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Original Article

The Effect of the Conservative versus the Traditional Access Preparation on Nickel Titanium Rotary Files

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Abstract:

Introduction: To decrease the amount of tooth structure loss a conservative access cavity (CAC) preparation was proposed where preserving peri-cervical dentin (PCD) would achieve that goal. The aim of this study was to evaluate the effect of the conservative access cavity on the surface changes of controlled memory Nickel titanium rotary files in comparison to the traditional access cavity.

Materials and Methods: One hundred and forty-four extracted mandibular first molars were randomly divided into two treatment groups (n=72). The Traditional Access cavity (TAC) and the CAC groups. Forty-eight file sets of Endo-Edge X7 rotary files (Henry-Schein, USA) have been used to prepare the mesial canals of all the teeth. The edge 30/0.04 rotary files were scanned by the scanning Electron microscope to assess the surface topographic changes in the files after the preparation of three, six and nine canals.

Results: The effect of the access cavity preparation design on the surface topographic changes in the edge files were non-significant in all the groups ($p>0.05$). The surface topographic changes were non-significant after preparation of the three and six canals in both the TAC and CAC groups, however after preparation of nine canals the changes were significant in both the TAC (3.25±0.50) and CAC (4.00±0.82) groups.

Conclusions: As the number of prepared root canals increases, the rotary nickel titanium file defects also increases.Both the TAC and CAC designs had no effect on the defects in the rotary NiTi files.

Keywords: Minimal Invasive Dentistry, Scanning Electron microscope, Surface Topography, Controlled memory Files, Conservative Access Cavity

Introduction:

Achieving a sound access cavity preparation design must begin with complete removal of the pulp chamber roof then widening the cavity until achieving straight line access to all the canals. This access design is known as the traditional access cavity (TAC). Straight line access will help to gain some advantages such as: decrease the rate of mishaps in endodontic treatment as ledges and zips, it will allow easier negotiation of the canals with rotary instruments, decrease the stresses on instruments which in return will decrease the rate of instrument separation (1). The extensive loss of tooth structure due to the endodontic access cavity and root canal instrumentation is one of the main reasons for tooth fractures (2). To decrease the amount of tooth structure loss and subsequent tooth fractures a conservative access cavity (CAC) preparation was proposed where preserving pericervical dentin (PCD) would achieve that goal (3). The fracture resistance of the molars and premolars prepared by the CAC was found to be higher than that of the TAC (4,5). Canal preparation usually gives rise to surface defects on files such as cracks, micro-cavities and unwinding of the flutes. Those defects might act as stress raisers, which ultimately lead to file fracture. The more the instrument is used the more likely that surface defects will emerge (6). Controlled memory (CM) nickel titanium rotary files have very high fracture resistance because they mainly exist in the martensite phase, which makes them highly resistant to cyclic fatigue and have a high surface hardness due to the thermomechanical surface treatment (7). The aim of this study was to evaluate the effect of the conservative access cavity on the surface changes of controlled memory Nickel titanium rotary files in comparison to the traditional access cavity. Evaluating those aspects can add valuable information to the risk assessment process regarding files fracture during root canal preparation. The proposed hypothesis in the current study was that the CAC will allow the files to show less surface topographic changes compared to the TAC.

Materials and Methods:

One hundred and forty-four extracted mandibular first molars with 30-40° curvatures according to Schneider's method have been selected for the current study. The teeth were collected from the Misr International university tooth bank after the approval by the Research Ethical Committee of the Faculty of Dentistry, Misr International University (MIU-IRB-00010118).

Randomization and grouping: The molars have been numbered from 1-144 and randomly divided into two treatment groups (n=72). The Traditional Access cavity (TAC) Group and the Conservative Access Cavity (CAC) Group according to a randomization list generated by www.random.org.

Forty-eight file sets of EndoEdge X7 rotary files (HenrySchein, USA) have been used to prepare the mesial canals of all the teeth, where 24 sets were used to prepare the TAC group and 24 sets were used to prepare the CAC group.

Out of the 72 teeth in the TAC group and their 24 sets of files, 8 file sets were used to prepare 3 mesial root canals of the molars, another 8 file sets were used to prepare 6 mesial root canals of the molars and another 8 sets were used to prepare 9 mesial root canals of the molars. The same process was repeated in the CAC group.

Four new EdgeEndo X7 30/.04 files were used as a control (N=4).

Molar Access Preparation:

a. Traditional access cavity preparation:

A tungsten carbide bur (Mani, Tokyo Japan) has been used to penetrate the roof of the pulp chamber through the central fossa, then complete removal of the pulp chamber roof was done. A probe was used to make sure there are no dentine lips or edges present.

b. Conservative access cavity preparation:

A tungsten carbide bur has been used to penetrate the roof of the pulp chamber through the central fossa. The cavity has been extended as minimally as possible in order to detect the canals orifices and preserve the pericervical dentin and part of the pulp chamber roof.

