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RADIOGRAPHIC ASSESSMENT OF THE EFFECT OF CONSERVATIVE ACCESS CAVITY PREPARATION AND DIFFERENT ROOT CANAL TAPERS PREPARATION ON APICAL TRANSPORTATION OF CURVED ROOT CANALS (IN VITRO STUDY)

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ABSTRACT

Aim: The aim of study was radiographic assessment of the effect of conservative access cavity preparation and different root canal tapers preparation on apical transportation of curved root canals.

Materials and methods: we used 45-extracted mandibular permanent molar having mesial root canal curvature range .CBCT done to determine the root curvature and anatomy for access cavity standardization. Teeth were selected and divided into three groups, according to access cavity preparation design into: Group1 (Traditional access cavity), Group2 (Conservative access cavity), Group3 (Truss access cavity). Pre instrumentation standardized periapical x-ray were done with #15 k-file inserted inside mesiobuccal canal Then teeth were divided according to rotary file system used for canal instrumentation into three subgroups (Oneshape , ProTaperNext and Trunatomy). After access preparation done all teeth were instrumented using OneShape 25/0.6 , Protaper Next X1,X2 and Trunatomy small (#20) and Prime (#26) . Post instrumentation standardized radiograph were taken with (OneShape 25/0.6, ProTaper Next X2 and Trunatomy Prime (#26)) file inserted inside mesiobuccal canal. Superimposition of pre and post instrumentation radiographs were done using Adobe Photoshop program . Image-J software was used to measure angle of deviation between the 2 files. Statistical analysis for image analysis results was performed by applying ANOVA test (one way) followed by Tukey post hoc test.

Results: Conservative access cavity showed highest angle of deviation when used with OneShape and Trunatomy while showed the lowest angle of deviation with ProTaper next .Regarding the type of file used, OneShape showed the highest angle of deviation with conservative and truss access cavities and lowest with traditional access cavity while ProTaper next showed the lowest angle of deviation with conservative and Truss access cavities .

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Conclusion: These findings indicated that conservative access cavity can produce comparable findings regarding apical transportation when compared to traditional and truss access cavities while using Trunatomy file system. Also Truss access cavity doesn't increase the apical transportation being compared with conservative and traditional access cavities. Trunatomy did not have an impact on the apical transportation in any type of access preparation made in this study.

KEY WORDS: canal transportation, Truss access cavity, Conservative access cavity, Trunatomy, ProTaper Next and OneShape.

INTRODUCTION

The goal of minimally invasive dentistry is to fill the gap that exists between dental intervention and prevention. They advise using a methodical reverence for the first healthy tissue. This suggests that the dental professions have to understand that natural tissue has greater biological value than artifacts. This can be achieved by removing and substituting as little tissue as possible tissue, preservation of sound tooth structure more ideally by preventing disease from occurring and avoiding its advancement [(1)].

Compared to their conventional counterparts, contracted endodontic canals have a more conservative appearance due to their smaller shape. They result in a greater preservation of dental tissue by increasing the resistance of endodontically treated teeth. [(2)]

While the design of a contacted access cavity helps to preserve the remaining tooth structure, it is also necessary to guarantee adequate endodontic access for reaching the ideal instrumentation. It is debated that contracted endodontic cavities may lead to operative difficulties during canal instrumentation, with coronal interferences having the potential to cause root canal transportation toward the outer aspect of the curvature. [(3)]

The Truss access cavity design includes the preservation of a dentine bridge and overlying enamel during making separate cavities that are prepared to aim directly at the canal orifices in multi-rooted teeth [(4)].

The inaccuracy of Truss access is a significant drawback as it might result in gouging or, in the worst-case scenario, a perforation or missed canals[(5)]. Truss access cavity preparation have significant limitations because there is insufficient data to support its use, raising questions about its practicality as a daily substitute for traditional access cavities[(6)].

