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Effect of different access cavity designs on root canal cleanliness

Maram Farouk Obeid[1] , Tariq Yehia Abdelrahman[2]

Abstract

Introduction: the research was conducted to evaluate the influence of conservative (CEC) and ultraconservative (truss access, TUS) endodontic access cavity designs on canal cleanliness when compared with traditional one (TEC).

Methods: Sixty (n=60) mandibular molars were divided into three groups according to the access cavity design (each n=20). Mesial root canals were instrumented then sectioned horizontally into three equal thirds (coronal, middle and apical thirds). All were grooved buccolingually then split vertically. Photos of all thirds were taken by a stereomicroscope. The amount of debris presented were calculated by the Image J software.

Results: For all sections, the highest percentage of debris was found in TUS followed by the CEC design while the lowest value was found with the TEC. Statistically, a significant difference between the groups in the middle and apical sections was found.

Conclusion: CEC and TUS are more conservative but compromise the cleanliness of root canal system.

Keywords Access cavity, canal cleanliness, debris percentage.

1 Ass. Prof. of Endodontics, Faculty of Dentistry, Ain Shams University
2 Lecturer of Endodontics, Faculty of Dentistry, Ain Shams University

Introduction

Traditionally, straight-line paths into root canals are the major accentuation of traditional endodontic cavities (TECs) to boost preparation efficiency and avert technical faults (1, 2). Concerns were identified with TECs as they involve removal of tooth structure by total deroofing of the pulp chamber and this may possibly lessen the resistance to fracture under masticatory loading forces (3, 4).

With the minimal invasive trend and the era of magnification and their wide application in dentistry, an alternate to this traditional tactic was introduced and named as conservative endodontic cavities (CECs) (3,5–11). The concept of which revolves around the value of preserving the tooth structure, including peri-cervical dentin to enhance the resistance to fracture of prepared teeth (8,9,12). The preparation of CECs in posterior teeth typically begins at the central fossa of the occlusal side (13). This differs from TECs in which total deroofing of the pulp chamber with divergent axial walls is mandatory to expose all canal orifices (14).

Furthermore and prior to the achievement of any scientific agreement concerning the additional advantage of CECs, ultraconservative endodontic access design called truss access (TUS) were announced (15). They come in the form of small openings located directly over canal orifices aiming to preserve the dentinal bridge (16). Some research (9,12) demonstrated comparable results concerning efficacy of root canal treatment with different access cavities.

Although mechanical instrumentation with irrigation to effectively debride the root canal system is a perfectly established tactics during root canal treatment (17,18), unfortunately, it has been recognized that even after proper root canal preparation untouched areas are yet available irrespective to the technique applied increasing the opportunity of biofilm colonization and microorganisms persistence within the root canal system (19,20). Concerning CECs, Krishan et al. (8) described even a larger area of untouched walls. He stated that this ineffectiveness is mainly due to incorrect shaping procedures that compromise the cleanliness. Nevertheless, the total studies targeting this point at the instant is inadequate. Thus, it is still obvious that canal cleanliness after chemico-mechanical preparation of root canal with CEC and TUS designs remains an issue that requires additional investigation. Hence, the current research designed to evaluate the influence of CEC and TUS on the cleanliness of canals and debris accumulation on mandibular molars when compared with TEC.

The tested null hypothesis was that no effect from access cavity design would be find regarding the investigated outcome.

Materials and Methods:

- **Sample size calculation:**

Founded on data after an earlier research (21), sample size for each group was calculated utilizing both Chi-squared and variance statistical tests (G*Power 3.1 software; Heinrich Heine University, Dusseldorf, Germany), it revealed that the sample size should be a bare of twenty canals minimally (a=0.05 and b=0.95).

