AJDS LAZHAR
Al-Azhar Journal of Dental Science
Vol. 21- No. 4- 395:400- October 2018
Record 1110-2624 | the ISSN Portal
portal.issn.org

THE EFFECT OF ADDING NANOSILVER PARTICLES ON PUSH OUT BOND STRENGTH AND MARGINAL ADAPTATION OF ENDODONTIC SEALERS

Ahmed D Abo Gabal [*], Mohammad SH Aly [**], Mahmoud H Mohamed [***] *and* Saad-Eldin S Al-Ghazawy[****]

ABSTRACT

Objectives: The adding of nanosilver particles to endodontic sealers may be affecting the push out bond strength and marginal adaptation. This study is directed to evaluate the bond strength and marginal adaptation for modified zinc oxide eugenol and resin based endodontic sealers. **Methods**: a total number of 120 samples were used for bond strength test and 40 samples for marginal adaptation test. Two types of endodontic sealer were used according to the type of sealer (zinc oxide eugenol sealer {Endofil} and resin sealer {Adseal}),for bond strength (n=60) and (n=20) for marginal adaptation test each group was subdivided into four subgroups (n=15) for bond strength and (n=5) for marginal adaptation test according to concentration of adding nanosilver [control, concentration A, B&C]. Each subgroup were also divided for three periods of treatment (one day, one week and one month). The push out test was done by using Instron while marginal adaptation test was done by using SEM (scanning electron microscope). T-test was used to evaluate the push out bond strength and marginal adaptation properties for the dental sealers. **Results**: It was found that the Adseal control subgroup had the highest value in bond strength (12.88 Mpa) and the lowest value for Endofil concentration C subgroup (0.62 Mpa). **Conclusions:** By increase the concentration of nanosilver particles into endodontic sealers, marginal adaptation and bond strength were significantly decreased.

INTRODUCTION

Adhesion of endodontic sealers to dentin and gutta-percha offers clues into their interaction with the wall of the root canal and the filling material. An ideal endodontic sealer should, in part, adhere firmly both to dentin and to gutta-percha. No specific interaction either with dentin or gutta-percha is expected from the setting reaction of calcium hydroxide-based sealers and the epoxy-based sealers.

In contrast, the zinc oxide-eugenol sealer should firmly bond to dentin and gutta-percha. The setting reaction of the zinc oxide-eugenol mixtures is a chelation reaction occurring with the zinc ion of the zinc oxide. In addition, eugenol is a solvent of gutta-percha that may soften it during the setting reaction and increase bonding of sealer to gutta-percha [(1)].

The push-out bond strength test is a well-known evaluation method used in various other studies. Thus, its results can be useful for evaluating the interfacial strength and dislocation resistance of root filling materials to the root dentin [(2)].

The push out test design has several advantages over the other tests. This test design makes it easy to align samples for testing and is less sensitive to small variations among specimens and to the variations in stress distribution during load application. The model has been shown to be effective and reproducible and this method allows root canal sealers to be evaluated even when bond strengths

* Assistant lecturer , Dental Bio-Materials Department, Faculty of Dental Medicine, Al-Azhar University. Assuit branch.
** Professor and Head of Dental Bio-Materials Department, Faculty of Dental Medicine, Al-Azhar University. Cairo (boys).
*** Professor and Head of Endodontic Department, Faculty of Dental Medicine, Al-Azhar University. Assuit branch.
**** Lecturer , Dental Bio-Materials Department, Faculty of Dental Medicine, Al-Azhar University. Cairo (boys).

are low. Bond strength is recorded in mega Pascal's (MPa). For root canal sealers push out bond strength determines the strength of adhesion of the sealer-dentin interface. Higher push out bond strength indicates that higher amount of load is required to fracture the sealer dentin interface. Thus, indicating that the bond is stable and lesser likely to undergo dissolution [3].

Leakage is considered a common reason for the clinical failure of endodontic therapy. Therefore, leakage studies on sealers remain important and necessary to determine the most suitable materials and to gain more understanding of the factors influencing the sealing properties. Hovland and Dumsha stated "Although all root canal sealers leak to some extent, there is probably a critical level of leakage that is unacceptable for healing, and therefore results in endodontic failure" [1].

This leakage may occur at the interface of the dentin and sealer, at the interface of the gutta percha and sealer, through the sealer itself, or by dissolution of the sealer. In choosing a sealer, factors other than adhesion must be considered: setting time, ease of manipulation, antimicrobial affect, particle size, radiopacity, tendency to staining, dissolvability and cytotoxicity. All presently available sealers leak, but some leak more than others, mostly through dissolution. The greater the sealer/periapical tissue contact, such as in open apex or apical perforation, the faster dissolution takes place.

