ZENTRUM FÜR ZAHN-, MUND- UND KIEFERHEILKUNDE
DER UNIVERSITÄT ZÜRICH

**KLINIK FÜR PRÄVENTIVZAHNMEDIZIN,
PARODONTOLOGIE UND KARIOLOGIE**

Introduction.

Simple shear bond strength tests do not sufficiently reflect clinical behavior of a dentinal adhesive. On the other hand, in vivo tests are too time consuming and too expensive for a pre-evaluation of a new product. Therefore, a sophisticated in vitro test is needed, which is able to deliver clinically relevant data.
The purpose of the study is to test the adhesive system in a clinically relevant in vitro test described below. In this way, the clinical potential of the adhesive system can be judged and, if necessary, suggestions for optimization can be made.

Materials and methods.

Four intact, caries-free upper premolars with completed root formation, stored in 0.1 % thymol solution, will be cleaned. After apical sealing with an dentinal adhesive (Syntac, Vivadent Ets., Schaan, Liechtenstein) and two coats of nail varnish, the roots will be fixed in the center of custom made specimen holders using a cold-polymerizing resin (Paladur, Kulzer & Co GmbH, Wehrheim, Germany). The pulpal tissue will not be removed. A cylindrical channel will be drilled into the pulpal chamber approximately at the middle third of the root, where a metal tube with a diameter of 1.4 mm will be luted using a dentinal adhesive (Syntac, Vivadont Ets., Schaan, Liechtenstein). This tube will be connected by a flexible silicone hose to a serum infusion bottle placed vertically 34 cm above the sample. The infusion bottle will be filled with 1: 3 diluted horse serum to simulate the dentinal fluid under the normal hydrostatic pressure of about 25 mm Hg. With the aid of a three-way valve, the whole system will be evacuated with a vacuum pump and finally filled bubble-free with the diluted horse serum. Two box-shaped class V cavities will be then prepared in all teeth using 40 microns diamond burs (Amalgam Prep Set, Intensiv SA, Lugano, Switzerland) at the cemento-enamel junction extending 50% each to enamel and dentin on the buccal and palatal surfaces under continuous water cooling. The dimensions of the cavities will be as follows: diameter 3.0 mm, depth 1.5 mm. The enamel margin will be beveled to a crescent-shape with a maximal breadth of 1.2 mm and the entire cavity will be finished using 25 microns diamonds (Amalgam Prep Set, Intensiv SA, Lugano, Switzerland).

The preparations will be made under a stereo microscope (Wild M5, Wild AG, Heerbrugg, Switzerland) at 12x magnification.

The bonding to enamel and dentin will be done following manufacturer's recommendations for the adhesive system. The cavities will then be filled with a composite material in a two-step technique, the first layer - about 1.3 - 1.5 mm thick - being placed into the cervical half of the cavity. Each layer will be cured for 60 s with visible light (Optilux 500).

Immediately after curing, the restorations will be finished and polished using flexible discs (Sof-Lex, 3M & Co, St. Paul, MN). The polishing will be checked with a stereo microscope at 12x magnification and perfected where necessary. An impression will be made of each restoration with a polyvinylsiloxane impression material (President light body, Coltène AG, Altstätten, Switzerland) immediately after polishing and will be prepared for the quantitative margin analysis in a scanning electron microscope (Amray 1810 T, Amray Inc., Bedford, MA).

After storage in the dark 0.9% NaCl-solution at 37°C for one week, the restored teeth will be simultaneously loaded with repeated thermal and mechanical stress in a custom-made, clinically correlated chewing machine. Thermal cycling will be carried out in flushing water with the water temperatures changing x 3,000 from 5° to 50°C each time for two minutes. The chewing stresses will consist of 1,200,000 load cycles in the center of the occlusal surface with a frequency of 1.7 Hz and a maximal load of 49 N applied by using the natural lingual premolar cusp prepared from an extracted human tooth.

The dentinal fluid simulation under stress will be assured by a modification of the stress apparatus test chambers. The slight pressure generated by the circulating water in the test chambers will be compensated with a correspondingly higher position of the serum infusion bottle. After the stress tests, replicas will again be taken of the restorations. Together with the replicas made initially, they will be subjected to a computerized quantitative margin analysis under x200 magnification. Percentages of "continuous margin" will be reported separately for the enamel and dentin margins. Differences in the percentages of "continuous margin" before and after loading will be tested for significance using statistical software (Stat View II, Brain Power Inc, Calabasas, CA) on a personal computer (Power Macintosh 8100 AV, Apple Computer Inc., Cupertino, CA) with non-parametric tests.

