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ASSESSMENT OF TWO ROOT CANAL SEALERS PUSH-OUT BOND STRENGTH IN ROOT CANALS OBTURATED USING TWO DIFFERENT OBTURATION TECHNIQUES

Bassem M. Eid* *and* Reem A. Abdel Gawad **

ABSTRACT

Background: The aim was to compare the push-out bond strength of calcium silicate-based sealer Total Fill BC Sealer with an epoxy resin-based sealer Adseal used in cold lateral and single cone obturation techniques. **Materials and Methods:** Forty-eight single-rooted teeth with completely formed apices were selected. Teeth were decoronated, and working length was determined. Instrumentation and irrigation were performed. The teeth were equally and randomly divided into four groups (n=12) according to the obturation technique and the root canal sealer used as follow; **Group I:** Root canals were obturated using gutta percha & Totalfill bioceramic sealer by using single cone technique single cone technique, **Group II:** Root canals were obturated using gutta percha lateral condensation technique & Totalfill bioceramic sealer, **Group III:** Root canals were obturated using gutta percha & Adseal sealer by using single cone technique, and **Group IV**: Root canals were obturated using gutta percha & Adseal sealer by using lateral condensation technique. Manipulation and application of the sealer was done according the manufacturer instructions. All teeth were stored in an incubator at 37 °C and 100% humidity for 1 week to allow complete setting of the root canal sealers. Each root was prepared for push-out test using universal testing machine with root slices of 2 mm thickness were obtained at 3, 7, 11 mm from apex representing (apical, middle, and coronal) respectively, and the push-out bond strength was calculated. Statistical analysis was performed using One-way ANOVA followed by Tukey post hoc t-test was used to compare between more than two groups in non-related samples. **Results:** The highest bond strength was found in Group II (Totalfill & cold lateral obturation technique) ($P < 0.05$) compared to other groups. The lowest bond strength was found in Group III (Adseal & single cone obturation technique). **Conclusion:** The push-out bond strength of Totalfill & Adseal root canal sealers with cold lateral obturation technique were highest followed by Totalfill& single cone technique and lowest bond strength was observed in Adseal & single cone on obturation technique. Higher push out bond strength values recorded in apical and middle thirds than coronal third.

KEY WORDS: Totalfill BC sealer, Adseal resin sealer, cold lateral obturation technique, single cone obturation technique and Push-out bond strength.

* Lecturer in Endodontic department, Faculty of Dentistry, Al-Ahram Canadian University, Assistant professor Al-Farabi dental college