The quality of apical seal obtained by root-end filling materials has been assessed by studies using dye penetration, radioisotope penetration, bacterial penetration; electrochemical means, fluid filtration technique, confocal microscopy and scanning electron microscopy (SEM), but none of these studies confirmed a correlation between marginal adaptation and microleakage [4].

MATERIALS AND METHODS

I. Materials:

Two types of endodontic sealers were used in this study (zinc oxide eugenol-based sealer [Endofil] and resin-based sealer [Adseal]). The prepared nanosilver particles were also used as additives with different concentrations (0.01%, 0.1% and 1% by weight).

II Methods:

II.1. Push out bond strength test:

II.1.1. Teeth selection:

Forty single rooted freshly extracted sound non-carious human permanent lower first premolar teeth free from cracks or any developmental defects by using stereomicroscope were used in this test. Exclusion criteria included teeth with more than one root canal, root canal curvature of more than 15°, the root surface's decay and the teeth with calcified canals. After extraction of teeth, their debridement was done by handle instruments and they were kept in 0.01% NaOCl (sodium hypochlorite) solution before use.

II.1.2. Samples grouping:

A total number of (120 samples) were used in this test. Samples were divided into two main groups (n=60) according to the type of sealer (Endofil and Adseal). Each main group was subdivided into four subgroups (n=15 each) according to the incorporation of NAgPs.

Subgroup1: control [sealer without adding nanosilver particles].

Subgroup 2: concentration A subgroup [adding 0.01% by weight nanosilver particles].

Subgroup 3: concentration B subgroup [adding 0. 1% by weight nanosilver particles].

Subgroup 4: concentration C subgroup [adding 1% by weight nanosilver particles].

Each subgroup was either subdivided to 3 subdivisions according to the site of disk prepared (n=5) according to the cutting site.

II.1.3. Dentin preparations:

All teeth crowns were cut and canals were prepared to obtain the prepared root canals. The diameter of canal was standardized to 1 mm.

II.1.4. Sealer placement:

Endodontic sealers of two different types of sealers were mixed and the nanosilver particles (NAgPs) were added as manufactures instructions.

II.1.5. Sample designing:

After sealer placement, each root was cemented in acrylic block. It was cut horizontally to disks using a diamond disc of IsoMet microsaw. All samples were cut perpendicular to their long axis to obtain slices of 1 mm each. The exact dimension of each disc was measured with an electronic digital caliper to be within the range of 1 ± 0.04 mm.

The disks were prepared from coronal, middle and apical root area. The resulting forty roots were given 120 disks, then disks were observed for circular shape of the core filling material and those not meeting this criterion were eliminated.

II.1.6. Bond strength testing:

The push out test was carried out by means of a universal testing machine at a crosshead speed of 1 mm/min. The maximum load applied to the core material before the occurrence of bond failure, was recorded in Newton (N). To calculate the bond strength in MPa the bonding surface area was measured using the ($2\pi rh$) formula.

II.2. Marginal Adaptation test:

II.2.1. Teeth selection:

Forty single rooted lower first premolar extracted teeth were selected as the same criteria that described before in the (bond strength test).

II.2.2. Samples grouping:

A total number of (40 samples) were used in this test. Samples were divided into two main groups (n=20 each) according to the type of sealer; Endofil and Adseal. Each main group was subdivided into four subgroups (n=5 each) according to the incorporation of NAgPs;

Subgroup1: control [sealer without adding nanosilver particles].

Subgroup 2: concentration A subgroup [adding 0.01% by weight nanosilver particles].

Subgroup 3: concentration B subgroup [adding 0. 1% by weight nanosilver particles].

Subgroup 4: concentration C subgroup [adding 1% by weight nanosilver particles].

II.2.3. Sample preparation:

All teeth crowns were cut and canals were prepared as described before in the (bond strength test), to obtain the prepared root canals.

II.2.4. Sealer placement:

Two different types of endodontic sealers; Endofil sealer used as the ZOE (zinc oxide–eugenol) sealer and Adseal used as the epoxy resin sealer were used. Two sealers without adding were used as control groups. All sealers were mixed according to manufacture instructions; they were mixed on a sterile glass slab with a plastic spatula according to the manufacturer's instructions, and then were injected into the canals using a sterile syringe.

All samples were placed at 37°C in 98% relative humidity to allow complete setting. Each group was examined by SEM and marginal gap was calculated by (μm).

II.2.5. Sample designing:

After sealer placement, each root was cemented in acrylic block. It was split longitudinally to obtain halves using a diamond disc of IsoMET microsaw.

The resulting eighty root halves were washed. Selection for 40 halves from all samples after cut with the microsaw by using stereomicroscope to detect the free from cracks.

II.2.6. SEM analysis:

Each half was fixed by 2.5% glutaraldehyde for 30 minutes and 1% osmium tetroxide (OsO_4) for 1 hour. The samples were dehydrated by increasing concentrations of ethanol, dried by using a drier and sputter-coated with gold-palladium in a vacuum evaporator. To assess the marginal adaptation between sealer materials and cavity walls, the quantity of width for gaps in both sides of each half of the specimens were measured and recorded.

