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Bond strength of different adhesive systems to bone

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Authors:
Dr. Katrin Bekes, Department of Operative Dentistry and Periodontology, University School of Dental Medicine, Martin-Luther-University Halle-Wittenberg
Dr. Christian Ralf Gernhardt, Department of Operative Dentistry and Periodontology
Dr. Dr. Peter Maurer, Department of Maxillofacial and Plastic Surgery
Prof. Dr. Hans-Günter Schaller, Department of Operative Dentistry and Periodontology
Prof. Dr. Dr. Johannes Schubert, Department of Maxillofacial and Plastic Surgery

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Introduction

The use of miniplates has revolutionised the treatment of maxillofacial fractures within the last years. However, there are numerous potential problems using these metallic implants. Perfect adaption to bone can be time-consuming and difficult in some areas. Furthermore the drilling of screw-holes has the potential to damage associated anatomical structures. It would be helpful to use a material that is highly maleable during the adaptation phase and rigid at the fixation stage. Recently, there have been promising developments in the field of dentin bonding agents. As the composition of dentin and bone are chemically and structurally similar, it is possible that some of the modern dentin adhesive systems may offer a suitable method of attaching rigid fixation devices to bone without the aid of screws [1-4].

Objectives

The aim of the present investigation was to evaluate tensile bond strength of three dentin adhesive systems (Excite, Clearfil New Bond, Etch&Prime 3.0) and two cyanoacrylate adhesives (Cyano Veneer, Histoacryl) to animal bone in vitro.

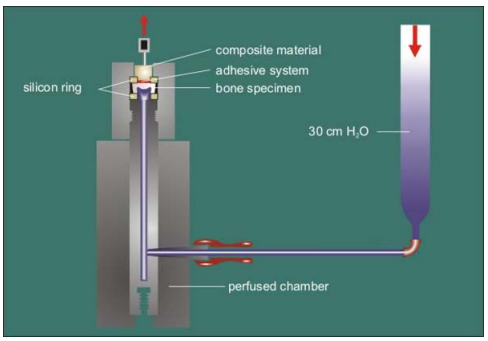

Fig. 1: Special designed apparatus to test tensile bond strength.

Material and Methods

Five mandibles of freshly sacrificed pigs were used to prepare ten specimens from each mandible using rotation burs under constant water cooling (Fig. 3). Bone specimens (diameter 9 mm) with a total thickness of 4 mm (± 0.5mm) and a cortical layer of 1.5 mm (± 0.2mm) were obtained under standardized conditions. Each ten specimens were randomly divided into five experimental groups. These groups were assigned to one adhesive system (A: Excite, B: Clearfil New Bond, C: Etch&Prime 3.0, D: Cyano Veneer, E: Histoacryl). All systems were applied as recommended by the manufacturers. Tensile bond strength of the above mentioned adhesive agents was measured 15 minutes after application and light curing of the composite material (Tetric Ceram, colour A2) using a universal testing machine (Fig. 1, 2). For each group mean value and standard deviation were calculated. Statistical analysis was performed using ANOVA and Tukey's test. After these measurements all specimens were examined by scanning electron microscopy to evaluate different fracture modalities. Therefore the organic bone was removed using 50% nitric acid for 48 hours.

Fig. 2: Special designed apparatus with installed bone specimen mounted in the universal testing machine.

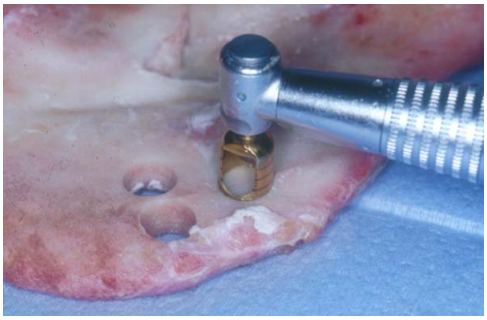

Fig. 3: Specimen preparation using a trephane bur.

Results

In all groups tensile bond strength could be measured. The highest values were evaluated for Clearfil New Bond, while the lowest were observed in specimens treated with Excite (Tab. 1, Fig. 9). Statistical analysis showed a significant influence of the used adhesive system on tensile bond strength ($p < 0.001$, ANOVA).

