Short Resin-posts Bonding to Primary Dentin. Microleakage and Micro-morphological an *in vitro* study.

Ferreira MC* / Kummer TR** / Vieira RS*** / Calvo MCM****

The aim of this in vitro study was to evaluate the adhesion of two bonding systems (Single Bond and Adper Prompt L Pop, 3M ESPE) to short resin posts in the root dentin of primary teeth. Statistical analysis (Mann Whitney) revealed that there were no statistically significant differences between the materials (p= 0.75), but the Single Bond group presented a wider resin-dentin inter-diffusion zone (RDIZ). Both groups showed long resin tags. It was concluded that although Single Bond produced a wider adhesive interface than Adper Prompt L Pop, leakage levels occurred in both systems.

Key words: *tooth, primary, dentin-bonding agents, dental posts, microscopy, electron, scanning*
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INTRODUCTION

Crown destruction of anterior primary tooth is a very common problem in the pediatric dental clinic, due to early childhood caries and crown fractures resultant from trauma. In wider crown destruction where there is little dental tissues left, conventional restorative procedures are inadequate[1] and rehabilitation treatments which solves functional and aesthetics are indicated. The use of posts and cores are one of them. According to Pithan *et al*[2] the type of posts and core does not interfere with the retention of the final restoration, meanwhile the bonding between adhesive and root canal dentin walls can interfere with the final restoration retention. Alves *et al*[3] found that the endodontic filling materials do not interfere with the post's adhesion. They found a 100% cohesive failure when the filling used was a eugenol type. The self-etching bonding systems, a new generation of dentin adhesives appears to promote a balance between the demineralized zone and the resin monomer penetration.[4] These adhesives partially demineralize the smear layer and the subjacent dentin, leaving part of them filling the dentinal tubules, thus becoming incorporated into the hybrid layer.[5,6,7] But some studies show that acid-etch with these systems is deeper and leakage is higher.[8,9] The self-etch system is less technique sensitive when compared to other adhesive systems. Collapse of collagen fibers due to drying is avoided[10] its technique simpler, which is an advantage where the operative time is directly associated to the child's behavior. Hence this study was conducted to *in vitro* evaluate the leakage around posts and cores in primary anterior teeth, using two types of bonding systems.

* Meire Coelho Ferreira, DDS, MsC in Pediatric Dentistry, postgraduate PhD student in the Santa Catarina Federal University
** Thais Regina Kummer, DDS, MsC in Pediatric Dentistry, postgraduate PhD student in the Santa Catarina Federal University
*** Ricardo de Sousa Vieira, DDS, MsC, PhD Pediatric Dentistry Division, Santa Catarina Federal University
**** Maria Cristina Marino Calvo, DDS, MsC, PhD Public Health Division, Santa Catarina University

Send all correspondence to: Dr Ricardo de Sousa Vieira, R Prof Eduardo Luz 319, 88037-210, Florianópolis-sc, Brazil.