RESULTS:

I. Measurements of push out test:

Effect of NAgPs concentration: the mean and standard deviation results of push out bond strength (Mpa) of both sealers with different NAgPs concentration are summarized figure [1]. Regardless to both segment approach, it was found that, Adseal sealer groups (unmodified and modified groups) was recorded statistically highest bond strength mean value (Mpa) than ZOE sealer groups mean value as indicated by independent t test followed by Pair-wise Tukey's post-hoc test.

The results of statistical analysis show that; Adseal sealer (control group) was recorded the highest bond strength mean value (12.88 ± 2.36 Mpa), while ZOE sealer (1% NAgPs concentration was recorded the lowest mean value (2.17 ± 0.62 Mpa) as indicated by independent t test. Pair-wise Tukey's post-hoc test showed significant difference between both sealers with different concentration.

II. Measurements of marginal adaptation by [SEM]:

The mean and standard deviation results of marginal gap for both sealers with different NAgPs concentration are summarized figure [2]. The results of statistical analysis show that; ZOE sealer was recorded statistically significant higher marginal gap mean value (μm) than Adseal sealer group as indicated by independent t test followed by Pair-wise Tukey's post-hoc test.

The result of their study showed, control group (unmodified sealer) of ZOE sealer was recorded the highest marginal gap mean value (15.65 ± 4.48 μm), while; Adseal sealer with 1% NAgPs concentration was recorded the lowest marginal gap mean value (2.57± 1.25 μm). Pair-wise comparisons among their groups revealed that; all group with statically significant difference.

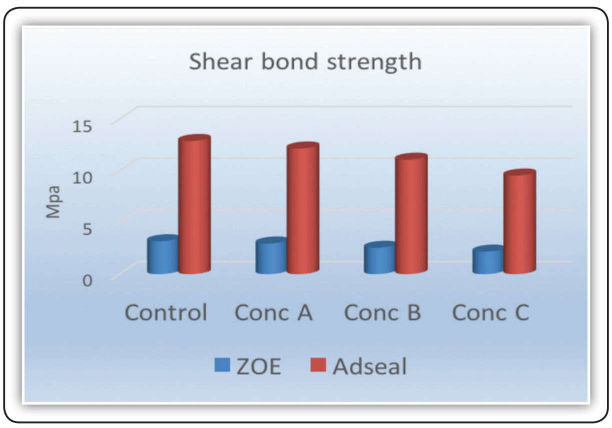

Fig. [1]: Column chart showing mean bond strength (MPa) of both sealers with different NAgPs concentrations.

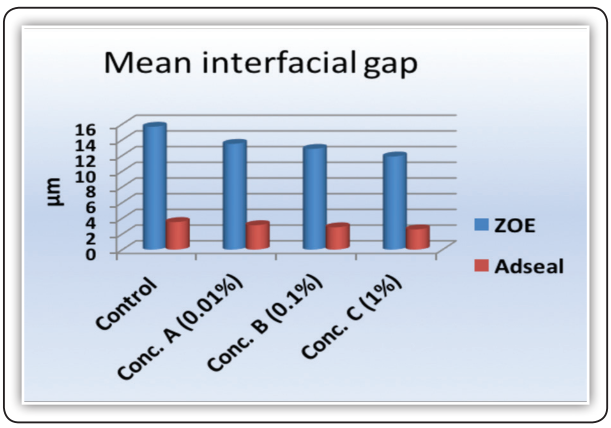

Fig. [2]: Column chart showing mean marginal gap (µm) in both sealers with different NAgPs concentrations.

DISCUSSION

One of the most important factors for the success of endodontic procedures is the bond strength of material to dentin. Various methods have been used for testing bond strength of root canal sealers such as shear bond strength, microtensile strength and push out tests. The latter is reproducible and can be done easily [(5)], in this study we used push out test to compare the bond strength of the sealers.

A lot of studies reported that the push out test is more reliable than other tests, and the push out method better reflects the clinical status of the fracture to determine the bond strength of root canal sealer. This test has been used by many researchers to determine the bond strength [(6)].

Some studies found that, different irrigation protocols influenced the bond strength of the resin sealers to the dentin. Thus, in the present study, the use of one irrigation protocol after remove of smear layer was used to assess the bond strength of the sealer to the dentine [(7)].

In relation to resin sealer, the most frequent failure modes in all groups were cohesive and mixed; this is similar to the previous study, reported that the most frequent failure was cohesive in resin sealer [(8)]. Epoxy resin sealer, is successfully and commonly used for root canal treatment due to many studies have shown good bond strength values with this sealer.