Ni-Ti alloys have been found to be 2-3 times more flexible than stainless steel files. This feature may allow Ni-Ti files to negotiate in curved channels with less lateral stress, but it does not allow Ni-Ti files to precurve. It remains questionable whether the physical tendency of Ni-Ti files to remain straight prevents ideal instrumentation or whether their high flexibility allows them negotiate curved canals despite their inability to curve.[(7)]

Shaping of root canal is considered an important step, having a great role in endodontic treatment[(8,9)]. The main goals of root canal shaping are removing pulp from the main root canals that aids in creating sufficient space for irrigation and root filling. In addition during achieving these goals preserving the integrity of the apical canal anatomy, avoiding iatrogenic damage to the root structure and supporting tissues, facilitate root canal filling, and preserving sound root dentin as much as possible to maintain the long-term function of the tooth should be under consideration [(10)]

Root canal transportation defined according to the Glossary of Endodontic Terms of the American Association of Endodontists as: when the file used for instrumentation removes canal wall structure on

the outside curve in the apical half of the canal. This happens due to the predisposition of files to restore themselves to their original linear shape during canal shaping that may lead to ledge formation and perforation. The position of physiologic end of the canal to a new iatrogenic location on the external root surface is transportation of the foramen. [11]

The aim of study will be radiographic assessment of the effect of conservative access cavity preparation and different root canal tapers preparation on apical transportation of curved root canals.

MATERIALS AND METHODS

Inclusion criteria of teeth

-Permanent first or second with two separate roots mandibular molars, Teeth having average ,root curvature range between 25-40° ,Mature apex and Teeth with no or minimal caries.

Exclusion criteria of teeth

Teeth with resorption, Teeth with root caries ,Teeth with vertical root fracture ,Teeth with perforation , Immature apex and Fused roots .

Sample Classification and Randomization :

Forty five mandibular molars: divided into three groups according to access cavity design :

Group I: Traditional access cavity (n=15)

Group II: Conservative access cavity (n=15)

Group III: Truss access cavity (n=15)

Each group will further subdivided into three equal subgroups according to rotary file system

CBCT for Determining the root curvature & access cavity standardization. All teeth were mounted in a silicone material Dupliflex ,the ratio of powder to liquid 1:1. The dimensions of the cubic mold were the 2x2 cm. the teeth were mounted vertically parallel to the long axis of the teeth using the pin of articulator to stabilize the tooth during the setting of the silicone material. CBCT scanner used to capture images of every Subgroup of teetht with a spatial resolution of 200 mm. [12]

Access standardization was done by two methods:

First, To minimize excess cavity preparation, an outline of access cavities was prepared by projecting trajectories to each canal orifice using CBCT imaging and exploring the anatomy of the mesial root canals prior to access marking cusp tip and the point of entrance using a marker and the distance was measured using periodontal probe. [13]

Second, All preparations were done using a microscope having 16X magnification (zumax oms 2360,china). Access cavities were prepared using Endo access bur, Endo Z bur attached to a handpiece of speed 10000-rpm NSK highspeed hand piece. [14]

Access cavity preparation

Traditional access cavity (TAC) was performed according to the principles of Patel and Rhodes. The penetration of the pulp chamber at the center of the tooth was done using tungsten carbide burs and extension to reach distal canals, For complete deroofing of the pulp chamber an Endo-Z bur having non cutting end used. [15]

Conservative access the teeth was accessed using carbide burs, at mesial quarter of the central fossa and extended for only detecting canal orifices, preserving peri-cervical dentin and part of the preserving peri-cervical dentin and part of the chamber roof. [16]

Truss access cavity done according to principles of Neelakantan, using small round carbide bur (Mani Inc. bur size no #2) the access was made above the mesial pulpal horn after measuring the distance between the mesial canals. Using the marker for pointing the mesio buccal and mesio lingual cusp tips [17]

Pre instrumentation Digital 2D radiograph (D1):

Pre instrumentation standardized digital radiograph (D1) was done with a #15 K- file in working length of the mesio buccal canals. Each tooth placed in a silicone block, which was lift on a special platform for maintaining a fixed film–object source position.

Paralleling technique was used for radiography acquisition with the help of the extension cone paralleling Rinn XCP instruments in an action to standardize the position of digital sensor [18]

Root canal instrumentations of mesial canals of selected samples :

Sub groups A ProtaperNext , X1 (size 17, tape 0.4), X2 (size 25 taper 0.6) files were used for shaping the canal . First patency was achieved, then Protaper Next X1 instrument was used according to the manufacturer's instructions speed 300rpm and torque of 2.8N/cm), then protaper next X2 was used. [19]

Subgroups B OneShape, the size of 25 with decreasing taper 0.06. was used as the manufacture's instruction using speed of 350 rpm in pecking motion and torque 4 Ncm. inserting the file down to the two-thirds of the working length using in and out movement without pressure with an amplitude of three mm. [20]

