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FRACTURE RESISTANCE OF TWO DIFFERENT SEALERS (IN VITRO STUDY)

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ABSTRACT

Study aim: Was to compare the in vitro effect of Adseal sealer and Endoseal MTA sealer on the fracture resistance of endodontically treated teeth.

Materials and Methods: Sixty extracted human mandibular premolars with single root were used for the study. Teeth were reduced occlusally to standardize the working length to 18 mm.the instrumentation was done by using protaper rotary files ,The teeth were distributed randomly to four groups according to type of sealer: Group I (n=20): the teeth were filled by Endoseal MTA sealer and Group II (n=20): the teeth were filled by Adseal resin-based sealer.Group I and group II further were divided into two subgroups according to use of EDTA: Subgroup (a): using EDTA (n=10) and Subgroup (b): without using EDTA (n=10). Group III(n=10): control -1 (prepared-unfilled) irrigated with EDTA , Group IV(n=10): Control-2 (prepared- unfilled) without EDTA

Results: The highest value of the resistance fracture test was showed in Adseal group followed by Endoseal MTA group, While the prepared-unfilled groups was the least mean resistance fracture, Therefor there is difference significatlly among all groups. Regardless use of EDTA, there was a statistical significance effect of EDTA on the fracture resistance of all tested groups except control groups.

Conclusion: The type of endodontic sealer has influence effect on fracture resistance of root dentin.Epoxy resin sealers provides better fracture resistance than Endoseal MTAsealers. Irrigation with EDTA provides more fracture resistance to roots.

KEYWORDS: Bond Strength, Fracture Resistance, Sealers.

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INTRODUCTION

Previously different materials of obturation introduced in dentistry[1]. studies of Grossman showed the property of the materials of obturation and found that the importance of adhesion as its properties in the cement of root canal [2].

Caicedo and von Fraunhofer were stating that the cement seals the space of the root canal and,the cement also adhere the canal walls and GP cone [3].

Tay and Pashley had showed the monoblock concept in endodontics and organized it into 1ry, 2nd, and 3rd according to interface number between the substrate bond surface and the material core. The concept of monoblock in endodontics allowed the reinforcing of the root canal[4].

To reinforce the tooth, sealers must have enough cohesive strength to hold the obturation together as well as adhere to both dentin and core material. This hypothesis had led to the improvement the adhesion of root canal sealers[5-7]

GP do not bond to dentinal wall of the root and should be accompanied with sealer to give a tight bond among the wall of root canal and core material and for obtaining a fluid-tight seal. The adhesive quality between gutta percha and conventional zinc oxide eugenol sealer is very poor. Hence, several new types of sealers have been intoduced to be used , thereby developing the root canal sealer and showing higher bond strength to dentin than the conventional materials, such as resin based sealers and Bioceramic sealers[8].

When teeth are treated endodontically they become weak and more prone to fracture ,many factors affect it, massiv tooth structure loss through trauma and caries,dentin dehydration, preparation of access cavity, filling and pressure during root canal filling. Therefore using root canal sealer that can strength the root is mandatory[9, 10].

Resin sealers are one of the most widely used, Epoxy resin-based sealers like AH plus, AH 26, Adseal, it characterized by reactive epoxide ring, they are polymerized by breaking this ring, a good adhesive properties, good flow, antibacterial, greater adhesion to dentin when smear layer is removed and better long term sealing ability compared to conventional sealers due to its expansion over time.

Methacrylate resin-based sealers are derived from polymer chemistry technology and its combination with gutta-percha cone has shown reduced apical sealing ability compared with gutta-percha with conventional epoxy resin based sealers. It includes four generations, the first generation (hydron), the second generation (EndoREZ), the third generation (Fiberfill, Resilon/Epiphany, Real Seal), the fourth generation (Metaseal, RealSeal SE, Realseal I).

Mineral trioxide aggregate (MTA) are widely used in endodontics because of it induces tissue repair and mineralization [11].

