

# A Comparative Evaluation Of Dentinal Microcracks Formation Using Three Different Pediatric Rotary Filing System In Root Canal Treatment Of Primary Teeth: An In- Vitro Study

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## Abstract:

**Background:** The main objective of chemomechanical root canal preparation includes the preservation of the original canal anatomy and cleaning of the entire root canal system. This study was aimed to evaluate and compare the dentinal microcracks formation by comparing three pediatric rotary filing systems.

**Materials and Methods:** Forty extracted human primary molar teeth with atleast two-third of the root length were selected for the study. Teeth were decoronated using Diamond Disc under cooling water, mounted in acrylic resin block and randomly divided into four groups of ten each with Group I – Hand H file, Group II – NT Pedo Gold file, Group III – ProTaper Gold and Group IV – Kedo SG Blue. Root canal preparation for each group, were carried out according to manufacturer's instructions. After preparation, roots were sectioned horizontally at 2, 4, and 6 mm from the apex with the aid of a low speed handpiece under water coolant using a diamond disc and evaluated under stereomicroscope at 20x magnification. The data was analysed by SPSS (21.0 version)

**Results:** No significant difference was seen in the incidence of microcrack formation at apical, middle and coronal third when Group II, Group III and Group IV files were used.

**Conclusion:** Kedo SG blue showed a minimal incidence of microcracks formation compared NT Pedo Gold and ProTaper Gold file systems.

**Key Word:** Dentinal microcracks, Pediatric, Rotary files.

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## I. Introduction

The main objective of chemomechanical root canal preparation includes the preservation of the original canal anatomy and cleaning of the entire root canal system. Advancement in the rotary nickel titanium instruments have provided better cleaning and shaping with minimal dentinal defects. A dentinal defect such as microcrack is a major concern regarding the prognosis of root canal treated tooth. One of the most common complications associated with mechanical preparation of root canal is vertical root fractures (VRF) leading to tooth loss.<sup>1,2</sup>

Various NiTi rotary systems with a modified technique have found its use in Pediatric Dentistry. The rotary technique of instrumentation is known to minimize the debris extrusion and also facilitates obturation.<sup>3</sup>

Considering the morphological differences in primary teeth, each of the rotary systems used in our study has unique file designs with constant or variable inclinations which prepare the root canal in harmony with the root anatomy.

**NT Pedo Gold File** (Nineten, Made in Europe) which combines American NiTi wire and European Precision Milling Technology, enhances cutting efficiency, cyclic fatigue resistance, and anti-screwing effect. The NT Pedo Gold Files shows a convex rectangular cross section with a uniform taper design. A package of three 18mm long files with 15/.06, 20/.04 and 25/.04 tip sizes. Use 'in and out' motion with the file instead of brushing motion at 300 RPM and 1.5–2.0 NCm of torque.<sup>4</sup>

**Protaper Gold file** (Dentsply Maillefer, Ballaigues, Switzerland) NiTi rotary system was developed with proprietary advanced metallurgy. ProTaper Gold files exhibit a convex triangular cross-section and has a progressively tapered design to improve the cutting efficiency and safety. The PTG instruments include three shaping (Sx, S1 and S2) and five finishing (F1, F2, F3, F4 and F5) files.<sup>5</sup>

The design of Kedo files system (Reeganz dental care Pvt. Ltd. India) is done to be compatible for preparation of root canal in primary teeth. **Kedo SG Blue** (controlled memory file) comprises of three Ni-Ti rotary files with a triangular cross section and a non-cutting tip. The file's length is 16 mm. The working length of the files is 12 mm. The files are called as D1, E1, U1 sequentially corresponding to their use; D1 file: has a tip diameter of 0.25 mm with a changeable taper. It is capable of being utilized in primary molars with narrow canals (disto-buccal canal in maxillary molars and mesial canals in mandibular molars), E1 file: possesses a 0.30 mm tip diameter and can be utilized in broader molar canals (palatal canal in maxillary molars and distal canal in mandibular molars), and U1 file: possesses a 0.40 mm tip diameter and utilized in primary incisor teeth.<sup>6</sup>

To the best of our knowledge, no investigation has been carried out to determine the occurrence of dentinal microcracks generated by the NT Pedo Gold file system.

Consequently, the current study was undertaken to compare the production of dentinal microcracks using the NT Pedo Gold, Protaper Gold, and Kedo SG blue rotary filing systems.

