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ESEM evaluation of three FRC post bonding systems

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Introduction

The use of endodontic fibre reinforced composite posts has increased in popularity because of their favourable physical and esthetic properties. The longevity of these posts is greatly influenced by the quality of adhesive bonding.

Objectives

The purpose of this study was to compare the interfaces formed by three different adhesive luting systems between endodontic posts and root canal dentine in vitro.

Material and Methods

A total of 120 extracted human incisors and canines were endodontically treated and their root canals were filled by lateral condensation of guttapercha. Post space preparation was performed with FRC Postec drills. The specimens were randomly divided into three groups of 40 samples each, and FRC Postec Plus posts (Ivoclar Vivadent, Schaan, Liechtenstein, Fig. 1) were inserted according to the manufacturer's instructions using three different bonding and luting systems.

Groups	Adhesive system	Self-etching	Bonding steps	Luting material
1	Excite	no	1	Multicore flow
2	AdheSe	yes	2	Multicore flow
3	Multilink Automix	yes	1*	Multilink Automix

Table 1: Adhesive luting systems (all Ivoclar Vivadent) used in the three sample groups
* Priming only; bonding step is integrated in the luting procedure

Between every handling the samples were stored in 0.9% saline solution containing 0.1% thymol. All specimens were longitudinally sectioned using a diamond saw at low speed and intense water coolant. The surface of interest was etched with 37% phosphoric acid for 15 seconds and examined with an environmental scanning electron microscope (ESEM; Philips, Eindhoven, Netherlands; Fig. 2) at 55 - 65% atmospheric humidity and a pressure of 670 - 800 kPa.

Fig. 1: FRC Postec Plus posts

Fig. 2: ESEM workplace

The quality of the interfaces between post and dentine was evaluated within cervical, middle and apical segments of the root using a standardized protocoll (Table 2). The specimens exhibiting adhesive defects were in addition transversally sectioned into three segments. The cross-sectioned surfaces were microscopically examined in order to exclude artefacts caused by a loss of humidity during the first ESEM observation (Fig. 3+4).
Data were statistically analyzed by the application of the nonparametric Chi-square, Kruskal-Wallis and Friedman tests.

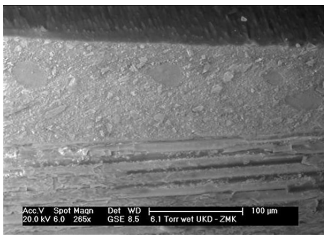

Fig. 3: ESEM Image of longitudinally sectioned sample

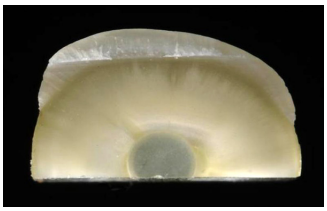

Fig. 4: Longitudinally and cross-sectioned sample

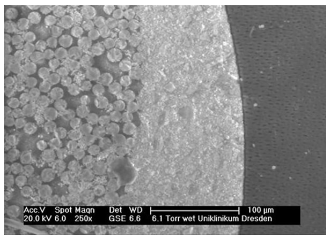

Fig. 5: ESEM Image of cross-sectioned sample

#	Interface between post ans luting
1	composite
#	Interface between luting composite and
2	adhesive
#	Interface between adhesive and dentine
3	a perfect interface b partial adhesive defect c complete adhesive defect
#	Hybrid layer
4	a complete hybrid layer b incomplete or absent hybrid layer

Table 2: ESEM evaluation criteria for interfaces #1-4

Results

Interface #1: post - luting composite
All samples exhibited perfect interfaces between the post and the luting composite in each of the three segments of the root, except for one case.

Interface #2: luting composite - adhesive (Fig. 6)
A perfect interface between luting and adhesive materials was observed in most of the cases (Fig. 6a). There were no statistically significant differences between the materials. Regarding to the root segments, differences in the quality of interfaces were only found in group 1 (Excite / Multicore flow). Some partial and a few total adhesive defects were recognized. The fewest adhesive defects were in group 3 (Multilink Automix), while group 1 revealed complete defects in 10% of the apical root segments (Fig. 6b+c).

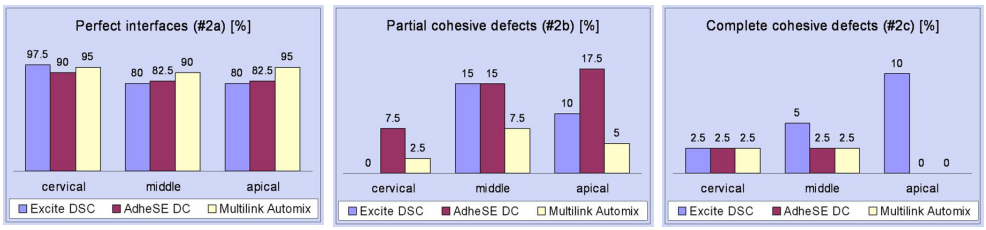

Figure 6a-c: Quality of interface #2 (luting composite - adhesive) at cervical, middle and apical levels of the root

Interface #3: adhesive - dentine (Fig. 7)
For this interface more distinct group-related differences became evident, proved to be significant in the middle and apical segment of the root ($p<0.05$). Group 1 showed the best, group 3 the worst results. Significant differences in the quality of interfaces between the three root segments were not observed.