** Lecturer in Endodontic department, Faculty of Dentistry, Suez Canal University, Assistant Professor Tibah University.

INTRODUCTION

As long as; chemo-mechanical preparation of root canals couldn't achieve its primary goal regarding eradication of microorganisms responsible for endodontic diseases and is not able to establish a microorganism-free a root canal system despite continuous developments of root canal disinfection agents and techniques[1, 2]. So a corono-apical seal inside the root canal system is essential to prevent the proliferation of residual microorganisms that cause reinfection[3]. Different obturation techniques are used to achieve maximum adaptation of filling materials with the root canal space; including thermoplastic, cold lateral compaction, single-cone techniques and others[4]. Maintenance of adequate obturation seal is of critical importance for prevention of bacterial microleakage[3]. However; cold lateral compaction obturation technique is the most commonly used technique; it results in an inhomogeneous poorly adapted gutta-percha mass, with a high percentage of sealer especially the apical portion, difficult and time-consuming technique[5,6]. With recent advents of root canals preparation using nickel-titanium (Ni-Ti) rotary instruments, provide an easy and fast preparation and preserving the natural curve of the root canal with minimizing procedural errors[7, 8]. Consequently; single-cone technique uses gutta-percha cones which are matched with rotary instruments become more popular, provides an easy, fast technique, produce a homogenous obturation[9,10]. Gutta-percha with a sealer has universally been accepted as the gold standard for root canal obturation; however it does not have a complete dentinal seal[11]. Adhesive obturation systems have been introduced recently in an attempt to obtain a "Monoblock "in which the core material, sealer and root canal wall form a cohesive unit within the root canal[12]. Adhesion to dentin might lead to greater strength of the restored tooth, more resistance to root fracture and clinical longevity of an endodontically treated tooth [13]. Differences in the interaction of endodontic sealers with either dentin or root core materials are expected due to difference in their chemical composition ,consequently, their adhesive properties [14]. A strong bond between the root canal sealer and the root dentin is essential for maintaining the integrity of the sealer-dentin interface during the preparation of post-spaces and during tooth flexure[15]. Recent advances in adhesive technology have led to the introduction of a new generation of endodontic sealers capable of bonding to radicular dentin; Adseal (Meta Biomed Co, Cheongju, Korea) is an easily mixed epoxy resin-based sealer have good physical properties, apical sealing ability, adequate biologic function and micro-retention to root dentin which the manufacturer claims excellent biocompatibility, good radiopacity, not cause tooth discoloration and does not dissolve in tissue fluids[16,17]. Bioceramic sealers have the ability to penetrate into the dentinal tubules and interact with dentine moisture to create bonds between the dentin and core filling materials, an optimum dimensional stability and the least amount of shrinkage[18,19]. Totalfill BC (FKG Dentaire SA, La Chaux–de–Fonds, Switzerland) is a recently introduced hydrophilic sealer, composed of zirconium oxide, calcium silicates, calcium phosphate monobasic, calcium hydroxide, and various filling and thickening agents [20].

The aim of this study was to compare the push-out bond strength of Totalfill BC sealer and Adseal resin sealer used with Gutta percha in cold lateral compaction and single cone obturation techniques. The null hypothesis was that there is no difference in the bond strength among the test groups.

MATERIALS & METHODS

Forty-eight human freshly extracted lower premolars with fully developed roots, single, straight root canals were selected for this study and collected from the out-patient clinic of Oral Surgery Department Al-Farabi dental college. All teeth were cleaned from calculus and any soft tissues by using ultrasonic scaler. All the teeth were decoronated

using a water coolant low speed diamond disc to standardize all the root lengths to 16 mm included and stored in distilled water until till the time of use. The working length was calculated by using K file #10 (Mani Inc, Japan) that was passed through the apical foramen so that the tip is just visible then the file was withdrawn out of the root canal and the length of the file was recorded, then the working was calculated by subtracting 0.5 mm from the recorded length. All the root canals were prepared using rotary nickel titanium ProTaper NEXT (Dentsply, Maillefer, Ballaigues, Switzerland) in brushing motion with rotational speed of 300 rpm and torque 2.0-5.2 using (X-Smart Plus electric motor), till X4 file(40/6), the prepared root canals were irrigated using 3m 5.25% Sodium hypochlorite (NaOCl) between each file and other then using 1 mL of 17% Ethylenediamine Tetraacetic Acid (EDTA) (MD-cleanser, Meta Biomed) to remove the smear layer and final rinse with 5 mL distilled water and were dried with paper points. All of the 48 teeth were equally and randomly divided into four groups (n=12) according to the obturation technique and the root canal sealer(table 1) used as follow; **Group I:** Root canals were obturated using gutta percha (Dentsply-Maillefer, Ballaigues, Switzerland)& Totalfill bioceramic sealer by using single cone technique single cone technique with Protaper Next matching single gutta percha cones corresponding to files (X4), **Group II:** Root canals were obturated using gutta percha lateral condensation technique with standardized gutta percha cones & Totalfill bioceramic sealer, **Group III:** Root canals were obturated using gutta percha & Adseal sealer by using single cone technique , and **Group IV**: Root canals were obturated using gutta percha & Adseal sealer by using lateral condensation technique. For **Groups I** and **III**: small amounts of sealer were applied to the canal by using a K-file #size 25 in a counter-clockwise rotation then the single cone was coated with sealer and inserted inside the canal to the full working length. For **Groups II** and **IV**: master gutta percha cone size 40 (2% taper) was selected and inserted into the canal, tug back was ensured, inserting spreader size #25 (Mani Inc., Tochigi, Japan) coated with sealer 1 mm shorter than the working length next to the master cone and the accessory gutta-percha cones were placed in the space provided by the spreader. This process was repeated until the spreader did not penetrate more than 1-2 mm from the canal orifice. After completion of obturation procedures, a heated plugger was used to remove the excess gutta-percha with no further vertical compaction. The coronal orifices were sealed with glass ionomer cement (Fuji, GC, Tokyo, Japan). All teeth were stored in an incubator at 37 °C and 100% humidity for 1 week to allow complete setting of the root canal sealers.

