

# **The Effect of Different Molar Access Cavity Designs on Root Canal Shaping Times using Rotation and Reciprocation Instruments in Mandibular First Molars**

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**The authors deny any conflicts of interest related to the study or sponsors.**

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## **Abstract**

**Introduction:** The aim was to compare the glide path and final preparation times of WaveOne Gold and TruNatomy in conjunction with two different endodontic access cavity designs in extracted human molar teeth. **Methods:** 60 extracted human mandibular molars with mesiobuccal canals were selected and randomly divided into two different access cavity design preparation groups (n=30). Traditional access cavities (TAC) and conservative access cavities (CAC). Within each cavity design group, the 30 teeth were divided into two instrumentation groups (WaveOne Gold Primary (n=15) and TruNatomy Prime (n=15)). Group 1: TAC, #10 stainless steel manual K-file followed by WaveOne Gold Glider and WaveOne Gold Primary. Group 2: CAC, #10 stainless steel manual K-file followed by WaveOne Gold Glider and WaveOne Gold Primary. Group 3: TAC, #10 stainless steel manual K-file followed by TruNatomy Orifice Modifier and Glider and TruNatomy Prime. Group 4: CAC, #10 stainless steel manual K-file followed by TruNatomy Glider and TruNatomy Prime. Glide path and final preparation times were recorded. **Results:** Shaping time with TruNatomy Glider in combination with TruNatomy Prime instruments were faster compared to the WaveOne Gold Glider/ WaveOne Gold Primary instruments regardless of the type of access cavity preparation. TAC design yielded faster preparation time ( $38.2 \pm 4.57$  seconds) compared to the CAC ( $55.6 \pm 6.91$  seconds) in the WaveOne Gold Glider/ WaveOne Gold Primary instrumentation group. No difference was found between the different access cavity design groups in combination with TruNatomy Glider/TruNatomy Prime preparation.

**Conclusion:** Preparation time with TruNatomy Glider and Prime instruments was significantly faster than WaveOne Gold Glider/WaveOne Gold Primary, regardless of the access cavity design. TAC design in combination with WaveOne Gold Glider/ WaveOne Gold Primary instrumentation resulted in faster preparation time compared to WaveOne Gold Glider/WaveOne Gold in combination with the CAC design.

**Keywords:** Conservative access cavity, traditional access cavity, canal preparation time, TruNatomy, WaveOne Gold

## Introduction

Endodontically treated teeth are more prone to fracture than vital teeth (1, 2). Retaining structural integrity and specially preserving pericervical dentine are key factors that determine the long-term prognosis for the fracture resistance of these teeth (3, 4). Access cavities and canal preparations should therefore provide direct access to the root canal system without compromising the conservation of tooth structure (5). Traditional access cavities (TAC) are prepared by obtaining straight-line access to the coronal and middle third of the root canal. The entire roof of the pulp chamber has to be removed so that all canal orifices can be seen without changing angulation (6). This access cavity design sacrifices more pericervical dentine. Recently, a new concept of conservative access cavity preparation (CAC) has been developed, aiming for minimally invasive dentistry and dentine preservation (7). This design limits the removal of dentine of the chamber roof, allowing the location of root canals without necessarily achieving straight-line access and requiring only partial deroofing of the pulp chamber floor. The pulpal chamber is accessed from the central fossa and only extended as far as necessary to locate canal orifices.

Access cavity walls can either be convergent or divergent. Magnification and advances in the flexibility of endodontic instrumentation systems have diminished the need for traditional endodontic access cavity preparation. The expansion of access cavity walls and subsequent dentine removal might be deemed unnecessary, given that it increases the risk of fracture (8). These CAC preparations might however affect the cleaning, shaping and obturation of canals and could also increase preparation time and iatrogenic complications during endodontic procedures (6). The literature shows increased preparation times in minimally invasive access cavity preparations compared to traditional endodontics access cavity preparations (9–11). A reduction in preparation time is also found in cases with minimally invasive endodontic access cavities compared to more traditional access cavity designs in non-surgical retreatment cases (12, 13).