Both Access preparations were performed under magnification (10x) using the microscope (Zeiss, Oberkochen, Germany).

Root canals preparation:

The mesial canals were scouted by k-file #10/.02 (Mani, Tokyo, Japan) to the estimated working length which was recorded from the pre-operative radiograph. The working length (WL) was established by a k-file #15/.02 by subtracting 1mm from the file length after being visible at the exact root apex under the microscope (Zeiss, Oberkochen, Germany). Edge rotary File X7 20/.04 was used to the full WL followed by 25/.04 and finally rotary file 30/.04. Twenty milliliters of 5.25% sodium hypochlorite were used as an irrigant throughout the entire canal preparation and patency by k-file #10/.02 was done in between each rotary file. X-smart Endo-motor (DentsplySirona, USA) was used during the root canal preparation with a speed of 500 rpm and a Torque of 2 N/cm^2.

Evaluation of the files surface topography by the Scanning Electron Microscope (SEM):

Four new EdgeEndo X7 30/.04 files have been scanned by the SEM to compare the surface topography between the new and used files after canal preparation. EdgeFile X7 30/.04 files have been cleaned by an ultrasonic bath for 20 minutes, autoclaved, wiped with gauze soaked in 70% alcohol, and then allowed to dry to be ready for evaluation. The new and used files were mounted on the SEM specimen mount stubs using a double-sided carbon tape. In an attempt to evaluate the same area of a file on multiple examinations, the flat area of each instrument handle faced the microscope lenses. Files have been imaged at 200x magnification 'Leo Supra 55 SEM' at 12mm from the file tip. Physical deformations such as disruption of cutting edge, blunting of cutting edge, pitting, metal strips, unwinding (figure 1), cracks and fractures (figure 2) of the flutes have been recorded in an excel sheet for each specimen after identification from the SEM photos. A scoring system has been adopted according to Troian et al (8) to give each file a score based on the amount of deformations identified (Table 1). The SEM photos have been analyzed by three blinded specialized examiners and the results based upon the scoring system were tabulated.

Scoring system:

Table (1): Scoring system to classify the topographic changes in the files

Score	Spiral distortion	Surface defects	Fracture
0	No unwinding	No defects along the shaft examined	No fracture
1	Unwinding for only one spiral along the shaft examined	Small number of defects: one to three areas with defects along the shaft examined	No fracture
2	Unwinding of 2 to 3 spirals	Moderate defects: four to five areas with defects along the shaft examined	No fracture
3	Unwinding of 4 or more spirals	Severe defects: more than 5 areas with defects along the shaft examined	Fracture

Statistical Analysis:

Numerical data were presented as mean and standard deviation (SD) values. They were explored for normality by checking the data distribution, and using Shapiro-Wilk test. Non-parametric data (surface topography scores) were analyzed using Kruskal-Wallis test followed by Dunn's post hoc test with Bonferroni correction. The significance level was set at $p \leq 0.05$. Statistical analysis was performed with R statistical analysis software version 4.1.3 for Windows.

Results:

1- Effect of access cavity design:

Intergroup comparisons, mean and standard deviation values of surface topography scores for different access cavity designs were presented in table (2).

The effect of the access cavity preparation design on the surface topographic changes in the edge files were non-significant in all the groups ($p>0.05$).

2- Effect of the number of canals:

Intergroup comparisons, mean and standard deviation values of surface topography scores for different number of canals were presented in table (3).

The surface topographic changes were non-significant after preparation of the three and six canals in both the TAC and CAC groups, however after preparation of nine canals the changes were significant in both the TAC (3.25±0.50) and CAC (4.00±0.82) groups.

Discussion:

The traditional access cavity (TAC) involves removing the entire roof of the pulp chamber, and all the peri-cervical dentin to obtain a straight-line access to all canal orifices (1). Recently, the concept of minimal invasive dentistry and the conservative access cavity (CAC), has been adopted to preserve the teeth's structural integrity and prevent teeth loss through saving the peri-cervical dentin and part of the pulp chamber roof (9). To minimize the incidence of rotary file fractures, manufacturers recommend the single use of rotary NiTi files (10,11). Besides the single use, rotary files are subjected to multiple thermomechanical treatments such as the controlled memory files to reduce any surface defects as pitting, metal strips, cracks, micro-cavities and fractures from development (12). Edge rotary files were selected for the current study due to the advanced thermomechanical treatments they have undergone during manufacturing.