TABLE (1): Endodontic sealers used in the study

Brand	Composition	Batch	Manufacturer
Totalfill	Premixed single syringe contains Calcium silicate, Calcium phosphate monobasic, zirconium, tantalum oxide and thickening agent	(10)17002SP	FKG Dentaire, LA-Chaux-de Fonds, Switzerland .
Adseal	Base: 25%–50% bisphenol A 10%–25% zirconium dioxide NS calcium tungstate NS iron oxide Catalyst: 2.5%–10% N, n-dibenzyl-5-oxanonandiamin-1,9 2.5%–10% amantadine	ADS1608271	META BIOMED, Chungju, Korea

Push-out bond strength test:

All the roots are vertically positioned and embedded in acrylic resin. Each root was sectioned in a horizontal plane perpendicular on the long axis using a water-cooled precision saw by using diamond disc 8-inch diameter and 0.6 mm thickness (Isomet 4000, Buehler, USA). From each root three sections with 2 mm thickness were obtained at 3, 7, 11 mm from apex representing (apical, middle, and coronal) respectively, each specimen thickness was measured with +/–0.02 mm accuracy using digital caliper (Mituyoyo, Japan). Oval root sections were discarded and replaced with new circular specimens. From each group, each slice was marked on its coronal side with an indelible marker to ensure that the direction of the plunger push was in the apical to coronal direction to avoid any interference because of the root canal taper. Each root slice was mounted in custom made loading fixture metallic block with circular cavity at the middle, this cavity for specimen housing having a central whole to facilitate displacement of extruded filling material, then subjected to compressive loading at a crosshead speed of 0.5 mm/min via a computer-controlled material testing machine. The plunger tip was sized and positioned to touch only the filling, without stressing the surrounding dentin. Failure manifested by extrusion of filling piece and confirmed by sudden drop along load-deflection curve recorded by Bluehill Instron computer software. The maximum failure load was recorded in N (Newton) and converted into MPa (Megapascals) according to the following formula [21]:

Push-out bond strength (MPa) = Maximum load (N)/ Adhesion area (mm^2).

The adhesion area was calculated by using the following formula:

$$(R-r)^{2}]^{0.5}$$

Where $\pi = 3.14$, R is the coronal radius, r is the apical radius, and h is the thickness of the slice. The push-out bond strength was determined for each root slice. Values were recorded, tabulated for each group and the mean and standard deviation values were calculated for each group in each test. Data were explored for normality using Kolmogorov-Smirnov and Shapiro-Wilk tests, push-out data showed parametric (normal) distribution. One-way ANOVA followed by Tukey post hoc t-test was used to compare between more than two groups in non-related samples. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows.

RESULTS

At the three levels of the study; there was a statistically significant difference between **Group I** (Totalfill bioceramic sealer & single cone obturation technique), **Group II** (Totalfill bioceramic sealer& cold lateral condensation technique), **Group III** (Adseal sealer &using single cone technique) and **Group IV** (Adseal sealer cold lateral condensation technique) where (p<0.001). The highest mean value at both coronal and middle thirds was found in **Group II**, followed by **Group IV** and **Group I**, while the least mean value was found in **Group III**, while at apical one third The highest mean value at both coronal and middle thirds was found in **Group II**, followed by **Group IV** and **Group III**, while the least mean value was found in **Group I** (table 2and figure 1).