The WaveOne Gold (Dentsply Sirona, Ballaigues, Switzerland) preparation system is a popular reciprocating file system with a counterclockwise cutting motion. The WaveOne Gold system is designed with a unique alternating parallelogram-shaped cross-sectional design with two 85°-angle cutting edges. This unique design limits the engagement of the file and dentine to only one or two points of contact at any given stage of the canal

preparation. These files are also designed with a progressively decreasing percentage taper to preserve coronal dentine (14). Dentsply Sirona recently launched the TruNatomy (Dentsply Sirona) file system, which is intended to aid in minimally invasive endodontic preparation. The manufacturing of the instruments begins with a smaller initial wire blank (0.8mm diameter) than the 1.1mm diameter of other instruments. The post-grind thermal treatments have been further refined to derive a product with more flexibility. This level of flexibility has been selected to complement the inherent flexibility of the fluting design and smaller maximum flute diameters (15). The aim of this study is to compare the glide path, final and combined preparation times of the WaveOne Gold and TruNatomy instrumentation systems and to evaluate the effect of different endodontic access cavity designs on these preparation times.

### **Method and Materials**

Ethics approval (reference 484/2020) was obtained from the Research Ethics Committee, Faculty of Health Science, University of Pretoria before the study began. Sixty extracted mandibular first molars were selected. Root canals had to be visible on pre-preparation radiographs and had to be previously untreated. Only first mandibular molars with mesiobuccal root canals with curvatures between 25° and 35° and radii < 10mm were used (16). The Schneider method was used to evaluate each canal curvature using a size 0.8 Kerr K-Flex file (Sybron Endo, California, USA) (17). Using a Dental Operating Microscope (Zumax Medical Co. Ltd), access cavity preparation was done with an Endo-Access bur (Dentsply Sirona) and refined in the case of TAC with an EndoZ bur (Dentsply Sirona). Working length was determined by subtracting 0.5mm from the length of the canal measured to the major apical terminus under 10x magnification. The mesiobuccal canals were explored with a size 0.8 K-file and negotiated to patency. The specimens were coded and randomly divided into four equal experimental groups (n=15).

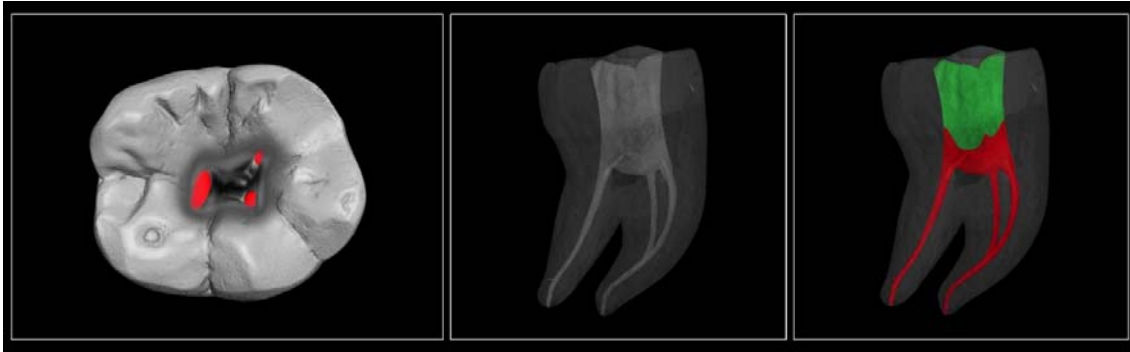
### **Canal Preparation**

Glide path and final preparation was performed by a single operator in strict accordance with the manufacturer's recommendations for each system. All rotary or reciprocating files were operated by a 16:1 gear reduction hand piece powered by the X.Smart IQ (Dentsply Sirona) cordless motor. RC Prep (Premier, Pennsylvania, USA) was used as a lubricating agent and 3%

