Biomedical Research 2016; 27 (1): 191-194

ISSN 0970-938X
www.biomedres.info

Fracture resistance of prepared maxillary incisor teeth after different endodontic access cavity location.

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Abstract

Objectives: The aim of this study was to evaluate the fracture resistance of prepared maxillary incisors with incisal access cavities and to compare it with conventional lingual access cavities. Materials and Methods: Freshly extracted maxillary central incisor teeth (n:45) were selected and prepared for full crown restorations. Then, they were divided into 3 groups: group 1, teeth with lingual access cavities (n: 15); group 2, teeth with incisal access cavities (n:15); and group 3, teeth without access cavities (n:15). Endodontic treatments were completed for group 1 and 2. All teeth were embedded in the self-curing acrylic resin. Specimens were subjected to fracture test and the maximum loads were recorded. One-way ANOVA and Tukey's HSD test were used for statistical analysis. Results: The mean fracture values of the group 3 (806.87 ± 174.80 N) were significantly higher than the group 1 (607.13 ± 131.14 N) and the group 2 (590.20 ± 237.29 N) ($p<0.05$). No statistically significant difference was detected between lingual and incisal access groups ($p>0.05$). Conclusion: The location of the endodontic access cavity of previously prepared maxillary incisors did not affect the fracture resistance. Clinical Relevance: An incisal access of previously prepared maxillary incisors may be preferred during endodontic treatment.

Keywords: Access cavity, Fracture resistance, Incisors, Preparation.

Accepted Dec 09, 2015

Introduction

The access cavity is one of the most important steps of the root canal treatment. An adequate access will facilitate cleaning, shaping and obturation of the root canal system in order to maximize the success of endodontic treatment [1]. The main reasons of the ideal access opening are to determine root canal orifices, obtain straight-line access to the apical part and make a conservative cavity preparation [2,3].

The traditional approach for maxillary anterior teeth is the lingual access that most commonly practiced [4-6]. The access cavity is located at the cingulum which has the shortest distance to the pulp chamber [5]. However, instrumentation of the root canals may be less effective with this approach, because a straight-line access to the apex is not allowed [4,7-9]. It has been also stated that traditional lingual access does not allow straight-line access to root canal systems of maxillary lateral incisors [4], maxillary central incisors and canines [7]. Then, the incisal access cavity was recommended in which a straight-line access to the apex would be allowed [4,7,10,11]. This access is a nearly universally acceptable technique [11], which facilitates proper cleaning, shaping and obturation of the tooth [3,7].

The design and location of access cavity affect the debridement of anterior teeth [4,7]. According to Davis, endodontic excavation of the coronal one third of the tooth should be as conservative as possible [12]. The loss of dental hard tissues is one of the most important reasons for fracture of endodontically treated teeth [13,14]. It is very important to preserve the lingual slope for anterior guidance because access cavity preparation may affect the risk of failure from direct contacts during anterior guidance for maxillary anterior teeth [15]. In addition, due to the greater dentin thickness on the lingual surface [16], the traditional lingual access cavity has a large preparation area that would weaken the clinical crown [10]. The purpose of this study was to determine the ideal location of endodontic access cavity in previously prepared maxillary incisor teeth in terms of fracture resistance.

Materials and Methods

The Yeditepe University Ethical Committee has independently reviewed and approved this study which has been conducted in full accordance with the World Medical Association Declaration of Helsinki. The authors obtained written consent from all partıcipants involved in thıs study. Freshly extracted maxillary central incisor teeth with similar dimensions and shapes were selected for the study. The minimum sample size for the mean fracture strength parameter (Δ:219, SD:190) was statistically analyzed (power: 0.80, β: 0.20, α:0.05), and it was determined that the minimum number in each group should be

13. The teeth were cleaned of surface debris and stored in 0.1% thymol solution. Then, they were observed carefully under magnification to confirm that they were devoid of resorptions, caries, cracks, restorations or deformities. The selected teeth were measured with a digital caliper (Mitutoyo Digimatic Caliper, Mitutoyo Corp., Kawasaki, Japan) with the minimum reading value of ± 0.001 mm, in the labiolingual, mesiodistal and incisocervical dimensions at the cemento-enamel junction (CEJ). Mean values and standard deviations were obtained, and teeth displaying more than 20% deviation were excluded from the experiment, leaving 45 teeth for the study. They were stored in distilled water at 37ºC until use.

