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Negotiation, Centering Ability and Transportation of Three Glide Path Files in Second Mesiobuccal Canals of Maxillary Molars: A CBCT Assessment

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ABSTRACT

Introduction: The aim of this study was to compare negotiation, centering ability and transportation of three path finder rotary instruments (ProGlider, ScoutRace and M3 Pro-Gold Path File) to create glide path in second mesiobuccal (MB2) canals of maxillary molars with cone-beam computed tomography (CBCT). **Methods and Materials:** In this *in vitro* study, 66 maxillary molars with separate second MB2 canals were selected with the following criteria: having 18-21 mm root length, without any resorption or calcification in radiography, without previous treatment and 20-40° curve according to Schneider's method. Then MB2 canals were randomly divided into three groups (*n*=22). CBCT scan before and after root canal negotiation was taken. A #10 K-file for determination of working length was inserted into all canals. In group1; ProGlider file, group2; ScoutRace file and in group 3; M3 Pro-Gold Path file was implemented. The calculated data from CBCT based on reaching full working length (RFWL) or not (NRFWL) were analyzed using the Pearson *Chi*-square test. Centering ability was calculated by Fisher's exact test and amount of transportation was determined with the Pearson *Chi*-square test in SPSS software. **Results:** ProGlider file had the least RFWL and ScoutRace was the best, but the results were not statistically significant ($P>0.05$). Regarding the centering ability and transportation, all 3 groups showed no significant differences ($P>0.05$), except at level of 2 mm from the apex in buccopalatal direction for ProGlider and ScoutRace files ($P<0.05$). **Conclusion:** In spite of insignificantly different results, ScoutRace file was better than other groups in negotiating and centering ability in mesiodistal direction of the MB2 canal in maxillary molars. Also, ProGlider file was significantly better than ScoutRace regarding transportation at level of 2 mm from apex in buccopalatal direction.

Keywords: Centering Ability; Cone-Beam Computed Tomography; ProGlider; Second Mesiobuccal Canal; Transportation

Introduction

The purpose of root canal preparation is to clean the root canal system respecting to its original shape [1-3]. In order to achieve this goal, especially when we use rotary files, we must create glide path; a narrow smooth tunnel from orifice to the end of the root canal [4-6]. In addition, glide path can prevent from torsional file fracture during preparation of root canal with greater taper and size of rotary instruments [4, 7, 8]. Creating glide path with #15 and #20 hand instruments can lead to ledge formation, transportation of canal or canal obstruction; therefore, some rotary nickel-titanium instruments were introduced for glide path creation [5, 9-14].

ProGlider instrument with an ISO #16 tip, a variable progressive taper (2-8%), with a square cross-section and M-wire NiTi alloy was introduced for creating the glide path. The properties of the alloy make it more flexible and more resistant to fracture [10, 11, 13, 15]. The ScoutRace system has a sequence of three instruments; a square cross-sectional design with a 2% constant taper and ISO tip diameters of 10, 15, and 20 [3, 10]. M3 Pro-Gold Path File has a sequence of three instruments, tip diameter of 13, 16 and 19 with a 2% constant taper, and with no history in the literature.

Different methods can be used for evaluation of dentin removal by NiTi rotary instruments [16, 17]. Cone-beam computed tomography (CBCT) is a noninvasive, precise method for assessment of root canal in a three dimensional plan before and after the root canal preparation [1, 12, 16, 18-20].

The aim of this study is to compare the negotiation, centering ability and transportation of 3 aforementioned NiTi rotary instruments in second mesiobuccal (MB2) canals of maxillary molars with CBCT.

Materials and Methods

In this *in vitro* study, 66 mature maxillary molars were selected based on following criteria : having 18-21 mm mesiobuccal (MB) root length, without any resorption or calcification in radiography, without previous treatment and 20-40° curve according to Schneider's method [21]. The teeth were stored in 0.5% sodium hypochlorite solution for 48 h for disinfection. Access cavities were prepared by fissure burs (Brasseler, Savannah, GA, USA).

