



“COMPARISON OF INSTRUMENTATION TIME AND CLEANING EFFICACY OF MANUAL K-FILE, ROTARY PROTAPER UNIVERSAL AND ROTARY PROTAPER NEXT IN PRIMARY ANTERIOR TEETH: AN IN-VITRO STUDY”

## Dental Science

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## ABSTRACT

**Introduction:** Pulpectomy of primary teeth with severe pulpal involvement is one of the most important concerns in Pediatric Dentistry. Root canal instrumentation is performed with files, reamers, sonic instruments and recently with rotary instruments. Although manual instrumentation is widely used in primary teeth, but they have limitations. The development of nickel titanium alloys and the possibility of changing the traditional design and taper have allowed use of rotary instruments in endodontic treatment. A new generation of NiTi rotary files has been introduced as the Protaper Next.

**Aim :** The present study aimed to compare the instrumentation time and cleaning efficacy of Protaper Next with rotary Protaper Universal system and manual K file in pediatric endodontics.

**Materials and Methods:** An *in-vitro* experimental study was conducted by injecting Indian ink in a total sample of 60 human single rooted primary anterior teeth. The teeth were randomly divided into three experimental groups, including K-file, ProTaper Universal, Protaper Next and one control group. The root canals were prepared using one of the three file system followed by clearing the teeth with different demineralising solutions. A chronometer was used to calculate the instrumentation time in each root canal and scores were analysed by a stereomicroscope. Data analyses were performed using version 21.0 of Statistical Package for Social Sciences.

**Results:** In the coronal third of root canals cleaning efficacy of K Files and ProTaper Next showed almost similar score. In the middle third of root canals cleaning efficacy scores in two file systems were significantly lower than K files. In the apical third ProTaper Next showed better cleaning efficacy compared to K files and ProTaper Universal Files systems. Difference between the different groups was statistically significant  $P=0.000(<0.001)$ .

**Conclusion:** This study showed that the use of Ni-Ti rotary instruments in the pulpectomy of primary anterior teeth represents a promising technique in pediatric patients, thus instrumentation is feasible, offering time-saving advantages in root canal preparation.

## KEYWORDS

Ni-Ti, Protaper Next, Protaper Universal, Pulpectomy, Rotary Endodontics

## Introduction

One of the most important concerns in paediatric dentistry is the early loss of primary teeth leading to space loss. Hence pulpectomy of primary teeth with severe pulpal involvement should be considered as a treatment of choice.<sup>1</sup> Pulpectomy technique should be fast and simple of short duration with minimal number of appointments including the effective debridement of the root canals without weakening the tooth structure or endangering the underlying permanent teeth, avoiding procedural complications and most importantly restoring the tooth to maintain function.<sup>2</sup>

Root canal instrumentation is performed with conventional instruments and recently with rotary system. Although manual instrumentation is widely used in primary teeth, with limitations regarding effective cleaning of root canals, possible ledge formation, perforations, dentine compaction and instrument fracture.<sup>3</sup>

The use of Nickel titanium (NiTi) rotary files in primary teeth was first described by Barr *et al* (2000).<sup>4</sup> The development of NiTi alloys and the possibility of changing the traditional design and taper have allowed use of rotary instruments in endodontic treatment. Advantages of rotary instruments in pediatric patients includes, there rotation on own axes in root canal thus avoiding damage to original anatomy, no precurving required due to elastic memory, quicker as operated by an endomotor, avoidance of root canal deformation due to its elastic memory and radial land that maintains the file in root canal center, thus favouring the patient's cooperation by shortening the treatment time for cleaning canals.<sup>5,6,7</sup>

The literature on rotary root canal preparation techniques is limited and there are not many studies available for use in primary teeth. The comparison between the various rotary endodontic systems is limited in primary teeth. The most common rotary system used in pedodontics

is Protaper Universal system and no study have been advocated till now regarding the use of Protaper Next (PTN) rotary system in pediatric dentistry. Hence this study was carried out to compare the instrumentation time and cleaning efficacy of Protaper Next with rotary Protaper Universal system and manual K file in pediatric endodontics.

