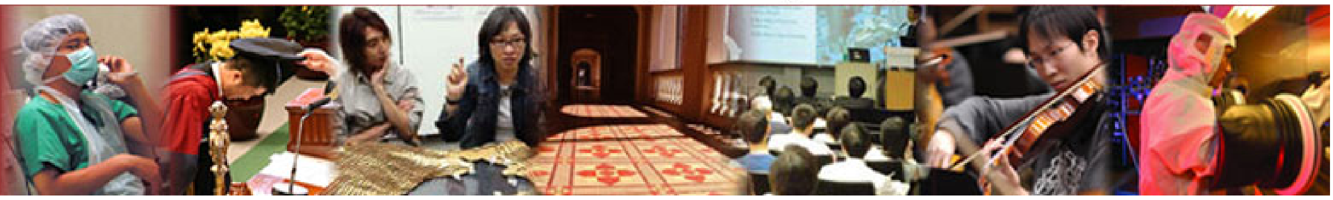

2921 Relationship Between the Thickness of Resin Layer and Bond Strength

L. ZHENG*, P.N.R. PEREIRA, M. NAKAJIMA, H. SANO and J. TAGAMI (Tokyo Med. & Dent. Univ., and Hokkaido Univ.)

The purpose of this study was to evaluate the effect of the thickness of the adhesive resin layer of two commercially available resin bonding systems on bond strength. Forty-six freshly extracted molars were ground flat and randomly divided into two groups to be treated with either Clearfil Liner Bond 2V (LB 2V, Kuraray Corp.) and Single Bond (SB, 3M Corp.). They were further divided into subgroups according to the different thickness of the adhesive resin layer. After 24h storage in water, the teeth were sectioned into 0.7 mm thick slabs and then trimmed to a cross-section area of 1 mm^2 and subjected to the microtensile bond test. The data were analyzed by one-way ANOVA and Fisher's PLSD ($p<0.05$).

Thickness of adhesive resin layer vs. Tensile bond strength to dentin

	Thickness(μ m)	TBS± SD(MPa)		Thickness(μ m)	TBS± SD(MPa)
LB 2V	5-30	31.4±11.0	SB	<7.5	34.0±3.1
	150-260	34.0±6.1		7.5-25	34.7±2.7
	300-470	45.6±4.8		45-50	30.4±8.6
	500-580	48.7±10.8		60-85	28.7±8.3
	700-870	56.8±8.0		120-290	20.3±2.0
	1100-1500	57.1±7.1		300-360	11.1±4.6

The vertical bar represents no statistical significant difference (p>0.05). For Liner Bond 2V, bond strength significantly increased as the thickness of adhesive resin layer increased. However, bond strengths of Single Bond significantly decreased with the increase of thickness of the adhesive resin layer.

2922 Resin Thickness and Single Vs Dual Cure Photopolymerization: Effects on SBS.

K. TITLEY,*R. CALDWELL, and G.V. KULKARNI.
(Faculty of Dentistry, University of Toronto, Canada).

Polymerization shrinkage occurs in all photo-polymerized resins affecting their physical properties and the marginal integrity of restorations. It has been suggested that shrinkage can be minimized by pre-polymerizing resins at low light intensity followed by a final cure at a higher intensity (dual cure) without significantly affecting the physical properties or marginal integrity. The purpose of this study was to determine if shear bond strength was influenced by the thickness of the resin and the curing method. Standard 4.0 mm diameter cylinders of Z100 (3M) resin composite in gelatin lined polyvinyl templates of 1.5, 3.0, and 4.5 mm in thickness were bonded to human third molar dentin (N=12 per group) by either 3M Scotchbond Multipurpose (SBMP), or 3M Single Bond (SB) adhesive resin. Using an ESPE Elipar® Highlight the adhesives were cured for 10s ($700mW/cm^2$), and the Z100 either dual cured (DC) 10s ($150mW/cm^2$) and 30s ($700mW/cm^2$), or single cured (SC) 40s($700mW/cm^2$). After 7days of storage in water at 37°C the cylinders were released from their templates and shear bond tested to failure. Shear bond strength (SBS) was recorded in MegaPascals (MPa).