For ease of procedure, all roots except mesial roots were separated. Ultrasonic device (Various, NSK-Nakanishi Inc., Tokyo, Japan) with troughing tip (E15D, NSK, Nakanishi Inc., Tokyo, Japan) was used for locating MB2 canal in each group [22]. For determining MB2 canal, a #10 K-file was inserted in each MB canal and then radiography was taken. Then the MB roots were divided into 3 groups (*n*=22), randomly. The MB roots of each group were mounted in silicon impression material (Speedex, Coltene/Whaledent, Altstätten, Switzerland) from the crown side.

Before preparation, all teeth were scanned by CBCT device (NewTom VG, Quantitative Radiology, Verona, Italy). The CBCT device was set at high resolution scan, with 0.125 mm axial pitch and 0.125 mm axial thickness, 110 kV and 9.87 mA [23, 24]. Two mL of 5.25% sodium hypochlorite solution was used for irrigation. A #10 K-file (C-Pilot, VDW, Munich, Germany) was used for initial negotiation. Working length was determined at 1 mm less than the length that the tip of file was visible.

In Group 1: ProGlider rotary instrument (Dentsply Maillefer, Ballaigues, Switzerland) (16/0.02, at speed of 300 rpm and 5 N/cm torque), Group 2: ScoutRace rotary instrument (FKG Dentaire, La Chaux-de Fonds, Switzerland) (10/0.02, at speed of 800 rpm, 1 N/cm torque) and Group 3: M3 Pro-Gold Path File rotary instrument (United Dental, Shanghai, China) (including sequence of 3 files naming #13/0.02, #16/0.02 and #19/0.02, at speed of 350 rpm and 1.5 N/cm torque) were used. Instruments were driven with a contra angle handpiece (Sirona, Bensheim, Germany)

Table 1. Frequency of centering ability in groups in 1, 2 and 3 mm from the apex in groups two by two

		ProGlider		**ScoutRace**			***P*-value**
		Centering ability	**No centering ability**	**Centering ability**	**No centering ability**	**Fisher's Exact Test**	
MD	**1 mm**	0	19	2	20	0.385	0.535
	2 mm	1	20	0	22	0.001	0.981
	3 mm	1	20	2	20	0.000	1.000
BP	**1 mm**	2	19	2	20	0.000	1.000
	2 mm	2	19	1	21	0.002	0.967
	3 mm	1	20	1	21	0.000	1.000
		ProGlider		**M3 Pro-Gold Path**		**Fisher's Exact Test**	***P*-value**
		Centering ability	**No centering ability**	**Centering ability**	**No centering ability**		
MD	**1 mm**	0	19	1	20	0.000	1.000
	2 mm	1	20	3	18	0.276	0.599
	3 mm	1	20	1	20	0.000	1.000
BP	**1 mm**	2	19	1	20	0.000	1.000
	2 mm	2	19	0	21	0.525	0.469
	3 mm	1	20	1	20	0.000	1.000
		ScoutRace		**M3 Pro-Gold Path file**		**Fisher's Exact Test**	***P*-value**
		Centering ability	**No centering ability**	**Centering ability**	**No centering ability**		
MD	**1 mm**	2	20	1	20	0.000	1.000
	2 mm	0	22	3	18	1.536	0.215
	3 mm	2	20	1	20	0.000	1.000
BP	**1 mm**	2	20	1	20	0.000	1.000
	2 mm	1	21	0	21	0.000	1.000
	3 mm	1	21	1	20	0.000	1.000

