

## A Comparison of Preparation Times between Manual, Rotary, and Reciprocating Files in Primary Molar Pulpectomy

### Abstract

**Aim:** To compare preparation times using manual, rotary, and reciprocating files during pulpectomy treatment of primary molars. **Settings and Design:** This study was an *in vitro*, randomised, cross-sectional study. **Methods:** The study was performed on 60 extracted human primary mandibular second molars. Only mesiobuccal canals were prepared using one of three preparation techniques; each preparation technique group comprised 20 canals. Canal preparations were performed by a single, skilled operator using stainless-steel (ss) K-files (ISO size 20–35), a ProTaper Gold SX file, and a WaveOne Gold Medium file following glide path preparation. Preparation times were recorded in second (s) with a digital stopwatch. **Statistical Analysis:** Preparation times were compared using analysis of variance and the Kruskal–Wallis analysis of variance, where appropriate. The level of significance was set at  $P \leq 0.05$ . **Results:** The mean preparation time using the ss K-files was significantly longer (186.4 s) than when using the ProTaper Gold SX (29.6 s) or WaveOne Gold Medium files (30.5 s) ( $P < 0.001$ ). Similar preparation times were recorded when using the ProTaper Gold SX and WaveOne Gold Medium files ( $P = 0.939$ ). **Conclusion:** Preparation times with the ProTaper Gold SX and WaveOne Gold Medium files were significantly faster than when using the ss K-files to prepare primary tooth root canals for pulpectomy. Similar preparation times were noted when using the rotary and reciprocation instrumentation groups ( $P > 0.05$ ).

**Keywords:** Preparation time, ProTaper Gold SX, pulpectomy, single-visit pulpectomy, WaveOne Gold Medium

### Introduction

Pulpectomy treatment is described as the removal of the coronal and radicular pulp in primary teeth with pulp necrosis or irreversible pulpitis due to caries or trauma.<sup>[1]</sup> Pulpectomy treatment in children can be challenging for dental operators and stressful for children and parents. Decreasing chair time can reduce dental anxiety and eliminate the need for multiple appointments, especially for uncooperative children. Chair time should also be as short as possible when performing treatment under general anaesthesia and when multiple treatments are required.<sup>[2]</sup> Although tooth extraction is an acceptable alternative, pulpectomy treatment is still considered the ideal since teeth will be retained for space maintenance, aesthetics, and function.<sup>[3]</sup>

Aside from the time element, pulpectomy treatment in children remains challenging due to the difficulty level. The internal anatomy of the root canal systems of primary

molars is complex, which adds to the difficulty of the treatment.<sup>[4]</sup> Conventionally, primary root canal systems are prepared using manual stainless-steel (ss) K-files or H-files, which have been shown to take much longer than rotary instrumentation. In a previous study, H-files showed inferior results regarding preparation times as well as obturation quality compared to ss K-files.<sup>[5]</sup> In 2000, Barr *et al.*,<sup>[6]</sup> were the first to compare the preparation times between nickel-titanium (NiTi) rotary files and ss K-files for pulpectomy in primary teeth, and they concluded that NiTi rotary instrumentation was faster. Other studies have also concluded that rotary instrumentation is faster than manual ss K-files in primary teeth.<sup>[2,7-10]</sup> In 2014, Katge *et al.*,<sup>[11]</sup> concluded that the reciprocating file system was even faster than the rotary file system. In their study, they compared instrumentation time and cleaning efficacy of primary teeth using the WaveOne Small file (Dentsply Sirona, Ballaigues, Switzerland), ProTaper Universal SX and S2 files (Dentsply Sirona), and ss K-files.

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In the present study, preparation times were compared using three different preparation techniques. The ProTaper Gold SX file (Dentsply Sirona) was selected as a rotary single file,<sup>[12]</sup> with the WaveOne Gold Medium file (Dentsply Sirona) as the reciprocating single file. A single-file protocol for both the ProTaper Gold SX and WaveOne Gold Medium files was used, similar to that reported by Mhatre *et al.*,<sup>[12]</sup> suggesting that preparation time may be more influenced by the number of instruments used during a single procedure rather than the type of instrument. Stainless-steel K-files (ISO size 20–35) were used in the manual preparation group in accordance with the prescribed manual technique.<sup>[7]</sup>