Resin Adhesive	Curing Method	1.5mm	3.0mm	4.5mm
SBMP	DC	16.02 ± 4.92	17.91 ± 4.74	16.20 ± 5.18
SBMP	SC	17.97 ± 6.26	17.30 ± 6.27	17.48 ± 5.27
SB	DC	22.58 ± 5.61	21.85 ± 3.66	12.75 ± 5.76
SB	SC	23.88 ± 3.74	23.19 ± 4.05	16.71 ± 5.00

The results showed that SBS for SBMP were consistent for all three thickness of resin composite (ANOVA; p>0.05) but for SB they decreased for both DC and SC for resin composite of 4.5mm in thickness (p<0.05). The results indicate that no more than 3.0mm increments of resin should be DC or SC at one time particularly when the bond is mediated by SB adhesive.

2923 Thermocycling and Shear Bond Strength – A Standardized Approach.

R. CALDWELL,* G.V. KULKARNI, K. TITLEY.
(Faculty of Dentistry, Univ. of Toronto, Canada).

Thermocycling (TC) has been suggested as being an important component of bond strength testing. The ISO recommends that specimens be exposed to 500 cycles between 5 ± 2° C and 55 ± 2°C with dwell times of at least 20 sec and a transfer time of between 5 and 10 sec. There are considerable variations in TC protocols used. The above ISO protocol was used in this study to assess at what stage after bonding TC exert its most significant effect. In this study 3 5th generation (3M Single Bond (SB), Bisco 1 Step (B1S), Prime and Bond 2.1(P&B 2.1), and 2 4th generation (Scotchbond Multipurpose (SBMP), Bisco All Bond 2 (AB2) adhesives were used to bond 4.0 mm diameter cylinders of Z100 (3M) resin composite to dentin of bovine incisors (N=12 per group). Control groups for each adhesive were stored in water for 7 days at 37°C and then shear tested. Experimental groups were either TC at 24 hr or 6.5 days and shear tested on the 7th day. Shear bond strengths (SBS) were recorded in Mega Pascals (MPa).

Adhesive system	Control 7 days	TC 24 hr SBS 7 days	TC 6.5 days SBS 7 days
SBMP	14.32 ± 4.57	9.79 ± 5.00	7.01 ± 3.58
SB	9.47 ± 3.74	10.45 ± 4.50	13.07 ± 4.23
P&B 2.1	5.74 ± 2.65	4.20 ± 2.75	5.43 ± 3.84
AB2	9.64 ± 4.73	7.94 ± 5.89	6.71 ± 3.25
B1S	8.06 ± 3.36	13.36 ± 4.35	7.14 ± 3.49

SBMP showed significant reductions in SBS after thermocycling (p<0.005), Bisco 1 Step showed a significant increase when TC at 24 hr, P&B 2.1 showed significantly lower SBS compared to all the other materials (p<0.05) which remained unchanged at the two time stages tested (p>0.05). All the other adhesives were not significantly different from each other. The SBS are dependent not only on individual materials but also on the length of time of thermocycling before shear testing.

2924 Degradation of Resin-Dentin Bond Structures in an Oral Environment.

M.Hashimoto[1]*, H.Ohno[2], M.Kaga[1], K.Endo[2], H.Sano[1] and H.Oguchi[1]
[1]Sch. of Dent., Hokkaido Univ., [2]Sch. of Dent., Health Sciences Univ. of Hokkaido.

The problem regarding the evaluation of the longevity of a resin restoration has come to occupy an important status in current adhesive dentistry. The purpose of this study was to investigate the degradation of resin-dentin bond structures aged in an oral environment for 1 to 3 years. The cavities were prepared in primary molars, and an adhesive resin system (Scotchbond Multi-Purpose, 3M, St. Paul, MN) was applied to the cavity. After 1 to 3 years, following the eruption of permanent teeth, the resin-restored teeth were extracted. Immediately after extraction, the teeth were sectioned perpendicular to the adhesive interface and trimmed to produce hourglass-shaped micro-tensile test specimens. Tensile tests were then performed at a crosshead speed of 1.0 mm/min. All fractured surfaces were observed by SEM, and the area fraction of failure mode in SEM photomicrographs was calculated using a digital analyzer. The resin-dentin bonded specimens produced after 24h were tested in the same manner as that of controls. The mean bond strengths of three groups (24h, 1 to 2y, and 2 to 3y) were statistically compared with one-way ANOVA (p<0.05). Several representative specimens of the extracted resin-restored teeth (made after 24h and 1 to 3y) were cross-sectioned perpendicular to the adhesive interface for SEM examination. There were significant differences in tensile-bond strength among the three groups (p<0.05), with mean values ranging from 28.3 ± 11.3 MPa (24h), 15.2 ± 4.4 MPa (1 to 2y), and 9.1 ± 5.1 MPa (2 to 3y). Fractographical analysis demonstrated that the proportion of demineralized dentin at the fractured surface in specimens aged in an oral environment was greater than that in control specimens. Moreover, degradation of the resin composite and depletion of collagen fibrils were observed at the fractured surface in the specimens aged in an oral environment. Deterioration of the bonding resin and the hybrid layer was observed at the interface of the oral environment specimens. The present study clearly showed that degradation of resin-dentin bond structures occurs with aging in the oral cavity.