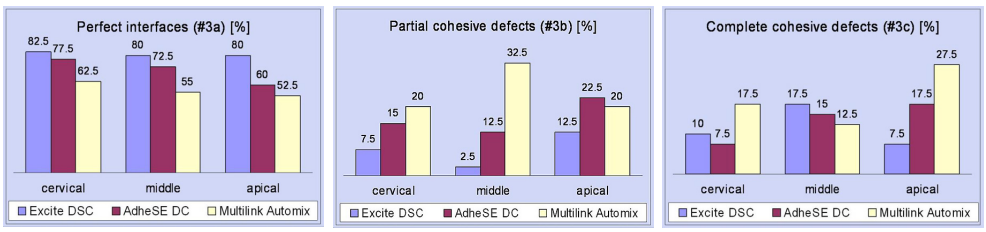

Figure 7a-c: Quality of interface #3 (adhesive - dentine) at cervical, middle and apical levels of the root

Interface #4: Hybrid layer (Fig. 8)
The formation of a complete hybrid layer was closely related with a perfect interface between the adhesive and the dentine (Fig. 7a and 8). This correlation was significant for every group and root segment ($p<0.05$). In both the cervical and the middle third of the root, group 3 exhibited the highest number of incomplete or absent hybrid layers ($p<0.05$). Differences between the root segments were significant in group 2 only ($p<0.001$).

Combination of interfaces (Fig. 9+10)
The portion of samples, which proved to be perfect in each of the first three interfaces, is shown in Fig. 9, revealing a decreasing trend of interface quality from group 1 to 3 and from cervical to apical. Figure 10 displays the percentage of samples without any adhesive defects along the entire root, classified for material groups and interfaces. This graph also makes obvious the high correlation between the quality of interfaces #3 and #4 .

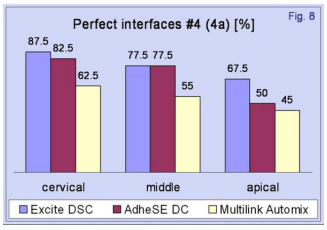

Fig. 8: Percentage of perfect hybrid layers

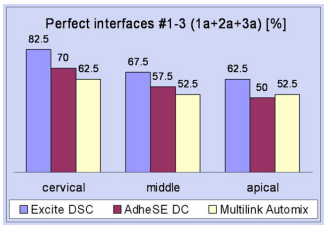

Fig. 9: Percentage of perfect interfaces #1-3

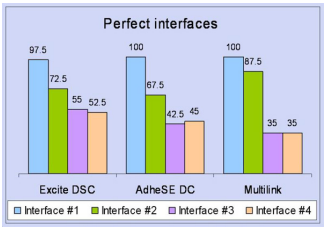

Fig. 10: Percentage of perfect interfaces along the entire root

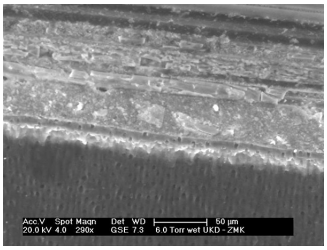

Fig. 11: ESEM Image of group 1 sample (Excite DC / Multicore flow)

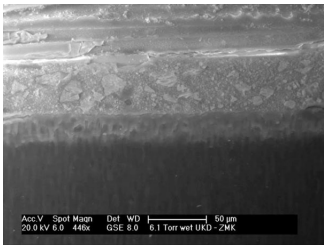

Fig. 12: ESEM Image of group 2 sample (AdheSE / Mulicore flow)

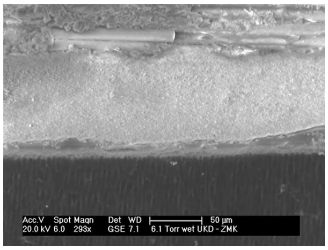

Fig. 13: ESEM Image of group 3 sample (Multilink Automix)

Summary and Conclusions

One hundred and twenty FRC Postec Plus posts (Ivoclar Vivadent, Liechtenstein) were inserted in the roots of extracted human anterior teeth using three different adhesive luting systems of the same manufacturer. The interfaces between the post and the dentine were evaluated by ESEM examination of longitudinally sectioned specimens at cervical, middle and apical levels using morphological criteria.
Statistically significant differences between the different adhesive luting systems were found concerning the quality of the adhesive - dentine interface and the formation of a hybrid layer. Multicore flow combined with the adhesive Excite DSC, which is applied after conventional acid conditioning of the dentine, demonstrated better results than the self-etching two-step luting system Multilink Automix. The three-step self-etching system AdheSe DC / Multicore flow ranged between the other two groups.
In summary it can be stated that there were no serious differences between the luting systems used for FRC post insertion. However, the advantages of simplified luting procedures were accompanied by losses in bonding quality.

This Poster was submitted by Dr. med. Thomas Klinke.

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Poster Faksimile:

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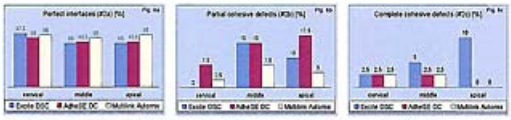

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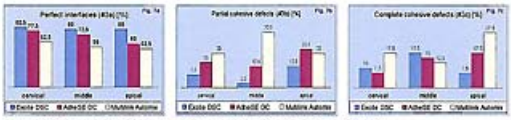

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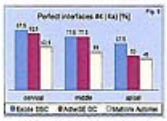

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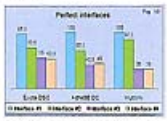

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