Endoseal MTA becomes new root canal sealer that contains Ca2O4Si, Ca aluminates, Ca aluminoferrite, and Ca sulfates. It is a paste-type premixed root canal sealer depending on pozzolan cement that has perfect properties. It is put in syringe to allow application the sealer to the canal root directly . Upon the manufacturer, it has antibacterial effect ,fast setting time, adequate flowability ,biocompatibility, promotes hard tissue formation and also excellent film thickness.[12].

MATERIALS AND METHODS

Sample selection: sixty lower premolar were chosen , calculus removed by scaler, they were with single root, single root canal and single apical foramen ,Root curvatures were among 0°to10° .Any calcifications, resorptions, extracanals and any sort of defects like internal and external resorptions, root caries and open apices were excluded .

Sample size Calculation

According to a previous study an effect size of 0.75 was added to power b = 95% and a = 5% inputs into F test family for repeated-measures analysis of

variance (G*power 3.1 for Macintosh). A total size of 42 samples was necessary to identify differences among the tested materials [13].

Sample preparation:

In all samples Accesscavity were prepared by roundburs, occlusal surface was reduced, working lengthwasst and ardized 18mm, it was instrumented by protaper (Dentsply) rotary system with standard sequence S1, S2, F1, F2 and F3 then irrigated with5.25%sodium hypochlorite through the instrumentation

Sample classification : the human mandibular teeth were distributed randomly to four groups according to type of sealer: ***Group I*** (n=20): the teeth were filled by Endoseal MT sealer and ***Group II*** (n=20): the teeth were filled by Adseal resin-based sealer.Group I and group II further was divided into two subgroups according to use of EDTA: ***Subgroup (a):*** using EDTA (n=10) and ***Subgroup (b):*** without using EDTA (n=10). ***Group 3*** (n=10): the teeth were instrumented and irrigated with EDTA but not filled.***Group 4(n=10):*** the teeth were instrumented and were not irrigated with EDTA.All samples were stored at 37°C and 100%humidity for 7 days for setting of the sealers.

Sample evaluation: the distance of 10 mm from the apex of all roots of were waxed then it was embedded into acrylic resin. Every single tooth was vertically put in acrylic resin cure cold (IMICRYL, Konya, Turkey) using a mold metal with a dimensions of 2.5*2.5*3 cm giving the exposure of five millimeter of the roots in its coronal part. After acrylic polymerization , we removed the roots from the resin, we cleaned the wax from the tooth by usin curette and we coated the roots with polyvinylsiloxane impression material layer (coltene/ whaledent AG, Altstatten, Switzerland), and then we embedded it bach into resin again that allow polymerization over night.We used a universal testing machine (instron 3366, iston crop, canton, MA, USA) to test the reistance to fracture . we adjusted the steel end of the Instron test device parallelly to the long axis for the tooth and we directed the tester to aspeed of 1 mm/min. When the tooth fracture occurred the value was recorded in newton.

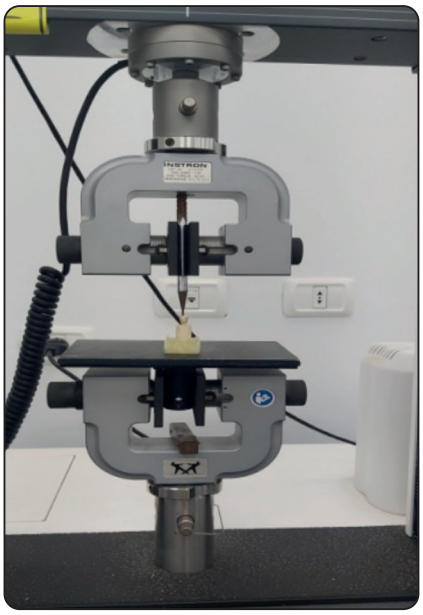

Fig. (1): Universal testing machine (instron 3366, iston crop, canton, MA, USA)

Statistical Analysis

Numerical data were explored for normality as we checked the data distribution. we calculate the mean and median values and using kolmogorov-Smirnov and Shapiro wilk tests. parametric distribution was showed in data so: It was represented by mean and standard deviation (SD) values. Comparisons between intergroups were done using one _way ANOVA followed by turkey's Post hoc test when the ANOVA test was significant. Intragroup comparisons were done using repeated measures ANOVA followed by Tukey post hoc test when. The ANOVA test was significant. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM @SPSS@ statistics Version 26 for Windows.