The proposed hypothesis in the current study that the CAC will show less surface topographic changes on the Edge Rotary files compared to the TAC was not fulfilled because there were no significant differences between both groups. In both CAC and TAC groups the rotary files were used to prepare three, six , and nine canals in-order to see the effect of the access cavity design and the different number of usages on the surface changes in the files. Surface defects were found in all rotary files after usage, even after use in the three canal groups. As the number of canals increased the file defects increased which was significant after nine canals in both the CAC and TAC groups, this was in agreement with multiple studies (13, 14). The SEM was used to scan twelve millimeters of the rotary files because the working part of the Edge-Endo X7 files were twelve millimeters.

The attempt to detect all specific types of defects in each file and group them by type is a very difficult process. This is because the defects that occurred in the files during the preparation of the root canals, sometimes by being minimal, make them difficult for the evaluators to recognize while comparing the SEM images, which can complicate their scoring decision, no matter how meticulous they may be (15). Multiple studies have found greater file defects and canal aberrations in the CAC compared to the TAC group (16, 17). However, in the present study no significant differences was found in the files surface topography in both groups, this can be explained by the fact that only a conservative access cavity was used not an ultraconservative one and also the used Edge files have high thermomechanical properties.

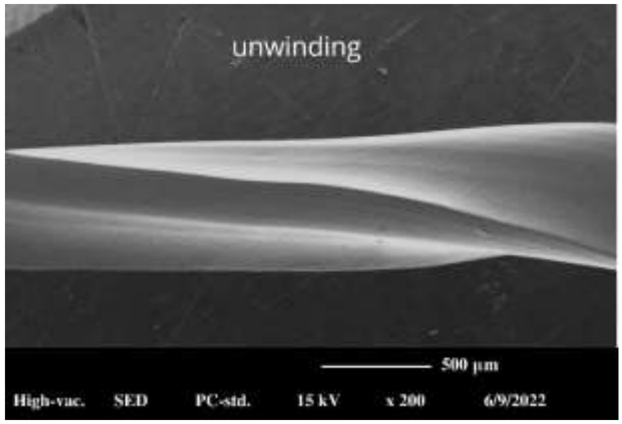

Figure 1: Edge file shows unwinding of the flutes after preparing 9 canals in the TAC group.

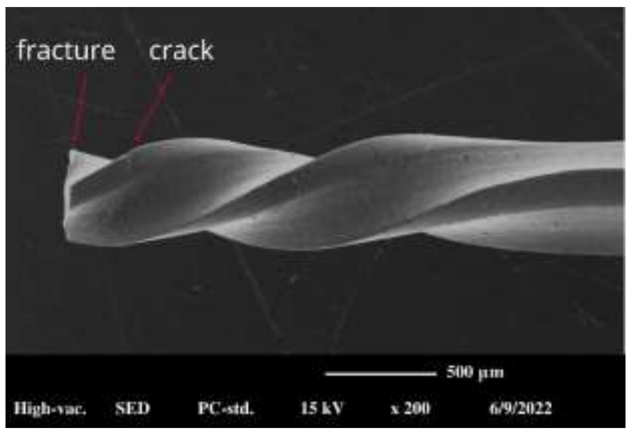

Figure 2: Edge file cracks and fractures after preparing 9 canals in the CAC group.

Table (2): Intergroup comparisons, mean and standard deviation values of surface topography scores for different access cavity designs:

File	Number of canals	Surface topography score (mean ±SD)		p-value
		Traditional	Conservative	
Edge files	**3 canals**	0.50±0.58	1.25±0.50	**0.134ns**
	6 canals	1.75±0.50	3.00±0.82	**0.063ns**
	9 canals	3.25±0.50	4.00±0.82	**0.206ns**

*; significant ($p \leq 0.05$) ns; non-significant (p>0.05)

Table (3): Intergroup comparisons, mean and standard deviation values of surface topography scores for different number of canals:

File	Access cavity design	Surface topography score (mean±SD)				p-value
		New file	3 canals	6 canals	9 canals	
Edge files	**Traditional**	0.00±0.00[B]	0.50±0.58[B]	1.75±0.50[AB]	3.25±0.50[A]	**0.004***
	Conservative	0.00±0.00[B]	1.25±0.50[AB]	3.00±0.82[AB]	4.00±0.82[A]	**0.004***

Different superscript letters indicate a statistically significant difference within the same horizontal row *; significant ($p \leq 0.05$) ns; non-significant (p>0.05)

A constant quest for conservation of the tooth structure during access cavity preparation is a prime goal for the prevention of teeth loss and to promote the longevity of the teeth in the oral cavity (18).

Conclusions:

1. As the number of prepared root canals increases, the rotary nickel titanium file defects also increases.
2. Significant rotary NiTi file defects were found after preparation of nine root canals in both TAC and CAC groups.
3. Both the TAC and CAC designs had no effect on the defects in the rotary NiTi files.

Conflict of Interest and Source of Funding:

Authors deny any conflict of interest. No funding was granted in the current study. **Refrences:**

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