Original Article

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Dentistry Section

Evaluation of Fracture Resistance of Mandibular Premolar Canals Filled with Four Different Obturation Techniques- An In vitro Study

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ABSTRACT

Introduction: To prevent the ingress of microorganisms and their byproducts into root canal space is the primary goal of obturation. Endodontically treated teeth are weak and more susceptible to fracture than vital teeth. Therefore, to increase the strength of the root canal and increase root fracture resistance by adhesion and mechanically interlocking root canal filling material with radicular dentin is also one of the goal of obturation.

Aim: To evaluate and compare the fracture resistance of mandibular premolar canals filled with four different obturation techniques.

Materials and Methods: The in vitro study was conducted in Department of Conservative Dentistry and Endodontics, Krishna Institute of Medical Sciences (Deemed To Be University), Karad, Maharshtra, India, from August 2020 to December 2020. A total of 100 extracted human mandibular premolars with single canals were collected for the study and sectioned horizontally to obtain a standardised length of 14 mm. With the help of 15 K-file (Dentsply) working length was determined and root canals were prepared to an International Organisation for Standardisation (ISO) size 45 file at the apex and flared using a #4 Gates-Glidden drill (Mani, Japan). The teeth were then randomly divided into four experimental groups, Group I-Lateral condensation, Group II-ROEKO GuttaFlow® bioseal, Group III-Guttacore, Group IV-Thermoplasticised gutta percha (System B) and two control groups, they were Group V-(Negative control), instrumentation was done, but no obturation, Group VI-(Positive control), teeth were neither instrumented nor obturated. All the experimental teeth were filled as per the obturation technique. A universal testing machine was used for evaluating fracture resistance. The results were analysed using the One-way ANOVA test. The significance between the groups was tested with Scheffe's post hoc test.

Results: There were statistically significant difference among six group for mean fracture load (N) with p-value <0.001. furthermore, pair wise comparison of fracture load (N) showed that the mean difference is significant at p-value <0.05. The mean difference between Group IV and V was not significant (p-value=0.935)

Conclusion: Under the limitation of this study, it was concluded that the resistance of the root to vertical fracture amongst the experimental group was maximum in Group III (Guttacore) and minimum in Group IV (Thermoplasticised gutta-percha, System B).

Keywords: Guttacore, Gutta flow bioseal, Thermoplasticised gutta percha

INTRODUCTION

The aim of root canal treatment is proper removal of all the infection from the root canal, preventing reinfection, maintaining the integrity of periodontium and achieving healing. Obturation not only announces healing of peri-apical tissues but also influences the fracture resistance of tooth structure and marks as the end point of the endodontic treatment sequence [1].

Endodontically treated teeth are susceptible to root fracture. It has been reported that operative procedures performed in the root canal after the root canal treatment results in vertical root fractures. Excessive pressure during filling procedures and excessive loss of tissue during chemo-mechanical preparation may lead to a decrease in resistance of teeth to fracture [1]. Thus, supporting the remaining dental structures is of critical value for the long-term success of the treatment. For successful bonding mechanism of the root filling, elasticity of dentine plays a major role. It has been suggested that the materials, which were capable to bond to the root dentine may support the tooth and thus advocated that it would be preferable to use root canal filling materials that can resist against load/fracture [2]. The root canal filling material should provide a proper seal so that it will prevents bacteria from the oral cavity to travel down the root canal.

For years, gutta percha is the most frequently used root canal filling material. It is unable for gutta percha to adhere to the root canal walls by itself, so gutta percha should be used in conjunction with sealer. AH 26 and AH Plus are resin based sealers, which are generally preferred because of their multiple advantages [3]. Some of the advantages are expands after setting, does not stain, extremely lubricated and easy to mix. To obturate the root canal, gutta-percha and root canal sealer are the materials of choice, but they can be used in a variety of ways. Probably the most commonly practiced obturation technique worldwide is the Cold Lateral Compaction (CLC). Voids, spreader tracts, incomplete fusion of the gutta-percha cones, lack of gutta percha adaptation with the root canal walls, possible lack of uniform density of the filling material and the inability to fill the canal irregularities are some of the disadvantages with this technique [4].

