993 Cutting with Tungsten Carbide Burs and Different Irrigant Media

J A von FRAUNHOFER S C SIEGEL* and S FELDMAN (Dental School University of Maryland Baltimore Maryland USA)

Previous studies indicated that enhanced cutting rates (chemo-mechanical effects) can be obtained with carbide burs when irrigated with 0 9% saline and Ringer's lactate at high cutting load and a handpiece speed of 100 000 rpm The present study was undertaken to evaluate irrigant effects under lower applied loads and handpiece speeds

A previously established testing regimen was modified for a KaVo INTRAsept 905 dental treatment system that digitally controls handpiece speed torque and water flow rate Cutting studies were performed on Macor machinable ceramic at a handpiece loading of 147 5 g (93 5 g at the bur tip) and 20,000 rpm at 1 5 Ncm torque Cutting was irrigated at 22 ml/min using water 0 9% saline and 1 5 and 1 10 Scope water mixes Six SS White 703 carbide surgery burs in a straight handpiece were used for each irrigant solution to make 3 cuts, 5 mm in length through 13 mm of Macor CRs were determined as time to trans-sect the Macor block and data were analyzed by 1-way ANOVA with *post-hoc* Scheffe tests

Mean cutting rates (CRs) in mm s^{-1} were water 0 05, saline 0 02, 1 5 mix 0 05 and 1 10 mix 0 04 with comparable decreases in CR found under all irrigants over 3 cuts There was no difference ($p>0$ 05) in CRs for water and Scope mixes but saline reduced the CR ($p<0$ 001)

In contrast to previous studies under higher loads, irrigation with saline appeared to have an adverse effect on cutting efficiency under test conditions of lower cutting loads and cutting speeds. Further, the chemo-mechanical effect found when sectioning Macor with diamond burs irrigated with Scope water mixes was not found with carbide burs.

994 Chemo-mechanical Effects in Dental Cutting

J A von FRAUNHOFER* S C SIEGEL and S FELDMAN (Dental School University of Maryland Baltimore Maryland USA)

Previous studies have shown that certain surface active agents added to the irrigation water for a dental handpiece can enhance bur cutting rates The present study was undertaken to evaluate these effects under test conditions simulating dental practice

A previously established testing regimen for diamond burs was modified for a KaVo INTRAsept 905 dental treatment system that digitally controls handpiece speed torque and water flow rate Cutting studies were performed on Macor machinable ceramic at a handpiece loading of 147 5 g (91g at the bur tip) a rotation speed of 160,000 rpm at maximum torque 22 ml/min coolant flow rate using water and 1 1 1 2 5 and 1 5 Scope water mixes and Brasseler 856-016 (medium grit) diamond burs Six burs were used for each irrigant mix to make 3 edge cuts, 5 mm in length through 13 mm of Macor Cutting rates (CRs) were determined as time to trans-sect the Macor block and data analyzed by 1-way ANOVA with *post-hoc* Scheffe tests

The cutting rates were water 0 09 1 1 mix 0 13 1 2 5 mix 0 16 and 1 5 mix 0 21 The CR differences between water and the Scope water mixes were significant ($p<0$ 001) The decrease in CR over 3 cuts was 31 5 and 51 7% for water, 2 2 and 25 1% for 1 1 mix 12 2 and 13 8% for 1 2 5 and 14 4 and 28 9% for the 1 5 mix The greater CR decrease for water compared to the mixes was significant ($p<0$ 05)

The addition of small amounts of Scope oral mouth rinse to water significantly enhanced the cutting of Macor by diamond burs. The enhanced cutting rates due to chemo-mechanical effects were accompanied by a slower decrease in cutting efficiency with prolonged cutting.

