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Effect Of Immediate And Delayed Post Space Preparation On Pushout Bond Strength Of Root Canals Obturated With A Hybridized Silicone Based Gutta-Percha Infused Bioceramic Sealer

Author

Abstract
Background:
Teeth with extensive decay that need endodontic treatment often lack sufficient support for a permanent restoration wherein intracanal post are utilized for core retention. Bond strength of the post to the root dentin varies depending on obturation technique, sealer used and the time elapsed between canal obturation and -post cementation. GuttaFlow bioseal is hybridized silicone-based Gutta-percha infused bioceramic sealer which has a high pH and good sealing ability that releases calcium ions inducing hydroxyapatite formation. There is no information available regarding pushout bond strength of endodontically treated teeth obturated with GuttaFlow Bioseal and rehabilitated with Glass fibre posts.
Aim*: To evaluate the effect of immediate and delayed post space preparation on pushout bond strength of root canals obturated with bioceramic sealer.*
Materials and Methods:
Twenty extracted human mandibular premolars with single root canals will be instrumented upto 25.06 using rotary files and obturated using single cone technique with GuttaFlow bioseal, followed by post space preparation leaving an apical seal of 5 mm Gutta Percha.
All the teeth will be randomly divided into two groups:
Group 1: Post space preparation done 15 min after the obturation.
Group 1a- Fiber posts cemented using self-etch adhesive
Group 1b- Fiber posts cemented using total etch adhesive
Group 2: Post space preparation done 7 days after the obturation.
Group 2a- Fiber posts cemented using self-etch adhesive
Group 2b- Fiber posts cemented using total etch adhesive
Sectioning of the interface of post and the gutta percha will be done using microtome precision saw. The pushout bond strength will be measured using INSTRON Universal Testing Machine for each sample.
Results:
One Coat Bond SL has been used in both the groups. The compressive stress at break is 6.64 and 17.01 respectively. (Group I and III). One Coat 7 Universal has been used for the self-etch group in this study. The compressive stress at break is 23.24 and 6.75 respectively. (Group II and IV). It consists of 10-methacryloyloxydecyl dihydrogen phosphate monomer (10-MDP).
Conclusions:
The longevity of an endodontically treated teeth rehabilitated with Immediate post space preparation with self-etch technique is beneficial for the clinicians as it emits the technique sensitivity of total etch technique.

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I. Introduction

Preserving sound tooth is a vital element for the long-term survival of teeth that have undergone endodontic treatment. After endodontic procedures the extent of damage to the tooth walls influences the likelihood of using endodontic posts to support the tooth buildup before crown placement.[1]

A variety of post systems, including metal, zirconia, fibre, and composite options, are available in the market.[2] Fiber posts, valued for their aesthetic qualities, are increasingly favoured due to their rigidity, which is similar to that of dentin, as well as their excellent biocompatibility.[3]

Several factors affect the bond strength of the posts by influencing the bond formed between cement-tooth and cement-fibre posts.[4] The factors to contemplate are the anatomy and preparation of the canal, type of

sealer used for obturation, the time elapsed between obturation and post cementation, the bonding protocol used and the stress caused by polymerization contraction of the cement and cyclic loads during mastication.[5]

With introduction into endodontics, bioceramic-based sealers have gained attraction for excellent physicochemical and biological properties. Their bioactivity is due to the ability to form hydroxyapatite on the sealer surface once it contacts with tissue fluids.[6] GuttaFlow bioseal (Colténe/Whaledent, Altstãtten/ Switzerland) contains a mixture of polydimethylsiloxane and gutta-percha powder with calcium silicate particle which forms hydroxyapatite crystals.[7]

The moisture condition of the root canal dentin may influence the adhesion of post to dentin by influencing dentin wettability and, thereby, the cement penetration. It is recommended to maintain a moist (but not dry or wet) dentin for methacrylate resin-based materials but the effect of dentin moisture on bioactive sealers remains unknown.[8]

The time of post space preparation (PSP) may influence some outcomes in endodontically treated teeth such as void formation,[9] displacement of filling material, the bond strength of the post .[10] There is a lacuna regarding the time interval between the endodontic treatment and post preparation.

II. Aim

The aim of this in vitro study is to evaluate the effect of immediate and delayed post space preparation on pushout bond strength of the root canals obturated with GuttaFlow bioseal.

III. Materials And Methodology

Ethical Approval:

The approval for the research was obtained from the committee for the student's proposal, a constituent of the Institutional Ethical Committee of Sri Ramachandra Institute of Higher Education and Research (DU), Porur, Chennai **[CSP/24/DEC/154/443].**

Specimen Preparation:

Mandibular premolar teeth (n=20) with caries-free, single-straight root, extracted for orthodontic purposes, were collected for the present study. Proximal view radiographs (mesial and distal) were taken to confirm the presence of a single-patent canal. Teeth with root caries, internal resorption, cracks, and curved and obliterated canals were excluded. Crowns of all teeth were cut off at cementoenamel junction and the length of roots was standardized to a 15 mm length.