RESULTS

When data is collected , tabulated and statically analyzed: In Adseal group in case of using EDTA the mean of fracture resistance recorded (588.4 ±44.8) while it was recorded (494.9 ±36) without EDT. In **Endoseal MTA group** in case of EDTA the mean value was (409.5 ±84.4) while it was recorded (316.2 ±71.8) without EDTA and in control group the mean value in case of using EDTA was (167.4 ±28.4) but without EDTA was (178.9 ±23.3).

Effect of Sealer type; the highere value of th mean was found in Adseal group followed by Endoseal MTA while the lower one was found in control group . Post hoc pairwise comparisons was showing the different groups to have significantly different values from each others. There was a statistically significant difference between Adseal and Endoseal MTA, and control group with and without using EDTA (p -value<0.001).

Effect of EDTA*:* In Adseal group, there was statistically significant difference between using EDTA and without it (p-value =<0.001), In Endoseal MTA group, there was statistically significant difference between using EDTA and without it (p-value =0.016) and In control group there was no a statistically significant effect of EDTA on fracture resistance (p-value =0.016).

TABLE (1) Effect of sealer type; means ±SD on fracture resistance

	With EDTA	**Without EDTA**
ADSeal	588.4 ±44.8 [a]	494.9 ±36.1 [a]
Endoseal MTA	409.5 ±84.4 [b]	316.2 ±71.8 [b]
Control	167.4 ±28.4 [c]	178.9 ±23.3 [c]
P-value	<0.001	<0.001

Means that don't share same letter are significantly different.

TABLE (2) Effect of EDTA; means ±SD on fracture resistance

	ADSeal	**Endoseal MTA**	**Control**
With EDTA	588.4 ±44.8 [a]	409.5 ±84.4 [a]	167.4 ±28.4 [a]
Without EDTA	494.9 ±36.1 [b]	316.2 ±71.8 [b]	178.9 ±23.3 [a]
P-value	<0.001	0.016	0.340

Means that don't share same letter are significantly different.

Overall comparison: there was statistically significant difference between all the tested groups, except between control group with EDTA and without EDTA there was no statistically significant difference.

TABLE (3) Overall means ±SD for all tested groups

	ADSeal		**Endoseal MTA**		**Control**	
	With EDTA	Without EDTA	With EDTA	Without EDTA	With EDTA	Without EDTA
	588.4 ±44.8 [a]	494.9 ±36.1 [b]	409.5 ±84.4 [c]	316.2 ±71.8 [d]	167.4 ±28.4 [e]	178.9 ±23.3 [e]
P-value	<0.001					

Means that don't share same letter are significantly different.

DISCUSSION

Teeth treated endodontically are weaker and more prone to fracture compared to the vital teeth. That's because of increased stresses during instrumentation procedures, post preparation, and placement. so the roots may be fractured and the resistance of root canals to loads may decrease. [14]

Reinforcement of the tooth structure that remains after endodontic treatment considered to be a major goal of root canal therapy. It is suggested that sealers that can adhere to the root canal dentin surface will strengthen the remaining tooth structure and will increase its resistance to fracture of Teeth treated endodontically, that leads to success of the Teeth treated endodontically. [14, 15]

Lower premolars were chosennto avoid the influence of root canal anatomy and variations such as webs, fins etc. Teeth were reduced occlusally to standardize the working length to 18 mm.

Protaper rotary files were used for canal instrumentation with standard sequence S1, S2, F1, F2, F3 to standardize the apical canal diameter of the enlarged root canals in accordance with the studies conducted by ***Sagsen et al.*** [16]***, Harikumar et al.*** [17]***, Cakici et al.*** [18]***, Ersoy et al.*** [19]***, Upadhyay et al.*** [12]***, Yendrembam et al.*** [20]

Irrigation was done by the use of 5.25% NaOCL because it's ability to dissolve tissue and antimicrobial activity.[21]

Endoseal MTA sealer was chosen because it is claimed to be biocompatible, perfect antimicrobial properties, flowy, expansion during setting time, high radiopacity, low solubility in contact with tissue fluids, and a substantially shortened setting time (in mere minutes). [22-25] Syringes are used to produce sealer in , inspite of many products with powder and liquid. This means it can be directly injected into the canal system without a mixing process.