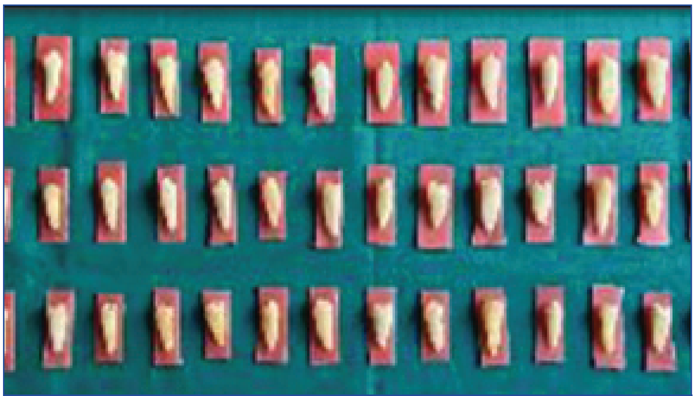
To improve the homogenicity and surface adaptation of the gutta-percha, the thermoplasticised injectable obturation technique was introduced. Major problem with these injection techniques is to control the apical extrusion of the softened gutta percha. Recently, the Obtura-II, has gained acceptance by endodontists [5].

In order to overcome the shrinkage and flow in apical areas in the thermomplasticised condensation, cold free flow obturation technique was introduced. Recently, Coltene has introduced ROEKO GuttaFlow® bioseal as a cold free-flow obturation technique. Calcium and silicate are some of the bioactive substances in guttaflow bioseal, which stimulate healing and tissue regeneration according to the manufacturer [6].

Several techniques of warm gutta-percha condensation are developed. GuttaCore system was recently introduced, which is a carrier based gutta-percha system and claims three-dimensional obturation of root canal systems [7]. Thus, the aim of this study was to evaluate and compare the fracture resistance of mandibular premolar canals filled with four different obturation techniques. Until now, there was no study that compared the fracture resistance of the experimental groups of the present study. So to check and compare the fracture resistance of different technique, this study was conducted. The null hypothesis stated that there was no difference in fracture resistance in the experimental groups.

MATERIALS AND METHODS

The present in vitro study was conducted in Department of Conservative Dentistry and Endodontics, Krishna Institute of Medical Sciences (Deemed To Be University), Karad, Maharshtra, India after due approval of Ethical Committee. (protocol no. 0330/2018-2019). A total of 100 extracted human mandibular premolars with single canals that were approximately of the same dimension were used for this in vitro study from August 2020 to December 2020 [Tables/Fig-1]. For conformation of single canal, radiographs were taken.



[Table/Fig-1]: Teeth selected for dissertation.

Inclusion criteria: Extracted teeth for Orthodontic reason, mandibular premolar with one canal and fully mature apices.

Exclusion criteria: Fracture root, carious teeth, resorption and calcified canals were excluded.

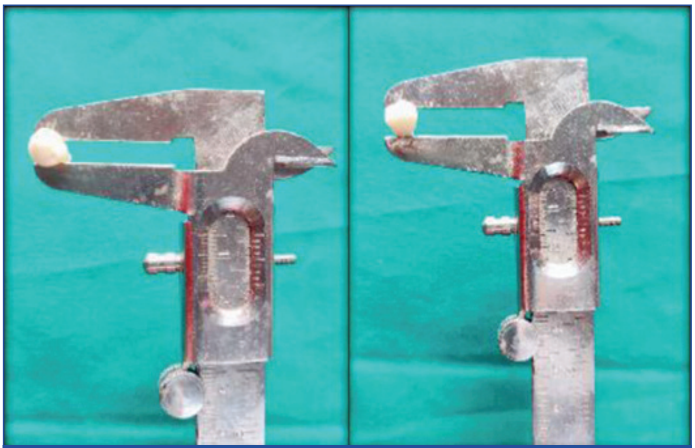
Procedure

The teeth were washed with water to remove blood and scaled with scaler to remove attached periodontal tissue, plaque and calculus and the teeth were disinfected with 5% sodium hypochlorite solution and then kept in normal saline solution at room temperature and used within one month.