Subgroups C TruNatomy was used for canal instrumentation TruNatomy™ PRIME file with Speed 500 rpm and Torque 1.5 Ncm with no force while the canals being irrigated with sodium hypochlorite with only 2-3 gentle motion 2-5 mm in-and-out of the canal. Full working length reached passively, the file was removed to avoid over-enlarging the apical foramen. In the presence of sodium hypo chloride the TruNatomy™ SMALL file was used in the same manner as mentioned above. [21]

Post instrumentation 2D Digital radiograph (D2)

The x-ray images standardized as previously discussed. Post-instrumentation radiographs taken in a bucco-lingual with the help of the radiographic platform and with the master file inside the canal up to the exact working length. According to each Sub Group, Sub Group A Protaper Next X2, Sub Group B OneShape file no.25, Sub Group C Trunatomy Small file. [22]

Fig. (1): showing Pre-instrumentation periapical x-ray and Post instrumentation periapical x-ray.

Figure shows Pre instrumentation periapical x-ray (left), Post instrumentation Periapical x-ray on (Right)

Superimpositions of Pre and Post X-RAY

Pre- and post-instrumentation radiographs were superimposed and apical transport was assessed using the difference between the intracanal K-15 file and the final NiTi file after instrumentation (44) Digitized images were contrast filtered using Adobe Photoshop software (Adobe Systems Incorporated, San Jose, CA, USA). Postoperative images converted to 50% transparency and superimposed on preoperative images. The images were contrast-filtered using Adobe Photoshop software (Adobe Systems Incorporated, San Jose, CA, USA). Postoperative images transformed to 50% transparency and superimposed on the preoperative images, Small translation and rotation movements done for perfectly matching the contours of the two images. [23]

Angle of deviation :

For measuring the angle of deviation , three dots were drawn on The superimposed images ; Dot A at the apical end of size 15 file; dot B at apical end of master file (ProTaper Next X2, OneShape no.25 and Trunatomy Small file); and dot C , at site where the instrumented canal begins to deviate from the anatomic one. It was represented by angle (a) (23) as shown in Figure (2)

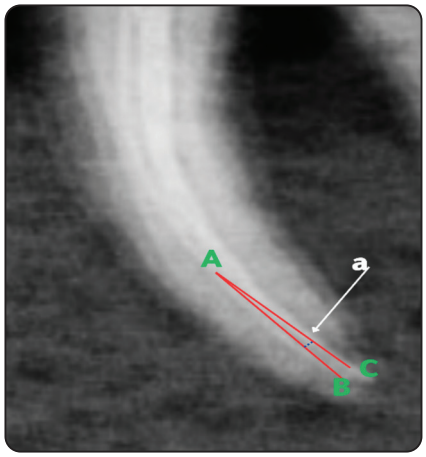

Fig. (2): shows the three dots, the angle of deviation (a) formed between the two drawn lines (AB, BC)

Statistics analysis

- Statistical analysis for image analysis results was performed by applying ANOVA test (one way) followed by Tukey post hoc test.
- $p \leq 0.05$ was considered statistically significant (95% significance level), $p \leq 0.001$ was considered as highly statistically significant (99% significance level)
- Shapiro Wilk test was used for testing the normality of data.
- Statistical evaluation was performed using the SPSS statistical package (version 25, IBM Co. USA).

RESULTS

When using Oneshape file_the highest angle achieved with Conservative group while the lowest angel achieved with Traditional group, while there was statistically significant difference between Traditional and Conservative groups.

While using OneShape

Design	Angle
Traditional	3.97 ± 0.79^{B}
Conservative	6.8 ± 2.09^{A}
Truss	5.3 ± 0.86^{AB}
P-value**	0.000^{HS}

- Letters for comparison between the three access cavity preparation groups at the same column (Tukey Post Hoc test), and the means that have the same superscript letters (at least one letter) are statistically not significant (P-value > 0.05).

- S= Statistically significant at P ≤ 0.05

- NS= Non-significant P < 0.05.

- HS= Highly significant at P ≤ 0.001

Using ProTaper Next_the highest angle achieved with Traditional group while the lowest angel achieved with Conservative group, according to the Tukey Post Hoc test, there was no statistically

significant difference in the mean of apical transportation between the three groups, and overall P-value was not statistically significant.

While Using ProTaper Next

Design	Angle
Traditional	5.75±1.24^{A}
Conservative	4.51±1.28^{A}
Truss	5.09±1.43^{A}
P-value**	0.103^{NS}

- Letters for comparison between the three access cavity preparation groups at the same column (Tukey Post Hoc test), and the means that have the same superscript letters (at least one letter) are statistically not significant (P-value > 0.05).