sodium hypochlorite (NaOCl) as canal irrigation. Specimens were mounted in an FKG vice (FKG Dentaire, La Chaux-de-Fonds, Switzerland) to simulate clinical scenarios and to standardise preparation conditions. The WaveOne Gold Glider and WaveOne Gold Primary instrument were used in reciprocating motion at a speed of 350rpm (150° counterclockwise and 30° clockwise), completing 360° in three cycles. The TruNatomy Glider and TruNatomy Prime were used in rotation motion at 500rpm and 1.5Ncm. All files were allowed to advance inwards passively and to progress apically (applying minimal apical pressure) upon activation, using three easy amplitudes in a pass until working length was reached. If necessary, the instruments were removed, cleaned and re-inserted for another three-amplitude pass until working length was reached. Each file in the glide path and final preparation of all the groups was used only once. Preparation times were recorded with an electronic iPhone stopwatch (Apple Inc., Cupertino, California). Irrigation time and the time taken to change or clean instruments were not considered. Only actual preparation time was recorded. RC Prep was used as a lubricant and 5ml of 3% sodium hypochlorite was used as irrigation solution throughout the instrumentation process. Preparation was confirmed by evaluating the fit of corresponding master gutta percha cones.

***TAC/WaveOne Gold Primary group:***

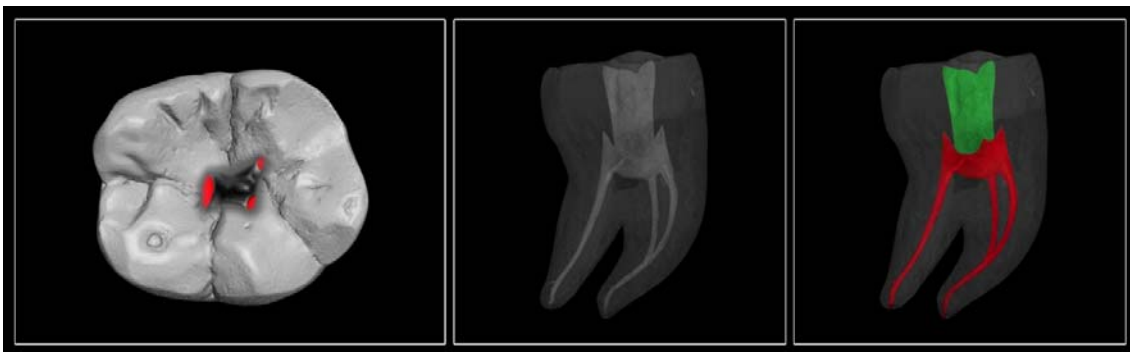
TAC design principles were used to prepare the endodontic access cavity (Figure 1). The TAC design refers to the exposure of all pulp horns and straight-line access to the root canal system with slightly diverging walls. Canal orifices should be visible without changing the angle of view and without any dentine undercuts or ledges (6). In each of the 15 canals a precurved stainless steel size 0.10 K-file was negotiated to working length with increasing amplitudes of 1–3mm to ensure an initial manually reproducible glide path. The WaveOne Gold Glider was then used to enlarge each canal in this group and final preparation was done with the Primary WaveOne Gold instrument according to manufacturers' instructions.



**Figure 1:** Micro-computed tomographic illustration of a mandibular molar showing a traditional access cavity preparation from occlusal and buccal views. The green areas represent the tooth structure removed during access cavity preparation.

***CAC/WaveOne Gold Primary group:***

CAC design principles were used to prepare the endodontic access cavity (Figure 2). CAC designs are based on the principle of dentine preservation with only partial deroofting of the pulpal roof, preservation of pulpal horns and slight convergence of cavity walls. Visualisation of orifices is possible only from different angles (7). In each of the 15 canals a precurved stainless steel size 0.10 K-file was negotiated to working length with increasing amplitudes of 1–3mm to ensure an initial manually reproducible glide path. The WaveOne Gold Glider was then used to enlarge each canal in this group and final preparation was done with the Primary WaveOne Gold instrument according to manufacturers' instructions.



**Figure 2:** Micro-computed tomographic illustration of a mandibular molar showing a conservative access cavity preparation from occlusal and buccal views. The green areas represent the tooth structure removed during access cavity preparation.