## **II. Material And Methods**

Forty extracted human primary teeth with atleast two-third of the root length were collected from Department of Pediatric and Preventive Dentistry, Darshan Dental College and Hospital, Udaipur.

### **Inclusion criteria and Exclusion criteria:**

Extracted human primary teeth due to extensive coronal caries, loss of bone support, non-restorable crowns, over-retained teeth with atleast two-third of the root length were included in the study. Fractured teeth, Endodontically treated tooth, Root caries, Cracks and dental anomalies were excluded from the study.

### **Procedure methodology**

Teeth were cleaned with an ultrasonic scaler, then stored in distilled water to prevent dehydration throughout the study. External surfaces of the roots were screened for pre-existing cracks under stereomicroscope. Teeth were decoronated using Diamond Disc under cooling water. ISO hand 10 no. K-file was used to assess the working length by introducing it into the root canal up to the point until it became visible at the apex and then subtracting 1mm from the total length.

A single layer of aluminium foil was applied on the outer surface of the roots and was mounted in acrylic resin block. Roots were removed from acrylic resin block along with aluminium foil. Silicone impression material was applied on the outer surface of the roots to replace the space created by aluminium foil and was remounted in acrylic resin block.

### **The samples were randomly distributed into four groups 10 samples in each group.**

- **Group I** : Hand H- file.
- **Group II** : NT Pedo Gold File.
- **Group III** : Protaper Gold File.
- **Group IV** : Kedo File.

Root canal preparation for each group, were carried out according to manufacturer's instructions and canals were flushed using sodium hypochlorite solution in between each filing and final flush was done with EDTA and normal saline solution.

**Group I:** Hand instrumentation was carried out using hand H-file (Dentsply Maillefer, OK, USA) up to no. 30 H-file in the apical third, and then step back technique was followed to prepare middle and coronal thirds of the canal using retraction motion.

**Group II:** Root canal preparation was carried out using NT Pedo Gold File (Nineten, Made in Europe). Initially, a glide path preparation was carried out upto working length using no. 15 K-file. NT Pedo Gold File files were then used in the following sequence: 15/06 NT file to further enhance the glidepath, 20/04 NT file was used for final preparation if canal was narrow and final canal preparation was done till 25/04 NT file if canal was wide. The preparation was carried at 300 RPM and 1.5-2.0 NCm torque with 'in and out' motion.

**Group III:** Root canal preparation was carried out using Protaper Gold File (Dentsply Maillefer, Ballaigues, Switzerland). Initially, a glide path preparation was carried out upto working length using no. 15 K-file. ProTaper Gold files were then used in the following sequence: S1 (18/.02) file was used to shape the root

canal's coronal third. The middle third was prepared with S2 (20/.04), and F1 (20/.07) was operated till the working length. The preparation was carried at 300 RPM and 2.0 NCm torque with brushing motion.

**Group IV:** Root canal preparation was carried out using Kedo File (Reeganz dental care Pvt. Ltd, India). Initially, a glide path preparation was carried out upto working length using no. 15 K-file. Kedo SG Blue files were then used in the following sequence: D1 file: used in primary molars with narrow canals, E1 file: used in broader molar canals. The preparation was carried at 250-300 RPM and 2.2-24 NCm torque with brushing motion.

After preparation, roots were removed from acrylic blocks and were sectioned horizontally at 2, 4, and 6 mm from the apex with the aid of a low speed handpiece under water coolant using a diamond disc.

The sectioned specimens were then analysed under stereomicroscope at 20X magnification and were classified in: Presence of cracks and Absence of cracks

**Statistical analysis**

Data was entered into Microsoft Excel spreadsheet and was checked for any discrepancies. Summarized data was presented using Tables. The data was analysed by SPSS (21.0 version). Shapiro Wilk test was used to check which all variables were following normal distribution. For finding the association between categorical variable, Chi square test was used. Level of statistical significance was set at p-value less than 0.05

**III. Result**

Table and graph no.1 showed no significant difference was seen in the incidence of microcracks formation among four study groups at coronal third.