Epoxy resin-based sealer was chosen as a reference material because it has good physical properties, apical sealing ability, micro-retention to root dentin, excellent biocompatibility, and not dissolve in tissue fluids.[26,27]

In the present study, the fracture resistance measurement had been done using universal testing machine. A vertically applied load was done along the longitudinal axis of the teeth, as in this method, the load entirely transfers to the root. This would result in decreased bending moments and maximum stresses located much more cervical, leading to smaller stresses. This study design is believed to mimic the clinical status, as it immitates the support given to teeth by alveolar bone [28].

This testing technique is similar to the one used by ***Sedgley and Messer***[29] to test the brittleness of endodontically treated teeth. This technique was found to be more relevant as it immitates the normal attachment apparatus of healthy tooth, with more homogenous stresses distribution and without stress build-up caused by unrealistic bending movements.

The result of the fracture resistance test give up that there was a statistically significant different values of samples obturated with different types of materials.

The fracture resistance of Adseal groups were higher than Endoseal MTA groups, and control groups with and without EDTA.

The mean value of Adseal group was the highest one. This might be attributed to the higher adhesion of Adseal to root dentin as the capacity of the creep and the period to be polymerized leading to better penetration into the micro-irregularities Besides, the covalent bonds between the epoxy resin and the amino groups of the dentinal collagen might result in a stronger bond of Adseal to dentin.

The results of our study came in accordance with ***Saba and ElAsfouri*** [28] who showed that teeth filled with AH Plus had a higher resistance to fracture than Bioroot and Endoseal MTA.

This finding was in full agreement with ***Mandava et al.***[30], who showed that teeth obturated with AH Plus had a higher fracture resistance than those with the Meta seal and MTA Fillapex.

Endoseal MTA had the lower fracture resistance in our study which could be attributed to that it does not actually bond to dentin, rather it deposits hydroxyapatite interfacially, which only makes the material resistnce of the friction increases .

The control groups have the lowest fracture resistance which proofs that root canal preparation weakens the root. On the other side, the results of all prepared-filled groups were higher than that of the prepared-unfilled group, showing that all tested filling combinations had somehow, reinforced the root against fracture.

In contrast ***Remya***[31], concluded that Endosequence BC sealer and Chitra-CPC were significantly higher than Epoxy resin based sealer (AH plus) and MTA basedsealer (MTA Fill apex). Also ***Mohammed and Al-Zaka***[32], showed that Totalfill BC sealer higher fracture resistance than AH plus and MTA Fill apex.

Regarding using EDTA there was a statistically significant effect of EDTA on fracture resistance for all the tested groups, except for control groups there was no statistically effect of EDTA on fracture resistance.

The fracture resistance of Adseal group with EDTA is higher than Adseal without EDTA and the fracture resistance of Endoseal MTA with EDTA is higher than Endoseal without EDTA group, because of the root strength might be increased by removal of the smear layer , which allows root canal sealers to contact the root canal wall by penetrating into the dentinal tubules. In many studies, smear layer decrease the adaptation, penetration and bond strength of root canal sealers [33-35].

This finding was in full agreement with ***Uzunoglu et al.*** [36] who showed that the fracture resistance of roots was higher after one minute irrigation with 17% EDTA when compared to that ofroot canals rinsed with distilled water only.

On the other hand ***Çobankara et al.***[37], showed that presence or abscene of the smear layer did not cause any significant effect on the root fracture resistance of the tooth.

From a clinical point of view, it safe to use EDTA with higher concentration for a shor time or a low concentration with a long time. The long use of very high concentration of EDTA increases the risk of tooth fractature.

CONCLUSION

The composition of endodontic sealer has influence effect on fracture resistance of root dentin. Epoxy resin sealers provides better fracture resistance than pozzolan based sealers. Irrigation with EDTA provides more fracture resistance to roots.