***TAC/TruNatomy Prime group:***

TAC design principles (as described above) were used to prepare the endodontic access cavity. In each of the 15 canals a precurved stainless steel size 0.10 K-file was negotiated to working

length with increasing amplitudes of 1–3mm to ensure an initial manually reproducible glide path. The TruNatomy Orifice Modifier and Glider was then used to enlarge each canal in this group and final preparation was done with the TruNatomy Prime instrument according to manufacturers' instructions. Preparation time with the TruNatomy Orifice opener was included in the glide path preparation time and not reported separately.

***CAC/TruNatomy Prime group:***

CAC design principles (as described above) were used to prepare the endodontic access cavity. In each of the 15 canals a precurved stainless steel size 0.10 K-file was negotiated to working length with increasing amplitudes of 1–3mm to ensure an initial manually reproducible glide path. The TruNatomy Orifice Modifier and Glider was then used to enlarge each canal in this group and final preparation was done with the TruNatomy Prime instrument according to manufacturers' instructions. Preparation time with the TruNatomy Orifice opener was included in the glide path preparation time and not reported separately.

***Statistical Analysis***

Data collected showed a parametric distribution. Mean and standard deviations were therefore determined for each group by a one-way analysis of variance (ANOVA) to statistically compare the mean glide path preparation and final shaping times between groups. Significance level was set at  $P < .05$ . Statistical procedures were performed on SAS Release 9.3 (SAS Institute Inc., Cary, NC) running under Microsoft Windows (Microsoft Corp, Redmond, WA) for a personal computer.

**Results**

The mean values for glide path preparation, final preparation and combined total canal shaping times using WaveOne Gold Primary file and TruNatomy Prime file in conjunction with two different access cavity designs are presented in Tables 1–3.

**Table 1. Glide path preparation time (sec) comparing TAC and CAC groups**

Preparation method	N	Access cavity design	Average glide path preparation time (s)	Standard deviation	Minimum value	Maximum value
WaveOne Gold Glider	15	<b>TAC</b>	<b>15.1<sup>a</sup></b>	<b>2.12</b>	<b>7.3</b>	<b>25.3</b>
TruNatomy Glider	15	<b>TAC</b>	<b>12.1<sup>a</sup></b>	<b>0.58</b>	<b>7.7</b>	<b>14.7</b>
WaveOne Gold Glider	15	<b>CAC</b>	<b>18.2<sup>a</sup></b>	<b>2.33</b>	<b>10.3</b>	<b>25.0</b>
TruNatomy Glider	15	<b>CAC</b>	<b>12.8<sup>a</sup></b>	<b>2.24</b>	<b>9.3</b>	<b>26.1</b>

Mean values with different superscript letters were statistically different at  $P < .05$ .

**Table 2. Final preparation time (sec) comparing TAC and CAC groups**

Preparation method	N	Access cavity design	Average final preparation time (s)	Standard deviation	Minimum value	Maximum value
WaveOne Gold Glider/ WaveOne Gold Primary	15	<b>TAC</b>	<b>23.1<sup>a</sup></b>	<b>3.10</b>	<b>10.2</b>	<b>37.7</b>
TruNatomy Glider/ TruNatomy Prime	15	<b>TAC</b>	<b>13.2<sup>b</sup></b>	<b>1.36</b>	<b>10.3</b>	<b>18.2</b>
WaveOne Gold Glider/ WaveOne Gold Primary	15	<b>CAC</b>	<b>37.4<sup>c</sup></b>	<b>5.12</b>	<b>11.0</b>	<b>50.2</b>
TruNatomy Glider/ TruNatomy Prime	15	<b>CAC</b>	<b>13.8<sup>b</sup></b>	<b>0.84</b>	<b>10.5</b>	<b>17.4</b>

Mean values with different superscript letters were statistically different at  $P < .05$ .



