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Original Research Article

Impact of Conservative Endodontic Access Cavity on Root Canal Transportation by Single File System in Maxillary Molars using CBCT and in Vitro Study

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Abstract

Aim: The aim of the present study was to evaluate the impact of conservative endodontic access cavity on root canal transportation by single file system in maxillary molars using cbct and in vitro study.

Materials and Methods: The present study was conducted in the Department of Dentistry, NMCH, Jamuhar, Sasaram, Bihar, India. In the present study, 50 mesiobuccal roots of extracted maxillary first molar teeth with completely formed apices were collected. Teeth having root curvature ranging from 15° to 30° were selected.

Results: During mechanical preparation, neither instrument fracture nor loss of working length was encountered in any of the teeth. A high degree of reliability was found between the two readings for transportation. The single ICC was 0.972 with a 95% confidence interval from 0.945 to 0.985 ($F(59,59) = 81.420$, $p < 0.001$) (Table 1), and was 0.999 with a 95% confidence interval from 0.998 to 0.999 ($F(59,59) = 1725.500$, $p < 0.001$) for centering ability (Table 2).

Conclusion: Wave One Gold single reciprocation file respected original canal anatomy better than Neoniti single continuous file.

Keywords: Cone-beam computed tomography, glide path, Neoniti, ProGlider, root canal transportation

Introduction

Endodontic access cavity is a crucial step to ensure that all root canals are properly cleaned, shaped, and filled [1] by enhancing both canal detection and instrumentation effectiveness through elimination of coronal interferences. [2] As an alternative to the traditional endodontic access cavities (TECs), minimally invasive endodontic cavities or contracted endodontic cavities (CECs) have been recently presented in the endodontic literature [3,4,5] stressing on the significance of maintaining the integrity of the tooth structure, and conserving the pericervical dentin. While contracted access cavities aims mainly to preserve tooth structure, however the limited accessibility and coronal interference may lead to endodontic instruments to function mostly on the root canal's internal surface, resulting in root canal transportation that negatively affects long-term prognosis due to excessive removal of dentin and straightening of the original root canal curvature. [6,7]

New generations of NiTi rotary instruments have recently been introduced, with higher flexibility and greater cutting efficiency. HyFlex electrical discharge machining (HFEDM) rotary Niti file system is submitted to controlled memory (CM) treatment, which has been shown to significantly increase flexibility and resistance to cyclic fatigue. HFEDM is currently the only instrument developed by electrical discharge machining (EDM), the design is distinguished by a variable cross section, shifting from a triangular cross section at the shaft side which provide more flexibility and fatigue resistance to rectangular at the tip (yielding higher torsional resistance). [8] Despite the different instrument designs and metallurgical advancements, root canal preparation is negatively influenced by the anatomical variation of root canals. [7]

The root form and canal anatomy of maxillary first premolars are highly variable. The most common anatomical features include two roots, narrow furcation entrances, deep mesial concavities and the presence of the palatal furcation groove of the buccal root, which is a developmental depression located at the palatal aspect of the buccal root. [9] Lack of knowledge about the extent and thickness of the dentin in this area might lead to excessive thinning of the dentinal wall during endodontic procedure. [10]

The preservation of dentin with CECs preparation can be guided using cone beam computed tomography (CBCT) technology as pre-access analyses can provide information regarding the number root canals and their orientation within the tooth. It can also identify the presence of complex anatomy such as developmental anomalies, isthmuses, and the presence buccolingually broad canals, which if taken into consideration before the access preparation, would lead to increasing the precision of CECs preparation. [11]

Therefore, the aim of the present study was to evaluate the impact of conservative endodontic access cavity on root canal transportation by single file system in maxillary molars using cbct and in vitro study.

Materials and Methods

The present study was conducted in the Department of Dentistry, NMCH, Jamuhar, Sasaram, Bihar, India. In the present study, 50 mesiobuccal roots of extracted maxillary first molar teeth with completely formed apices were collected. Teeth having root curvature ranging from 15° to 30° were selected.