## Materials and Methods

The present *in-vitro* study was carried out in the Department of Paedodontics and Preventive Dentistry, Hitkarini Dental College and Hospital, Jabalpur (M.P), in collaboration with Department of Biotechnology, Nanaji Deshmukh University of Veterinary Science, Jabalpur, Madhya Pradesh with the objectives to assess instrumentation time and compare the cleaning efficacy of manual K-file, rotary ProTaper Universal, and ProTaper Next in the cleaning of root canals in primary anterior teeth. Ethical approval was obtained from the ethical committee of Hitkarini Dental College and Hospital, Jabalpur, India.

60 extracted human deciduous single rooted teeth with two-thirds of intact root with or without moderate root angulation were selected. The teeth with pathological root resorption, perforation in furcation area, severe root angulation and with root length less than two third were excluded from the study.

Freshly extracted teeth were washed under running water to remove all the soft tissue from root surface. Teeth were subjected to ultrasonic scaling to remove stains and calculus. Disinfection of teeth were performed by immersion in 3% sodium hypochlorite for 1 week for and then stored in distilled water till they were ready for study.

The coronal access was achieved with BR 031 diamond round bur (Mani, Japan) at high speed, under cooling with distilled water. The

pulp chamber and root canals were irrigated profusely with 3% sodium hypochlorite to remove the debris. A #10-sized K-file was introduced in to each root canal to determine the patency of the root canal. Working length determination was done by introducing #10 K file into the root canal, the tip of the file was visualized using magnifying glass. The final working length was established 1 mm short of this recorded length. All specimens were rinsed with saline. The root canals were then filled with India ink using a 30 gauge needle syringe. The ink was then reapplied at least three to four times into the root canals. The teeth were left in wet conditions at room temperature for 48 hours.

All prepared sample were randomly divided into four groups, three experimental groups and one control group. All root canals were prepared by one operator.

**Group I (n=15):** A total sample of 15 were instrumented manually with K-files (Dentsply Maillefer, Ballaigues, Switzerland) with the step-back technique with file up to size 30. After each instrumentation each root canal was irrigated with 5 ml of 1.0% sodium hypochlorite solution.

**Group II (n=15):** A total sample of 15 were instrumented with ProTaper Universal System (Dentsply Maillefer, Ballaigues, Switzerland) in a crown-down technique with two instruments in the following sequence, initially SX was inserted into the canal to about 3 mm beyond the root canal orifice and finally S2 file was inserted till the working length. Each root canal was irrigated with 5 ml of 1.0% sodium hypochlorite solution.

**Group III (n=15):** A total sample of 15 were prepared using ProTaper Next System (Dentsply Maillefer, Ballaigues, Switzerland) using the crown-down technique. Initially X1 file was inserted upto 3 mm beyond the apex and finally X2 file was use up to the working length of each root canals followed by irrigation with 5 ml of 1.0% sodium hypochlorite solution after each instrumentation.

**Group IV (n=15):** A total sample of 15 were used as a control group in which no instrumentation and no irrigation were performed.

The instrumentation time in each root canal was measured by a chronometer. All teeth were flushed with 5 ml normal saline and dried with absorbent paper points. The pulp chamber was then restored with temporary cement (TMP-RS, Prime Dental Product Pvt Ltd) and apical ends were sealed with sticky wax. The instrumented teeth were stored in wet condition.

All samples were then placed separately in 7% Hydrochloric acid (Qualigens fine chemicals, Navi Mumbai) and the acid solutions were changed daily until the teeth were completely decalcified.

