EGYPTIAN
DENTAL JOURNAL
www.eda-egypt.org

Vol. 70, 2917:2922, July, 2024

Print ISSN 0070-9484 • Online ISSN 2090-2360

Conservative Dentistry and Endodontics

Submit Date : 06-05-2024 • Accept Date : 01-06-2024 • Available online: 10-0702024 • DOI :10.21608/EDJ.2024.286438.3030

EFFECT OF ROOT CANAL OBTURATION USING RESIN AND BIO-CERAMIC SEALERS ON REINFORCEMENT OF ENDODONTICALLY TREATED TEETH

Ahmed Ali Youssef* *and* Essam Fawzy Mahmoud*

ABSTRACT

Aim: Comparing the fracture resistance of roots obturated with gutta-percha using two different sealers.

Materials and methods: Forty human single rooted mandibular premolars teeth were decoronated and standardized to 16 mm length. Instrumentation was done using PLEX-V system rotary file system up to PLEX-V 40.04. Samples were randomly classified into two equal experimental groups according to the type of sealer used for obturation of root canals (Adseal and Ceraseal). The roots were aligned vertically along their long axis in self-curing acrylic blocks and mounted on the universal testing machine to measure the fracture resistance. Data collected and statistically analyzed.

Results: The fracture resistance values of Adseal group were higher than Ceraseal group. A statistically significant difference was found between Adseal group (I) and Ceraseal group (II) where ($p<0.001$).

Conclusion: Within the limitation of this study, it can be concluded that the obturation using Adseal resin sealer combined with gutta percha points significantly increases the fracture resistance of endodontically treated teeth compared to Ceraseal bioceramic sealer combined with gutta percha points.

KEYWORDS: Bioceramic sealer, Ceraseal , fracture resistance

* Lecturer, Department of Endodontics, Faculty of Dentistry, Minia University, Egypt.

INTRODUCTION

The materials used to seal the root canal must support the residual tooth structure after endodontic treatment[1]. The resistance of endodontically treated teeth usually less than sound ones, this is due to loss of enamel and dentin which result from caries, trauma, attrition, or from the multiple steps of the endodontic treatment itself, and also due to loss of hydration after replacement of pulp tissues and fluids by synthetic material [2,3].

Gutta percha is the material usually used to obturate root canal space after cleaning and shaping that showed low elastic modulus and cannot reinforce roots after treatment [4-6]. Also, gutta percha doesn't bond to the dentin of the root canal; therefore, sealer should be used to bond the obturation material with dentin of the root canal and to obtain three-dimensional obturation [7]. Bondable root canal sealers such as resin-based sealers and Bio-ceramic sealers increase the resistance of endodontically treated teeth to fracture by bonding to root canal dentin and creating monoblocks by maintaining the integrity of the sealer-dentin interface [8,9].

Adseal is an epoxy resin-based sealer presented in the paste–paste consistency in double syringe. Base paste consists of epoxy resin and calcium phosphate. Catalyst paste consists of amines and bismuth III carbonate. The two components are combined by manually mixing the two pastes [10].

Ceraseal is a bioceramic sealer which supplied as a premixed syringe include bioactive components (tricalcium silicate and dicalcium silicate), tricalcium aluminate and zirconium dioxide as radiopacifiers. Also, the paste includes some traces of thickening agents [11].

Hence the aim of this study was comparing the fracture resistance of roots obturated with gutta-percha using two different sealers. The sealers used in the current study were Adseal resin sealer and Ceraseal bioceramic sealer. A postulated null hypothesis that there is no difference between Bioceramic-based sealer and Resin based sealer in increasing the fracture resistance of endodontically treated teeth when bonded to root canal dentin.

MATERIALS AND METHODS

Selection of samples:

The research proposal was agreed by the Ethical Committee of the Faculty of Dentistry, Minia university (Registration no. 103/ 890). Forty freshly extracted human mandibular premolars with single roots and mature apex were collected from the outpatients' clinic of oral and maxillofacial surgery department, faculty of Dentistry, Minia University. The teeth were selected from patients that have ages ranging from 16 to 40 years. Any tooth with more than single canal, calcifications, internal or external resorption, and open apex were excluded.