Root canal preparation:

Access cavity preparation was done, and a size 10 K file was used to determine its patency. The working length (WL) was determined 0.5 mm short of the radiographic apex. All the root canals were mechanically prepared using the GenENDO™ rotary NiTi files (Colténe, Newyork, USA) up to size 25.06. All root canals were irrigated with 3% NaOCl at each change of file. The canals were finally irrigated with 17% EDTA for 1 minute followed by normal saline. All teeth were obturated using using GuttaFlow bioseal (Colténe/Whaledent, Altstãtten/ Switzerland).

All the teeth will be randomly divided into two groups (n=10):
Group 1 (Immediate): Post space preparation done 15 min after the obturation.
Group 2 (Delayed): Post space preparation done 7 days after the obturation.

In all groups, post space preparation was done utilizing Peeso reamers size:1-3(Dentsply, Swiss) leaving 5 ml of apical gutta percha. The post space was rinsed with 2 mL of 3% sodium hypochlorite (NaOCl) for 3 min; after that the canal rinse with 2 mL of 17% EDTA was accomplished for 3 min and then 2 mL of saline was used as a final rinse.

The teeth were subdivided into two groups according to bonding protocol(n=5):

(Group I and III): For total etch group, root dentin in the prepared post spaces of all the specimens etched with 37% phosphoric acid gel (Magic Acid; Vigodent) 15 s in dentin, rinsed for 30 s and water excess removed with sterile filter-paper for 10 s. Two-step etch-and-rinse adhesives One Coat Bond SL (Colténe/Whaledent AG, Altstãtten, Switzerland) was applied in 1-5 consecutive coats.

(Group II and IV): For self-etch group, One Coat 7 Universal (Colténe/Whaledent AG, Altstãtten, Switzerland) adhesive was applied to the dentin with a micro brush and scrubbed for 20 sec, followed by gentle air drying for 5 sec.

All samples were light curing for 10 sec with a light-curing unit (Waldent ECO Plus Light Curing Unit) set at a power 1200-mw/cm².

Then, each post was cemented into the respective specimens using ParaCore® (Colténe Whaledent, USA) dual-cure resin cement as per the manufacturer's instructions. Periapical radiographs were recorded to verify the post fit after cementation. Then, all the specimens were mounted in acrylic resin. The specimens were transversely sectioned into 3 mm thick slice in coronal third using a precision cutting saw (Isomet Low Speed Saw, Buehler Ltd., Lake Bluff, IL, USA) at a speed of 150 rpm with a diamond cutting blade under copious water cooling.

Push-out test:

Each 3 mm thick slice was subjected to a push-out bond strength test using a universal testing machine (Instron, model 8500 Plus; Dynamic Testing System; Instron Corporation.; Norwood, MA, USA.) at a constant vertical static load of 50 kg and a crosshead speed of 0.5 mm/min until the post was debonded. The maximum load recorded at the point of extrusion of the post from the slice was considered the point of bond failure. The push-out bond strength of each slice was recorded in megapascal (MPa).
All the clinical images have been depicted in Figure 1.

Statistical Analysis

The IBM SPSS v25 (Statistical Package for Social Sciences, Armonk, NY, US) program was used for statistical analysis. The Kolmogorov–Smirnov test and Shapiro-Wilk test were used to determine whether the numerical data were normally distributed. The intergroup comparison among the experimental and comparison groups was done using independent t test and Mann Whitney U test. The intragroup comparison was done using One-way ANOVA test. p value of ≤0.05 was considered as statistically significant.

IV. Results

Kolmogorov–Smirnov test and Shapiro-Wilk test revealed the normal distribution of data in this study. (Table 1)

Group		Kolmogorov-Smirnov			Shapiro-Wilk		
		Statistic	df	P value	Statistic	df	P value
A	Compressive stress at maximum force(MPa)	.146	10	.200	.936	10	.508
	Compressive stress at break	.389	10	**.0001**	.565	10	**.0001**
B	Compressive stress at maximum force(MPa)	.142	10	.200	.947	10	.634
	Compressive stress at break	.149	10	.200	.959	10	.775

Parameter	Group	N	Mean	SD	Mean Rank	Sum of Ranks	P value
Compressive stress at break	A	10	14.94000	30.725367	10.10	101.00	0.79
	B	10	11.88000	11.634145	10.90	109.00	

Comparison of Compressive stress at Break between groups

V. Discussion

Endodontically treated teeth have undergone extensive loss of coronal structure and lack an adequate support for a permanent restoration. Thus, these teeth need core retention through intracanal post placement.[11]