After decalcification, all samples were washed under running water till the acid completely got washed away from tooth surface followed by dehydration of teeth was done in a series of ethyl alcohol concentrations (Changshu Yangyuan Chemicals, China). Dehydration was started with 70% alcohol for 16 hours (change after eight hours) followed by 80% alcohol for eight hours, 95% alcohol for eight hours and 100% alcohol for 8 hours.

After decalcification and dehydration, all teeth were kept in methyl salicylate (Qualigens fine chemicals, Navi Mumbai), till they got transparent in appearance. It took nearly 2 to 3 hours for teeth to get completely cleared. Then all the samples remained in the methyl salicylate solution till analysis.

After clearing method all samples were examined under a stereomicroscope (SMZ-45 series, Nikon Company, USA) at 10X magnification and each root canal was inspected carefully for the removal of India ink from the coronal, middle and apical thirds. The removal of the dye was analyzed from all the walls of the root canal. The scoring was done by an independent blinded examiner. They were scored according to the amount of India ink remaining in the coronal, middle and apical thirds of the canal on a scale of 0-3.<sup>3,5</sup>

- Score 0** - Total clearing (No ink remaining in any part of root canal).
- Score 1** - Almost complete ink removal (Traces of ink found in some areas).
- Score 2** - Partial ink removal (Ink found on some walls in some areas).
- Score 3** - No ink removal (Appreciable amount of ink present).

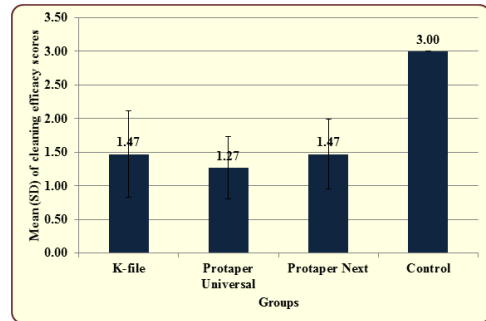
The obtained scores were tabulated and statistical analysis was done

using version 21.0 of Statistical Package for Social Sciences (IBM Corporation, Armonk, New York, USA). One Way ANOVA and Kruskal Wallis test. Mann Whitney U test were applied.

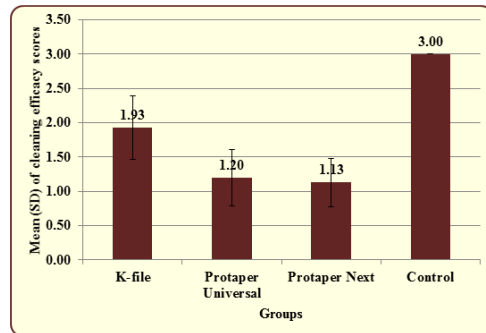
**Results**

In the coronal third of root canals cleaning efficacy of K Files and ProTaper Next showed almost similar scores (Graph 1). In the middle third of root canals cleaning efficacy scores in two file systems were significantly lower than K files. Difference between the different groups was statistically significant  $P=0.000(<.001)$ . The pair wise comparison showed that there was no significant difference between ProTaper Universal and ProTaper Next for cleaning efficacy scores (Graph 2). In the apical third ProTaper Next showed better cleaning efficacy compared to K files and ProTaper Universal Files systems. Difference found between the different groups was statistically significant  $P=0.000(<.001)$ . However the pair wise comparison showed no difference between K File and ProTaper Universal for cleaning efficacy scores. (Graph 3) The overall cleaning efficacy score suggested that cleaning efficacy of ProTaper Next was better than ProTaper Universal and K files. (Graph 4)

