Research examining the amount of tooth tissue removed during guided access cavity preparation in guided endodontics—an ex vivo study

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ABSTRACT

Introduction: Guided endodontics emerged as an alternative capable of providing greater precision and accuracy to endodontic treatments.

Objectives: To compare the volume of dental tissue removed after guided endodontic access (GEA) and conventional endodontic access (CEA) to mandibular incisors, maxillary Premolars and maxillary molars.

Materials and Method: Twenty extracted human mandibular incisors, maxillary premolars, and maxillary molars were selected and submitted to cone-beam computed tomography (CBCT) examination. They were divided into two groups: G1 (mandibular incisors), G2 (maxillary premolars), and G2 (maxillary molars), and subdivided into G1a (CEA), G1b (GEA), G2a (CEA), G2b (GEA), G3a (CEA), and G3b (GEA). The DICOM files obtained by examining the CBCT were transferred to the CS 3D IMAGE V3.10.43 software to calculate the initial volume (IV) of each tooth. G1b, G2b and G3b teeth were scanned with a device to plan and print the guides. After gaining endodontic access, new CBCT exams were performed to calculate the final volume of each sample unit (FV). The Student's test for independent samples compared the volumes among the groups.

Results: The G1 group had an average volume reduction of 31.667 mm³ (10.62%) using CEA and 26.523 mm³ (10.65%) using GEA, with no significant difference among the groups ($p = 0.960$).

There was an average volume reduction of 44.526 mm³ (4.05%) in the G2 group using CEA and 50.677 mm³ (5.11%) using GEA, with a significant difference among the groups ($p = 0.005$).

There was an average volume reduction of 62.526 mm³ (5.86%) in the G3 group using CEA and 45.677 mm³ (4.11%) using GEA, with a significant difference among the groups ($p = 0.004$).

Conclusions: GEA preserved a greater volume of dental tissue in extracted maxillary human molars than CEA, followed by GEA preserving a greater volume of dental tissue in extracted maxillary premolar human molars than CEA; however, there was no significant difference between CEA and GEA in the volume of dental tissue removed from mandibular incisors as the previous section to examine the type of material that filled the internal resorptive cavities under a stereomicroscope.

Keywords: Cone beam computed tomography, endodontics, dental pulp cavity, guided endodontics.

INTRODUCTION

Proper planning represents an essential strategy for successful endodontic treatment. The preparation of an effective treatment plan can be supplemented with the wealth of information and accuracy of diagnoses provided by cone-beam computed tomography (CBCT).[1-3] Exploration of CBCT techniques for dental treatment planning has allowed innovations in the areas of implantology and periodontics and has enabled guided surgeries and three-dimensional (3D) prototypes of anatomical structures to be performed.[2,4] In endodontics, the association of digital planning using CBCT with 3D prints can aid in clinical situations that are more difficult to resolve. Guided endodontics has already proved useful in cases requiring access to the root canal system of calcified teeth, cases of *dens evaginatus* or *dens invaginatus*, and those of endodontic surgeries.[5-14] Conventional coronal access is achieved by removing dental structures and anterior restorations in the occlusal pulp direction until the pulp chamber is reached. This is enabled by clinical visualization of the internal morphology of the tooth, a measure required to identify the entrance to the canals but entailing additional wear. A challenge for the dental surgeon is to perform endodontic access that allows entry to the root canals without subjecting the dental structures to unnecessary wear. The amount of tooth structure remaining after performing endodontic treatment is a relevant factor in determining tooth stability and longevity.[15] Operative procedures of endodontic access in complex situations, such as cases of pulp obliteration, result in dentinal losses. Thus, when performed conventionally, these procedures have a greater chance of causing negative impacts on internal morphology and tooth fracture resistance and may lead to deformability.[16] The amount of tooth structure removed in endodontic treatment influences the behavior of the tooth against occlusal forces. Thus, teeth with higher volumes of coronal wear present a higher concentration of stress in the cervical region.