**Table 3. Combined total preparation time (sec) comparing TAC and CAC groups**

Preparation method	N	Access cavity design	Combined average preparation time (s)	Standard deviation	Minimum value	Maximum value
WaveOne Gold Glider/ WaveOne Gold Primary	15	TAC	38.2 <sup>a</sup>	4.57	18.2	58.1
TruNatomy Glider/ TruNatomy Prime	15	TAC	25.3 <sup>b</sup>	2.28	13.2	37.2
WaveOne Gold Glider/ WaveOne Gold Primary	15	CAC	55.6 <sup>c</sup>	6.91	35.3	59.7
TruNatomy Glider/ TruNatomy Prime	15	CAC	26.6 <sup>b</sup>	2.36	20.3	39.3

Mean values with different superscript letters were statistically different at  $P < .05$ .

### ***Glide Path Preparation Time***

No statistically significant difference were recorded in glide path preparation times when evaluating TruNatomy Glider with WaveOne Gold Glider in combination with either TAC or CAC preparation groups. Although not statistically significant, WaveOne Gold Glider resulted in slower glide path preparation times compared to the TruNatomy Glider.

### ***Final Preparation Time***

Fastest preparation times were recorded with the TruNatomy Prime group in combination with both the TAC and CAC designs. WaveOne Gold Primary preparation resulted in significantly reduced preparation times. The type of access cavity design had no statistically significant influence on the TruNatomy preparation time. In contrast, in the WaveOne Gold

Primary group, the CAC resulted in significantly reduced preparation times compared to the TAC design group.

### ***Combined (Total) Preparation Time***

Preparation with TruNatomy Glider in combination with TruNatomy Prime resulted in the fastest combined (total) preparation time and was not influenced by the type of access cavity design. The slowest preparation time was recorded in the WaveOne Gold Glider/WaveOne Gold Primary combination group. CAC design resulted in the slowest combined (total) preparation time in the WaveOne Gold Glider/ WaveOne Gold Primary preparation group.

### **Discussion**

Final and combined canal shaping times with TruNatomy Glider and TruNatomy Prime instruments are statistically significantly faster than WaveOne Gold Glider and WaveOne Gold Primary shaping instruments, regardless of the type of access cavity preparation. Access cavity design has little effect on the preparation time when using TruNatomy Glider and Prime shaping instruments. This could be explained by the regressive taper and slim design of the TruNatomy system, specifically for minimally invasive endodontics not restricted by CAC designs. The researchers are not aware of any literature comparing preparation times of TruNatomy with any other endodontic preparation system in combination with different endodontic access cavity preparation designs. A study by Pit et al (18) compared the preparation times of different shaping instruments and also found significantly reduced preparation times with TruNatomy compared to the other systems. In this study, WaveOne Gold was statistically slower than TruNatomy when comparing final and combined preparation times. The design of the access cavity also affected the final and combined preparation times in the WaveOne Gold Glider/ WaveOne Gold Primary preparation group. TAC design yielded faster final and combined preparation times than the CAC when evaluating the WaveOne Gold Glider in combination with the WaveOne Gold Primary group. The type of access cavity design, however, had no statistically significant effect on the glide path preparation time between different preparation or access cavity design groups in this study.

Multiple studies have reported reduced preparation times when shaping instruments were used in combination with CAC compared to TAC (10, 11, 18). Marchesan et al (11) report that CAC designs increase preparation 2.5-fold compared to teeth with TAC designs. The authors also mention that more pecking motions were required to instrument the mesial canals of specifically mandibular molars with CACs than with traditional access cavity designs (11). When comparing reciprocation and rotation in terms of preparation time, some studies favour reciprocation (19) while others report faster preparation times in rotation motion (20). A study by D'Amario et al (21) compared the preparation time of three single-file instruments in reciprocation and rotation motion and reported no clinically relevant difference between these three preparation groups. The results of this study suggest that a smaller, regressive taper, single file used in rotation motion will yield faster preparation times than larger, variable tapered, single files used in reciprocation motion.

### **Conclusion**

Within the limitations of this study the authors recommend the use of WaveOne Gold Glider and WaveOne Gold Primary instrument with TAC and the use of TruNatomy Glider and Prime instruments in combination with either TAC or CAC when taking preparation time only into account. Other factors like procedural errors, canal location, centring ability and transportation, irrigation potential and obturation space etc. should also be evaluated to select the appropriate access cavity design.

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