e-mail: rvieira@ccs.ufsc.br

MATERIALS AND METHODS

20 upper and lower primary canines with at least 2/3 of root length, caries free and with no previous endodontic treatment, were used. Teeth were collected from the UFSC's Pediatric Department Human Tooth Bank and the University's Ethics Committee in Human Research approved the study. Teeth were washed in running water and immersed in 10 vol. hydrogen peroxide solution for disinfection. When necessary root surfaces were cleaned with scalers to remove debris. Crowns were detached with a 11-4253 diamond disc (Buehler, Lake Bluff, IL, USA) with a slow speed saw (Isomet 1000, Buehler). Root canal length was measured by visually with a # 15 Flexo-file, which was introduced into the root canal until the point could be observed at the resorption area. Root canals were filed with first series K-Flexo-files up to number 40 Flexo-file. At the end of each file, roots were irrigated with a 1% sodium hypochlorite. In all teeth, a type I zinc oxide-eugenol cement (SS White, Rio de Janeiro, Brazil) was used as filling material. It was manipulated according the UFSC's protocol, which consisted in a mixing of 0.5g of zinc oxide powder with a 0.4ml of eugenol. The filling material was introduced into the root canals with a lentulo spiral instrument cut 1mm shorter than the length of the root. A final vertical condensation was made with cotton pellets. Teeth were sealed with a glass ionomer cement (Vitromolar, DFL, Rio de Janeiro, Brazil). Then roots were stored in a humid environment at 37ºC for 72 hours. After this period, 4mm of the filling material was removed with a # 4138 bur (KG Sorensen, Sao Paulo, Brazil) and with a syringe (Centrix, DFL, Rio de Janeiro, Brazil) a new layer of glass ionomer cement (Vitromolar) was placed. Roots were again stored in humidity at 37ºC for 24 hours. With a 3mm number 4138 diamond bur (KG Sorensen) the GIC was removed, so that the cement layer had 1mm thickness and the root cavity 3mm. Then the roots were randomly divided into two groups (n=10). In G1 the cavities were acid-etched with a 37% phosphoric acid gel for 15 seconds, rinsed with an

air/water spray for 15 seconds and dried with absorbent paper. Then two layers of Single Bond were applied and each layer photo-cured for 10 seconds. With the composite resin Filtek Z250 (3M ESPE) all the root cavity was filled, in small increments, each one photo-cured for 40 seconds and a 3mm core was built. In G2 the cavities were treated with Adper Prompt L Pop (3M ESPE) following the manufacturer's instructions. After manipulation the adhesive was rubbed to the cavity walls for 15 seconds. The excess of solvent was removed with a gentle stream of compressed air and the adhesive photo-cured for 10 seconds. The post and core was built with the same resin and in the same way as described for G1. All cores from the two groups were finished and polished using an extra-fine diamond bur (KG Sorensen) and Sof-Lex Pop-On discs (3M ESPE). Specimens were then stored in distilled water for 7 days at 37ºC and then thermo-cycled (500 cycles, at 5º and 55ºC). After that specimens were dried and the resorption areas were coated with an epoxy resin (Araldite, Vantico Ltda, Taboão da Serra, Brazil) and two layers of nail polish (Risqué, Taboão da Serra, Brazil) were coated 1mm beyond the cervical margins of the resin core. The specimens were then immersed in a 0.5% basic fuchsine dye for 24 hours at room temperature. They were washed in running water for 24 hours and longitudinally cut, in a mesio-distal direction. Each resulting section was examined using a stereobinocular microscope (MZS 200, Dimex, Mexico) at 20X magnification to assess dye penetration at the cores margins and along the interface of the post-canal walls. The degree of leakage was evaluated and scored as described in Table1. Section that exhibited the most leakage was scored and used for evaluation by SEM. Specimens were analyzed under a Phillips XL 30 SEM (Philips Electronic Instruments Inc, Mahwah, NJ, USA), at 20kV. Photomicrographs were taken to evaluate the resin-dentin inter-diffusion zone (RDIZ), resin tags and presence of gaps. The difference in the degree of the microleakage between the groups was compared using the Mann Whitney U-Test.

Table 1 –Criteria used for leakage measurement.

Scores	Leakage extension
0	No leakage
1	Leakage through _ of cervical dentin wall
2	Leakage beyond _ of cervical wall, but not reaching dentin in the root canal
3	Leakage through _ root dentin wall (resin post)
4	Leakage beyond _ root dentin wall (resin post)
5	Leakage beyond GIC stop