MATERIALS AND METHODS

Selection of teeth

Ninety extracted teeth, i.e., 20 mandibular incisors, 20 maxillary premolars, and 20 maxillary molars, were immersed in 5% sodium hypochlorite (Fitofarma, Lt. 20442, Goiânia, GO, Brazil) for 30 minutes to remove organic tissue and then stored in a vial containing a 0.2% thymol solution. Digital periapical radiographs (Vatech RVG EZ Sensor Classic, Hwaseong, Gyeonggi, Korea) were performed to determine the following:

Inclusion criteria: Central/lateral mandibular incisors, first/second maxillary premolars, and first/second maxillary molars with fully formed apices and similar length and degree of canal curvature; intact teeth or teeth with superficial restorations.

Exclusion criteria: Comprised of teeth with internal resorption, total or partially obliterated pulp chambers, previous endodontic treatment, and deep restorations.

Acquisition of CBCT images

Computed tomography (CT) scans were performed at two-time points:

1) Initial—before the operative stage of coronal access, and

2) Final—after coronal access.

The CBCT images were acquired after placing the teeth in an acrylic resin holder to

standardize the acquisitions. The tomograph used was CS 8200 3D NEO EDITION (Atlanta, Georgia, Europe), FOV: 8 cm x 8 cm, voxel 75 micrometre. The voltage was 90 kVp, and the current was 2-15 mA, with an exposure time of 33.5 s.

Coronal access

After the initial CBCTs were performed, the samples were divided into two groups:

Group 1 (mandibular incisors)		Group 2 (maxillary premolar)		Group 3 (maxillary molar)	
G1a (conventional endodontic access)	G1b (guided endodontic access)	G2a (conventional endodontic access)	G2b (guided endodontic access)	G2a (conventional endodontic access)	G2b (guided endodontic access)

All procedures were performed by a single operator specialized in endodontics, with over 15 years of experience, using a dental loupe (x3.5 magnification).

In the G1a (conventional access in incisors) group, access was made with spherical diamond bur no. 1011 and conical bur no. 2200 (KG Sorensen, Barueri, SP, Brazil). The pulp cavities were accessed initially with round diamond burs on the lingual face, close to the cingulate. The wear was initiated with a diamond bur positioned perpendicular to the lingual and posterior side, sloping obliquely to the pulp chamber. A triangular contour shape with a base facing the incisal face was prepared to provide regularization of the walls and a slight inclination of the proximal walls.

G1b access (guided access in incisors) was planned and performed using the images of the initially acquired CBCTs and of the sample scans made using the 3Shape Dental System™ apparatus (Copenhagen, Denmark).

By digitally scanning the samples and superimposing DICOM (Digital Imaging and Communications in Medicine) and STL (stereolithography) data generated by CBCT, the access guides were created virtually using Blue Sky Plan® software (Blue Sky Bio, UK). The guides were made using at least 3 mm of resinous material (Sheraprint Model Plus UV, Shera, Lemford, Germany). To confirm that the tooth surfaces were correctly placed, visual examination sites were established. The guide drawings were printed using a 3D printer (Straumann® CARES® P30).

By placing the guides on the samples and using graphite to indicate the first wear region on the palatal surface, guided coronal access routes were started. A milling cutter measuring 1.3 mm in diameter and 20 mm in length was inserted up to the working length after the enamel was worn with diamond tips number 1011. The access paths were constructed using a NeoSurg Pro engine (Neodent, Curitiba, PR, Brazil) with a torque of 40 N.cm and a speed of 800 rpm. Metal washers with an internal diameter of 1.5 mm (Guided Surgery - Neodent, Curitiba, PR, Brazil) were used to guide the wear length and direction.

Wear was started in the central fossa of the occlusal surface with rounded diamond tips # 1013 (KG Sorensen, Barueri, SP, Brazil) in Group G2a (traditional access in molars), parallel to the tooth's long axis. A multi-laminated conical bur type Endo Z (Dentsply / Maillefer, Ballaigues, Switzerland) was used to create a trapezoidal contour form.

