances. The appliances were worn by ten persons for five weeks.

One side was brushed daily with a fluoride-containing toothpaste (Aronal). During meals, the appliance was stored in 10% sucrose solution. After the in situ period, two slabs (150 microns) were ground. The depth of the demineralized areas was determined using a polarized light microscope. For each group mean value and standard deviation were calculated. Statistical analysis was performed using ANOVA and Tukeys test.

Results: Concerning lesion depth, ANOVA revealed significant differences between brushed (b) and non-brushed (nb) specimens. Following lesion depths were evaluated (mean values and standard deviation in microns):

Compared to the untreated control, lesion depths in groups A-E were significantly decreased in the brushed and also in the non-brushed subgroups ($p < 0.05$, Tukeys test).

Conclusions: Within the limitations of an in situ study it can be concluded that the demineralization of the root surface can be hampered by application of dentin adhesives and desensitizers under different oral hygiene conditions.

Group	A		B		C		D		E		F	
Oral hygiene	B	NB	B	NB	B	NB	B	NB	B	NB	B	NB
Mean lesion depth	27.1	61.4	28.9	56.3	21.7	49.2	32.8	68.2	33.8	71.1	72.4	99.7
+/-	8.7	15.4	9.4	12.0	8.4	11.2	7.8	11.8	10.8	16.9	16.1	21.7

1627

Tensile Strength Comparison of Three Different Obturation-Posts in Vitro

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Objective: To compare in vitro tensile strength of three different obturation-post systems.

Methods: Forty-five human, single rooted teeth (Average root length 17.5mm) were collected and temporarily stored in a saline and sodium azide 5% solution for 24 hours and then stored in distilled water until testing. The anatomic crowns were removed to the level of the cemento-enamel junction. The teeth were allocated randomly into three groups of 15 (N=15) and obturated:

Group 1 = Lateral Condensation technique with hand files

Group 2 = Thermafil (DENTSPLY Tulsa) technique with rotary files

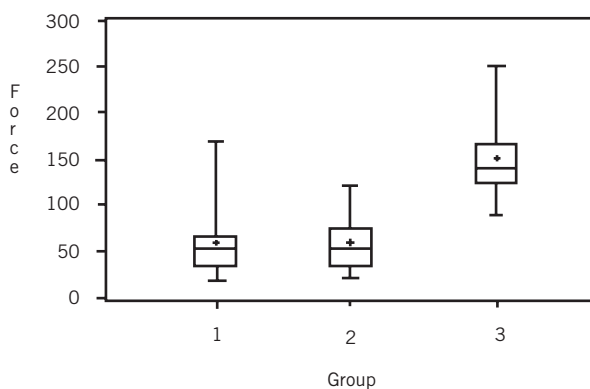
Group 3 = InnoEndo (Heraeus Kulzer) technique with rotary files

Post space was created for Groups 1 & 2. The appropriate parapost (Coltene Whaledent) was selected and cemented using Fuji II cement (GC America Inc). Group 3 was a two-in-one post/obturator system using a dual-cured resin cement.

Group 3 resulted in tensile strength that was twice that of either Group 1 or 2. To detect a 100% difference in force required between the groups, and assuming a common standard deviation of 40 N, N= 15 to achieve 95% power (nQuery 5.0). One-way analysis of variance (ANOVA) was used to test whether or not there was difference among the 3 treatments. An overall difference was detected and a pairwise t-test was performed using Scheffe's adjustment for multiple comparisons. All tests were two-sided; p-values < 0.05 were considered statistically significant. All analyses were performed using SAS (Version 9.1, Cary NC).

Conclusion: Based on the one-way ANOVA, we see that the means for the 3 groups differ greatly ($p < 0.0001$). There was no statistically significant difference between the mean for Group 1 and 2 ($p=0.998$) but both groups performed worse than Group 3 ($p < 0.0001$).

Results:



Notes

Only Heraeus, Charisma, Durafill, Flexitime, iBOND GLUMA inside, iBOND Self Etch, InnoEndo, GLUMA Comfort Bond + Desensitizer, GLUMA Solid Bond, Translux Power Blue and Venus are registered trademarks of Heraeus Kulzer.

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