	Excite	**Clearfil New Bond**	**Etch&Prime 3.0**	**Cyano Veneer**	**Histoacryl**
Mean Values (in MPa)	2,96	8.00	4.05	4.56	5.22
Standard deviation	(±1.34)	(±1.36)	(±1.53)	(±0,76)	(±2.01)

Tab. 1: Mean value and standard deviation within the different groups.

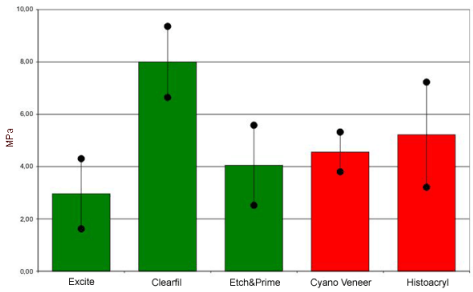

Fig. 9: Mean value and standard deviation within the different groups.

Clearfil New Bond showed significant higher bond strength than the other four adhesives ($p < 0.001$, Tukey's test). In the group treated with Excite tensile bond strength was significantly reduced ($p < 0.001$, Tukey's test). The SEM evaluation of unloaded specimens showed no comparable tag formation as known from dentin (Fig. 4-6). The examination of loaded specimens showed in all cases cohesive fractures within the used adhesive (Fig. 7,8).

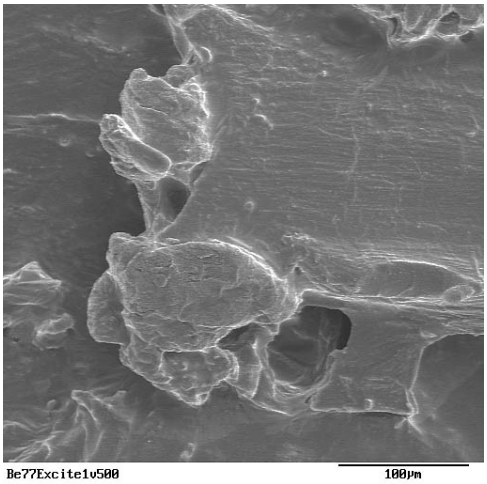

Fig. 4: Specimen treated with Excite after removing of the organic bone. SEM; 500 x.

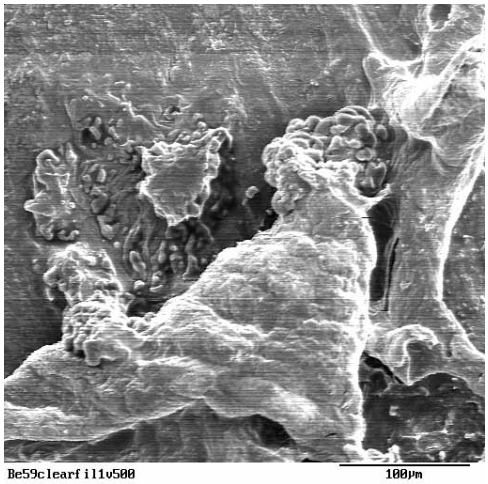

Fig. 5: Specimen treated with Clearfil New Bond. SEM; 500 x.

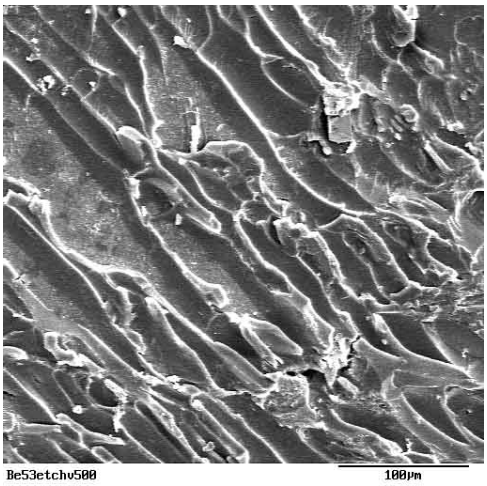

Fig. 6: Specimen treated with Etch&Prime 3.0. SEM; 500 x.