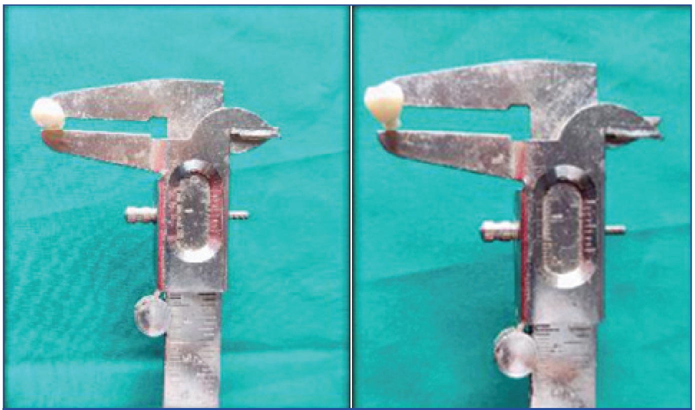
To standardise the teeth, only orthodontically extracted teeth were considered and measurements were made for every specimen at two points i.e., the Cemento-Enamel Junction (CEJ) and 8 mm more apical from the junction, in the buccolingual as well as mesiodistal direction of every specimen to check the buccolingual and mesiodistal extent of the teeth. In this way, four different measurements were taken for each specimen. The measurements were made using a Vernier Calliper. At the CEJ, the mesiodistal diameter were 4.7±0.2 and buccolingual diameter were 6.5±0.3 mm [Tables/Fig-2]; in the 8 mm apical region, the mesiodistal diameter were 3.1±0.3 and the buccolingual diameter were 4.8±0.3 mm [Tables/Fig-3].

All the samples were horizontally sectioned to obtain a standardised length of 14 mm. Apical patency was established with a size 10 K-file until it was visible at the apical foramen. Except in the non-prepared group (Group VI), the working length was determined. As 10k file was used for apical patency, working length was determined using a size 15 K-file (Dentsply), which was 1 mm short of the apical foramen. The root canals were instrumented to an ISO size 45 file (0.32 mm) at the apex and flared using a # 4 Gates Glidden drill (1.30 mm) (Mani, Japan).

During the instrumentation, irrigation with 1 ml of 3% sodium hypochlorite (Prime) was provided and a final rinse of 1 mL of 15%



[Table/Fig-2]: Mesiodistal and Buccolingual measurement at CEJ.



[Table/Fig-3]: Mesiodistal and Buccolingual measurement at 8 mm from CEJ.

ethylenediaminetetra acetic acid (Prevest) was used in order to remove the smear layer. Root canals were then irrigated with saline solution and dried with paper points (Sure Endo).

The teeth were then randomly divided into four experimental groups, they were Group I-Lateral condensation, Group II-ROEKO GuttaFlow® bioseal, Group III-Guttacore, Group IV-Thermoplasticised gutta percha (System B) and each group containing 20 teeth and two control groups, Group V-(Negative control), instrumentation was done, but no obturation, Group VI-(Positive control), teeth were neither instrumented nor obturated and each group containing 10 teeth [8].

For Group I, III, IV the sealer used was AH Plus sealer and for group II the sealer used was ROEKO GuttaFlow® bioseal sealer. For group V and VI no sealer was used, as they were control group.

Group I-Lateral condensation-AH Sealer was applied and master apical cone of ISO size of 45 (2%) was selected and subsequently canal was obturated using accessory cones with cold lateral condensation technique.

Group II-ROEKO GuttaFlow® bioseal-ROEKO GuttaFlow® bioseal was applied and the master cone size 45 (6%) was placed into the canal upto the working length and the obturation was carried out with single cone technique.

Group III-Guttacore-AH Sealer was applied and the warmed cone size no. 45 (ThermaPrep® 2 Oven was used to warm the gutta-percha, in that gutta-percha was kept for 90 second) was placed into the canal upto the working length in one continuous motion.

Placement handle was removed at the orifice by using round bur.

Group IV-Thermoplasticised gutta percha (System B)-Canal was thinly coated with AH plus sealer and ISO size 45 master cone was placed up to the working length. A medium to large insert tip (Kerr dental) binding to the canal 4 mm from the working length was used for obturation. After that back filling was done using system B technique (Kerr dental). Temperature used in this technique was about 200°C.