2925 Two Year Composite to Dentin Shear Bond Strengths.

J.C. MEIERS*, D. YOUNG. (University of Connecticut School of Dental Medicine, Farmington, CT)

The purpose of this study was to examine the composite to dentin shear bond strengths over two years of single bottle dentin adhesives(DBA). Three DBA's were evaluated: a water based DBA-Syntac One-Step(SOS); an acetone based DBA-Prime and Bond 2.1(PB), and: a alcohol based DBA-Optibond Solo(OS). Extracted human molars stored in 0.2% sodium azide were randomly assigned to each of three dentin bond groups for testing at 5 time periods(n=15). Teeth were sectioned to expose occlusal dentin and the roots embedded in acrylic. The dentin was etched with 37% H_3PO_4 for 20 seconds, rinsed and dentin adhesives applied per manufacturers instructions. A column of Z-100 composite was bonded to the treated dentin surface and light cured. Teeth were stored in distilled water at 37° C and thermocycled for 1000 cycles between 5° C and 55° C and tested in shear at 24 hours(baseline), 6, 12, 18 and 24 months. Mean ± SD shear bond values(SBV) determined in MPa were:

DBS	Baseline	6 mon	12 mon	18 mon	24 mon
OS	16.3±5.2	20.4±3.1	23.1±4.3	22.2±2.4	11.9±2.1
PB	13.3±7.3	17.8±6.7	19.7±5.4	18.7±4.8	10.5±3.7
SOS	6.8±2.4	7.8±2.5	8.1±3.5	9.5±3.7	4.5±1.7

ANOVA at a significance level of p < 0.05 revealed OS had significantly higher SBV at 6 & 12 months compared to baseline. PB had significantly higher SBV at 12 months compared to baseline. SOS had significantly higher SBV at 18 months compared to baseline. However, at 24 months the SBV for OS and SOS were significantly lower than at baseline. PB SBV was not significantly not lower when compared to baseline but to the 6 month value. **Though SBV initially rose over time, two of the three DBA's showed lower SBV after two years.**

2926 Normal and Transparent Root Dentin: Adhesion and Hybrid Layer Formation.

S. FOPPIANO*, L.G. WATANABE, G.W. MARSHALL, S.J. MARSHALL (University of California, San Francisco, CA)

Current dentin bonding adhesive systems are tested primarily using normal dentin as a substrate. In clinical practice the actual substrate is probably an altered form of dentin, most likely transparent dentin. The purpose of this study was the evaluation and comparison of hybrid layer and shear strength of a commercial adhesive system on two different substrates: non-carious transparent root dentin and normal root dentin. Six normal and six transparent root dentin specimens from documented human teeth were bonded with Single Bond Dental Adhesive System™ (3M, St. Paul, MN). Dentin bonding surfaces were finished to 320-grit roughness perpendicular to the tubule axis and mounted into a standard single-plane shear system. Bonded areas were 2 mm in diameter. Bonding was performed according to manufacturer's directions and was followed by application of a restorative composite material (Z100™ 3M). All specimens were stored for 24 hours in 100% humidity at 37° C prior to shear testing at 5 mm/min. The hybrid layer was evaluated by SEM analysis, with the thickness measured in 20 places per specimen at 2000x. The data were compared using a t-test (p<0.05).
The bond strengths (n=6 for each variable) to normal root dentin were significantly greater than to transparent root dentin, 26.4 ± 3.5 MPa and 19.3 ± 5.4 MPa, respectively. The hybrid layer thickness with transparent root dentin was significantly greater than with normal root dentin, 3.7 ± 0.9 µm, and 3.0 ± 1.1 µm, respectively. Thus, bonding to transparent root dentin may be more challenging than to normal root since the bond strength was lower and the hybrid layer thickness is greater. Supported by NIH/NIDCR Grant P01DE09859.