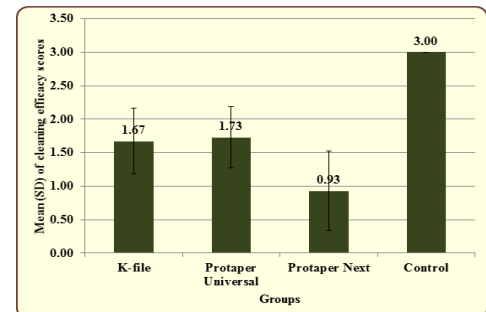
K File Group (Group I) showed highest instrumentation time among all experimental groups while ProTaper Universal (Group II) and ProTaper Next (Group II) showed almost similar instrumentation time. Statistically significant difference was observed between experimental groups  $P=0.000(<.001)$ . However the pair wise comparison with Mann-Whitney U test showed no difference between ProTaper Universal and ProTaper Next for instrumentation time. (Graph 5)



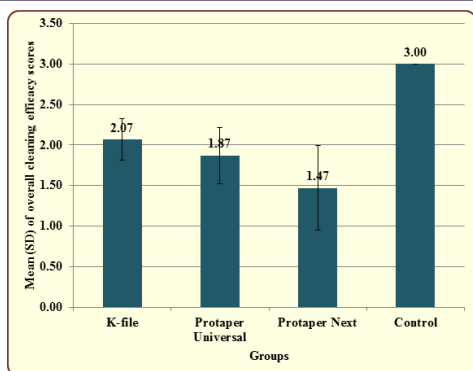
**Graph 1:** Comparison of cleaning efficacy in different experimental groups in coronal third



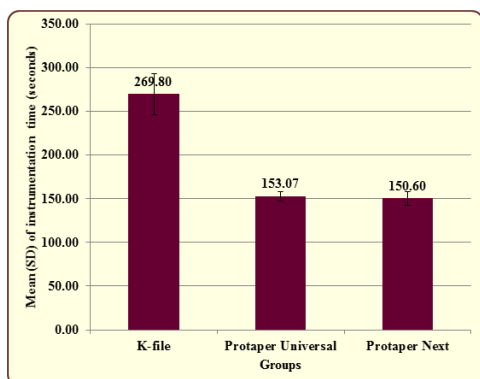
**Graph 2:** Comparison of cleaning efficacy in different experimental groups in middle third



**Graph 3:** Comparison of cleaning efficacy in different experimental groups in apical third



**Graph 4:** Comparison of overall cleaning efficacy in different experimental groups



**Graph 5:** Comparison of instrumentation time in different experimental groups

## Discussion

The pulpectomy procedure for restorable primary teeth is the preferred treatment for infected pulpal tissue in single rooted teeth and in molars with signs of furcal radicular involvement. Conventional endodontic technique for primary teeth remains manual instrumentation which is time consuming and often causes fatigue to the operator and child.<sup>8</sup>

In the present study comparison was made between the stainless steel K-file, rotary ProTaper Universal and rotary ProTaper Next regarding their cleaning efficacy and instrumentation time in deciduous teeth. The SS K-file was chosen as these files are traditionally used for cleaning and shaping of root canal in primary teeth. The second file system was ProTaper Universal system as it is widely used nowadays for biomechanical preparation of primary teeth. The ProTaper Next is the successor of the ProTaper Universal system and till date no study was performed regarding cleaning efficacy of ProTaper Next in primary teeth, so this study compared the cleaning efficacy of PTN with ProTaper Universal system and K-file in primary root canals.

Previous studies compared different rotary systems other than the ProTaper Universal and ProTaper Next systems. Different approaches have been used to evaluate the cleaning ability of instruments, in many studies debris removal was the focus of studies,<sup>3,5,9</sup> and other used scanning electron microscopy to examine smear layer removal.<sup>10,11</sup>