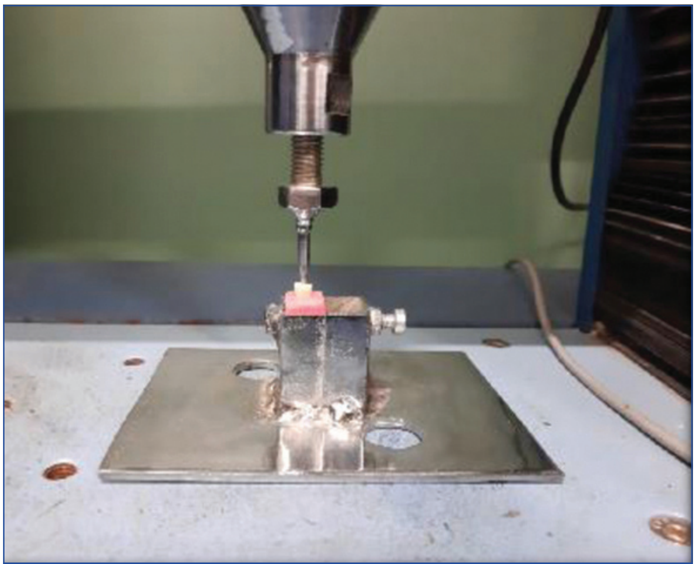
Group V-(Negative control), instrumentation was done, but no obturation.

Group VI-(Positive control), teeth were neither instrumented nor obturated.

After obturation done with all the groups, a cavity for temporary filling was drilled into the canal to 1 mm below the CEJ and canal opening was sealed with Cavit (3M ESPE). All teeth were then stored in incubator at 37°C in 100% humidity for two weeks. All the procedure was performed by a single endodontist.

Fracture Resistance Assessment

All the roots were mounted vertically in Copper rings (20 mm high and 20 mm in diameter), filled with acrylic resin, exposing 8 mm of the coronal part. A universal testing machine was used for the strength test [Tables/Fig-4]. The acrylic blocks were placed on the lower plate of the machine. The upper plate has a steel spherical tip of 2 mm diameter. Until fracture line was visible, slowly vertical force was increased to 1 mm minute. When the fracture line was visible, that force was recorded as Newtons.



[Table/Fig-4]: Universal testing machine.

STATISTICAL ANALYSIS

Comparison of Fracture Load (N) among six groups were done by One-way Analysis of Variance (ANOVA) and Pair wise Comparison of Fracture Load (N) among six groups were done by Scheffe's post-hoc Test. All the above test p-value was considered statistically significant when it was <0.05. The software used was Statistical Package for Social Sciences (SPSS) version 19.0.

RESULTS

The minimum fracture load (N) among Group I- Lateral condensation (n=20) was 110.55 while maximum 215.25 with mean 172.0900±27.11634.

The minimum fracture load (N) among Group II- ROEKO GuttaFlow (n=20) was 189.45 while maximum 301.05 with mean 240.7625±36.05530. The minimum fracture load (N) among Group III-Guttacore (n=20) was 269.85 while maximum 401.25 with mean 340.5225±41.15979. The minimum fracture load (N) among Group IV-Thermoplasticised guttapercha (System B) (n=20) was 102.25 while maximum 149.45 with mean 127.2150±14.12541. The minimum fracture load (N) among Group V (Negative control) (n=10) was 98.05 while maximum 128.65 with mean 112.4100±11.18205. The minimum fracture load (N) among Group VI-Positive Control (n=10) was 392.50 while maximum 575.25 with mean 467.5600±58.21564 [Tables/Fig-5]. Comparision of the mean fracture load (N) between the groups found to be statistically significant except between the Group IV and V [Tables/Fig-6].

Descriptive statistics					
Groups	N	Minimum fracture load (N)	Maximum fracture load (N)	Mean fracture load (N)	Std. Deviation
Group I	20	110.55	215.25	172.0900	27.11634
Group II	20	189.45	301.05	240.7625	36.05530
Group III	20	269.85	401.25	340.5225	41.15979
Group IV	20	102.25	149.45	127.2150	14.12541
Group V	10	98.05	128.65	112.4100	11.18205
Group VI	10	392.50	575.25	467.5600	58.21564

[Table/Fig-5]: Descriptive Statistics for Fracture Load (N) among six groups.
One-way Analysis of Variance (ANOVA)