Sample preparation:

For soft tissue dissolution and surface disinfection, the teeth that fulfill the inclusion criteria were stored for two minutes in sodium hypochlorite 5.25% (NaOCl; Clorox, HC Egyptian company, Cairo, Egypt) and then stored in saline to prevent dehydration. For length standardization to 16 mm ± 1mm, crowns of all teeth were removed using high-speed disc (Dica, Dendia, USA) under water cooling [12]. ISO K- files size #10 (Dentsply Maillefer, Ballaigues, Switzerland) were used to determine each canal patency by penetrating the apical foramen and pulling back until the file flushed with the visible apical foramen. Samples were mechanically prepared by PLEX-V system rotary file system up to PLEX-V 40.04(Orodeka, Italy) using cordless endodontic hand-piece ENDO-MATE TC2 Wireless Endo-motor (NSK Nakanishi, Tochigi, Japan) at speed 300 rpm and 1.5N.cm torque for the orifice opener and at speed 500 rpm and 2.5N.cm torque for the remaining files according to the manufacture instructions. Irrigation was done after each instrument used by 3ml of 5.25% NaOCl and 17% Ethylene diamine tetra acetic acid (EDTA, Cerkamed, Pawłowski, Poland)) one minute by using a 30-gauge needle (Endo Top irrigation needles, Cerkamed, Pawłowski, Poland) adapted to a plastic syringe. After the last instrument was used, each canal was irrigated with distilled water and dried with size 40 taper 4 paper points (Dentsply Sirona, York, Pennsylvania) [6].

Sample grouping:

The prepared roots were randomly divided into two equal groups according to sealer used during obturation procedure:

- **Group I:** Adseal (MetaBiomed, Korea) resin sealer (n =20).
- **Group II:** Ceraseal (Meta Biomed Co., Ltd. Korea, Republic) bioceramic sealer (n= 20).

Root canal obturation

For Adseal group (I), freshly mixed Adseal was delivered to each root canal using the master gutta-percha cone by a slow up and down movement against the canal walls until the working full root canal length was reached to confirm the whole coating of the canal walls with the sealer. The cone was then removed and loaded again with the sealer and lastingly placed into the canal. Then, the gutta-percha was condensed laterally and accessory cones size 25 were inserted after using a finger spreader size 30. The excess was cut off at the orifice level using a hot instrument and lightly compacted with a figure plugger (Dentsply Maillefer, Ballaigues, Switzerland) [13].

For Ceraseal group (II), The mixing tip of the sealer was positioned inside the root canal, and about half of the root canal was filled with the sealer. Gutta-perch cone was covered with the sealer and was slowly introduced into the canal up to the full root canal length. Lateral condensation using a spreader and adding an accessory cone was done and then the excess was removed as in group I [13].

The quality of the obturation was assessed and confirmed using a buccal and proximal radiograph. Orifices of all specimens were sealed using resin composite. Samples were saved in an incubator (100% humidity and 37°C) for one week to allow the complete setting of the sealers [14].

Evaluation of the fracture resistance

The apical 5mm portion of the samples were immersed into molten wax in order to simulate the surrounding periodontal ligament space and tissues. Then, each sample was embedded in self-cure acrylic resin (Acrostone dental factory, Industrial Zone, Salam City, Egypt) install the roots vertically in copper rings [15].

A universal testing machine (Instron Corp, Canton, MA) was used to measure the fracture resistant of the obturated roots (Figure1). During the root fracture test, an upward force was gradually applied to each obturated root until it fractured. The force was increased slowly to ensure precision and accuracy in determining the root fracture point. The test was conducted with utmost care to obtain reliable and consistent results. The test was stopped at this point, and the force needed to fracture the samples was measured in Newton [3]. This value was then converted to megapascals using the following equation:

$$\text{MPa} = \frac{\text{Maximum load in Newtons (N)}}{(\text{Area of cross section of plunger of contact})^{2}}$$

π = 3.14 (constant value), Area of cross-section of plunger = 2.2 (uniform for all specimens).