RESULTS

Leakage scores are presented in Table 2. No statistically significant differences were found in microleakage between the two groups (p=0.75). In both groups none of the specimens was leakage free (0) and none presented leakage highest score (5). The resin-dentin inter-diffusion zone (RDIZ) was present at root canal walls in 7/10 of specimens from G1 showing a good sealing (Figure 1). Resin tags length was uniform along these walls (Figure 2). At the cervical walls RDIZ and resin tags were observed in 4/10 specimens. A thick layer of adhesive was observed at dentin interfaces. RDIZ in the root canal walls was present in 8/10 specimens from G2 (Figure 3). Tags were longer than in G1, being wider and thinner close to dentin surface. In the cervical walls RDIZ and resin tags were observed in 3/10 specimens (Figure 4). A thin adhesive layer was observed at dentin surfaces. Residues of GIC remained over the dentinal walls in some specimens (Figures 5 and 6). In G1 gaps were observed at the cervical walls, between the adhesive and dentin walls (2/10), in the adhesive layer (1/10), between the adhesive and composite resin (1/10) and between the adhesive and GIC (2/10). In G2 the same gaps were observed at cervical walls, between the adhesive and dentin walls (2/10) and between the adhesive and GIC.

Table 2 – Frequency of leakage

Scores	Group 1	Group 2	Total
0	0	0	0
1	4	1	5
2	0	5	5
3	4	4	8
4	2	0	2
5	0	0	0
Total	10	10	20

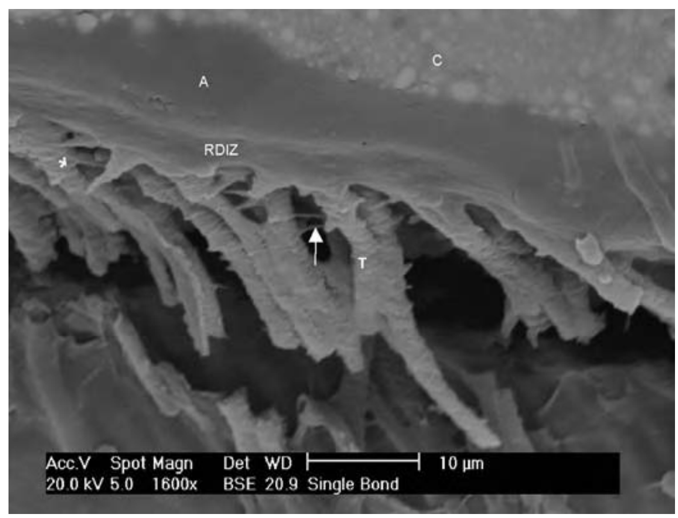

Figure 1: Single Bond sample (G1). Resin tags grouped and presence of lateral ramifications (* and arrow). C- Composite resin; A- Adhesive; RDIZ- Resin-dentin inter-diffusion zone; T- tags.

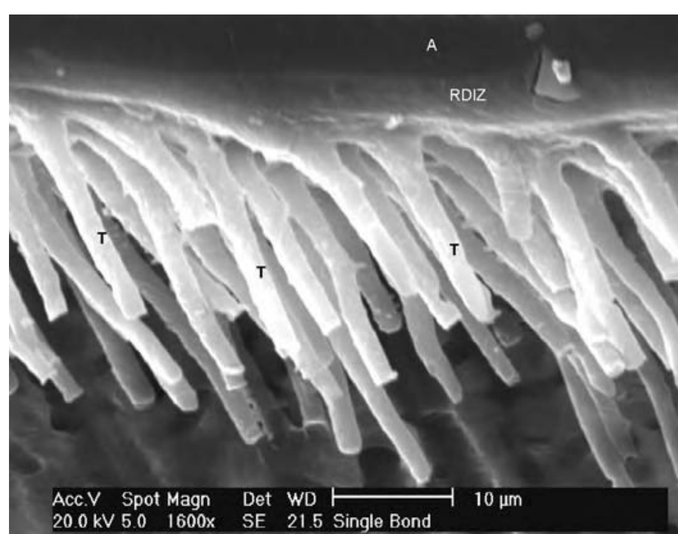

Figure 2: Single Bond sample. A- Adhesive; RDIZ- Resin-dentin inter-diffusion zone; T- Resin tags.