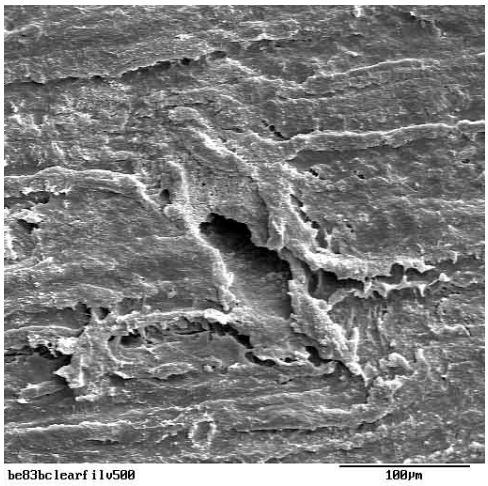

Fig. 7: Specimen treated with Clearfil New Bond after tensile bond strength measurement. SEM; 500 x.

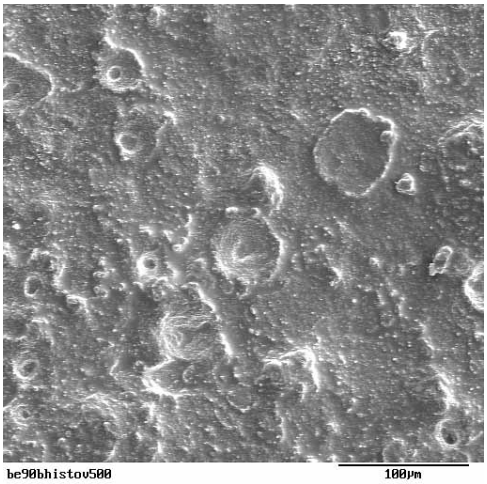

Fig. 8: Specimen treated with Histoacryl after tensile bond strength measurement. SEM; 500 x.

Conclusion

Regarding the adhesive systems tested in this study, differences in tensile bond strength could be observed. The specimens treated with Clearfil New Bond showed the highest bond strength while those treated with Ecxite were weakest. Within the limitations of an in vitro investigation, it can be concluded that adhesive systems might be useful in bone bonding. Measured tensile bond strength of the adhesive systems tested on bone are comparable to those evaluated on dentin in former investigations.

References

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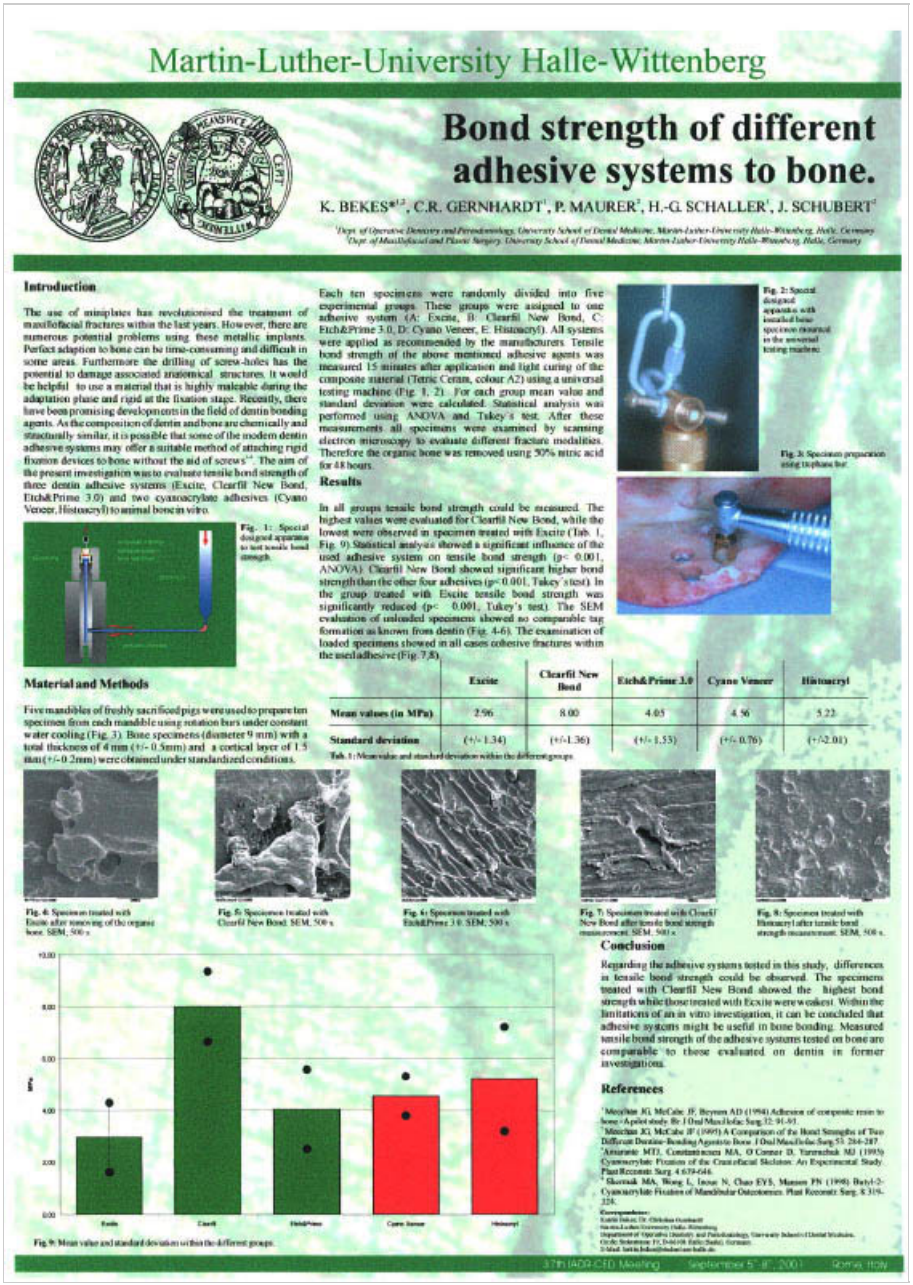
Abbreviations

