Original Article

The effect of access cavity design on apical debris extrusion

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Abstract

Objective: This study aimed to evaluate the effect of access cavity design on the amount of apically extruded debris in maxillary molars.

Methods: Twenty-eight extracted maxillary molars were selected for this study. Inclusion criteria were caries-free teeth with mature roots and similar mesiobuccal root dimensions. The samples were randomly assigned into two groups, as follows: conservative endodontic cavity (CEC) and traditional endodontic cavity (TEC). Mesiobuccal canals of the teeth were instrumented using Reciproc instruments. Preweighed plastic tubes were used for collecting the apically extruded debris. The weights of plastic tubes (pre- and post-instrumentation) were determined using an electronic balance. The data were analyzed with an independent sample t-test, and a P-value < 0.05 was considered statistically significant.

Results: The weight of apically extruded debris was significantly lower in the TEC group than in the CEC group (P =0.003).

Conclusions: The results of this in vitro study demonstrated that TEC preparation was superior to the CEC approach in terms of minimizing apical extrusion of debris.

Keywords: Debris, Dental pulp, Dentin, Endodontics, Molar, Root canal preparation

Introduction

Minimally invasive treatment approaches have gained increasing popularity in the field of dentistry. The concept of Conservative Endodontic Cavities (CECs) was introduced by Clark and Khademi (1, 2) in 2010. They presented CEC as a conservative treatment modality in endodontics to preserve a greater amount of tooth structure than traditional endodontic cavities (TECs) (1, 2). In TEC preparation, tooth structure is meticulously removed to potentially decrease the risk of procedural errors during root canal treatment (3). Unlike TEC preparation, CEC preparation aims at less removal of pericervical dentin, corresponding to the minimally invasive dentistry approach (4-7). CEC design has some benefits and drawbacks. The most expected benefit of CECs, compared to TECs, is to increase the fracture resistance of teeth. However, the literature suggests that the CECs have lower results than TECd when comparing the instrumentation efficacy (8).

During root canal instrumentation, extrusion of irrigant solution, dentin chips, pulp tissue, and microorganisms through the periapical tissues may occur. Extrusion of these materials may result in post-endodontic pain and complications or delayed healing (9). Studies evaluating the extrusion of debris have stated that all instruments and all instrumentation methods caused the extrusion of apical debris (10-12).

According to our literature review, no study has to date investigated the effect of access cavity design on the amount of apically extruded debris. Therefore, this in vitro study aimed to compare CEC and TEC regarding the amount of apically extruded debris during instrumentation of mesiobuccal canals of maxillary molars. The null hypothesis was that there would be no significant difference between CEC and TEC groups regarding the amount of apical debris extrusion during root canal preparation of mesiobuccal canals of extracted maxillary molar teeth.

Materials and Methods

Specimen preparation

The sample of the present study consisted of 28 freshly extracted intact human maxillary molars. Inclusion criteria were caries-free teeth that had mature roots with no signs of resorption and similar mesiobuccal root dimensions (length, curvature).

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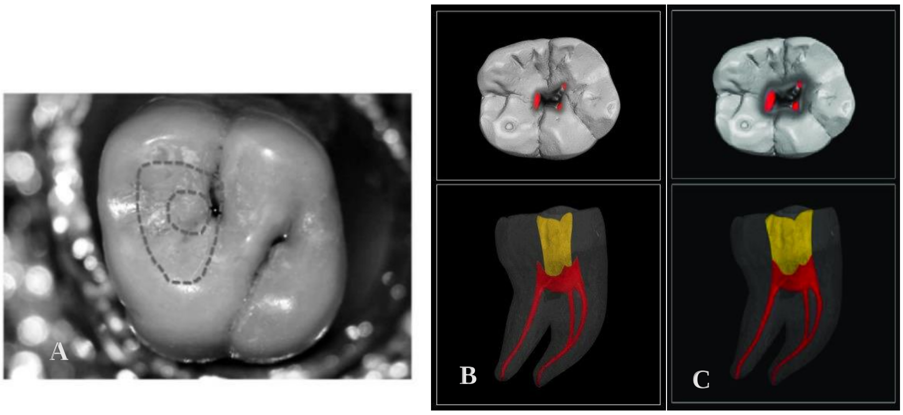