995 Finishing of chamfer preparations with 4 different instruments in vitro

J SCHAFERS*, S RINKE, F SCHAFERS

(Private Dental Office, Hattorf, Germany)

In order to obtain good clinical results, the preparations should be finished before impresssion-taking The present study aims a comparison among the quality of four different finishing instruments in vitro Following instruments were investigated 1) A tungsten carbide finishing instrument, 2) An arkansas-abrasive 3) A finishing diamond (grid size 15µm), these three instruments were used in a contra angle handpiece The fourth system was the oscilating EVA-system 61 LA (KaVO Comp Germany) with a lift of 0 4 mm using modified Proxoshape files (grid size 15 µm) Of each group 20 extracted human third molars were prepared with a circular chamfer

All preparation margins were circulary examined with a SEM (DSM 960, Zeiss Germany) under a 50-fold magnification The quality of the finished preparations was divided in three groups score 1 exact preparation, no chip-out and smooth surface, score 2 preparation with minor chip-outs and increased surface roughness, score 3 not acceptable chip-outs and obviously rough surface

The results were stastically analysed with a Pearson Chi-Square test split in 2x2 tables for multiple analysis

	Diamond	EVA	Tungsten carbide	Arkansas
Score1	542	534	524	516
Score2	314	448	334	403
Score3	78	46	110	49

There was no significant difference between Arkansas and EVA No significant difference between diamond and tungsten carbide could be found There were significant differences between arkansas and diamond/ diamond and EVA/ EVA and tungsten carbide/ arkansas and tungsten carbide ($p<0$ 005) The results with the most chip-outs were noted with the tungsten carbide finishing instrument The best margins could be achieved with the EVA-system and the arkansas.

996 Citric Acid-Ferric Chloride Etching of Dentin AFM study

K SAEKI, S J MARSHALL, S A GANSKY G W MARSHALL* (University of California, San Francisco, CA, USA)

Citric acid etchants with ferric chloride (10-3) promote adhesion and are effective etchants However, 10-3 did not prevent shrinkage on drying of etched dentin (IADR 99) We used AFM to compare etching for a variety of 10% citric −X% Fe-Cl etchants (10-X) Commercial 10-3 (Superbond green etch, Sun Medical, Moriyama Japan) was the control Dentin disks were prepared and part was masked during etching so that the unetched dentin served as a reference Changes in depth (nm) relative to the reference height (Table) for intertubular dentin are shown after etching 15 sec , clinical air drying, rewet 1-5 minutes desiccation for 24 hrs rehydration for 24 hrs Differences of log (depth change) were tested with mixed effects cell mean models Overall differences were significant ($p<0$ 001) Significant differences were found between etchants and greater collapse occurred on drying and was dependent on pH and Fe-Cl content Following long term rehydration samples recovered but those with 0 or 1% Fe-Cl did not recover as completely ($p<0$ 01) Etching and collapse depended on Fe-Cl content. The collapse was largely reversed on rehydration Supported by NIH/NIDCR Grant R01 DE 11526

Soln	pH	Etched (nm)	Air Dried (nm)	Rehydrated < 5 min (nm)	Desiccated (nm)	Rehydrated 24 hrs (nm)
10-0	1 63	84 (46)	194 (77)	85 (48)	210 (85)	170 (77)
10-1	0 86	130 (50)	918 (213)	169 (62)	1045(273)	398 (226)
10-1 8	0 76	171 (<4)	939 (237)	133 (46)	1057 (313)	187 (89)
C&B 10-3	0 74	213 (140)	743 (350)	172 (73)	814 (325)	271 (149)
10-3	0 42	212 (86)	1679 (929)	325 (117)	1797 (904)	290 (154)

997 Comparative Observation of Resin-dentin Interfaces with TEM and FEISEM

L BRESCHI*, J PERDIGÃO, P GOBBI, M LOPES, G MAZZOTTI (Institute of Anathomy, University of Bologna, Italy, University of Minnesota, Minneapolis, MN, University of North Carolina at Chapel Hill NC)