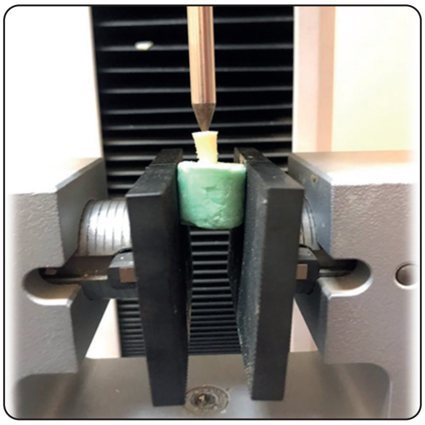

Fig. (1): Specimen mounted on testing machine.

Statistical analysis:

Mean values and standard deviations were calculated. Kolmogorov-Smirnov and Shapiro-Wilk tests were used for normality exploration. To compare between the two groups in non-related samples, independent sample t-test was used. The significance level was determined as P≤0.05. Statistical analysis was performed using IBM® SPSS® Statistics version 20 for Windows.

RESULTS

Adseal resin sealer group (Gp I) recorded the highest mean value of fracture resistance that required a load of (605.75±38.97 N) to fracture the obturated root, while Ceraseal bioceramic sealer group (Gp II) recorded the lowest mean values of fracture resistance that required a load of (550.89±25.66 N) to fracture the obturated root. There was a statistically significant difference between (Gp I) and (Gp II) at (p<0.001). (Table1, Figure 2)

TABLE (1) Mean values, standard deviation (SD) of fracture resistance between the tested groups.

Variables	Fracture resistance	
	Mean	**SD**
Gp I (ADSEAL resin sealer)	605.75	38.97
Gp II (CERASEAL bioceramic seale**r**)	550.89	25.66
p-value	<0.001*	

Significant (p<0.05)

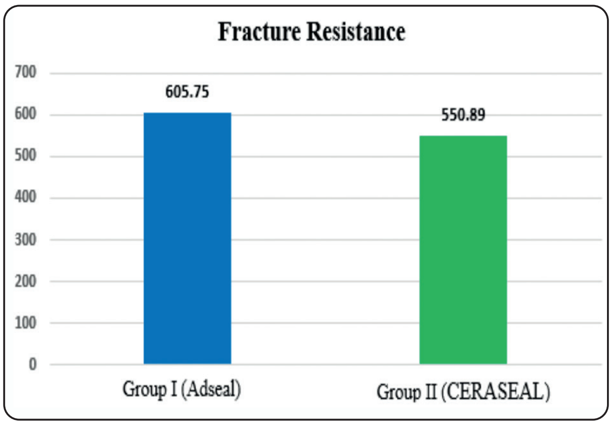

Fig. (2): Mean values of fracture resistance of the tested groups.

DISCUSSION

One of the main objectives of root canal obturation is the reinforcement of the root canal dentin by increasing the fracture strength of the obturated root. The mechanical interlocking between the filling material and root canal dentin is crucial to significantly reduce the risk of root fracture and effectively strengthen the remaining tooth structure [16]. Adhesive sealers that bond to root canal dentin can improve the strength of endodontically treated teeth. Research has unequivocally proven that these sealers dramatically increase the fracture strength of treated teeth. [17]. This study compared the fracture resistance of roots obturated with gutta-percha using two different adhesive sealers.

In current study, extracted human mandibular premolars were used because they are more susceptible to fracture after the endodontic treatment due to their size, root length and location in the jaw which is usually exposed to different types of forces [18]. A Sodium hypochlorite-EDTA irrigation protocol was used to create a favorable environment for successful root canal obturation, which ultimately improves the clinical outcome of the root canal procedure. EDTA is often used with NaOCl in clinical settings to effectively remove the smear layer [19].

The fracture resistance of obturated roots was tested in this study using the universal testing machine to apply parallel load leading to splitting stress over the canal orifice. This approach is more clinically applicable as it stimulates the natural tooth support by the alveolar bone and lead to less stress accumulation from unrealistic bending movements [20].

The fracture resistance of the obturated roots was tested in this study using the universal testing machine. The load was applied parallel to the long axis of the obturated roots, leading to splitting stress applied over the canal orifice. This resulted in lesser stresses because of decreased bending movements and maximum stresses located more cervically. This strategy was found to be more clinically applicable as it better stimulates the support given to the natural tooth by alveolar bone and results in less stress accumulation that result from the unrealistic bending movements [20].