The ProTaper Gold SX file is 19 mm long and has a tip size of 0.19 mm with a variable taper ranging from 3.5% to 19%.<sup>[13]</sup> The ProTaper Universal SX (Dentsply Sirona) file has been described as a successful option for single-file pulpectomy preparation, resulting in shorter appointments.<sup>[12]</sup> The ProTaper Gold rotary file has the exact same geometries as the ProTaper Universal file, but the ProTaper Gold offers increased flexibility due to proprietary advanced metallurgy. The ProTaper Gold file has a shorter handle, which improves accessibility to primary teeth in younger patients who have smaller mouths.<sup>[14]</sup>

WaveOne Gold is a reciprocating NiTi file system, cutting in a counterclockwise motion. The files are designed with a progressively decreasing percentage taper to preserve pericervical dentin.<sup>[15]</sup> The WaveOne Gold series consists of four files in assorted lengths: Small (20/07), Primary (25/07), Medium (35/06), and Large (45/05). According to the manufacturer, the Primary (25/07) file is suitable for shaping most root canals in permanent teeth but will not be suitable for primary teeth due to the increased taper of primary root canals.<sup>[15]</sup> It was decided to use the 21 mm Medium (35/06) file due to its tip size, which is the same as the prescribed manual technique of using a K-file up to ISO size 35.<sup>[7]</sup>

Due to the complex internal anatomy of root canal systems of primary molars, canal preparation is the most time-consuming aspect of a pulpectomy procedure.<sup>[4]</sup> Therefore, a novel technique that produces well-obtured canals in the shortest possible chair time needs to be investigated. The aim of this study was to determine which preparation technique would result in the fastest preparation time to limit the clinical chair time in paediatric patients.

## Methods

Sixty, extracted, human primary mandibular second molars were selected, and the mesiobuccal root canal of each tooth was prepared using one of the three preparation techniques. The study was approved by the Research Ethics Committee, Faculty Health Sciences, University of Pretoria (Reference nr: 272/2019), and in accordance with the Helsinki

Declaration of 1975, as revised in 2000. Only teeth with intact mesio-buccal roots, measuring 8 mm or more from the cemento-enamel junction, and an apical foramen size of no bigger than 0.3 mm were used. Root canals had to be clearly visible on the pre-preparation radiographs.<sup>[3]</sup> Primary mandibular second molars with sclerosed mesial canals or canals that were previously accessed endodontically were excluded from the study.<sup>[3]</sup> Teeth were coded and randomly divided into three treatment groups using Research Randomizer software (n = 20).

The teeth were placed in a simulated jaw, similar to a phantom head in a dental learning environment, to replicate the clinical setting. Periapical, pre-operative radiographs were taken before preparing the root canal. Coronal access was prepared using a high-speed hand piece and a fissure diamond bur. An Endo-Z bur (Dentsply Sirona) was used to ensure straight-line access to all canals. The teeth were then removed from the simulated jaw and mesiobuccal canals were explored with a size 10 ss K-file and negotiated to patency. Working length was determined by subtracting 1 mm from the length of the canal measured to the major apical terminus under 10 times magnification using a dental operating microscope (Zumax Medical Co, Ltd, Suzhou, China).<sup>[16]</sup>

The teeth were placed back into the simulated jaw, and an initial, manually reproducible micro glide path was prepared by moving the size 10 ss K-file in and out of the root canal with amplitudes of 1–2 mm up to the working length for all 60 canals. Once the ss K-file moved more freely up to the working length, a size 15 ss K-file was used in a similar manner. A final reproducible glide path was confirmed when the size 15 ss K-file could be placed at the working length, pulled 4 mm backwards and pushed back to the full working length using light finger pressure without any interference or obstruction.<sup>[16]</sup>

**K-file group:** Root canals (n = 20) were enlarged using 21 mm pre-curved size 20, 25, 30, and 35 ss K-files up to the working length with the quarter-turn-pull technique.

**ProTaper Gold SX group:** Root canals (n = 20) were enlarged using the ProTaper Gold SX file in rotation up to the working length according to the manufacturer's instructions.

**WaveOne Gold Medium group:** Root canals (n = 20) were enlarged using the 21 mm WaveOne Gold Medium file in reciprocation up to the working length according to the manufacturer's instructions.

A 16:1 speed reducing hand piece (X-Smart Endo motor; Dentsply Sirona) was used for canal preparation for the rotary and reciprocating groups. The flutes of the files were cleaned of debris after each insertion. Throughout the glide path preparation and instrumentation process, RC Prep (Premier, Pennsylvania, USA) was used as a lubricant and 5 ml of 3% sodium hypochlorite as an

irrigation solution per canal was prepared. Each rotary and reciprocating file was only used once to prepare one canal before being discarded. Each ss K-file was also only used once before being discarded. Canal preparation times were measured with a digital stopwatch and recorded in seconds. The preparation time included active instrumentation as well as the time required for changing instruments, cleaning the flutes of the instruments, and irrigation of the canal. The preparation time did not include glide path preparation.