A guide was created for every maxillary molar canal in Group G2b (Figure 1). The same process used for guided access of the mandibular incisors (G1b) was used to create the guides. Following access in each group, a #15 K-flex file (Maillefer, Ballaigues, Switzerland) was used to identify the root canals and establish patency. This was verified by directly visualizing the instrument's tip at the apical foramen.

Analysis of the volume of dental tissue

On a Dell computer running the Core i9 operating system (Dell Technologies Inc., Round Rock, Texas), the InVesalius® program (Renato Archer Information Technology Centre, Campinas, SP, Brazil) was used to evaluate tooth structural wear. At first, the volume was calculated without taking into account the volume of the pulp chamber or the acrylic resin support. To determine the threshold, the minimum density value was progressively raised until the support was completely removed from the picture (**Figure 2**). Each tooth's initial volume (IV) of dentin and enamel was measured in cubic millimeters. To determine each element's final volume (FV), the same steps were taken with the program. The following formula was used to determine the volume of tissue removed at the coronal opening (RV): RV = IV – FV. To analyze the data, CS IMAGING V3.10.43 for Windows was used. A normal distribution was shown using the Shapiro-Wilk test. Each group's percentage of dental structural wear was determined and characterized, and a Student's t-test for independent samples was used for comparisons with a 5% significance level.

RESULTS

Eighteen mandibular incisors were evaluated in G1 after performing conventional and guided endodontic access. During the coronal opening procedure, two incisor specimens were lost due to fracture. The mean volume of dental tissue removed in G1 was 31.677 mm³ for conventional access and 26.523 mm³ for guided access (Table 1). These values represent a mean reduction in total dental tissue volume of 10.62% in G1a and 10.65% in G1b; therefore, there is no significant difference ($p = 0.960$).

In the group of maxillary premolars (G2), 20 specimens were analyzed, and this resulted in a mean reduction of 44.526 mm³ (4.05%) in conventional access volume and 50.677 mm³ (5.11%) using guided access volume, with a significant difference among the groups ($p = 0.005$).

In the group of maxillary molars (G3), 20 specimens were analyzed, and this resulted in a mean reduction of 62.526 mm³ (5.86%) in conventional access volume and 45.677 mm³ (4.11%) in guided access volume, with a statistically significant difference between the groups ($P = 0.004$). (**Table 1**)

Figure 3 presents the average values of the volumes in the different steps for the three groups**.**

Figure 1. Sequence of endodontic guide construction for maxillary molar group (G2b).

A) Virtual planning of guided endodontic access with *Blue Sky Plan®* software (Blue Sky Bio, United Kingdom), showing the axis of insertion, angulation, and limit of drill actuation to the root canal entrance orifice in the molars;

B) A three-dimensional image of the virtual design of an access guide in the mesiobuccal canal 2;

C) Sample of 3 specimens included in an acrylic resin base;

D) Guide printed with washers in an adapted position on the 3 upper molar samples;

E) Bur used in guided access (NeoSurg Pro engine).