Specimen preparation

The teeth were embedded in the silicone impression material individually (Zetaplus, Zhermack, Italy) to facilitate handling before crown preparation. They were prepared with an incisal reduction of 2 mm, a lingual reduction of 1.5 mm and an axial reduction of 1.5 mm with rounded line angles with a high-speed air turbine hand piece (320,000 rpm) under water cooling and a chamfer diamond bur (No:290, Acurata GmbH, Thurmansbang, Germany). The cervical finish lines were prepared 1 mm above the CEJ. Same prosthodontist performed all preparation procedures, and a new diamond bur was used for each tooth.

The teeth were divided into 3 groups randomly: group 1, teeth with lingual access cavities (n:15); group 2, teeth with incisal access cavities (n:15); and group 3, prepared teeth without access cavities (n:15). The group 3 was served as a control group. The entire process of access opening was performed by the same endodontist to standardize the procedure.

In group 1, the initial point of entry was made at a right angle to the long axis of the tooth on the center of the lingual surface with a round diamond bur (No: 001, Acurata GmbH, Thurmansbang, Germany). Then, the entrance was enlarged until the access cavity was extended minimally to remove the entire pulp chamber roof mesiodistally and cervico-incisally with a round tungsten-carbide bur (No: 175, Acurata GmbH, Thurmansbang, Germany).

In group 2, the initial point of entry was made parallel to the long axis of the tooth to the incisal edge of the prepared crown with a round diamond bur (No: 001, Acurata GmbH, Thurmansbang, Germany). Then, the entrance was enlarged until the access cavity was extended minimally to remove the entire pulp chamber roof mesiodistally and cervico-incisally with a round tungsten-carbide bur (No: 175, Acurata GmbH, Thurmansbang, Germany).

After preparing endodontic access cavities, patencies of the canals were checked with #10 K-File (Maillefer/Dentsply, Ballaigues, Switzerland). The working lengths of the canals were determined by subtracting 1 mm from the actual canal length. All canals were shaped with ProTaper Next (PTN) (Dentsply Tulsa Dental, Tulsa, OK, USA) nickel-titanium rotary files in crown-down approach according to the manufacturers' instructions. PTN files X1 (17/0.04), X2 (25/0.06) and X3 (30/0.07) were rotated at 300 rpm and at 2 Ncm torque. During shaping procedures, canals were copiously irrigated with 5% sodium hypochlorite. Then the canals were dried with paper-points (Diadent, Diadent Group International, Chongchong Buk. Do, Korea) and filled with lateral condensation of cold gutta-percha. AHPlus (Dentsply-Detrey, Konstanz, Germany) was used as a sealer. Following filling procedure, gutta-percha was removed to the level of the cemento-enamel junction and the cavities were restored with a bulk-fill flowable composite material according to manufacturer's instructions (SDR, Dentsply, York, PA, USA).

Fracture testing

The teeth were stored in distilled water at 37°C for 24 hours. Then, 45 teeth were embedded individually in self-curing acrylic resin (Meliodent Denture Material, Heraeus Kulzer, Hanau, Germany) covering the roots from the apex to 2 mm below the CEJ, with the long axis parallel to the center of the metal ring. Specimens were mounted in a jig at an angle of 45º, which applied a compressive load by a universal testing machine (Model 3345, Instron Corp., Norwood, MA, USA), at the center of the lingual surface of the tooth at a crosshead speed of 1 mm/min until fracture (Figure 1). The maximum load at fracture was recorded in Newtons.