Bioceramic sealers that were recently introduced into the endodontic field have the ability to stimulate the healing process of the peri-radicular tissues after endodontic treatment and induce mineralized tissues formation, also it has an antibacterial effect resulting from the alkaline pH and the release of calcium ions [21]. Ceraseal is a free of resin bio-ceramic based root canal sealer which also free of monomer to ensure better biocompatibility and zero shrinkage. It helps re-mineralization by the formation of hydroxy apatite due to its high pH and bioactive properties [12].

In current study Adseal was as an epoxy resin-based sealers which have a greater bond to root canal dentine and exhibit a dentinal tubule deep permeation. Fracture resistance of the obturated roots eventually increase by using epoxy resin-based sealers as a result of the retention of the obturation material that enhanced by the mechanical interlocking between the sealers in and the root canal walls [13,22]. The result of the fracture resistance test in our study showed that there were statistically significant different values of samples obturated with both sealers. Statistical analysis revealed that Adseal group had a significantly higher fracture resistance value (605.75±38.97) compared to Ceraseal group. The long setting time and creep capacity of the resin sealer allows it to infiltrate micro-irregularities of root canal dentine, contributing to its good adhesive properties. This, in turn, enhances the mechanical connection between the sealant and the root dentin. The fracture resistance value of the Ceraseal group could be attributed to the difference in the bond between resin and bioceramic sealers. In Ceraseal, the bonding to root canal dentin results from the deposition of the hydroxyapatite interracially, which only makes the material resistance of the friction increase, unlike the true bond in resin sealer [9].

The results of our study came in accordance with ***Abdallah et al*** [9] who showed that teeth filled with Adseal had a higher resistance to fracture than and Endoseal MTA. On the other hand, ***Hassan N*** & ***Hassan R*** [3] concluded that roots obturated with NeoSealer Flo bioceramic sealer have higher fracture resistance than roots obturated with AH Plus resin sealer which may be due to the use of different methodology in tooth preparation different sample size in both studies which lead to different results.

Also, The results of the present study totally disagreed with the findings of ***Hosny N & ElAbbasy F*** [12] who declared that the obturation using Ceraseal bioceramic sealer significantly increased fracture resistance of endodontically treated teeth compared to Adseal resin sealer, the different results in their study from our study may be due to using of bioceramic sealer along with C-points and Adseal combined with traditional gutta percha points where combination of slow of bioceramic sealer with the sluggish expansion of C-points when subjected to moisture, may lead to pushing the sealer deeply into spaces that resin sealer with gutta-percha could not reach[12,23].

The in vitro evaluation of the fracture resistance test on obturated single roots may not replicate the oral condition of endodontically treated teeth. Also, it does not reflect the strength of multirooted teeth after endodontic treatment.

CONCLUSIONS

In conclusion, within the limitation of this study; Adseal epoxy resin increased resistance to fracture of endodontically treated teeth more than Ceraseal bioceramic sealer when using the traditional gutta percha points as core obturating material. Further studies using different obturation techniques on single and multirooted teeth are required to evaluate the fracture resistance of both sealers. Also, studies under clinical conditions should be considered