Figure 1. A: The inner line indicates the occlusal view of a conservative endodontic cavity (CEC) design and the outer line indicates the occlusal view of a traditional endodontic cavity (TEC) design. **B:** Micro-computed tomographic illustration of a mandibular molar showing a CEC. **C:** Micro-computed tomographic illustration of a mandibular molar showing a TEC. **D:** Pericervical dentin 4mm coronal to the crestal bone and 6mm apical to the crestal bone

The selected maxillary molars were randomly divided into two groups, as follows (n=14):

Conservative endodontic cavity (CEC): Cavity preparation commenced at the central fossa. Cavities were enlarged enough to only detect the root canal orifices. The pericervical dentin and part of the pulp chamber were preserved (2, 4) (Figure 1 A and B).

Traditional endodontic cavity (TEC): Cavity preparation was initiated at the central fossa. The roof of the pulp chamber and pericervical dentin were completely removed and the cavity was enlarged to provide straight-line access for all canal orifices (3, 13) (Figure 1 A and C).

Endodontic cavity preparation was performed by a single operator using high-speed diamond burs. Major apical foramen was negotiated using a #10 K-file (Dentsply Sirona, Ballaigues, Switzerland) under a dental operating microscope (Carl Zeiss, Oberkochen, Germany). The actual length was established by inserting the file until its tip was in contact with the major apical foramen. The working length was determined by deducting 0.5mm from the actual length. Teeth with a minor constriction larger than #10 K-file (Dentsply Sirona, Ballaigues, Switzerland) were subsequently excluded.

Experimental apparatus

Twenty-eight tubes were numbered and weighed (without caps) using an electronic balance (Precisa XB 220A; Precisa Instruments, Dietikon, Switzerland) with an accuracy of 10^{-4} precision. The tubes were weighed three times and the average weight was recorded as the initial weight of each tube.

The experimental setup, as described by Myers and Montgomery (14), was used to collect the extruded apical debris. Teeth were securely placed into holes made in the caps of plastic tubes. These holes were then sealed tightly with Pattex Super Glue (Türk Henkel, Inc., Istanbul, Turkey) to secure the teeth in position. The entire tube was covered with a stretch film to prevent any external contamination. To maintain consistent air pressure inside and outside of the tubes, a 25-G needle was inserted into the tube's cap, allowing for potential debris extrusion (Figure 2).

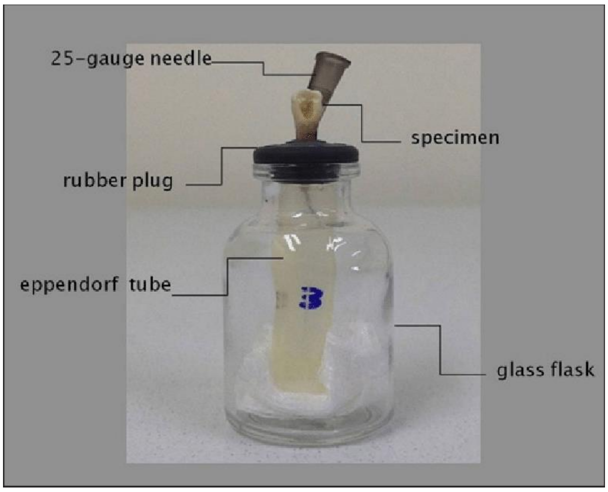

Figure 2. An experimental model system used to evaluate debris extrusion.

The mesiobuccal canals were reshaped using Reciproc instruments (VDW, Munich, Germany). The instruments were used with the ‘‘Reciproc’’ program using a torque-controlled endodontic motor (VDW Silver; VDW). Each specimen was passively irrigated with 10 mL of distilled water using a side-vented needle (30-G; CK Dental Ind.Co.Ltd, Korea) throughout the instrumentation procedure.

After the removal of teeth from tubes, the apexes of teeth were washed with 1 mL of distilled water to include the debris, which was apically extruded but adhered to the apex of the tooth.