Present study showed significant differences in the cleaning efficacy between manual and rotary techniques ( $P > 0.00$ ). The Rotary instruments showed better cleaning efficacy than Manual K-File. In agreement with present study, Katge *et al*<sup>12</sup> concluded from their study on primary molar pulpectomy that the reciprocating system (Wave One) and the rotary system (Pro Taper) showed better cleaning efficiency compared to manual instrumentation especially in the coronal and middle one third of root canals. Guelzow *et al*<sup>13</sup> compared various parameters of root canal preparation using a manual technique and six different rotary Ni-Ti instruments in primary teeth and concluded that all Ni-Ti systems maintained the canal curvature and were more rapid than a standardized manual technique. Makareme *et al*<sup>14</sup> conducted a randomized controlled clinical trial by performing pulpectomy of primary second molar teeth. They achieved

superior radiographic findings and less chair time with Flex-Master system. Musale *et al*<sup>15</sup> evaluated the efficacy of rotary PROFILE, ProTaper, Hero Shaper, and K file in shaping ability, cleaning efficacy, preparation time and instrument distortion in primary molars and concluded that rotary files prepared more conical canals in primary teeth than manual instruments.

In contrast to present study, several studies showed no difference between rotary and manual root canal file systems. Bahrololoomi *et al*<sup>16</sup> evaluated and compared the cleaning ability and instrumentation time of manual and rotary methods used for preparation of primary anterior teeth and found no significant difference in cleaning capacity between the two techniques. Silva *et al*<sup>17</sup> and Schäfer and Zapke<sup>18</sup> reported that the manual and rotary instruments yielded similar degree of cleanliness. According to Ramezani *et al*<sup>19</sup> the cleaning efficacy of rotary instruments was same as hand K files in apical, middle and cervical thirds of primary molar root canals. Reza *et al*<sup>20</sup> found, Manual K-files and the Mtwo and ProTaper rotary systems showed equally acceptable cleaning ability in primary molar root canals.

Some studies noted the benefits of hand instrumentation over rotary files with regard to root canal wall preparation.<sup>20,21</sup> Kiumarsal *et al*<sup>22</sup> found superior cleaning efficacy of K file in coronal third of root canals compared to Flex Master rotary system in primary molars.

In all three experimental groups, cleaning capacity was apparently better in the coronal and middle thirds of the canal than in the apical third. Foschetti *et al*<sup>23</sup>, also reported that none of the manual or rotary systems could clean the apical part of root canals completely. In present study PTN showed better cleaning efficacy than ProTaper Universal and K file in apical third of root canals, because of unique new swagging motion property of PTN system.<sup>24</sup> The apical taper of PTN X2 file is .06 and apical taper of ProTaper Universal S2 file is .04 which may be the reason of superior cleaning efficacy of PTN in apical third of root canal.<sup>6</sup>

In the present study, instrumentation time was significantly lesser with rotary systems as compared to manual K file as the rotary files are lesser in number and are engine driven with higher cutting efficiency. Preparing a canal with PTN requires the use of two files, i.e. X1 and X2 similarly in ProTaper universal group only SX and S2 files are used, therefore the working time is lesser as compared to many other multiple rotary file system and manual K file.<sup>25</sup> Mechanical preparation of primary teeth utilizing Ni-Ti rotary files was first done by Barr *et al*<sup>7</sup> (2000) concluding that the use of Ni-Ti rotary files for root canal preparation in primary teeth was cost effective, faster, and resulted in consistently uniform and predictable fillings. Silva *et al*<sup>17</sup> reported that Ni-Ti rotary preparation for extracted teeth was faster than hand preparation. Shashikiran *et al*<sup>26</sup> also compared the Ni-Ti rotary PROFILE and K files hand instrumentation on root canal preparation of primary and permanent molars for their efficacy in preparation time, instrumentation failure, and shaping the canals and concluded that PROFILE 0.04 taper 29 series prepared canal rapidly than conventional K files.

## CONCLUSION

Our study substantiated that the use of rotary instruments in the pulpectomy of primary anterior teeth represents a promising technique being advantageous for the pediatric patients with significantly reduced chair time. The positive results of our study emphasize the need for further clinical in vivo investigation. Such studies should be randomized, blinded clinical assays, so that the clinical and radiographic effects of rotary instrumentation used in pulpectomies of primary anterior teeth can be compared and they should have adequate follow-up.

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