REFERENCES

1. Ersoy I, Evcil MS. Evaluation of the effect of different root canal obturation techniques using two root canal sealers on the fracture resistance of endodontically treated roots. Microscopy research and technique. 2015; 78:404-7.
2. Grossman, L.I. Physical properties of root canal cements. Journal of Endodontics 1976; 2: 166-175.
3. Caicedo, R., and Von FraunhoferJ. A. "The properties of endodontic sealer cements." Journal of Endodontics 1988; 14.11: 527-534.
4. Tay, Franklin R., and David H. Pashley. "Monoblocks in root canals: a hypothetical or a tangible goal." Journal of endodontics 2007; 33.4: 391-398.
5. Johnson ME, Stewart GP, Nielsen CJ, Hatton JF. Evaluation of root reinforcement of endodontically treated teeth. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology. 2000;90(3):360-4.
6. TEIXEIRA FB, Teixeira EC, Thompson J, LeinfelderKF, Trope M. Dentinal bonding reaches the root canal system. Journal of Esthetic and Restorative Dentistry. 2004; 16(6):348-54.
7. Teixeira FB, Teixeira EC, Thompson JY, Trope M. Fracture resistance of roots endodontically treated with a new resin filling material. The Journal of the AmericanDental Association. 2004;135(5):646-52.

8. Rahimi, M., Jainaen, A., Parashos, P., & Messer, H. H. Bonding of resin-based sealers to root dentin. Journal of Endodontics 2009; 35: 121-124.

9. Helfer AR, Melnick S, Schilder H. Determination of the moisture content of vital and pulpless teeth. Oral Surgery, Oral Medicine, Oral Pathology. 1972; 34:661-70.

10. Holcomb JQ, Pitts DL, Nicholls JI. Further investigation of spreader loads required to cause vertical root fracture during lateral condensation. Journal of endodontics. 1987;13:277-84.

11. Duarte MA, Marciano MA, Vivan RR, TanomaruFilho M, Tanomaru JM, Camilleri J. Tricalcium silicate-based cements: properties and modifications. Brazilian oral research. 2018;32.

12. Upadhyay ST, Purayil TP, Ginjupalli K. Comparative evaluation of fracture resistance of endodontically treated teeth obturated with pozzolan-based MTA sealer and epoxy resin-based sealer: an in vitro study. World Journal of Dentistry. 2017; 8:37-40.

13. Elfaramawy, M. T. The Effect Of Different Adhesive Obturating Materials On The Fracture Resistance Of Endodontically Treated Teeth. Egyptian Dental Journal, 2017; 63: 1695-1698.

14. Almohaimede, A., Almanie, D., Alaathy, S., &Almadi, E. Fracture Resistance of Roots Filled With Bio-Ceramic and Epoxy Resin-Based Sealers: In Vitro Study. European Endodontic Journal 2020; 5: 134.

15. Dibaji, F., Afkhami, F., Bidkhori, B., &Kharazifard, M. J. Fracture resistance of roots after application of different sealers. Iranian endodontic journal 2017; 12: 50.

16. Sagsen B, Ustu n Y, Demirbuga S, Pala K. Push-out bond strength of two new calcium silicate-based endodontic sealers to root canal dentine. International Endodontic Journal 2011; 44: 1088–1091.

17. HarikumarVemisetty RP, Jayaprada Reddy S, Ramkiran D, Jaya Nagendra Krishna M, RajaniSayini JY. Comparative evaluation of push-out bond strength of three endodontic sealers with and without amoxicillin-An Invitro Study. Journal of clinical and diagnostic research. 2014; 8:228.

18. Cakici F, Cakici EB, Ceyhanli KT, Celik E, Kucukekenci FF, Gunseren AO. Evaluation of bond strength of various epoxy resin based sealers in oval shaped root canals. BMC oral health. 2016; 16:1-5.

19. Ersoy I, Evcil MS. Evaluation of the effect of different root canal obturation techniques using two root canal sealers on the fracture resistance of endodontically treated roots. Microscopy research and technique. 2015; 78:404-7.