At the coronal third: A statistically significant difference was found between **Group I** and each of ***Group II*** and ***Group IV*** where (p=0.001) and (p=0.009), while no statistically significant difference was found between **Group I** and ***Group III*** where (p=0.994). A statistically significant difference was found between **Group III** and ***Groups II*** and ***IV*** where (p=0.001 &0.004) respectively. While no statistically significant difference was found between **Group II** and **Group IV** where (p=0.890).

At the middle third: A statistically significant difference was found between **Group I** and each of ***Group II*** and ***Group IV*** where (p<0.001) and (p=0.007), while no statistically significant difference was found between **Group I** and ***Group III*** where (p=0.862). A statistically significant difference was found between **Group III** and each of **Group II** and **Group IV** groups where (p=0.001). While no statistically significant difference was found between **Group II** and ***Group IV*** where (p=0.512).

At the apical one third: A statistically significant difference was found between **Group I** and each of ***Group II*** and ***Group IV*** where (p<0.001) and (p=0.001), while no statistically significant difference was found between **Group I** and ***Group III*** where (p=0.999). A statistically significant difference was found between **Group II** and ***Group III*** where (p<0.001), while no statistically significant difference was found between **Group II** and ***Group IV*** where (p=0.941). A statistically significant difference was found between **Group III** and ***Group IV*** where (p=0.002).

TABLE (2): The mean, standard deviation (SD) values of push-out bond strength of different materials and obturation techniques at different levels.

Variables	Push-out bond strength					
	Coronal		Middle		Apical	
	Mean	SD	Mean	SD	Mean	SD
Group I : Total fill& single cone	2.42 [b]	0.94	2.98 [b]	1.46	2.98 [b]	1.97
Group II: Total fill & lateral condensation	4.58 [a]	1.64	5.89 [a]	1.70	6.13 [a]	1.44
Group III: Adseal single cone	2.29 [b]	1.27	2.51 [b]	1.15	3.08 [b]	1.53
Group IV: Adseal & lateral condensation	4.20 [a]	1.28	5.05 [a]	1.54	5.75 [a]	1.62
p-value	**<0.001***		**<0.001***		**<0.001***	

Means with different letters in the same column indicate statistically significance difference. * ; significant (p<0.05) ns; non-significant (p>0.05)

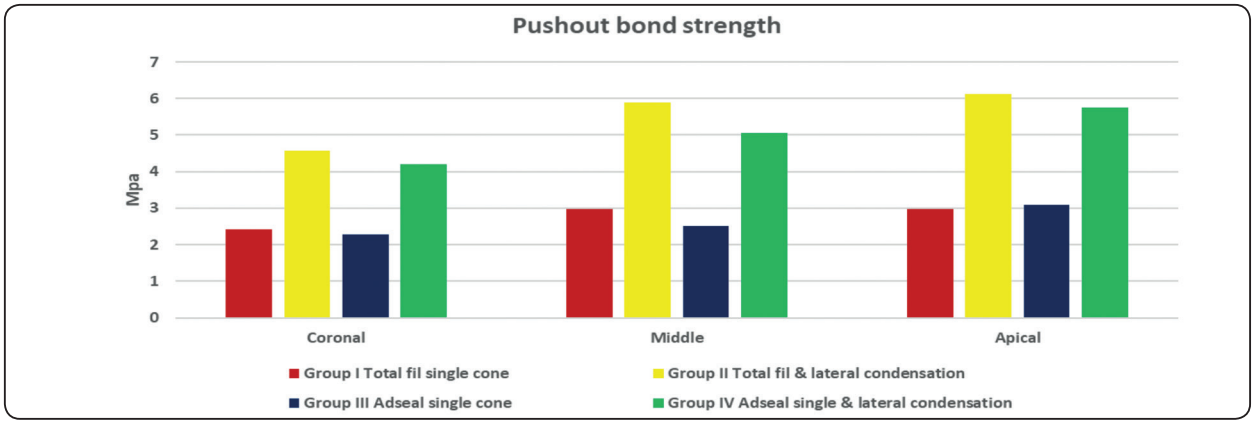

Fig. (1): Bar chart representing effect of different sealers used and obturation techniques on push-out bond strength