Dependent variable: Fracture load (N) Scheffe						
					95% Confidence interval	
(I) Group	(J) Group	Mean difference (I-J)	Std. Error	Sig. p-value	Lower bound	Upper bound
Group I	Group II- ROEKO GuttaFlow	-68.67250*	10.63298	<0.001*	-104.8189	-32.5261
Group I	Group III- Guttacore	-168.43250*	10.63298	<0.001*	-204.5789	-132.2861
Group I	Group IV- Thermoplasticised gutta percha (System B)	44.87500*	10.63298	0.005*	8.7286	81.0214
Group I	Group V-Negative control	59.68000*	13.02269	0.002*	15.4098	103.9502
Group I	Group VI- Positive Control	-295.47000*	13.02269	<0.001*	-339.7402	-251.1998
Group II	Group III- Guttacore	-99.76000*	10.63298	<0.001*	-135.9064	-63.6136
Group II	Group IV- Thermoplasticised gutta percha (System B)	113.54750*	10.63298	<0.001*	77.4011	149.6939
Group II	Group V-Negative control	128.35250*	13.02269	<0.001*	84.0823	172.6227
Group II	Group VI- Positive control	-226.79750*	13.02269	<0.001*	-271.0677	-182.5273
Group III	Group IV- Thermoplasticised gutta percha (System B)	213.30750*	10.63298	<0.001*	177.1611	249.4539
Group III	Group V-Negative control	228.11250*	13.02269	<0.001*	183.8423	272.3827
Group III	Group VI- Positive control	-127.03750*	13.02269	<0.001*	-171.3077	-82.7673
Group IV	Group V-Negative control	14.80500	13.02269	0.935*	-29.4652	59.0752
Group IV	Group VI- Positive control	-340.34500*	13.02269	<0.001*	-384.6152	-296.0748
Group V	Group VI- Positive control	-355.15000*	15.03731	<0.001*	-406.2688	-304.0312

[Table/Fig-6]: Pair wise Comparison of Fracture Load (N) among six groups by Scheffe's post-hoc Test.
Scheffe's post-hoc Test. * The mean difference is significant at the 0.05 level

DISCUSSION

To prevent the ingress of microorganisms and their byproducts into root canal space is the primary goal of obturation. Due to the mechanically interlocking between the obturating material with radicular dentin, there is also increase in the fracture resistance [9].

Meticulous cleaning and shaping of root canals assured an effective obturation, which however, make the tooth more susceptible to fracture if cleaning and shaping can be overdone. Other factors which result in increased brittleness of root filled teeth after the endodontic procedure are excessive pressure during obturation [10], dehydration of tooth tissues [11] and prolonged use of chemical agents during disinfection [12].

Filling of the materials in root canal space were done according to manufacturer's instruction. As root canal filling materials and root canal filling methods plays an important role in fracture resistance, so in this study only gutta-percha was used with different techniques to evaluate the fracture resistance.

The prevalence of Vertical root fracture was reported to be in a range from 11% to 20% in endodontically treated teeth [13]. Vertical root fracture (VRF) can be diagnosed several years after completion of all endodontic and prosthodontic procedures.

The following order of different groups fracture resistance was arranged in descending order:

Positive Control (Group VI) > Guttacore (Group III) > ROEKO GuttaFlow® bioseal (Group II) > Lateral condensation (Group I) > Thermoplasticised gutta-percha, System B (Group IV) > Negative control (Group V)

The null hypothesis was rejected as all the experimental groups had difference in their fracture resistance.

Group VI (positive control) showed the highest fracture resistance. Group VI was taken as positive control, so the sample in this group was neither instrumented nor obturated. Because of this unprepared root, no force was imparted in the teeth and there was also no dentin loss as chemico-mechanical preparation was not done in this group. All this leads to maintain the fracture resistance of the tooth. According to Teixeira FB et al., removal of tooth structure during instrumentation phase decreases the fracture resistance and create a weakening effect on root [14].