REFERENCES

1. Qadir, E. Fracture Resistance of Endodontically Treated Teeth Filled with Protaper Guttapercha and Using Two Different Types of Sealers (A Comparative Study). Journal of Global Scientific Research. 2022; 7:2679-82.
2. Tang W, Wu Y, Smales RJ. Identifying and reducing risks for potential fractures in endodontically treated teeth. J Endod. 2010; 36:609–17.
3. Hassan N. & Hassan R. Fracture resistance of roots obturated with bioceramic and epoxy resin- root canal sealers using different obturation techniques: an ex-vivo study. Egyptian dental journal. 2023; 69:3217-24.
4. Karapinar Kazandag M, Sunay H, Tanalp J, Bayirli G. Fracture resistance of roots using different canal filling systems. Int Endod J 2009; 42:705-10.
5. Ribeiro FC, Souza-Gabriel AE, Marchesan MA, Alfredo E, Silva-Sousa YT, Sousa-Neto MD, et al. Influence of different endodontic filling materials on root fracture susceptibility. J Dent 2008; 36:69-73.
6. Patil P, Banga KS, Pawar AM, Pimple S, Ganeshan R. Influence of root canal obturation using gutta-percha with three different sealers on root reinforcement of endodontically treated teeth. An in vitro comparative study of mandibular incisors. J Conserv Dent. 2017; 20:241-4.
7. Rahimi M, Jainaen A, Parashos P, Messer H. Bonding of resin-based sealers to root dentin. Journal of Endodontics 2009; 35: 121-124.
8. Hajihassani N, Heidari S, Ghanati M, Mohammadi N. Comparison of Fracture Resistance of the Endodontically Treated Roots with Two Sealer Types: An In Vitro Study. Dental Hypotheses. 2022; 13:45
9. Abdallah Y, Nagy M, Hussein S. Fracture resistance of two different sealers (in vitro study). Egyptian dental journal.2022;69:793-800.
10. Scelza MZ, da Silva D, Scelza P, de Noronha F, Barbosa IB, Souza E, et al Influence of a new push-out test method on the bond strength of three resin-based sealers. Int Endod J. 2015;48:801–6
11. Zamparini F, Prati C, Taddei P, Spinelli A, Di Foggia M, Gandolfi MG. Chemical-Physical Properties and Bioactivity of New Premixed Calcium Silicate-Bioceramic Root Canal Sealers. Int J Mol Sci. 2022; 23:13914.
12. Hosny N & ElAbbasy F. Evaluation of Fracture Resistance of Bioceramic sealer with C points with and without laser activation (An In-vitro study). Egyptian Dental Journal. 2024; 70:979-86.
13. Kumar N, Prasada K, Govind M. Comparative evaluation of fracture resistance of endodontically treated teeth using resin based sealer and bioceramic sealer with various irrigation protocols-An In Vitro Study', International Journal of Current Advanced Research.2021; 10: 24355-8.
14. Kharouf N, Arntz Y, Eid A, Zghal J, Sauro S, Haikel Y, Mancino D. Physicochemical and Antibacterial Properties of Novel, Premixed Calcium Silicate-Based Sealer Compared to Powder–Liquid Bioceramic Sealer. J. Clin. Med. 2020; 9:3096.
15. Topçuoğlu HS, Tuncay Ö, Karataş E, Arslan H, Yeter K. In vitro fracture resistance of roots obturated with epoxy resin-based, mineral trioxide aggregate-based, and bioceramic root canal sealers. J Endod. 2013; 39:1630–3.
16. Omran A, & Alhashimi R. The effect of AH plus and GuttaFlow bioseal sealers on the fracture resistance of endodontically treated roots instrumented with reciprocal rotary systems. International Journal of Medical Research & Health Sciences.2019; 8: 102–8.
17. Imai Y, & Komabayashi T. Properties of a new injectable type of root canal filling resin with adhesiveness to dentin. Journal of Endodontics.2003; 29: 20–3.
18. Kala M, Shaktidar PR, Allappanavarkeerti S, Guptha-nagendra VR. A comparative evaluation of fracture resistance of endodontically treated teeth obturated with AH plus with gutta percha, guttaflow with gutta percha and resilon epiphany- an in vitro study. IOSR J Dent Med Sci. 2014; 13:54-8.
19. Fang J, Mai S, Ling J, Lin Z, Huang X. In vitro evaluation of bond strength and sealing ability of a new low-shrinkage, methacrylate resin-based root canal sealer. Journal of the Formosan Medical Association. 2012;111: 340–6.
20. Phukan, A. H., Mathur, S., Sandhu, M., & Sachdev, V. The effect of different root canal sealers on the fracture resistance of endodontically treated teeth-in vitro study. Dental Research Journal.2017; 14: 382.
21. Bianco, E., Calvelli, C., Citterio, C. L., Pellegatta, A., Venino, P. M., & Maddalone, M. Evaluation with micro-CT of the canal seal made with two different bioceramic cements: Guttaflow bioseal and bioroot RCS. Journal of Contemporary Dental Practice. 2020; 21:359–66.
22. Chandra S, Shankar P, Indira R. Depth of penetration of four resin sealers into radicular dentinal tubules: a confocal microscopic study. Journal of endodontics. 2012; 38:1412-6.
23. Ibrahim N, & Nayif M. Bond Strength of Endosequence Bioceramic Sealer to Root Canal Dentine Irrigated with Different Solutions. Int J Enhanc Res in Sci Techno and Eng. 2015; 4:136–9.