- **Sample selection and preparation**

This study was reviewed by Research Ethics Committee, Faculty of Dentistry, Ain Shams University. The Research Ethics Committee approval number is FDASU-Rec E102113. Sixty recently extracted mandibular molars with completely developed roots were involved. All were inspected under a stereomicroscope(X20) (Olympus BX43; Olympus Co, Tokyo, Japan), if root cracks or fractures were detected, samples were replaced. Digital radiographs were exposed to evaluate root canal anatomy and to ration curvature (Schneider 1971) (22). Moderately curved mesial roots (<10°) that showed separated canals were incorporated in this study. The teeth were fixed in plaster to hide the roots to mimic the existence of surrounding tissues. Pink wax was used to shield the apex to prevent apical foramen blockage. All preparation procedures were completed by a solitary expert endodontist. Access drilling was done with a size 856 diamond bur (Komet Italia srl, Milan, Italy) at high-speed and adequate cooling. Molars were randomly allocated into three groups as per access cavity designs:

TEC group (n=20): in which a traditional endodontic access cavity began from the mesial portion of the central fossa continuously till total removal of the entire roof of the pulp is achieved. At the end of TEC preparation, all orifices were totally observable through the access opening.

CEC group (n=20): a conservative endodontic access cavity was cut complying to the mesial half of the central fossa, extending apically and distally while preserving portion of the roof and dentine (3,8,12).

TUS group (n=20): oval cavities were cut above the mesial and distal canals, but the roof was maintained (21). Our drilling tactics followed Saberi EA (23). Briefly, on radiographs a graduated periodontal probe was utilized to ration the distance from the marginal ridges to the floor. Then separate buccolingual oval access cavities separated by a dentin-enamel bridge on the occlusal surface had been drilled reaching the mesial and distal orifices.

A new Reciproc blue R25 files (VDW GmbH, Munich, Germany) file was used for each tooth to prepare all canals following manufacturer's protocol. Irrigation was accomplished by means of a 25-gauge needle (Ameco, Cairo, Egypt) loaded with 3 ml of 2.25% sodium hypochlorite (NaOCl) after each file.

- **Sectioning of the teeth and evaluations**

Teeth sectioning was done following Caron et al (24). Under DOM, two horizontal grooves were cut down utilizing a diamond-cutting disk (Microsaw; Dentsply Friadent, Mannheim, Germany) to separate the mesial root into three equal thirds (coronal, middle and apical thirds). Then, all were grooved buccolingually and split vertically using an enamel chisel. Photos of all thirds of each section were visualized under a stereomicroscope (Olympus SZX16) at X50. Any material on the inner wall of the canal were considered as debris. Root canals area and amount of debris were calculated (Image J, National Institutes of Health, v1.39a). To decide canal cleanliness, the percentage of debris was calculated by dividing the amount of debris by the total area of each third.

- **Statistical analysis:**

Mathematical data were denoted as mean and standard deviation (SD) values. Shapiro-Wilk's test was used for normality testing. Similarity of variances was verified using Levene's test. Assumption of sphericity was confirmed using Mauchly's test of sphericity. One-way ANOVA test followed by Tukey's Post Hoc test was conducted to test intergroup comparisons. The significance level was set at $P \leq 0.05$ within all tests. Statistical analysis was made with R statistical analysis software version 4.1.0 for windows.

Results:

Results in the form of means of debris percentage in different groups and root sections were presented in table (1), figures (1,2).

Table (1): Inter and intragroup comparisons for debris percentage (%)

Section	Debris percentage (%) (Mean±SD)			P-value
	TUS	CEC	TEC	
Coronal	19.56 ± 5.43^{Ab}	18.47 ± 6.06^{Ab}	13.93 ± 6.14^{Ab}	0.095
Middle	27.44 ± 3.54^{Aa}	23.29 ± 5.89^{Aab}	17.15 ± 5.27^{Bab}	<0.001*
Apical	30.17 ± 4.09^{Aa}	28.37 ± 3.84^{Aa}	21.19 ± 4.84^{Ba}	<0.001*

Means with different upper and lowercase superscript letters within the same row and column respectively are statistically significantly different *; significant ($P \leq 0.05$)

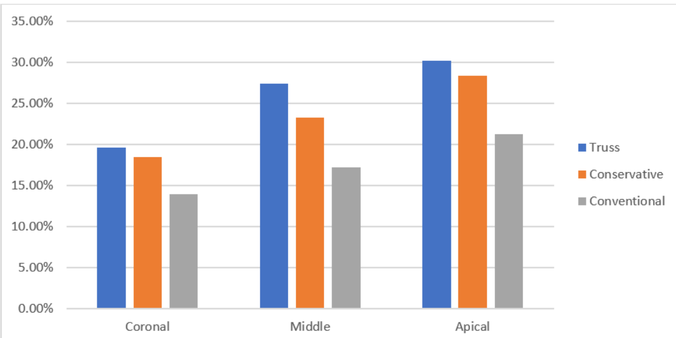

Figure (1): Bar chart showing average debris percentage in different access cavities