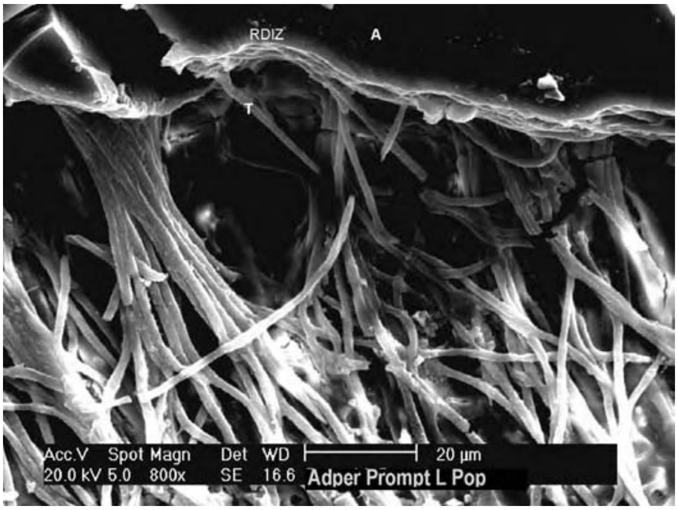

Figure 3: Micro-morphology of the resin/dentin interface from a Adper Prompt L Pop sample (G2) in the primary root dentin. The interface is thin and tags are grouped. A- Adhesive; RDIZ- resin-dentin inter-diffusion zone; T-Resin tags.

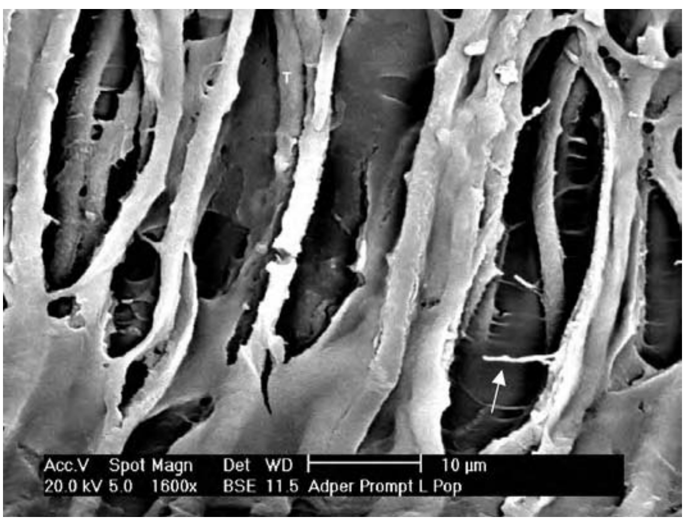

Figure 4: Adper Prompt L Pop sample. Adhesive and smear layer . Lateral ramifications in resin tags (arrow). T- Resin tags

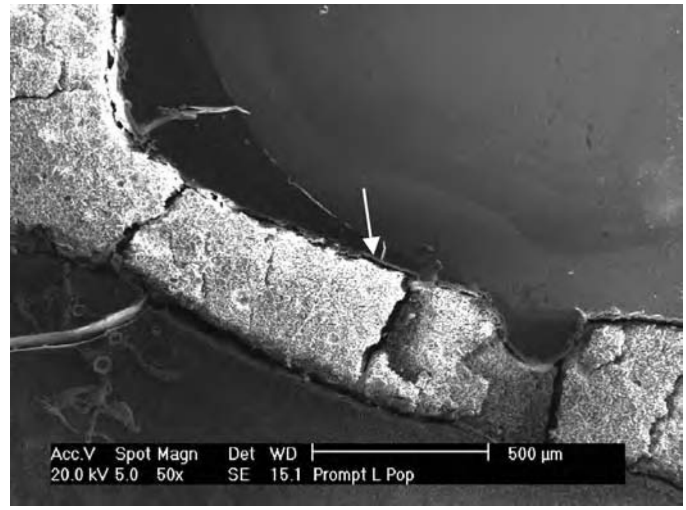

Figure 6: Closer view of the sample in Figure 5, showing the GIC (arrow)