DISCUSSION

Root canals obturation golden goal is to seal the root canal system in order to prevent reinfection of the periapical tissues, so its resistance against dislodgment from the root canal dentin during tooth flexure and post space preparation is crucial for preserving the integrity of the sealer-dentin interface[22]. Variable methods have been used to determine the effectiveness of sealers in retaining the filling materials within the root canal walls including; shear bond strength, micro-tensile strength and push-out tests. In this study we used push-out test as it is a reliable, reproducible and can be easily interpreted technique which is based on the shear stress at the interface between dentine and cement, which is comparable with stresses under clinical conditions[12]. In the present study, the bond strength of Adseal and TotalFill root canal sealers utilized in single matched-taper gutta-percha cone techniques were evaluated and compared with that of the lateral compaction technique. The results showed there is a role of both the filling technique and the sealer in bond strength of the filling material to the root canal which makes the null-hypothesis rejected. Lateral compaction technique showed the highest bond strength values compared to single-cone techniques which showed lowest bond strength values whatever the type of sealer used, which came against the results showed by ***Nagas et al***, [(6)] who proved the single-cone technique with a master cone with 0.06 taper has a higher bond strength to dentin compared to the lateral compaction technique. This contradiction can be attributed to differences in methodologies between the two studies. On the other hand; the results of this study came in accordance with ***Mokhtari et al.*** [23] who attributed the high bond strength showed by cold lateral obturation technique to; compaction pressure upon the use of a finger spreader to create space for the insertion of accessory cones which might achieve better contact between the sealer and dentin, reduce of voids in the sealer and fill the irregularities in the root canal using of accessory gutta-percha cones reducing the thickness of the sealer layer and increasing retention[24].While single cone obturation technique shows an insufficient adaptation of larger master cones to the root canal due to lack of sustained pressure with variant and irregular morphologies and increased sealer thickness and voids[25]. it also recorded in both group of the present study had higher bond strength in apical, middle thirds than coronal third which came along with ***Mannocci et al*** [26]study that attributed the high values of bond strength at apical and middle root thirds of the root as result of anatomical variations of the root canal thirds, sealer thickness, included voids, and low densities of dentinal tubules and that apical areas of root dentin have higher bond strength than middle and coronal thirds. On basis of the results of this study; TotalFill root canal sealer showed higher bond strength compared to Adseal individually in each obturation technique. This inferred to its true `` micromechanical interaction `` nature, through production of hydroxyapatite during setting forming a chemical bond with dentin wall by the "mineral infiltration zone", in addition to its hydrophilic property, low contact angle with canal walls allowing its spread and showing good adaptation and hermetic seal[27.] On the other hand; Adseal root canal sealer utilized in cold lateral compaction showed significantly higher bond strength results than both tested sealer utilized in single cone technique, which can be related to previously mentioned merits of cold lateral obturation technique, and advantageous properties of the resin sealer including; its flow-ability, longer polymerization time enables it to penetrate deeply into the dentinal tubules and low shrinkage [28, 29]. In the present study, the bond strength of Total Fill and Adseal root sealers used in either single cone technique or cold lateral compaction technique were tested in straight, circular root canals. Further research is required to compare them with other obturation techniques and root canals configurations.

CONCLUSION

Within the limitations of this (in-vitro study) study, the push-out bond strength of the tested TotalFill root canal sealer was higher than the push-out bond strength of Adseal resin sealer. Push–out bond strength of both sealers was higher when utilized with cold lateral compaction technique.

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