Table 4/1-8: Marginal adaption in mixed fillings class V after mechanical and thermal loading - in vitro: All adhesive systems are tested with the component which belongs to the system,

n = 6, % continuous margin

Materials	Enamel		Dentin	
	before loading	after loading	before loading	after loading

Tabelle 4/1-8: Marginale Adaptation in gemischten Klasse-V-Füllungen nach mechanischer und thermischer Belastung - in vitro: Alle Adhäsivsysteme wurden mit dem zum System gehörenden Komposit geprüft, n = 6, % Kontinuierlicher Rand

Materialien	Schmelz		Dentin	
	vor Belastung	nach Belastung	vor Belastung	nach Belastung
Ælitebond (Bisco)	99,0 ± 1,1	88,6 ± 16,8	82,6 ± 20,8	66,4 ± 19,3
All-Bond 2 (Bisco)	91,2 ± 12,6	63,5 1 33,7	89,2 ± 9,4	26,.5 ± 26,3
Ana Norm Bonding (Nordiska)	100,0 ± 0,0	94,0 ± 7,1	100,0 ± 0,0	46,1 ± 8,6
Ana Single Bond (Nordiska)	76,3 ± 8,0	65,1 ± 13,9	88,8 ± 9,2	60,5 ± 25,8
A.R.T. Bond (Coltène)	**89,3 ± 11,4**	**98,8 ± 1,1**	**93.4 ± 8,2**	**83,1 ± 16,5**
Bond 1 (Jeneric / Pentron)	**100,0 ± 0,0**	**98,8 ± 1,1**	**93,4 ± 8,2**	**83,1 ± 16,5**
Clearfil Liner Bond System (Kuraray)	**99,8 ± 0,5**	**99,7 ± 0,6**	**100,0 ± 0,0**	**100,0 ± 0,0**
Clearfil Liner Bond System 2 (Kuraray)	79,5 ± 12,2	28,1 ± 10,7	69,8 ± 19,2	40,2 ± 11,9
D7XX/KDE (exp)	92,1 ± 4,8	83,8 ± 16,0	89,4 ± 2,5	9,3 ± 11,4
Dentamed P & B (Ihde Dental AG)	97,9 ± 3,5	84,9 ± 6,4	52,7 ± 14.4	8,4 ± 11,1
Denthesive (Kulzer)	81,6 ± 24,1	70,9 ± 32,8	64,1 ± 27,5	23,4 ± 16,3
Denthesive II (Kulzer)	**94,2 ± 3,5**	**85,4 ± 4,7**	**92,9 ± 2,9**	**83,8 ± 13.1**
EBS (ESPE)	97,7 ± 3,1	97,3 ± 3,7	81,8 ± 29,5	63,5 ± 28,9
Etch & Prime 3.0 (Degussa)	93,5 ± 3,3	90,4 ± 12,9	90,8 ± 8,1	58,3 ± 29,2

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Tabelle 4/2-8: Marginale Adaptation in gemischten Klasse-V-Füllungen nach mechanischer und thermischer Belastung - in vitro: Alle Adhäsivsysteme wurden mit dem zum System gehörenden Komposit geprüft, n = 6, % Kontinuierlicher Rand

Materialien	Schmelz		Dentin	
	vor Belastung	nach Belastung	vor Belastung	nach Belastung
Gluma (Bayer)	78,2 ± 15,2	66,4 ± 21,6	80,0 ± 30,5	57,8 ± 37,8
Gluma 2000 (Bayer)	98,8 ± 1,4	91,9 ± 8,1	90,1 ± 11,6	56,6 ± 9,6
Gluma CPS (Bayer)	94,1 ± 0,6	81,7 ± 0,4	32,3 ± 1,1	18,5 ± 15,6
One Coat Bond (Coltène)	**99,8 ± 0,4**	**98,4 ± 1,6**	**93,9 ± 6,1**	**80,8 ± 26,4**
One-Step (Bisco)	93,6 ± 3,6	66,7 ± 25,0	57,0 ± 24,2	49,9 ± 23,9
Optibond (Kerr)	**100,0 ± 0,0**	**99,5 ± 0,9**	**94,6 ± 8,8**	**85,9 ± 19,9**
Optibond FL (Kerr)	91,7 ± 5,6	69,8 ± 6,1	43,6 ± 15,0	32,1 ± 13,4
Optibond Solo (Kerr)	86,1 ± 7,2	39,3 ± 10,9	95,5 ± 4,0	83,1 ± 8,8
Panavia Ex (Kuraray)	85,2 ± 17,1	71,6 ± 19,0	26,9 ± 29,2	19,4 ± 29,2
Pentra Bond (Optec / Jeneric)	54,0 ± 40,0	25,2 ± 31,4	5,1 ± 11,0	0,8 ± 2,3
Permaquik (Ultradent)	94,4 ± 3,4	87,4 ± 7,2	94,3 ± 2,2	45,0 ± 37,9
Primabond 97 (BJM)	97,6 ± 1,2	95,4 ± 4,6	67,8 ± 38, 2	50,5 ± 16,5
Prime & Bond 2.0 (Caulk)	89,5 ± 5,7	68,5 ± 5,1	93,2 ± 1,8	70,9 ± 13,1
Prime & Bond 2.1 (Caulk)	94,0 ± 2,8	93,2 ± 1,4	66,2 ± 14,9	59,9 ± 22,1