DISCUSSION

The use of intra-canal posts and cores enables larger reconstructions of destroyed anterior primary teeth, solving functional and esthetic problems, without interfering with root resorption. In this study posts and cores, as described by Pithan *et al* [2] were used. The aim of this study was to evaluate the influence of the bond system between posts and cores and the dentin surface of root canals in anterior primary teeth. A major goal in the use of dental adhesives is the control of marginal leakage. Studies show that dental adhesives do not avoid leakage in composite restorations, no matter its composition.[7,11,12,13,14] In the present study the adhesives tested, Single Bond and Adper Prompt L Pop did not prevent microleakage and there was no significant difference in the degree of microleakage between both adhesives. This finding is supported by Stalin *et al* [11] that evaluated the bond strength, fracture mode and leakage with these adhesives, in class V restorations in primary molars. In their study however, the cervical margins were located in enamel. On other hand Atash and Abbeele[7] found a good marginal seal at cervical margins located in enamel and cement, in class V restorations in primary molars, using the Adper Prompt L Pop.

In the present study gaps were observed mainly at the cervical

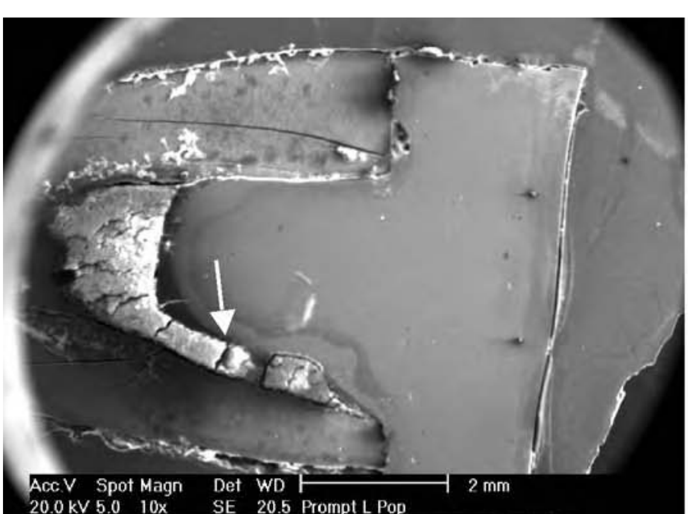

Figure 5: Prompt L Pop sample. Presence of glass ionomer cement at the root canal lateral wall (arrow)