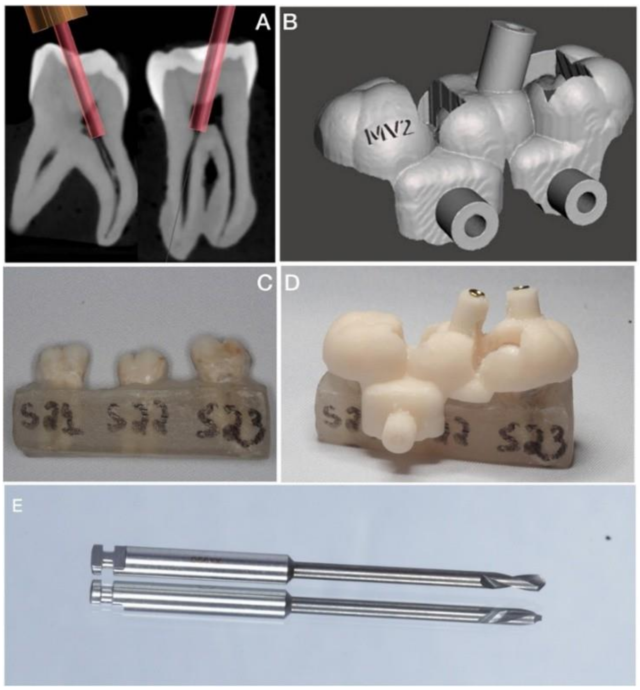

Figure 2. Three-dimensional reconstruction of a maxillary molar specimen in InVesalius® software, after digital exclusion of the acrylic resin base:

A) Initial reconstruction—before endodontic access;

B) Final reconstruction—after guided endodontic access;

C) Initial reconstruction—before endodontic access;

D) Final reconstruction—after conventional endodontic access.

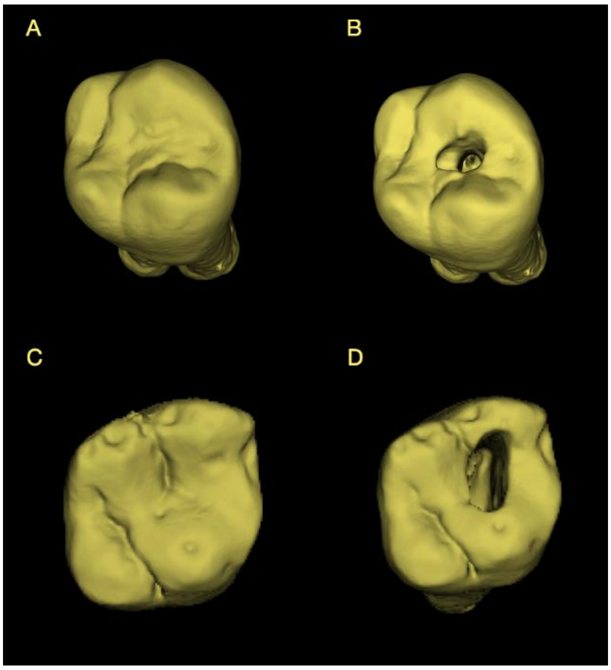

Figure 3. Graph of the initial and final volume of dental tissue for conventional versus guided access in mandibular incisors (G1), maxillary premolars (G2), and maxillary molars (G3) groups.

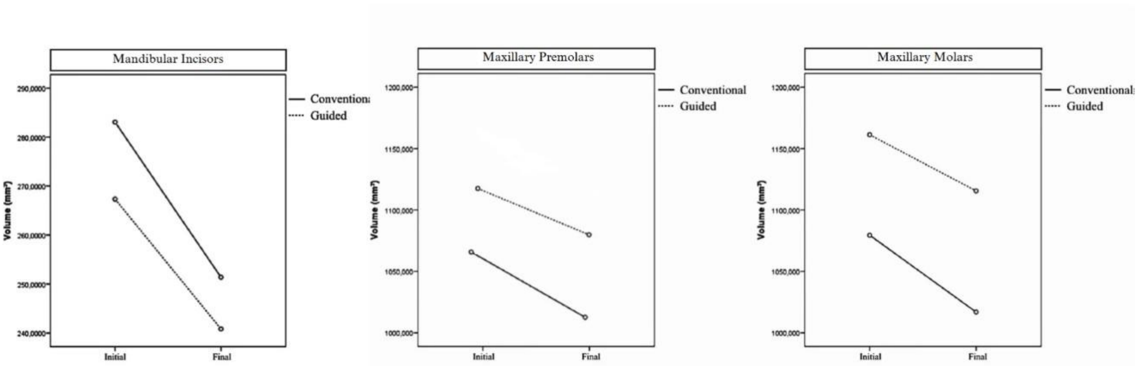

Table 1. Mean volume (mm^3) of dental tissue removed during conventional and guided coronal access to mandibular incisor and maxillary molar groups.