During the post space preparation (PSP), the root canal filling material may be twisted, vibrated, or dislocated, consequently creating voids.[12] Several factors, including apical integrity, the remaining amount of root

canal filling materials, the obturation techniques, the gutta-percha removal techniques, sealer type, and preparation time may affect the integrity of obturating material and cause microleakage and bacterial infiltration. Thus, it is essential to provide an adequate apical sealing and to avoid recolonization of bacteria.[13]

The time of PSP may influence some outcomes in endodontically treated teeth such as void formation, displacement of filling material, and the bond strength of the post to the root dentin.[14] In the present in vitro investigation, the effect of immediate (Group A) and delayed (Group B) post space preparation on pushout bond strength of bioceramic sealer was measured. It was concluded that Group A had a higher value of compressive stress at maximum force than Group B (p=0.79). This can be attributed to the amount of remaining filling material after PSP. Earlier literature suggested that post space preparation does not completely remove the remaining filling material. [15,16] due to difference in cross sections of canals. Teeth with long-oval or flattened cross-section have a lack of compatibility between the root canal diameter, the preparation drills and the fiberglass post. Therefore, there is filling material removal from the polar areas whereas dentin removal occurs from the nonpolar areas of the root canal, compromising bond strength of post to the root dentin.[17] It is also reported that the post spaces made immediately after root canal obturation showed less leakage than those prepared one week after obturation which coincides with the results of the current study.[8,18]

The chemical composition of the adhesive system directly influences the bonding ability. The two-step etch-and-rinse adhesives are a combination of primer and bonding resin in a single bottle that containing hydrophilic and hydrophobic monomers. In our study, One Coat Bond SL has been used in both the groups. The compressive stress at break is 6.64 and 17.01 respectively. (Group I and III). This can be attributed to the adhesive composition. One Coat Bond SL is a filled adhesive and consists of 53 % hydrophilic monomers and 41 % hydrophobic monomers. It contains 5 % of fumed silica and the same concentration of water. This adhesive did not contain acetone or any type of alcohol as organic solvent, which is rare among bonding agents. The functional methacrylates monomers (HEMA and hydroxypropyl methacrylate) with hydroxy groups belongs the hydrophilic part therefore compatible with water.[19] The absence of an organic solvent might reduce the infiltration rate of adhesive monomers into demineralized dentin, which compromise the longevity of dentin bonding as observed in this study.

One Coat 7 Universal has been used for the self-etch group in this study. The compressive stress at break is 23.24 and 6.75 respectively. (Group II and IV). It consists of 10-methacryloyloxydecyl dihydrogen phosphate monomer (10-MDP). The 10-MDP monomer provides acidity and, consequently, the capability to etch the dentin surface. During the demineralization promoted by the acidic monomer, other substances present in the adhesive infiltrate into the demineralized dentin. Also it has the ability to chemically bond to the hydroxyapatite in dentin and enamel, favouring the bond to dental tissue. In self-etch mode, the residual hydroxyapatite that remains around the collagen fibrils serves as a receptor for chemical interaction with 10-MDP and subsequently contributes to adhesive performance.[20]

VI. Conclusion

The longevity of an endodontically treated teeth rehabilitated with Immediate post space preparation with self-etch technique is beneficial for the clinicians as it emits the technique sensitivity of total etch technique.

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Figure 1: Clinical steps involved in pushout bond strength measurement for total etch and self-etch groups in the study

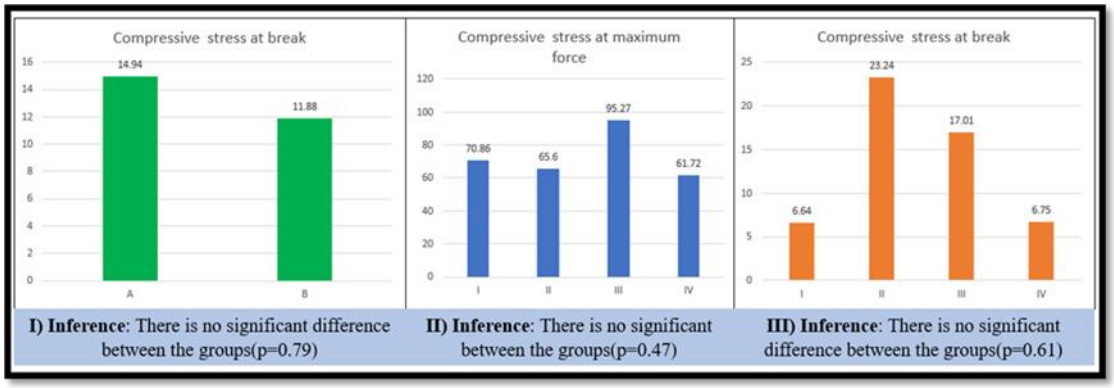

Figure 2: Graphs depicting the intergroup and intragroup comparison of compressive stress