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Tabelle 4/3-8: Marginale Adaptation in gemischten Klasse-V-Füllungen nach mechanischer und thermischer Belastung - in vitro: Alle Adhäsivsysteme wurden mit dem zum System gehörenden Komposit geprüft, n = 6, % Kontinuierlicher Rand

Materialien	Schmelz		Dentin	
	vor Belastung	nach Belastung	vor Belastung	nach Belastung
Prime & Bond NCR (Caulk)	76,9 ± 16,5	39,5 ± 13,8	19,8 ± 9,4	16,7 ± 12,8
Prime & Bond NT (Caulk)	85,2 ± 8,1	61,4 ± 3,4	37,1 ± 12,5	32,8 ± 16,1
Prisma Universal Bond 2 (Caulk)	62,3 ± 28,0	59,9 ± 27,9	70,6 ± 28,0	52.0 ± 32,5
ProBond (Caulk)	92,6 ± 1,6	57,0 ± 15,5	84,1 ± 11,2	62,9 ± 12,0
Restobond 3 (Lee Pharmaceuticals)	43,0 ± 28,5	23,5 ± 24,3	33,0 ± 32,8	7,8 ± 12,1
Resulcin Aqua Prime + MonoBond (Merz)	**98,2** ± **0,9**	**94,8** ± **3,4**	**95,9** ± **0,4**	**86,6** ± **15,4**
Scotchbond Multi-Purpose	93,2 ± 6,4	76,0 ± 15,2	85,1 ± 16,3	63,2 ± 21,4
Scotchbond 1 (3M)	**97,6** ± **1,2**	**92,3** ± **5,6**	**77,8** ± **38,2**	**77,2** ± **17,0**
SolidBond (Kulzer)	82,7 ± 1,9	44,6 ± 25,1	71,0 ± 17,0	21,0 ± 11,1
Solist (DMG)	77,3 ± 11,4	44,4 ± 17,4	35,4 ± 7,0	5,2 ± 6,4
Solobond M (Voco)	**94,8** ± **4,2**	**95,4** ± **5,6**	**96,1** ± **1,3**	**88,9** ± **17,1**
Syntac Classic (Vivadent)	**97,9** ± **2,1**	**98,3** ± **1,6**	**93,9** ± **7,6**	**88,4** ± **17,9**
Syntac Single (Vivadent)	86,8 ± 4,1	41,4 ± 6,9	83,3 ± 9,6	40,1 ± 16,6
Syntac Sprint (Vivadent)	94,3 ± 2,5	95,4 ± 2,3	77,7 ± 23,9	71,6 ± 19,1

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Tabelle 4/4-8: Marginale Adaptation in gemischten Klasse-V-Füllungen nach mechanischer und thermischer Belastung - in vitro: Alle Adhäsivsysteme wurden mit dem zum System gehörenden Komposit geprüft, n = 6, % Kontinuierlicher Rand

Materialien	Schmelz		Dentin	
	vor Belastung	nach Belastung	vor Belastung	nach Belastung
Syntac III (Vivadent)	94,0 ± 5,8	53,9 ± 8,7	59,0 ± 18,6	46,2 ± 8,7
Tenure (DenMat)	89,2 ± 7,5	81,5 ± 26,5	59,6 ± 38,2	34,4 ± 28,7
Tenure Quick (DenMat)	92,2 ± 2,9	51,8 ± 10,1	72,4 ± 24,2	0,2 ± 0,4
Tripton (ICI)	84,2 ± 16,3	79,9 ± 19,6	17,6 ± 20,1	13,3 ± 20,2
XR Bond (Kerr)	91,8 ± 12,5	72,3 ± 22.5	43,7 ± 29,9	14,8 ± 19,7

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