Amongst the experimental groups, highest fracture resistance was observed in group III (Guttacore). In this group, Guttacore was used in combination with resin based sealer (AH Plus). GuttaCore is simple to use, form fewer voids and helps in formation of 3D seal [15]. On the canal walls it allows the formation of tenaciously adherent layer as well as it can flow into the isthmuses, lateral canals and canal irregularities. Moreover, AH Plus (epoxy resin-based sealer) has shown slight expansion on setting [16] and also has a penetrating ability into the dentinal tubule [17]. Its long setting time and creep capacity increases mechanical interlocking to root dentine, thereby reinforcing and improving adhesion to the tooth structure [18]. According to Goyal K et al., when compared to GuttaFlow 2, continuous wave condensation and lateral compaction obturation method, GuttaCore system showed superior fracture resistance [9].

Guttaflow Bioseal showed inferior fracture resistance than Guttacore but superior than all other experimental groups. GuttaFlow Bioseal is a silicone-based root canal filling material which adapts closely to the dentinal walls, thus providing a homogenous obturation. The superior sealing ability of Guttaflow Bioseal could be attributed to the volumetric changes that occur during the setting of sealers. Minimum generation of stresses resulted in a dense mass due to the high viscosity, allows proper condensation [19].

Lateral condensation showed inferior fracture resistance than Guttacore and Guttaflow Bioseal but superior than System B and negative control group. Although the most widely used method of obturation is lateral condensation, it has some drawback. The drawback of this method is that, it involves the use of spreaders which may exert excessive wedging forces making the tooth more susceptible to vertical root fracture [20,21]. In another study by Piskin B et al., evaluated the effect of spreader use on the fracture resistance of roots filled with lateral condensation technique and stated that number 25 had the highest fracture resistance which was followed by 35 and 40 and the result was statistical significance [22].

Lowest fracture resistance amongst experimental groups was seen in Group IV (System B). This is because of the force which was created by the plugger used and the heat applied which caused thermal expansion in the root dentin, all this affect the fracture resistance adversely [23]. According to Lertchirakarn V et al., 1999, the fracture resistance of the roots reduced due to excessive removal of dentin to facilitate the usage of spreaders in cold lateral condensation technique and pluggers in heat condensation technique with vertical compaction [24].

Amongst all the groups which were tested for fracture resistance, lowest fracture resistance was seen in group V (negative control). This is associated with the loss of tooth structure occurring during endodontic treatment and not filling that space with a reinforcing material [25]. Schafer E et al., compared fracture resistance of root canals which were not widened and root canals which were widened but not filled and stated that fracture resistance of non-widened root canals were statistically significantly higher [26].

Limitation(s)

The limitation of the above study was that while using different obturation technique the forces that were exerted on the tooth while doing obturation, were not standardised.

CONCLUSION(S)

Under the limitation of this study, it was concluded that the resistance of the root to vertical fracture is decreased with instrumentation, and the root canal obturation techniques used are not able to provide reinforcement. Furthermore, studies should be conducted using various obturation materials and technique, to check for increase in fracture resistance of the tooth. In the present study Guttacore (Carrier based technique) shows superior fracture resistance than other obturation technique.

REFERENCES

[1] Karapinar Kazandag M, Sunay H, Tanalp J, Bayirli G. Fracture resistance of roots using different canal filling systems. Int Endod J. 2009;42(8):705-10.
[2] Tay FR, Pashley DH. Monoblocks in root canals: A hypothetical or a tangible goal. J Endod. 2007;33(4):391-98.
[3] Komabayashi T, Colmenar D, Cvach N, Bhat A, Primus C, Imai Y. Comprehensive review of current endodontic sealers. Dental Materials Journal. 2020;39(5):703-20.
[4] Naseri M, Kangarlou A, Khavid A, Goodini M. Evaluation of the quality of four root canal obturation techniques using micro-computed tomography. Iran Endod J. 2013;8(3):89-93.
[5] Frantzeska K, Christopoulos D, Chondrokoukis P. Gutta percha and updated obturating techniques. J Dent Health Oral Disord Ther. 2017;8(2):00276.
[6] Saygili G, Saygili S, Tuglu I, Davut Capar ID. Invitro cytotoxicity of guttaflow bioseal, guttaflow 2, ah-plus and mta fillapex Iran. Endod J. 2017;12(3):354-59.
[7] Marques-Ferreira M, Abrantes M, Ferreira HD, Caramelo F, Botelho MF, Carrilho EV. Sealing efficacy of system B versus Thermafil and Guttacore obturation techniques evidenced by scintigraphic analysis. Journal of Clinical and Experimental Dentistry. 2017;9(1):e56.
[8] Punjabi M, Dewan RG, Kochhar R. Comparative evaluation of fracture resistance of root canals obturated with four different obturating systems. J Conserv Dent. 2017;20(6):445-50.
[9] Goyal K, Paradkar S, Saha SG, Bhardwaj A, Vijaywargiya P, Sai Prasad SSA. Comparative evaluation of fracture resistance of endodontically treated teeth obturated with four different methods of obturation: An invitro study. Endodontology. 2019;31(2):168.
[10] Ulusoy OI, Genç O, Arslan S, Alaçam T, Görgül G. Fracture resistance of roots obturated with three different materials. Oral Surg. Oral Med. Oral Pathol Oral Radiol Endod. 2007;104(5):705-08.
[11] Zhang YR, Du W, Zhou XD, Yu HY. Review of research on the mechanical properties of the human tooth. Int J Oral Sci. 2014;6(2):61-69.