20. Yendrembam, B., Mittal, A., Sharma, N., Dhaundiyal, A., Kumari, S., & Abraham, A. Relative assessment of fracture resistance of endodontically treated teeth with epoxy resin-based sealers, AH Plus, MTA Fillapex, and Bioceramic Sealer: An in vitro study. Indian Journal of Dental Sciences 2019; 11: 46.

21. Salas, H., Vieira, G. C., Palomino, I., Valero, J., Pacheco-Yanes, J., Campello, A. F., & Pérez, A. R. Outcome of endodontic treatment with chlorhexidinegluconate as main irrigant: A case series. Australian Endodontic Journal 2020, 46: 307-314.

22. Kaur A, Shah N, Logani A, Mishra N. Biotoxicity of commonly used root canal sealers: a meta-analysis. J Conserv Dent. 2015;18:83-88.

23. Ørstavik D. Materials used for root canal obturation: technical, biological and clinical testing. Endodontics Topics. 2005;12:25-38.

24. Al-Haddad A, CheAb Aziz ZA. Bioceramic-Based Root Canal Sealers: A Review. Int J Biomaterials. 2016.

25. Lee BN, Hwang YC, Jang JH, et al. Improvement of the properties of mineral trioxide aggregate by mixing with hydration accelerators. J Endod. 2011;37:1433-1438.

26. Lee, K. W., Williams, M. C., Camps, J. J., &Pashley, D. H. Adhesion of endodontic sealers to dentin and gutta-percha. Journal of endodontics 2002, 28, 684-688.

27. Razmi, H., Bolhari, B., Dashti, N. K., &Fazlyab, M. The effect of canal dryness on bond strength of bioceramic and epoxy-resin sealers after irrigation with sodium hypochlorite or chlorhexidine. Iranian endodontic journal 2016, 11, 129.

28. Saba, A. A., &ElAsfouri, H. A. Fracture Resistance of Endodontically Treated Teeth Obturated with Different Root Canal Sealers (In vitro study). Egyptian Dental Journal 2019;65: 1567-1575.

29. Sedgley CM, Messer HH. Are endodontically treated teeth more brittle?. Journal of endodontics. 1992;18(7):332-5.

30. Mandava J, Chang PC, Roopesh B, Faruddin MG, Anupreeta A, Uma C. Comparative evaluation of fracture resistance of root dentin to resin sealers and a MTA sealer: An in vitro study. Journal of Conservative Dentistry: JCD. 2014;17(1):53.

31. Remya, V. Comparison of Fracture Resistance of Teeth Obturated with Different Root Canal Sealers: An Invitro study (Doctoral dissertation, Sri Ramakrishna Dental College and Hospital, Coimbatore), 2017.
32. Mohammed, Y. T., & Al-Zaka, I. M. Fracture Resistance of Endodontically Treated Teeth Obturated with Different Root Canal Sealers (A Comparative Study). The Journal of Contemporary Dental Practice 2020; 21: 490-493.
33. Sağsen, B., Üstün, Y., Pala, K., & Demirbuğa, S. Resistance to fracture of roots filled with different sealers. Dental materials journal 2012, 31: 528-532.
34. Vilanova WV, Carvalho-Junior JR, Alfredo E, Sousa-Neto MD, Silva-Sousa YT. Effect of intracanalirrigants on the bond strength of epoxy resin-based and methacrylate resin-based sealers to root canal walls. International endodontic journal. 2012;45(1):42-8.
35. Faria-e-Silva AL, Menezes MD, Silva FP, Reis GR, Moraes RR. Intra-radicular dentin treatments and retention of fiber posts with self-adhesive resin cements. Brazilian Oral Research. 2013;27:14-9.
36. Uzunoglu, E., Aktemur, S., Uyanik, M. O., Durmaz, V., &Nagas, E. Effect of ethylenediaminetetraacetic acid on root fracture with respect to concentration at different time exposures. Journal of endodontics 2012, 38: 1110-1113.
37. Çobankara FK, Adanır N, Belli S. Evaluation of the influence of smear layer on the apical and coronal sealing ability of two sealers. Journal of Endodontics. 2004; 30(6):406-9.