The tubes were then stored in an incubator at 70°C for 5 days and weighed by the electronic balance. The measurement was performed three times and the mean value was recorded as the final weight. The weight of the apically extruded debris was calculated by subtracting the initial weight of the empty tube from the final weight.

Statistical analysis

All the statistical analyses were performed using SPSS 15.0 (IBM SPSS Inc, Chicago, IL, USA) software. The statistical significance level was set at 0.05. An independent sample t-test was used to analyze the data.

Results

Both of the access cavities resulted in apical extrusion of debris. The weight of the apically extruded debris (mean values and standard deviation) of each experimental group is presented in Table 1. The amount of apically extruded debris was significantly lower in the TEC group (1.864 ± 0.668 mg) than in the CEC (2.914 ± 0.952 mg) group ($P < 0.05$).

Discussion

The pulp chamber is localized at the tooth's center and encircled by dentin and enamel (15). The endodontic access cavity is an anatomic projection of the dental pulp chamber, and landmarks identified at the coronal level guide the clinician in preparing the access cavity (3-5, 7, 16). Preparing correct cavity access is an important step in root canal treatment. A properly prepared cavity provides several benefits, such as ideal instrumentation and sufficient irrigation of the root canal, thereby affecting the outcome of endodontic therapy (17).

On the other hand, drilling an endodontic access cavity and root canal instrumentation results in less fracture resistance of a tooth (18, 19). Maintaining an intact tooth structure may improve the survival of the tooth against regular occlusal forces. CEC design aims at less removal of tooth structure and is expected to increase the fracture resistance of the tooth. However, the literature lacks sufficient evidence to support that CECs enhance fracture resistance values of endodontically treated teeth.

The present study quantitatively evaluated one of the potential benefits and risks related to the access cavity designs. The null hypothesis suggested that there is no difference in the amount of apically extruded debris between the TEC and CEC access cavity designs. The findings of the present study revealed that the amount of apically extruded debris was significantly lower in the TEC group compared to the CEC group, the null hypothesis was rejected.

Eaton et al. (5) reported that curvature angles significantly differ for each access preparation technique. Minimally invasive access cavity design leads to greater canal curvature (5). This means that in the CEC design, instruments come into contact with a greater amount of tooth structure due to more pronounced curves. In contrast, with a slight curvature, as observed in the TEC design, debris produced within the root canal is more effectively moved toward the crown. It can be claimed that more debris extrusion in the CEC group depends on the curvature view. Serefoglu et al. (20) and Karataslioglu et al. (21) reported that root canal curvature affects the amount of extruded debris. In contrast, Leonardi et al. (22) did not indicate significant differences between various root canal curvatures in terms of apical debris extrusion.

Beyond the curvature perspective, the findings might also be attributed to the TEC design offering a larger space for debris accumulation in the tooth's coronal cavity. Previous studies have shown that after CEC preparation a greater number of pecking motions are required until reaching the tooth apex.

Table 1: The mean and standard deviation (SD) values of apically extruded debris in milligrams in the study groups

	n	Mean ± SD
Traditional Endodontic Cavity (TEC)	14	1.864 ± 0.668
Conservative Endodontic Cavity (CEC)	14	2.914 ± 0.952
P-value	0.003	

This is because coronal interferences lead to much more pressure on the instrument towards the outer wall of the root canal curvature. In addition, it was also reported that CEC caused more canal transportation, particularly in the apical portion of the root canal (6). These consequences of CEC preparation may lead to more debris extrusion.

The limitation of the present study was that periapical tissues were not simulated. In clinical conditions, periapical tissues act as a barrier preventing further extrusion of debris. Therefore, the results of the present study cannot be extrapolated to clinical conditions. Another limitation of the present study was that the curvature angle of teeth was not determined after cavity and root canal preparation.

Further clinical studies should be performed to evaluate the effect of access cavity design on the long-term efficacy of root canal treatment.

Conclusions

According to the obtained results, TEC preparation resulted in a significantly less amount of extruded debris compared to the CEC approach. This should be taken into consideration to enhance the efficacy of endodontic treatments.

Conflict of interest

The authors declare that they have no conflict of interest.

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