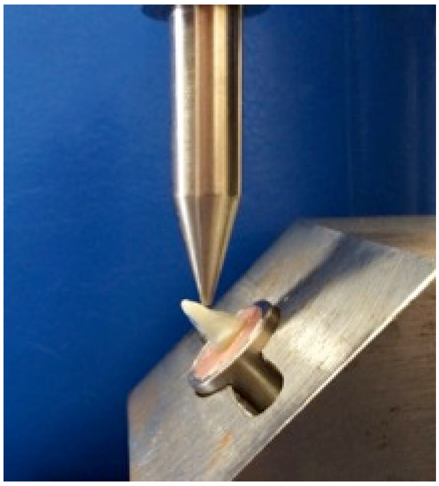

Figure 1*: The jig allowing the fixation of specimens with an angle of 45°.*

Statistical analysis

SPSS 15.0 for Windows program (Microsoft Corporation, Redmond, WA, USA) was used for the statistical analysis of the data. One-way analysis of variance (ANOVA) test was used for the comparison of groups and Tukey's HSD test was used for the determination of the group leading to significance. Significant level was set at $p<0.05$.

Results

Table 1 shows the results of fracture resistance values related with each group. The mean fracture resistance value obtained for the control group (Group 3) was 806.87 ± 174.80 N. The mean values of the lingual access group (Group 1) and incisal access group (Group 2) was 607.13 ± 131.14 N and 590.20 ± 237.29 N, respectively.

Table 1: *The mean fracture resistance values in Newtons and standard deviations of all groups and results of One-Way ANOVA test*

Groups	Mean ± SD
Lingual access	607.13 ± 131.14
Incisal access	590.20 ± 237.29
Control	806.87 ± 174.80
p	0.004**

There was statistically significant difference between the groups (p=0.004; p<0.01). According to Tukey's HSD test, the mean fracture value of the control group was significantly higher than lingual access group (p=0.015; p<0.05) and incisal access group (p=0.008; p<0.01). No statistically significant difference was detected among the fracture resistance values of lingual access and incisal access groups (p>0.05) (Figure 2).

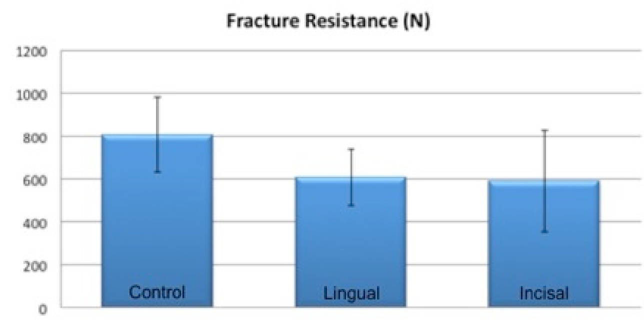

Figure 2: *The schematic drawing of the results.*

Discussion

The results of the present study showed that there was no significant difference between two approaches. The location of the endodontic access cavity of prepared maxillary incisors did not affect the fracture resistance of the teeth. This result is in agreement with a previous study by Nissan et al. [9] that has reported labial or palatal endodontic accesses did not affect the fracture resistance of maxillary incisors. Although Stambaugh and Wittrock [16] measured different dentin thickness from the pulp chamber to the external tooth surface, it was claimed that this difference was not big enough to significantly influence the fracture resistance of the teeth [9]. Another reason may be the hard tissue removal from the lingual surface during preparation of the teeth. The difference of the present study from the others was the use of prepared teeth with an incisal reduction of 2 mm, lingual reduction of 1.5 mm and axial reduction of 1.5 mm. The location of the access cavity on remaining dentin thickness would not affect the fracture resistance.

Endodontic treatment may be indicated in previously prepared and crowned teeth, caused by various factors such as direct or occlusal trauma, deep caries and periodontal pulpal involvement [17]. The reason of endodontic treatment during preparation of teeth for the crown restorations is exposition of vital pulp, especially in teeth with large pulp chamber. Access cavity is the initial step in root canal treatment [1]. The preparation of maxillary incisors leads to smaller buccolingual and mesiodistal dimensions compared to intact teeth. These narrow teeth offer a limited area for access cavity opening after tooth preparation [3].