Means and standard deviations (SDs) were determined for each group, and analysis of variance (ANOVA) was used to compare the mean preparation times for the three groups, with pairwise comparisons to detect between group differences. Median values of the three groups were compared using the non-parametric Kruskal–Wallis analysis of variance. The level of significance was set at  $P \leq 0.05$ .

## Results

The mean and SD values for the preparation times of the three different groups are presented in Table 1. The mean preparation time using ss K-files (186.4 s) was significantly longer than when using the ProTaper Gold SX files (29.6 s;  $P < 0.001$ ) and WaveOne Gold Medium files (30.5 s;  $P < 0.001$ ). The mean preparation time using the ProTaper Gold SX files (29.6 s) and the WaveOne Gold Medium files (30.5 s) did not differ significantly ( $P = 0.939$ ). The median values of the three preparation groups were also compared using the non-parametric Kruskal–Wallis analysis of variance, which was found to be significant ( $P < 0.001$ ).

## Discussion

This study compared preparation times using manual, rotary, and reciprocating files during pulpectomy treatment. Reducing the duration of treatment in children is important as anxiety is lessened.<sup>[5,17]</sup> According to Kuo *et al.*,<sup>[8]</sup> a successful pulpectomy procedure for primary teeth is characterised by appointments with a limited chair time and successful cleaning of the root canal system without damaging the underlying tooth germ or root structure, whilst maintaining the function until the tooth is naturally shed. Our findings support previous studies that report reduced preparation times using rotary or reciprocating files, in particular ProTaper Gold SX and WaveOne Gold Medium files.

Pulpectomy treatment aims to effectively clean, disinfect, and fill the root canal system.<sup>[17]</sup> Shaping and cleaning of canals is a complex, time-consuming component of the procedure. The “gold standard” of canal preparation has traditionally been manual preparation using ss K-files,<sup>[8,17]</sup> but this has proven to be more time-consuming, subsequently increasing anxiety and behaviour management problems in children.<sup>[5]</sup>

Several studies have compared the preparation times using manual and rotary files in primary teeth with all studies concluding that manual files take longer than rotary files.<sup>[5,6,8,12,17]</sup> In the current study, comparison was done by using manual, rotary, and reciprocating file systems. The authors observed that the preparation time when using manual ss K-files was significantly slower than when using the rotary ProTaper Gold SX or reciprocating WaveOne Gold Medium files. Katge *et al.*,<sup>[11]</sup> were the first to compare preparation times using manual, rotary, and reciprocating files in primary teeth. In their study, using reciprocating files took less time than both rotary and manual files,<sup>[11]</sup> which is in contrast to our findings that similar preparation times were observed using the rotary ProTaper Gold SX and reciprocating WaveOne Gold Medium files. These contrasting results could be explained by the fact that we used a single-file protocol, while Katge *et al.*,<sup>[11]</sup> used a two-file protocol (ProTaper Universal SX and S2). The authors used a single-file protocol for both the ProTaper Gold SX and WaveOne Gold Medium files, similar to that reported by Mhatre *et al.*,<sup>[12]</sup> suggesting that preparation time may be more influenced by the number of instruments used during a single procedure rather than the type of instrument. Our findings support the use of a single-file system (rotary or reciprocation) in primary teeth instead of multiple files or preparation using manual ss K-files. Further studies should be done to investigate the effect of these systems on remaining dentin thickness, obturation quality, and cleaning efficiency as the authors of this study only evaluated preparation times.

## Conclusion

Based on the results of this study, preparation times using both rotary and reciprocating files, specifically single-file systems, were significantly shorter than when using traditional manual instrumentation during pulpectomy treatment in primary molars. This may reduce the chair time for paediatric patients.

**Table 1: Preparation times during pulpectomy using three different preparation techniques**

Statistical measure	Preparation time (s)		
	K-file group	ProTaper Gold SX group	WaveOne Gold Medium group
<i>n</i>	20	20	20
Mean (SD)	186.4 <sup>a</sup> (62.0)	29.6 <sup>b</sup> (11.6)	30.5 <sup>b</sup> (10.5)
Median (IQR)	188 (135–245)	28 (22–32)	31 (25–34)
Minimum/Maximum	81/308	16/54	9/54

Mean values with the same superscript letters were not statistically different at  $P > 0.05$ . SD= Standard Deviation, IQR= Interquartile range

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## Conflicts of interest

There are no conflicts of interest.

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