MPa = Megapascals
Fig. = Figure
Tab. = Table

This Poster was submitted by Dr. Katrin Bekes.

Correspondence address:
Dr. Katrin Bekes
Grosse Steinstrasse 19
06108 Halle (Saale)
Germany

Poster Faksimile:



Martin-Luther-University Halle-Wittenberg

Bond strength of different adhesive systems to bone.

K. BEKES[1,2], C.R. GERNHARDT[1], P. MAURER[2], H.-G. SCHALLER[1], J. SCHUBERT[2]

[1]Dept. of Operative Dentistry and Periodontology, University School of Dental Medicine, Martin-Luther-University Halle-Wittenberg, Halle, Germany
[2]Dept. of Maxillofacial and Plastic Surgery, University School of Dental Medicine, Martin-Luther-University Halle-Wittenberg, Halle, Germany

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Fig. 2: Special designed apparatus with installed bone specimen mounted to the universal testing machine.

Fig. 3: Specimen preparation using triphase bur.

Results

In all groups tensile bond strength could be measured. The highest values were evaluated for Clearfil New Bond, while the lowest were observed in specimen treated with Excite (Tab. 1, Fig. 9). Statistical analysis showed a significant influence of the used adhesive system on tensile bond strength ($p < 0.001$, ANOVA). Clearfil New Bond showed significant higher bond strength than the other four adhesives ($p < 0.001$, Tukey's test). In the group treated with Excite tensile bond strength was significantly reduced ($p < 0.001$, Tukey's test). The SEM evaluation of unloaded specimens showed no comparable tag formation as known from dentin (Fig. 4-6). The examination of loaded specimens showed in all cases cohesive fractures within the used adhesive (Fig. 7,8).

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Fig. 4: Specimen treated with Excite after removing of the organic bone. SEM, 500 x.

Fig. 5: Specimen treated with Clearfil New Bond. SEM, 500 x.

Fig. 6: Specimen treated with Etch&Prime 3.0. SEM, 500 x.

Fig. 7: Specimen treated with Clearfil New Bond after tensile bond strength measurement. SEM, 500 x.

Fig. 8: Specimen treated with Histoacryl after tensile bond strength measurement. SEM, 500 x.

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Correspondence:
Kerstin Bekes, Dr. Christian Gernhardt
Martin-Luther-University Halle-Wittenberg
Department of Operative Dentistry and Periodontology, University School of Dental Medicine,
Grosse Steinstrasse 19, D-06108 Halle (Saale), Germany
E-Mail: kerstin.bekes@medizin.uni-halle.de

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