Several microscopic methods are used to observe the hybrid layer (HL) upon the application of dentin adhesives TEM is among the most powerful tools with very high resolution In-Lens Field Emission SEM (FEISEM), works at low kV and allows for high-resolution topographic mapping The objective of this study was to correlate the TEM findings of resin-dentin interfaces with the corresponding FEISEM observation Twelve 800 µm-thick dentin disks were obtained from middle dentin and assigned to four groups (1) Clearfil SE Bond (2) One Coat Bond (3) Prime&Bond NT, (4) AD Gel (10%NaOCl) for 15 sec + NT Disks were restored with a 1mm thick layer of Æliteflow Four sticks (1 mm^2) were taken from each disk, decalcified in 10% EDTA, and stained with lead citrate+uranyl acetate (for groups 1, 2, 3) or kept in water (group 4) The sticks were processed for TEM, sectioned in 85 nm-thick slices and mounted on Ni grids After TEM observation, the same grids were coated with a 1 5nm Pt-C film and observed under a JSM-890 (JEOL) at 7 kV and $1x10^{-11}$ amp probe current Specimens were tilted at 45° to enhance topography For group 1, it was observed a 0 5 µm-thick HL and resin blending with the smear plug The FEISEM allowed for the visualization of the mingling of the adhesive within the HL For group 2, the TEM showed an amorphous HL with deposition of dense material into the tubules The FEISEM showed globular structures lining the dentin surface and the wall of the tubules For Group 3, while the TEM allowed the observation of the nano-filler in contact with collagen, the FEISEM showed a 3-D relation between those structures For group 4, the FEISEM showed an increase in interfibrillar spaces within the HL, probably the result of the effect of NaOCl In conclusion, FEISEM and TEM are complementary tools for the fine observation of the ultrastructure of the hybrid layer

998 An ultrastructural study of bonding to dentin smear layers

*E Pashley[1] FR Tay[2], H Sano[3], RM Carvalho[4], DH Pashley[1] ([1]Medical College of Georgia, USA, [2]University of Hong Kong, HKSAR, [3]Hokaido University Japan, [4]University of São Paulo, Brazil)

The objectives of this study were (1) to determine the depth of demineralization into intact dentin using several self-etching primer systems with different pH values, and (2) to evaluate whether hybridization of intact dentin in Clearfil SE Bond (Kuraray) may be affected by variation in the thickness of the smear layers Dentin disks were created from extracted, human third molars In the first part of the study, a standardized smear layer was produced using wet 600-grit SiC paper Three self-etching primer systems (Clearfil Liner Bond II, Liner Bond IIV and SE Bond) were applied separately to these disks An adhesive system-technique that was known to infiltrate the smear layer only [All-Bond 2 (Bisco) – 'no-etch' technique] was used as the control In the second part of the study, dentin disks with different thickness of the smear layer were produced For the control group, the middle dentin surface was cryofractured to create a bonding surface that was devoid of a smear layer The experimental teeth were ground with wet 60 180 or 600-grit SiC paper and bonded using Clearfil SE Bond Dentin disks from the same group were laminated using a chemical-cured resin, demineralized and embedded in epoxy resin for TEM examination When applied on a standardized dentin smear layer, the four systems examined all produced a hybridized smear layer of similar thickness All-Bond 2 as the control, did not etch beyond the smear layer when used according to the 'no-etch" technique The three self etching primers etched beyond the smear layer to form an authentic hybrid layer within intact dentin This layer was thicker in Clearfil Liner Bond II In both Clearfil Liner Bond 2V and SE Bond the authentic hybrid layers were very thin Application of Clearfil SE Bond to dentin prepared with SiC paper of different roughness produced hybridized smear layers of variable thickness However, the thickness of the underlying authentic hybrid zone was consistent for the four groups It is concluded that a) the depth of penetration into the intact dentin is dependent upon the pH of the primer and the etching time, and b) formation of the authentic hybrid layer is independent of the thickness of the surface smear layer. (Supported in part, by DE06427, NIDCR)

999 TEM evaluation of self-etching adhesives resin-dentin interfaces

M A VARGAS*, B VAN MEERBEEK, Y. YOSHIDA, C BERGERON, P LAMBRECHTS, G VANHERLE (Catholic University of Leuven, Belgium, University of Iowa, Iowa, USA & Laval University, Canada)