2927 Bonding to sclerotic dentin using two conditioning methods.

*SM Kwong; GSP Cheung; HK Yip; FR Tay and DH Pashley[1] (The University of Hong Kong, Hong Kong SAR; [1]Medical College of Georgia, Augusta, USA)

This study evaluated the regional microtensile bond strength (µTBS) of a self-etching primer on sclerotic dentin in the absence or presence of adjunctive phosphoric acid conditioning. Naturally occurring non-carious cervical lesions on extracted bicuspids were hand-cleaned with a slurry of pumice and chlorhexidine and bonded without further cavity preparation. One group was bonded using Clearfil Liner Bond 2V (Kuraray) alone. The other group was conditioned with K-etchant (37% phosphoric acid, Kuraray) prior to the application of the self-etching primer. Artificially prepared wedge-shaped cavities were also made in sound biscuspids and bonded with the two methods. Composite buildups were made using Clearfil Protect Liner and APX resin composite (Kuraray). After storage in water for 24h, the teeth were sectioned into 0.6 x 0.6 mm composite-dentin beams along the occlusal, gingival, and the deepest part of the lesions. The use of two conditioning methods, two substrate types and three different locations yielded 10-12 beams for each of the six groups. After testing for µTBS, representative fractured beams were examined with SEM. Additional fractured beams were demineralized and processed for TEM examination. Three-way ANOVA and SNK test showed that regardless of the conditioning methods, bond strength to sound dentin was significantly higher than sclerotic dentin (p<0.05). With sclerotic dentin, there was no difference in the conditioning methods used, except that K-etchant significantly improved the bond strength at the gingival side of the lesions. Fractographic analysis revealed that the self-etching primer could not etch into the underlying sclerotic dentin. Interfacial failure occurred along the surface of the mineralized intermicrobial matrix and/or hypermineralized layer. With the use of phosphoric acid, a hybrid layer was only seen in sclerotic dentin when the surface layers were thin. Incompletely removed sclerotic casts were evident in both groups. It is concluded that it may be beneficial to remove the surface layers of sclerotic dentin and/or conditioning with stronger acids to obtain stronger bonding. (Supported, in part, by DE06427, NIDCR)

2928 Effect of Dentin Desensitizers on Bond Strength on Deep Dentin.

D. LI*, K.L. O'KEEFE, J.M. POWERS. (Houston Biomaterials Research Center, University of Texas-Houston Dental Branch, Houston, TX, USA).

Tensile bond strength of a composite to deep dentin was measured after first applying 5 dentin desensitizers before priming with a bonding agent (Optibond Solo, OS) and then storing under 3 conditions [24 hour storage in distilled water at 37 C for 24 h, 7 d in distilled water at 37 C, and thermocycling between 10-50 C for 1000 cycles (T1000)]. Dentin specimens (n=8) were prepared from freshly extracted human molars and randomly divided into 18 groups. The teeth were embedded in acrylic resin and ground until deep dentin was exposed. Five desensitizers [Gluma (GL), Health-Dent (HD), Hemaseal & Cide (HC), HurriSeal (HS), Aqua-Prep F (AP), and moisture (CO) as control] were applied after etching but before priming. Composite (Prodigy) was applied and specimens were stored under 3 conditions before testing for tensile bond strength in a testing machine at a crosshead speed of 0.5 mm/min. Means and standard deviations of bond strengths (MPa) are listed. Data were analyzed by

	CO	GL	HD	HC	HS	AP
24 h	16.0 (5.3)	22.5 (6.8)	21.9 (5.6)	21.7 (4.7)	21.6 (6.5)	18.8 (5.3)
7 d	17.8 (6.0)	21.8 (6.8)	19.5 (5.7)	22.7 (7.2)	17.9 (6.4)	19.1 (6.4)
T1000	16.2 (2.4)	24.7 (4.3)	20.7 (6.0)	22.2 (6.0)	17.8 (4.1)	18.1 (3.8)

analysis of variance. Scheffe's intervals (p=0.05) for comparison of agents were 5.6 (CO-GL), 5.7 (CO-HD, HC and HS), and 5.5 MPa (CO-GL). The storage conditions did not affect the bond strengths of OS. Desensitizers GL, HD, and HC at 24 hours, as well as GL and HC after thermocycling, demonstrated increased bonding strengths compared to the control. Products provided by manufacturers.