Access cavities were prepared with access preparation kit (Dentsply, Maillefer, Ballaigues, Switzerland) and the root canals were negotiated using #10 K-file (Dentsply, Maillefer, Ballaigues, Switzerland). Distobuccal and palatal roots of all teeth were separated using diamond disc at the furcation level. A size #10 K file was placed in the canal until it was visible at the apical foramen and WL was established 1 mm short of this length. For more uniform samples, the crowns were flattened and a final WL of 18 mm was standardized for each specimen. Roots were embedded in acrylic blocks of 2.5 cm × 2.5 cm.

The teeth were randomly divided into two experimental groups (n = 50). For both the groups (n = 25), glide path was established using ProGlider. ProGlider (size 16,.02 taper) was used in the continuous rotation (300 rpm speed; 2–5.2 Ncm torque) until the WL. In group 1, teeth were prepared with WaveOne Gold, primary file (25/0.07) according to the manufacturer's instructions, installed on a hand piece powered by electric torque control motor (Silver, VDW, Munich, Germany) set on WaveOne Gold program.

In group 2 (n = 25), Neoniti C1 (25/0.12) was used for shaping of the coronal third with circumferential brushing motion (300 rpm speed; 2–5.2 Ncm torque).

Further, Neoniti A1 (25/0.08) was used with alternating 2–3 circumferential wall brushing actions and 2–3 pecking motions till the WL. Neoniti A1 was used for middle and apical third enlargement of canals with speed of 300 rpm and torque of 1.5 N/cm.

The final apical preparation was standardized for all specimens at size 25. Instrumentation was done using Glyde (Dentsply Maillefer) as a lubricating agent. Canals were irrigated with 2 ml of 3% Sodium hypochlorite during instrumentation. Once the instrumentation was completed, 1 ml of 17% ethylenediamine tetraacetic acid (EDTA) was used for 3 min followed by a final irrigation with 2 ml of saline. Each instrument was used to prepare three canals and then, the files were discarded. Teeth were then scanned under the same condition as the initial scan and data were analyzed.

Image Analysis

All the teeth were scanned using CBCT (New Tom VGi, QR SRL Co., Verona, Italy) with the following setup: 90 kVp, 3 mA, 0.1 mm × 0.1 mm × 0.1 mm voxel size and 0.1 mm axial thickness. The first section was at 3 mm from the apical end of the root (apical level), the second section at middle third (mid-root level) 5 mm from the apex and third section at the coronal third, 7 mm from the apex were recorded. After the initial scan, root canals were instrumented, and image analysis was performed using NNT Viewer software (NNT software corporation, Yokohama, Japan).

Cone-Beam Computed Tomography Measurements

The following formula was used for the calculation of canal transportation mesiodistally and buccolingually at each level for both the group Mesiodistally = (m1-m2)-(d1-d2)

Buccolingually = (l1-l2)-(b1-b2)

Where,

Mesial (m1)/lingual (l1) is the shortest distance from the mesial/lingual edge of the root to the mesial/lingual edge of the uninstrumented canal.

Distal (d1)/Buccal (b1) is the shortest distance from the distal/buccal edge of the root to the distal/buccal edge of the uninstrumented canal.

m2/l2 is the shortest distance from the mesial/lingual edge of the root to the mesial/lingual edge of the instrumented canal.

d2/b2 is the shortest distance from the distal/buccal edge of the root to the distal/buccal edge of the instrumented canal.

According to this formula, a negative result indicates transportation towards the distal/buccal portion, a positive result towards the mesial/lingual portion and zero, the absence of transportation.

Statistical Analysis

The inter-group comparison was made using independent sample t-test and Mann–Whitney U-test. The intragroup comparison was made using Friedman's test. SPSS software (SPSS version 17.0, SPSS, Chicago, IL, USA) was used for statistical analysis, and the level of significance was set at 0.05.