walls in both groups. While leakage scores confirm these findings, gaps occurred in a uniform pattern along the entire wall, which could suggest a technical artifact during the vacuum forming, which could enlarge a previous existing gap. According to Sano *et al* [15] damages to the samples are difficult to avoid when one is examining the resin/dentin interface using a conventional SEM because of the severe dehydration caused by the extreme vacuum required during the process. da Silva Telles *et al* [16] reported larger and more frequent interfacial gaps in restorations where Prompt L Pop was used than in those where the Single Bond was used. According to the authors the self-etching adhesive's low pH could compromise the resin monomers polymerization and for this reason a strong and stable hybrid layer could not be formed. A thick layer of adhesive was observed along the root canal walls from the specimens of the Single Bond group which is also supported by Perdigão *et al* [17] and Asakawa *et al.*[18] In the Adper Prompt L Pop group the adhesive layer was thinner and irregular, which could be related to the lack of inorganic fillers in the material's composition. According to Atash and Abbeele[7] the incorporation of filler particles into the bonding resin may promote formation of adhesive films with appropriate thickness, which allows a better bonding during the initial polymerization time. Kaaden *et al* [4] found that even with the application of various layers of the Prompt L Pop adhesive, there was no formation of a thick and uniform adhesive layer. They found that the composite was in direct contact with the hybrid layer. While the Single Bond adhesive had formed a thick adhesive layer, leakage was not lower than the self-etch adhesive. Thicker layers of adhesive are important to absorb impacts. This layer could absorb, in part, the polymerization shrinkage stress of the resin preventing gap formation.[5,19,20] RDIZ was thicker in the Single Bond group than in the Prompt L Pop group. This finding was supported by Watanabe *et al* [22] however, in their study RDIZ was observed at the root dentin. At the cervical walls of some specimens, areas with no sign of hybridization were observed. According to Frankenberger *et al* [21] the lack of hybrid interfaces found in the Prompt L Pop group is due to the adhesive drying which promotes dried areas where probably the adhesive is too thin to being successfully photo-polymerized. The absence of the hybrid layer was also observed by da Silva Telles et al16 with the use of Prompt L Pop and Filtek Z250, contrary to the Single Bond and Z250 group, that showed a hybrid layer. Even a thin and not observable RDIZ, by SEM, does not mean a lower bonding strength. Prati *et al* [23] did not find a significant statistical correlation between the bond strength and RDIZ thickness. They found that even with a thinner hybrid layer, self-etch adhesives showed good bond strength. The formation of a thinner hybrid layer in the intertubular dentin does not mean an insufficient infiltration of the adhesive into the dentinal tubules,[25] which was observed in the present study. The thin hybrid complex formed at the intertubular dentin did not block the resin tags formation and the hybrid layer formation at the level of demineralized peritubular dentin. In the presence of a large smear layer, self-etching adhesives might not be capable to go through it. Besides, the primer acidity could be buffered by the mineral content of the smear layer[26] decreasing its demineralization potential and hybrid layer formation. However, self-etching adhesives can be too aggressive, as the Prompt L Pop has demonstrated, dissolving all the smear layer, demineralizing the sub-superficial dentin and consequently forming a real hybrid layer with width between 3.5 to 5.0 m.[6] Aggressiveness of this bonding system was found in the present study where long resin tags were observed, demonstrating that the adhesive had penetrated into the smear layer producing a demineralizing effect into the primary dentin. According to Nör *et al* [25] primary dentin is more reactive to acid etching. Long resin tags were observed at the root dentin in both groups with exception to one specimen from the Single Bond group, which presented short and homogeneous resin tags. The morphological aspects of the resin tags found by Prati *et al* [23] in permanent dentin revealed that there is a morphological difference between resin tags formed by self-etching adhesives and those formed by total etch adhesives. According to the authors the tags morphology is probably related to acid treatment given to the smear layer. Although self-etching adhesives dissolves the smear layer, residues of this smear layer are not removed and hence its buffered capacity remains and acts in the adhesive penetration. Limitation of the self-etch adhesive penetration is the major reason for the formation of resin tags with large base and thin apices.[25] The only difference found between the tags formed by Single Bond and Adper Prompt L Pop was their appearance. In the Single Bond group, tags appeared to be more distant to one another and seem to involve collagen fibers in the peripheral tubules. In the Adper Prompt L Pop group, the tags were located closer to the interface, sometimes grouped and apparently involved with a smooth and uniform coat. Probably the external appearance looks like to dissolved smear layer, which was reinforced by the resin adhesiveness.

The use of a GIC to isolate the endodontic filling material allows the GIC to remain into the dentin walls, which could interfere with the resin adhesion. But literature data[26] shows that bonding between GIC and composite resin occurs because of the presence of HEMA in both materials.

CONCLUSIONS

1. Single Bond performed equally in terms of microleakage, to Adper Prompt L Pop.
2. Neither of the two adhesives systems was able to completely prevent leakage of resin posts and cores in primary anterior teeth.
3. Despite Single Bond presented a wider resin-dentin inter-diffusion zone than Adper Prompt L Pop, leakage occurred in both groups.

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