Dental Group	Access type	Volume removed		*p**
		(mm^3)	(%)	
Mandibular incisors	Conventional	31.667	10.62	0.960
	Guided	26.523	5.11	
Maxillary premolars	Conventional	44.526	4.05	0.005
	Guided	50.677	5.11	
Maxillary molars	Conventional	62.526	5.86	0.004
	Guided	45.677	4.11	

* p-value obtained through Student's t-test for independent samples

DISCUSSION

According to the study's findings, guided endodontic access in mandibular incisors reduced the volume of dental tissue in a manner comparable to that of conventional endodontic access. The same technique used in the maxillary molars was able to predictably identify the root canal entrance orifice and also allowed free access of the endodontic instrument to the root canal system, although the guided access technique showed that the group of molars had more preserved dental tissue. As a result, the guides were a good substitute for coronal access planning since they could identify the canal entrance orifices, which allowed for controlled wear of the dental structures.

Computerized microtomography (micro-CT) can be used continually to assess 3D changes in the volume and shape of dental structures.[21, 22] The CBCT is a precise instrument that may be utilized in research techniques examining tooth structures, much like the micro-CT. Its benefit is that it enables the utilization of these structures in in vivo studies.[1]

The current study uses InVesalius® software in conjunction with CBCT equipment to reconstruct and analyze dental specimens in terms of volume. Dental groups with varying levels of complexity were used to test the use of guided access to endodontic therapy. Both uni-radicular teeth (central and lateral mandibular incisors) and multi-radicular teeth (first and second maxillary molars) with varying coronal volumes and morphologies were utilized to assess the damage to dental structures brought on by endodontic access.[23]

In the modern era, the use of technology in dentistry, such as 3D printers for prototyped guidelines and software for virtual planning, has been a constant resource, particularly in the field of implantology.[2, 24] The most precise and quick guided endodontic access methods have been made possible by related technologies, which have also been utilized for endodontic application, particularly when the coronal opening extends considerably toward the apical region.[25]

When combined with appropriate cleaning practices, the preservation of enamel and dentin structure during endodontic treatment ensures the procedure's success and enables the tooth to respond more favorably to functional loads.[26] Various writers have linked the coronal access surgical method to tooth fractures and the ensuing failure of treatment.[15, 17, 27, 29]

For this reason, measuring the amount of dental structure destroyed following surgery is crucial.

Connert et al. (2019) [19] conducted an *in vitro* study to compare dental tissue loss in guided and conventional endodontic access procedures used to locate calcified root canals using CBCTs. The authors found a significant difference in the amount of dental tissue removed in the two treatment modalities. The guided endodontic access was faster, more predictable, and more conservative than the conventional endodontic access, corroborating the results found in the maxillary molar group of this study. The divergence from the results of the mandibular incisors group can be explained by the lower indexes of anatomical variations and lower complexity levels of multiradicular teeth.

The applications of guided endodontics have been studied increasingly and have improved continuously. Guided procedures have been used mainly in cases of difficult access to reduce the possibility of iatrogenic effects and excessive wear.[20] However, the clinical application of endodontic guides must take into account the possible harmful effects caused by rotation or torque applied by motor-driven instruments in already fragile structures, such as restorations, extensive carious processes, and previous trauma. In addition, it is crucial to understand that ultraconservative access may make it difficult to clean the coronal chamber to improve disinfection in cases of endodontic infection; moreover, it could compromise instrumentation efficacy.[30] On the other hand, structures such as the cingulum, the oblique ridge, and the pulp chamber roof, which play a very important role in the chewing function, should be protected as a way of enhancing tooth fracture strength.[30]

Because of the present results, it was concluded that guided endodontic access promotes less loss of tooth structure in dental groups of greater morphological complexity. No significant difference was observed in the volume of dental tissue removed with conventional versus guided endodontic access in mandibular incisors. However, guided endodontic access preserved a greater amount of dental tissue in the maxillary molar group.