Endodontically treated teeth have been reported to be more susceptible to fracture. It has been indicated that loss of coronal tooth structure, moisture content, degradation of dentin collagen, decrease in elasticity and weakening of tooth structure during shaping procedures are all factors that pose the risk of fracture [13,14]. In the present study, the mean fracture resistance of the prepared teeth without endodontic treatment (control group) was significantly higher than the teeth with endodontic treatment.

According to results of this study, it can be suggested that an access opening through the incisal edge of previously prepared maxillary anterior teeth may be preferred during endodontic treatment, because this cavity type did not affect the fracture resistance of these teeth compared to conventional lingual access cavity. Further studies with various designs are necessary to determine the strength of maxillary incisor teeth with different endodontic access cavity location.

Conclusion

Within the limitations of the present study, the following conclusions can be drawn:

1. The location of the endodontic access cavity of previously prepared maxillary incisors (lingual or incisal) did not affect the fracture resistance of the teeth.

2. The mean fracture resistance of the prepared teeth without endodontic treatment was significantly higher than the teeth with endodontic treatment.

Acknowledgement

The authors declare that they have no conflict of interest.

References

1. Adams N, Tomson PL. Access cavity preparation. Br Dent J 2014; 216: 333-339.
2. Ingle JI, Himel VT, Hawrish CE, Glickman GN, Serene T, et al. Endodontic cavity preparation. In: Ingle JI. Bakland LK (ed), Endodontics, 5th edn. Elsevier, Ontario 2002; 404-570.
3. Logani A, Singh A, Singla M, Shah N. Labial access opening in mandibular anterior teeth-an alternative approach to success. Quintessence Int 2009; 40: 597-602.
4. Zillich RM, Jerome JK. Endodontic access to maxillary lateral incisors. Oral Surg Oral Med Oral Pathol 1981; 52: 443-445.

5. Harty F. Pulp anatomy and access cavities. In: Harty FJ (ed), Endodontics in Clinical Practice, 1st edn. Wright and Sons, Bristol 1976; 65-70.
6. Burns RC, Herbranson EJ.Tooth morphology and cavity preparation. In: Cohen S, Burns RC (ed), Pathways of the Pulp, 8th edn. Mosby, St. Louis 2002; 173-231.
7. LaTurno SA, Zillich RM. Straight-line endodontic access to anterior teeth. Oral Surg Oral Med Oral Pathol 1985; 59: 418-419.
8. Nissan J, Zukerman O, Rosenfelder S, Barnea E, Shifman A . Effect of endodontic access type on the resistance to fracture of maxillary incisors. Quintessence Int (2007) 38: e364-367.
9. Gulabivala K, Stock CJR. Preparation of the root canal. In: Stock CJR, Gulabivala K, Walker RT, Goodman JR (ed), Colour Atlas and Text of Endodontics, 2nd edn. Mosby-Wolfe, London 1995; 107-110.
10. Rybicki RM, Heuer MA. Straight-line access. J Am Dent Assoc 1999; 130: 470-472.
11. Davis MW. Providing endodontic care for teeth with ceramic crowns. J Am Dent Assoc 1998; 129: 1746-1747.
12. Lewinstein I, Grajower R. Root dentin hardness of endodontically treated teeth. J Endod 1981; 7: 421-422.
13. Sedgley CM, Messer HH. Are endodontically treated teeth more brittle? J Endod 1992; 18: 332-335.
14. Broderson SP. Anterior guidance-the key to successful occlusal treatment. J Prosthet Dent 1978; 39: 396-400.
15. Stambaugh RV, Wittrock JW. The relationship of the pulp chamber to the external surface of the tooth. J Prosthet Den 1977; 37: 537-546.
16. Madjar D, Kusner W, Shifman A. The labial endodontic access: a rational treatment approach in anterior teeth. J Prosthet Dent 1989; 61: 317-320.

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