In this study, resin sealer was the best performer, showing the highest values of push out bond strength in the coronal one third. This could be because increases the bond strength of resin and also a greater number of dentinal tubules is present in the coronal third. More the dentinal tubules present, more will be the resin penetration and resin tag formation; which leads to higher bond strength of sealer [(4)].

In this study to accurately determine the bond strength, canal could have been completely filled with sealer in order to reduce the interfaces. This will lead to primary monobloc formation. When use gutta percha with sealer; during push out test, it is difficult to determine that fracture occurs at sealer-dentin interface or gutta-percha sealer interface. Thus, with monobloc formation accurate determination of fracture at sealer-dentin interface can be done.

Some authors showed that resin sealer was being the better than ZOE in marginal adaptation and sealing capacity, that in agreement with the present study [(9)]. Other studies showed that even though resin sealer sets faster, it tends to shrink and cause early debonding from the root canal wall, that may affect on adaptation [(10)].

As Adseal is an epoxy resin sealer, it penetrates better into the micro-irregularities than others and also increases the mechanical interlocking between the sealer and root dentin because of its creep capacity, resulted that resin sealer has greater adhesion to root dentin than other sealers [(11)].

The present study showed that among the two sealers compared, resin sealer shows a good marginal adaptation. Thus, may be important in preventing leakages suggested by SEM observation [(12)]. These studies concluded that on comparison of different types of sealers, the Adseal sealer was better in providing the apical seal than other sealers [(13)].

Our study exhibited small mean of gap size than the other study, possibly because of the difference in the method of sectioning; that was done without blocking, but in the current study sectioned the specimens after blocking. The force and vibration due to sectioning can cause increases in the mean gap size [(14)].

CONCLUSIONS

By increase the concentration of nanosilver particles into endodontic sealers, marginal adaptation and bond strength were significantly decreased.

REFERENCES

1. Joe D, Sharma N. Root Canal Sealers & its Role in Successful Endodontics A Review. Ann Dent Res. 2012; 2: 68-78.

2. Assmann E, Scarparo RK, Böttcher DE, Grecca FS. Dentin bond strength of two mineral trioxide aggregate based and one epoxy resin-based sealers. J Endod. 2012; 38:219-21.

3. Gupta PR, Aggarwal SD, Kshirsagar SP, Bhargava K, Rai V, Chawla M. Comparative evaluation of push-out bond strength of resin-based sealer and mineral trioxide aggregate-based sealer after using normal saline and 2% chlorhexidine as a final irrigant: In vitro study. Endod. 2016; 28:32-7.

4. Xavier CB, Weismann R, de Oliveira MG, Demarco FF, Pozza DH. Root-end filling materials: apical microleakage and marginal adaptation. J Endod. 2005; 31:539–42.

5. Hasan R, Behnam B, Negar K. The Effect of Canal Dryness on Bond Strength of Bioceramic and Epoxy-resin Sealers after Irrigation with Sodium Hypochlorite or Chlorhexidine. Int Endod J. 2016; 11: 129-33.

6. Goracci C, Tavares AU, Fabianelli A, Monticelli F. The adhesion between fiber posts and root canal walls: Comparison between microtensile and push-out bond strength measurements. Eur J Oral Sci. 2004; 112:353-61.

7. Prado M, Renata A. Effect of different irrigation protocols on resin sealer bond strength to dentin. J Endod. 2013; 39:689–92.

8. Saleh IM, Ruyter IE, Haapasalo M, Orstavik D. The effects of dentine pretreatment on the adhesion of root-canal sealers. Int Endod J. 2002; 35:859-66.

9. Gurgel E, Leite F, Lima J. Comparative evaluation of push-out bond strength of a MTA-based root canal sealer. Braz J Oral Sci. 2014; 13:114-7.

10. Ruddle, CJ. Advanced endodontics, gauging the terminus: a novel method. J Endod. 2012; 25:133-45.

11. Pawar S, Pujar M, Makandar S. Evaluation of the apical sealing ability of bioceramic sealer, AH plus and epiphany: an in vitro study. J Conserv Dent. 2014; 17:579-82.

12. Remy V, Krishnan V, Job TV, Ravisankar MS, Raj CVR, John S. Assessment of Marginal Adaptation and Sealing Ability of Root Canal Sealers: An in vitro Study. J Contemp Dent Pract. 2017; 1812:1130-4.

13. Ahuja L, Jasuja P. A Comparative Evaluation of Sealing Ability of New MTA Based Sealers with Conventional Resin Based Sealer: An In-vitro Study. J Clin Diag Res. 2016; 10: 76-9.

14. Shipper G, Grossman E, Botha A, Cleaton-Jones P. Marginal adaptation of mineral trioxide aggregate (MTA) compared with amalgam as root-end filling material: a low-vacuum (LV) versus high-vacuum (HV) SEM study. Int Endod J. 2004; 37: 325–36.