Self etching adhesives represent an alternative to conventional multi-step systems because they eliminate some of the technique-sensitive steps encountered during bonding, especially to dentin The purpose of the study was to characterize by TEM the resin-dentin interface morphology produced by 7 self-etching adhesives (SEA) Mid-coronal dentin of extracted human third molars was exposed, fresh smear layer obtained and the SEA were applied according to the manufacturer's instructions The following SEA were used in this study Clearfil Liner Bond 2V (CLB 2V, Kuraray), Clearfil SE (C SE, Kuraray), Prime&Bond NT with Non-Rinse Conditioner (PB/NRC, Dentsply), Prompt L Pop (L-Pop ESPE), Sustel (Su, 3M), UniFil Bond (UB, GC), and Vivadent Exp (VE) Eight resin dentin sticks were obtained from each tooth Half of the specimens were demineralized with formic acid and the other half left non demineralized Specimens were prepared for TEM and 70-100 nm ultra-thin sections were stained with uranyl acetate and lead citrate, and examined in a Phillips CM-10 TEM The resin-dentin interfaces were comparatively examined for the following characteristics

Adhesive	CLB 2V	C-SE	PB/NRC	L-Pop	Su	UB	VE
HL Thickness (µm)	± 0 6	± 1	2-3	2-3	± 1	± 0 5	± 2
HAp in HL	++	+	-	-	-	++	-
Tubule content	RT / SP	RT	RT	RT	RT	SP	RT
Tubule Wall Hybridization	limited	yes	yes	yes	yes	no	yes

HL Hybrid layer, HAp Hydroxyapatite, SP Smear plug, RT Resin tag.

All SEA showed evidence of producing hybrid layers (HL) that vary in thickness No evidence of incomplete infiltration was observed for any SEA An abrupt interface between the hybrid layer and intact dentin was observed for all SEA but Su Collagen encapsulation was observed and some display '*shag-carpet*' appearance at the top of the hybrid layer All SEA were capable of forming micro-mechanical bonding to dentin through hybridization The respective interfacial ultra-morphology most likely depends on the acidity of the self-etching primers.

1000 Correlative AFM, Fe-SEM and TEM Examination of the Resin-Dentin Interface produced by a '*All-in-one*' Adhesive

M PEUMANS*[1], M VARGAS[2], B VAN MEERBEEK[1], S. INOUE[3] J SNAUWAERT[1], P LAMBRECHTS[1] G VANHERLE[1] ([1]Catholic University of Leuven, Belgium, [2]University of Iowa, USA [3]Hokkaido University, Japan)

Among major shortcomings of today's adhesives are their relatively high technique-sensitivity and the apparent difficult to-solve compromise to bond equally effective to enamel and dentin Especially the approach of self-etching primers appears to be most promising in overcoming these shortcomings The tendency of decreasing the number of bottles or application steps has recently lead to the introduction of a true *all-in-one* self-etching adhesive system that according to the manufacturer s instructions requires one single application step The aim of this study was to correlatively evaluate the dentin hybridization effectiveness of Prompt L-Pop (Espe) using AFM, Fe-SEM and TEM Resin-dentin interface specimens were prepared from freshly extracted human third molars Non demineralized and demineralized 70-90 nm diamond knife sections were examined by TEM The remaining smear-layer free interfacial cross-sections, from which before the non-demineralized sections were cut for TEM, were imaged successively by AFM and Fe-SEM All three microscopy techniques showed the formation of a 2-3 µm thick hybrid layer with substantial tubule wall and lateral tubule hybridization Infiltration of the adhesive up to the depth of demineralization was confirmed by the heavy electron dense staining of the phosphate component of the adhesive within the hybrid layer The hybrid layer was loosely organized with a *shag-carpet* appearance at the top of the hybrid layer and tiny adhesive-filled 10-20 nm interfibrillar spaces separating individual collagen fibrils It is concluded that the combination of the conditioning, priming and adhesive resin application step resulted in a hybridization process that ultra morphologically resembled that observed previously for conventional three-step smear-layer removing adhesives The specimen preparation method used allowed specimens from the same tooth area to be imaged successively by AFM, Fe-SEM and TEM Diamond-knife sectioning enabled interfaces that are free of smearing effects to be examined by AFM and Fe-SEM