MD: mesiodistal direction; BP: buccopalatal direction

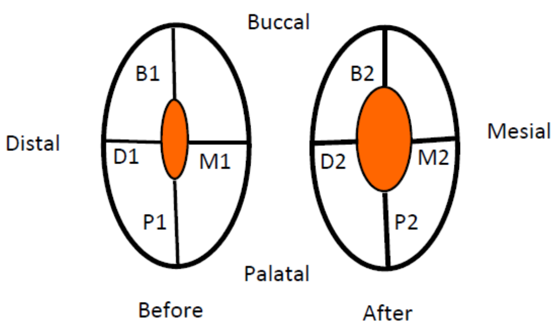

Figure1. Measurement of M1, D1, B1, P1, M2, D2, B2 and P2

powered by an electric motor (VDW Silver, VDW, Munich, Germany). Then the instruments were inserted into the canals gently accompanying with 3 mm amplitude limit and up and down pecking motion. After 3 complete pecking motions, the instrument was removed from the canal and the flutes of instrument were cleaned with a wet gauze. Each instrument was used on a single tooth. The MB2 canal was irrigated with 2% sodium hypochlorite solution for 1 min.

If the instrument reached the working length, it would be classified as "reaching full working length" (RFWL) and if the instrument encountered resistance, was not able to reach full working length and the auto-reverse mode of the device activated, it would be classified as "not reaching full working length" (NRFWL).

A CBCT scan was prepared with the similar exposure parameters and axial pitch and thickness. Thickness of root wall was calculated in NNT viewer software (NNT Software Corporation, Yokohohma, Japan) at 1, 2 and 3 mm from the apex. The first opacity in axial plane of each MB2 root was determined as apex then 1, 2 and 3 mm from apex were calculated according the axial thickness (0.125 mm). Centering ability of MB2 canal was calculated by following formula: (*M1-M2*)/(*D1-D2*) or (*D1-D2*)/(*M1-M2*) and (*B1-B2*)/(*P1-P2*) or (*P1-P2*)/(*B1-B2*) which M, D, B and P show the thickness of mesial, distal, buccal and palatal wall, respectively (Figure 1). The number 1 and 2 shows thickness before and after preparation, respectively. The ratio between 0 and 1 shows higher centering ability of the instrument [1, 25-27]. The formula (*M1-M2*)-(*D1-D2*) and (*B1-B2*)-(*P1-P2*) calculated the canal transportation of MB2 canal to mesiodistal and buccopalatal direction, respectively. If the calculated number was zero the canal was not transported and if it was positive the canal was transported to mesial/buccal direction and if it was negative the canal transportation happened in distal/palatal direction [1, 25-27]. Centering ability and transportation were calculated in 1, 2 and 3 mm from the apex in each teeth.

Statistical analysis

Data analysis was performed with Statistical Package for the Social Science (SPSS) (SPSS version 24.0, SPSS, Chicago, USA). The frequency distributions (%) of root canals which classified as RFWL and NRFWL, centering ability and transportation were compared using the Pearson *Chi*-square test. The α-type error was set at 0.05.

Results

Negotiation

In group1, three ProGlider instruments and in group 3 one M3 Pro-Gold Path file did not reach full working length and in group 2, all ScoutRace instruments reached full working length. Comparison between all groups showed no significant differences (P>0.05). Two of ProGlider instrument and one of the M3 Pro-Gold Path file were fractured.

Centering ability

Table 1 shows the frequency of centering ability between instruments. There was no significant differences between groups (P>0.05).

Table 2. Frequency of transport in mesiodistal direction in groups in 1, 2 and 3 mm from the apex

		ProGlider			ScoutRace			M3 Pro-Gold Path file			X^2	*P*-value
		M	D	No T	M	D	No T	M	D	No T		
MD	1 mm	6	5	8	6	5	11	10	5	6	2.673	0.614
	2 mm	2	7	11	8	4	10	8	7	6	6.558	0.161
	3 mm	6	4	11	6	4	12	10	5	6	3.737	0.443

M: mesial, D: distal, No T.: No transport

Table 3. Frequency of transport in buccopalatal direction in groups in 1, 2 and 3 mm from the apex