- S= Statistically significant at P ≤ 0.05

- NS= Non-significant P > 0.05.

- HS= Highly significant at P ≤ 0.001

While Trunatomy the highest angle achieved with Conservative group while the lowest angel achieved with Traditional group, according to the Tukey Post Hoc test, there was no statistically significant difference in the mean of apical transportation between the three groups, and overall P-value was not statistically significant.

While Using Trunatomy

Design	Angle
Traditional	5.75±1.24^{A}
Conservative	4.51±1.28^{A}
Truss	5.09±1.43^{A}
P-value**	0.103^{NS}

- Letters for comparison between the three access cavity preparation groups at the same column (Tukey Post Hoc test), and the means that have the same superscript letters (at least one letter) are statistically not significant (P-value > 0.05).

- S= Statistically significant at P ≤ 0.05

- NS= Non-significant P < 0.05.

- HS= Highly significant at P ≤ 0.001

DISCUSSION

Natural teeth selected because they have large differences in dentin hardness and root canal morphology. Their use appears to mimic clinical conditions and is beneficial compared to canals simulated of resin blocks. Resin blocks have the advantage that the shape, size, taper, and curvature of the root canal are standardized, but the hardness is completely different from that of normal dentin, resulting in inconsistencies. [24]

In the current study curved mesiobuccal root canals of mandibular first molars were chosen, as they are often narrow and have accentuated curves that make debridement and shaping more difficult and mesiobuccal root canals usually show more significant root canal transportation on instrumentation than other canals [24] .

For that reason and for standardization of root canal curvature only root canals having angle of curvature ranging between (25 and 45 degrees) were included . The angle was measured using Schneider method as it considered the most common and the simplest method for measuring the canal curvature. [25]

In the present study, three cavity designs were tested to evaluate their impact on apical transportation using different rotary file system with different taper.

The apical transportation was measured by measuring the angle of deviation between the 15-K file and the master apical file as described by lopez. [23]

The results showed that conservative access cavity showed higher apical transportation distance and angle of deviation as in occurdance with previous study [27,28]

Alovisi et al. [28] found that a greater displacement of the instrument in the central region of the root canal in teeth subjected to minimally invasive endodontic access when instrument #25/0.07 was

used. According to the researchers, with occlusal interferences in the more conservative access, there are a greater number of pecking motions for the instrument to reach the WL, and thus a greater probability of the instrument correcting the curvature of the root canal and causing apical transportation.

The higher number of pecking motions in the CEC group may be related to the presence of coronal interferences, which may have led to an increased straightening of the root canal curvature and apical transportation in their study they used Wave One Gold single file system for instrumentation . In this study we used OneShape single file that could explain the high apical transportation when using OneShape and conservative access cavity. 0.06 taper of the OneShape file system could be a factor that led to apical transportation. As The increase in the taper cause reduction in instrument flexibility, the size of the taper was considering a key factor in root canal apical transportation. [3]

Rover et al [27] also found that The palatal canal showed less transportation and was more centralized in TECs when compared with CECs, probably because of the straight-line access in the TEC group.

Krishan et al. found that canal instrumentation efficacy was decreased in the distal canals of molars with CEC being compared to TEC. due to the oval-shaped canals might be further compromised by the restrictive CEC. An assumption to solve this problem , the distal outline of CEC should be slightly extended buccolingually to better match the wide dimension of the distal canals. This may facilitate approaching the distal canal as two pathways, which is suggested to improve instrumentation efficacy and decrease the probability of canal transportation especially at the apical part. [2]

The result was in accordance with Elkhodary et al . that Trunatomy file system was able to effectively shape curved root canals in terms of canal transportation and centering ability when compared to PTN and M-pro . [29]

CONCLUSION

Under the condition of the present study, the following can be concluded:

1. Conservative access cavity has a negative impact on apical transportation especially when used with OneShape Taper 6%
2. Truss access cavity has no effect on apical transportation when compared with traditional and conservative access cavity
3. OneShape file showed the least angle of deviation when used with traditional access cavity.
4. Pro Taper Next file system showed the least angle of deviation when used in truss and conservative access cavity.
5. Trunatomy has no impact on apical transportation.

Further investigations

1. More studies needed to declare the ability of Trunatomy to preserve the canal anatomy.
2. More studies needed to examine the effect of truss access cavity on apical transportation.
3. More studies needed to compare the conservative and truss access cavity regarding the canal anatomy preservation.
4. More studies needed to test the Trunatomy metallurgy.

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