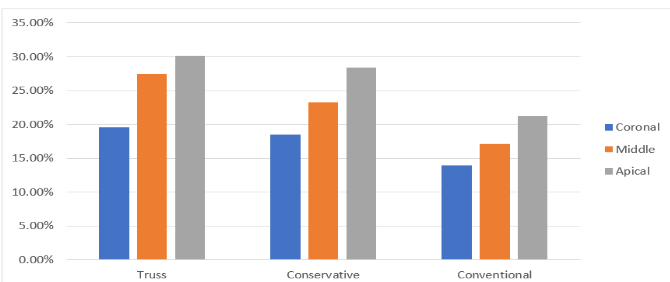

Figure (2): Bar chart showing average debris percentage in different root sections

For all sections, the highest percentage of debris was found in TUS followed by the CEC design while the lowest value was found with the TEC. Statistically, there was no significant difference between the groups in coronal sections (P = 0.095), while at the middle and apical sections the difference was significant (P<0.001).

Regarding root sections, there was a significant difference between percentage of debris (P<0.05). For all access designs, the highest percentage was found in the apical section followed by the middle section while the lowest value was found in the coronal section. In TUS group, Post Hoc Pairwise comparisons showed lower percentage in the coronal section, and this was statistically significant (P<0.001). CEC and TEC, the coronal section showed lower values than the apical section only and was statistically significant (P<0.001).

Discussion:

As mentioned earlier, irrigation with instrumentation have sound proven rules for fruitful endodontic treatment but beside that, an adequate preparation of access cavity is equally vital (25). As we are in the era of conservation and minimal invasive strategy in dentistry, CEC and TUS designs become progressively used today. The aim of the research was to compare CEC, TUS to TEC regarding the cleanliness of root canal system.

It is noted that the physical operator's skill is the chief factor to be considered in root canal preparation, therefore all the endodontic procedures in the present study were carried out by a single endodontist with proficiency in rotary practices (26). Since the most problematic anatomy of root canals is presented in molar teeth, they are frequently liable for clinical complications thus they were selected in our study (27,28). Moreover, the lower first molar is the tooth that owns the prime location in the record of teeth necessitating root canal treatment putting it as a priority in researching (29-31).

The results in this study showed collection of debris irrespective to the design of occlusal access cavity. This was parallel to Keles A et al (32) who documented that it is impossible to prevent the accumulation of dentin particles resulted from the rotary instruments' cuts. TUS group had the highest percentage of debris which imply that reduced access cavities possibly boast a negative consequence in the preparation, disinfection, and cleanliness of root canals and probably in the feat of endodontic treatment. TUS and CEC groups had statistically parallel results, probably as both have more coronal interferences during root canal preparation that prevent adequate irrigation. These coronal interferences might cause the inadequate cleanliness that was reported in specimens of these groups.

Our results were like Moore B et al (10) who concluded that the smaller the access cavity, the greater the danger and probability of missing canal orifices with sequent increase in the liability of having debris and necrotic tissues. The ideal access cavity should grant total elimination of debris, necrotic materials, and pulp tissue (10). Complete deroofing of the pulp chamber is not indicated in CEC and TUS. Thus, these designs keep the undermined dentin of the soffit therefore direct view is not applicable (10,11).

Finally, it worth to mention that most designs in minimally invasive access cavities are recognized to exist noticeably problematic to do in extracted teeth, where nearly all difficulties often encountered while handling a patient are not present. This was addressed by Rover G et al (33) and Saygili G at al (34). Similarly, other studies have shown that canal identification (12,16), and instrumentation (35,36) are trickier using these types of minimal invasive cavities.

Consequently, to use these designs as a normal one for endodontists to be defended, there would need to be strong proof of huge benefits related with their use. Moreover, a foremost characteristic problem when using them is the place of orifice as this is lessened by the restricted sight of the chamber floor.

Conclusion:

CEC and TUS conserve more hard tissue; still, it is tricky to locate the canal's orifices with such a tactic. Unfortunately, this compromised the cleanliness of root canal system, and later, this will become a forte for upcoming reinfection of root canal system.

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