[12] Kinney JH, Balooch M, Marshall SJ, Marshall GW Jr, Weihs TP. Hardness and young's modulus of human peritubular and intertubular dentine. Arch Oral Biol. 1996;41(1):09-13.
[13] Hsiao LT, Ho JC, Huang CF, Hung WC, Chang CW. Analysis of clinical associated factors of vertical root fracture cases found in endodontic surgery. Journal of Dental Sciences. 2020;15(2):200-06.
[14] Teixeira FB, Teixeira EC, Thompson JY Trope M. Fracture resistance of roots endodontically treated with a new resin filling material. J Am Dent Assoc. 2004;135(5):646-52.
[15] Yadav S, Nawal RR, Chaudhry S, Talwar S. Assessment of quality of root canal filling with c point, guttacore and lateral compaction technique: A confocal laser scanning microscopy study. European Endodontic Journal. 2020;5(3):236-41.
[16] Versiani MA, Carvalho-Junior JR Jr, Padilha ML, Lacey S, Pascon EA, Sousa-Neto MD. A comparative study of physicochemical properties of AH plus and epiphany root canal sealants. Int Endod J. 2006;39(6):464-71.
[17] De-Deus G, BrandÓo MC, Souza EM, Reis C, Reis K, Machado R, et al. Epoxy resin-based root canal sealer penetration into dentin tubules does not improve root filling dislodgement resistance. European Endodontic Journal. 2017;2(1):1.
[18] Nunes VH, Silva RG, Alfredo E, Sousa-Neto MD, Silva-Sousa YT. Adhesion of epiphany and AH plus sealers to human root dentin treated with different solutions. Braz Dent J. 2008;19(1):46-50.
[19] Anantula K, Ganta AK. Evaluation and comparison of sealing ability of three different obturation techniques-Lateral condensation, obtura II, and guttaFlow: An invitro study. J Conserv Dent. 2011;14:57-61.
[20] Tamse A. Vertical root fractures in endodontically treated teeth: Diagnostic signs and clinical management. Endod Top. 2006;13(1):84-94.
[21] Makam S. A comparative evaluation of the fracture resistance of endodontically treated teeth using two obturating systems-an invitro study. Int J Contemp Dent. 2011;2:93-96.
[22] Pişkin B, Aydın B, Sarıkanat M. The effect of spreader size on fracture resistance of maxillary incisor roots. International Endodontic Journal. 2008;41(1):54-59.
[23] Mardini A, Alhalabiah H. Effect of different root canal prepration and obturation methods on roots fracture resistance of endodontically treated teeth. International Journal of Applied Dental Sciences. 2020;6(2):287-90.
[24] Lertchirakarn V, Palamara JE, Messer HH. Load and strain during lateral condensation and vertical root fracture. J Endod. 1999;25:99-104.
[25] Wu MK, van der Sluis LW, Wesselink PR. Comparison of mandibular premolars and canines with respect to their resistance to vertical root fracture. J Dent. 2004;32:265-68.
[26] Schafer E, Zandbiglari T, Schafer J. Influence of resin based adhesive root canal filling on the resistance to fracture of endodontically treated roots: An invitro preliminary study. Oral Surg Oral Med Oral Pathol. 2007;103:274-79.

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