REFERENCES

1. Azevedo B, Azevedo JR, Leles CR, Bueno MR, Estrela C. The precision of panoramic and periapical radiography, as well as cone beam computed tomography, in identifying apical periodontitis. Endodontics Journal, March 2008, 34(3), 273–9.
2. D'haese J, Van De Velde T, Komiyama A, Hultin M, De Bruyn H. Accuracy and Complications Using Computer-Designed Stereolithographic Surgical Guides for Oral Rehabilitation by Means of Dental Implants: A Review of the Literature. Clin Impl Dent And Related Res 2010;14:321-35.
3. Diogenes A, Azevedo BC, Estrela C, and Bueno MR. The creation of a novel cone-beam CT program for endodontic diagnosis. Dec. 2018, Brazilian Dental Journal, 29(6), 517–29.
4. Jung RE, Zwahlen M, Marquardt P, and Schneider D. A comprehensive analysis of computer-guided template-based implant dentistry's precision and clinical results. Research on Clinical Oral Implants. 2009 Sep. 20:73–86.
5. Álvaro Zubizarreta Macho, Ferreiroa A, Rico-Romano C, Luis Oscar Alonso-Ezpeleta, Jesús Mena-Álvarez. Diagnosis and endodontic treatment of type II dens invaginatus by using cone-beam computed tomography and splint guides for cavity access. Journal of the American Dental Association. 2015 Apr 1;146(4):266–70.

6. Krattl G, Ku€hl S, Zehnder MS, Connert T, and Weiger R. A new method of treating teeth with apical disease and pulp canal calcification is guided endodontics. 32:2406 in Dent Traumat 2016;32.
7. Mena-Álvarez J, Rico-Romano C, Lobo-Galindo AB, Zubizarreta-Macho Á. Endodontic treatment of dens evaginatus by performing a splint-guided access cavity. Journal of Esthetic and Restorative Dentistry [Internet]. 2017 Jul 6 [cited 2019 Dec 15];29(6):396–402.
8. Strbac GD, Schnappauf A, Giannis K, Moritz A, Ulm C. Guided Modern Endodontic Surgery: A Novel Approach for Guided Osteotomy and Root Resection. Journal of Endodontics. 2017 Mar;43(3):496–501.
9. Anderson J, Wealleans J, Ray J. Endodontic applications of 3D printing. International Endodontic Journal [Internet]. 2018 Sep 1;51(9):1005–18.
10. Fonseca Tavares WL, Diniz Viana AC, de Carvalho Machado V, Feitosa Henriques LC, Ribeiro Sobrinho AP. Guided Endodontic Access of Calcified Anterior Teeth. Journal of endodontics [Internet]. 2018 Jul 1 [cited 2021 Nov 24];44(7):1195–9.
11. Lara-Mendes ST de O, Barbosa C de FM, Santa-Rosa CC, Machado VC. Guided Endodontic Access in Maxillary Molars Using Cone-beam Computed Tomography and Computer-aided Design/Computer-aided Manufacturing System: A Case Report. Journal of Endodontics. 2018 May;44(5):875–9.
12. Ahn SY, Kim NH, Kim S, Karabucak B, Kim E. Computer-aided Design/Computer-aided Manufacturing–guided Endodontic Surgery: Guided Osteotomy and Apex Localization in a Mandibular Molar with a Thick Buccal Bone Plate. Journal of Endodontics. 2018 Apr;44(4):665–70.
13. Shi X, Zhao S, Wang Wei-dong, Jiang Q, Yang X. Novel navigation technique for the endodontic treatment of a molar with pulp canal calcification and apical pathology. Australian Endodontic Journal. 2017 Jun 23;44(1):66–70.
14. Maia LM, de Carvalho Machado V, da Silva NRFA, Brito Júnior M, da Silveira RR, Moreira Júnior G, et al. Case Reports in Maxillary Posterior Teeth by Guided Endodontic Access. Journal of Endodontics. 2019 Feb;45(2):214–8.
15. Clark D, Khademi J. Modern molar endodontic access and directed dentin conservation. Dental Clinics of North America. 2010 Apr 1;54(2):249–73.
16. Connert T, Krug R, Eggmann F, Emsermann I, ElAyouti A, Weiger R, et al. Guided Endodontics versus Conventional Access Cavity Preparation: A Comparative Study on Substance Loss Using 3-dimensional–printed Teeth. Journal of Endodontics. 2019 Mar;45(3):327–31.
17. Jiang Q, Huang Y, Tu X, Li Z, He Y, Yang X. Biomechanical Properties of First Maxillary Molars with Different Endodontic Cavities: A Finite Element Analysis. Journal of Endodontics. 2018 Aug 1;44(8):1283–8.
18. Zehnder MS, Connert T, Weiger R, Krastl G, Kühl S. Guided endodontics: accuracy of a novel method for guided access cavity preparation and root canal location. International Endodontic Journal. 2015 Oct 3;49(10):966–72.
19. Accuracy of 3-dimensional–printed Endodontic Surgical Guide: A Human Cadaver Study. Journal of Endodontics [Internet]. 2019 May 1;45(5):615–8.