Results

Table 1: ICC for transportation test

Measurements	Intraclass Correlationb	95% Confidence Interval		F Test with True Value 0			
		Lower bound	Upper bound	Value	df1	df2	Sig
Single Measures	0.972a	0.940	0.980	81.420	59	59	0.000
Average Measures	0.986	0.960	0.990	81.420	59	59	0.000

Table 2: ICC for centering ability test

Measurements	Intraclass Correlationb	95% Confidence Interval		F Test with True Value 0			
		Lower bound	Upper bound	Value	df1	df2	Sig
Single Measures	0.999a	0.998	0.999	1725.500	59	59	0.000
Average Measures	0.999	0.999	1.000	1725.500	59	59	0.000

During mechanical preparation, neither instrument fracture nor loss of working length was encountered in any of the teeth. A high degree of reliability was found between the two readings for transportation. The single ICC was 0.972 with a 95% confidence interval from 0.945 to 0.985 ($F(59,59) = 81.420$, $p < 0.001$) (Table 1), and was 0.999 with a 95% confidence interval from 0.998 to 0.999 ($F(59,59) = 1725.500$, $p < 0.001$) for centering ability (Table 2).

Discussion

Predictable endodontic success is dependent on three dimensional cleaning, shaping, and obturation of root canal system. [9] However, endodontic preparation in curved and narrow root canals is more challenging, with a tendency for the prepared canal to deviate away from its original axis leading to procedural errors such as ledging, zipping, and transportation. [10]

The creation of a glide path is essential to allow the proper action of NiTi instruments either used in a rotary or reciprocating motion. [11] A mechanical or manual glide path is key to reducing the effect of torsional stresses along the canal, the screwing effect of rotary instruments, and the risk of instrument failure. [12] Furthermore, a glide path created mechanically might be faster and associated with a lower prevalence and severity of postoperative pain. [13] The single use of endodontic instruments has further supported to reduce instrument fatigue and possible cross-contamination associated with the use of NiTi rotary instruments for canal instrumentation. [14]

The mesiobuccal root of maxillary first molars was chosen as they usually present with remarkable curvatures and have mesiodistal flattening. [15] Teeth having root curvature ranging from 15° to 30° were selected. Curved canals were selected for this study because they present greater challenges to instrumentation. [16]

In the present study, at 3 mm mesiodistally, the transportation is more with Neoniti than WaveOne Gold, which was statistically significant. Similar findings were reported by Yoo and Cho. where wave one reciprocating system maintains original canal contour better than files with continuous rotation, which tend to transport the outer canal wall of the curve in the apical part of the canal. [17] Berutti et al. have reported that reciprocating movement allows a more centralized chemo mechanical preparation when compared to continuous rotary motion, especially in the apical third. [18] At 7 mm level, buccolingually, there was statistically significant transportation with Neoniti than WaveOne Gold. This could be attributed to the coronal preflaring with Neoniti C1, (taper-0.12) used in circumferential brushing motion. Similar findings were reported by Radwanski et al. where WaveOne with reciprocating motion caused lesser transportation than protaper with continuous rotation. [19]

Buccolingually, wave one gold exhibited a significant canal transportation at 5 mm when compared to 7 mm, in intragroup comparison. This may be because wave one gold has a fixed taper from D1 to D3, a progressively decreasing percentage tapered design from D4 to D16. [20] According to yang et al., constant taper produced good centering ability compared to instruments with a progressive taper. [21] Neoniti did not exhibit any statistically significant transportation at 3 mm, 5 mm, and 7 mm, either mesiodistally or buccolingually, within the group. Cross section of Neoniti is a homothetic rectangle, the built-in abrasive property of the flutes, hard cutting edges, circumferential brushing motion in the middle, coronal third and pecking motion in apical third, may have led to aggressive cutting and caused canal transportation. [22]

Conclusion

Within the limitations of our study, it was concluded that WaveOne Gold single reciprocation file respected original canal anatomy better than Neoniti single continuous file.

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