		ProGlider			ScoutRace			M3 Pro-Gold Path file			X^2	*P*-value
		B	P	No T	B	P	No T	B	P	No T		
BP	1 mm	6	8	5	9	8	5	6	6	9	2.636	0.620
	2 mm	3	11	7	7	14	1	9	7	5	9.519	0.049*
	3 mm	7	10	4	5	10	7	6	7	8	4.192	0.381

*B: buccal, P: palatal, No T.: no transport, *: indicates a statistically significant difference*

Discussion

The goal of this study was to compare negotiation, centering ability and transportation between ProGlider, ScoutRace and M3 Pro-Gold Path file in second mesiobuccal canals of maxillary molars with CBCT. The results of negotiation revealed no significant difference among groups and these finding was in line with De-Deus *et al*. results [10]. In spite of insignificant results, ScoutRace was better than the other 2 groups. This result was due to special design of the instrument including the small size of tip (ISO #10) and constant taper (2%) in comparison with other studied systems. The special design of ScoutRace minimizes the contact area between instrument and dentin wall culminating to decreases the torque [28] and finally proceeds toward the apex easier. In the study by Coelho *et al.* [29], manual glide path creation increased the total time preparation but decreased the required time for RFWL in WaveOne and Reciproc instruments in curved canals.

The MB2 canal is the most frequently canal that is missed in maxillary molars in clinical situation and even when found negotiation of it is difficult and challenging, due to its special anatomy [30].

In this study ProGlider instrument had the highest fracture rate (0.09%) followed by M3 Pro-Gold Path file (0.04%) and in ScoutRace group no fracture was observed. Alternative cutting edges, electro polishing procedure and smaller tip size in contrast with others may be the cause of ScoutRace resistance to fracture. In the study by De-Deus *et al.* [10], the fracture rate was higher than our study, which can be because of not using instruments according to the manufacture recommendation .

M3 Pro-Gold Path file is a Chinese instrument that was introduced recently. No study was found about characteristic of M3 Pro-Gold Path file. It seems that 0.02 constant taper, lower torque used in clinical situation due to manufacturing alloy (CM: controlled memory), resulted in lower the rate of file fracture.

Centering ability of ScoutRace was higher at level of 1 and 3 mm from apex in mesiodistal direction compared to other groups, but the difference was not significant. Differences in instrument design, torque and speed of rotation for clinical use makes it different. The square cross section of ScoutRace, variable pitch and rounded tip with long transition angle can lead to it being a less aggressive instrument [6].

Transportation in buccopalatal direction at level of 2 mm from apex was significant between ProGlider and ScoutRace instruments. In ProGlider group 33% of instruments showed no transportation, but in ScoutRace group it was 4.5%. The lower speed and M-wire technique of ProGlider may be the reasons for lower transportation. Madani *et al.* [31] found similar transportation of K3 and K-Flexofile in MB canal of maxillary molars with 20-40° curvature with CBCT assessment. In the study by Moazzami *et al.* [32], Reciproc instrument had more transportation than Neoniti in 15-30° curvature in maxillary molars. Mohammadian *et al.* [33] showed that transportation of RaCe and precurved stainless steel files in reciprocating handpiece were similar in mandibular molars with radiography.

CBCT is a tomographic scanning device that provides 3D images from tooth. Its advantages including non-aggressive, low dose, high speed of scanning, high resolution, no destructive effect on tooth and removing the superimposition of structure [34, 35]. Although Micro-CT is the gold standard, evidence suggest that CBCT is useful for determining the amount of removed dentin and thickness of dentin wall [36].

Conclusion

In spite of non-significant results, ScoutRace file was better than other groups regarding canal negotiating and centering ability in mesiodistal direction in the second mesiobuccal canal in maxillary molars. ProGlider file was significantly better than ScoutRace in terms of transportation in 2 mm level from apex in buccopalatal direction. Further investigation should be done.

Conflict of Interest: 'None declared'.

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