20. Moreno-Rabié C, Torres A, Lambrechts P, Jacobs R. Clinical applications, accuracy, and limitations of guided endodontics: a systematic review. Int Endod J 2020;53:214-31.
21. Peters OA, Peters CI, Schönenberger K, Barbakow F. ProTaper rotary root canal preparation: effects of canal anatomy on final shape analyzed by micro-CT. International Endodontic Journal. 2003 Jan 31;36(2):86–92.
22. Kishen A, Ossareh A, Rosentritt M. Biomechanical studies on the effect of iatrogenic dentin removal on vertical root fractures. Journal of Conservative Dentistry. 2018;21(3):290.
23. Hartwell G, Appelstein CM, Lyons WW, Guzek ME. The incidence of four canals in maxillary first molars. The Journal of the American Dental Association. 2007 Oct;138(10):1344–6.
24. Nickenig HJ, Wichmann M, Hamel J, Schlegel KA, Eitner S. Evaluation of the difference in accuracy between implant placement by virtual planning data and surgical guide templates versus the conventional free-hand method – a combined in vivo – in vitro technique using cone-beam CT (Part II). Journal of Cranio-Maxillofacial Surgery. 2010 Oct;38(7):488–93.
25. Connert T, Zehnder MS, Weiger R, Ku€hl S, Krastl G. Microguided endodontics: accuracy of a miniaturized technique for apically extended access cavity preparation in anterior teeth. J Endod 2017; 43:787–90.
26. Estrela C, Holland R, Estrela CR de A, Alencar AHG, Sousa-Neto MD, Pécora JD. Characterization of Successful Root Canal Treatment. Brazilian Dental Journal [Internet]. 2014 Jan;25(1):3–11.
27. KISHEN A. Mechanisms and risk factors for fracture predilection in endodontically treated teeth. Endodontic Topics. 2006 Mar;13(1):57–83.
28. Ree M, Schwartz RS. The Endo-Restorative Interface: Current Concepts. Dental Clinics of North America. 2010 Apr;54(2):345–74.
29. Tang W, Wu Y, Smales RJ. Identifying and Reducing Risks for Potential Fractures in Endodontically Treated Teeth. Journal of Endodontics [Internet]. 2010 Apr 1;36(4):609–17.
30. Krishan R, Paqué F, Ossareh A, Kishen A, Dao T, Friedman S. Impacts of a conservative endodontic cavity on root canal instrumentation efficacy and resistance to fracture assessed in incisors, premolars, and molars. Journal of Endodontics [Internet]. 2014 Aug 1 [cited 2021 Dec 11];40(8):1160–6.

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