**Table no 1: Incidence of microcracks formation on dentin at coronal third**

	No cracks		Cracks		Total	%
	N	%	N	%	N	%
Group I	7	70	3	30	10	100
Group II	5	50	5	50	10	100
Group III	3	30	7	70	10	100
Group IV	6	60	4	40	10	100
P value	0.320, ns					

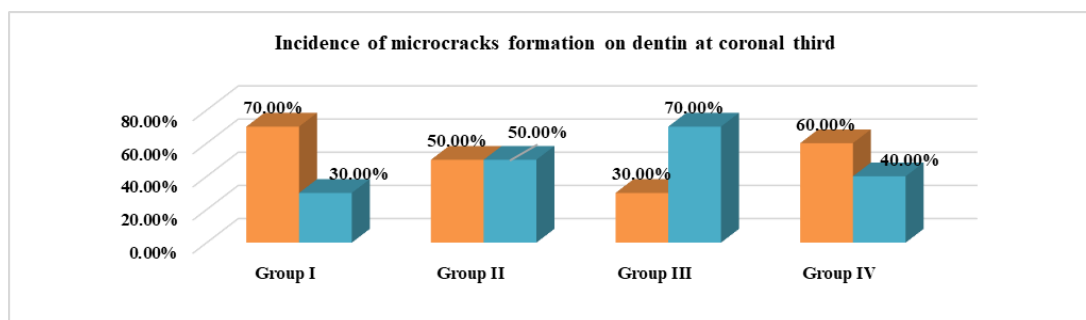


Table and graph no.2 showed significant difference in the incidence of microcracks formation among four study groups at middle third. Incidence of microcracks was found to be significantly more in Group 3 files as compared to Group I, II and IV files.

**Table no 2: Incidence of microcracks formation on dentin at middle third.**

	No cracks		Cracks		Total	%
	N	%	N	%	N	%
Group I	8	80	2	20	10	100
Group II	8	80	2	20	10	100
Group III	4	40	6	60	10	100
Group IV	10	100	0	0	10	100
P value	0.017*					

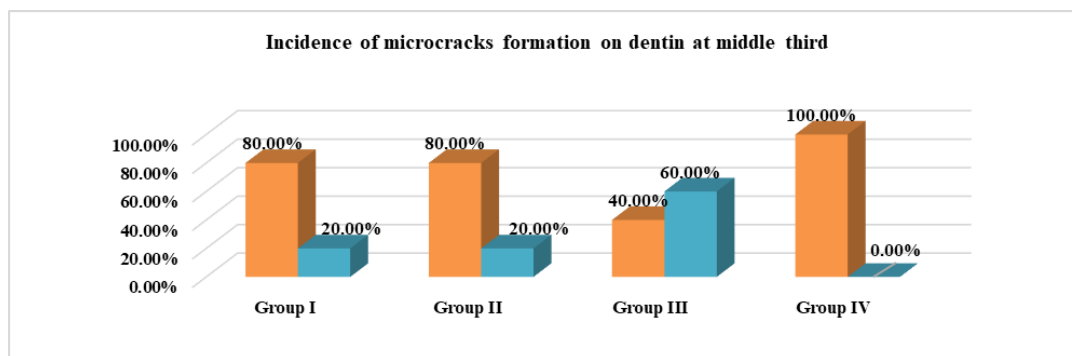


Table and graph no. 3 showed no significant difference was seen in the incidence of microcracks formation among four study groups at apical third.

**Table no 3:** Incidence of microcracks formation on dentin at apical third

	No cracks		Cracks		Total	
	N	%	N	%	N	%
Group I	8	80	2	20	10	100
Group II	7	70	3	30	10	100
Group III	3	30	7	70	10	100
Group IV	8	80	2	20	10	100
P value	0.017*					

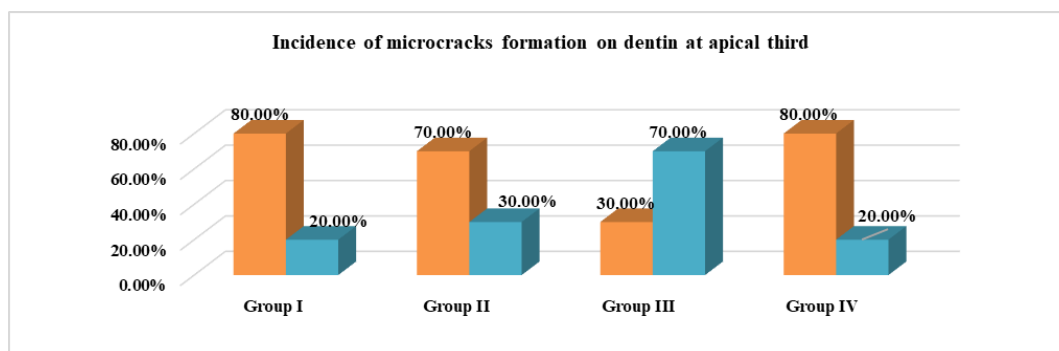
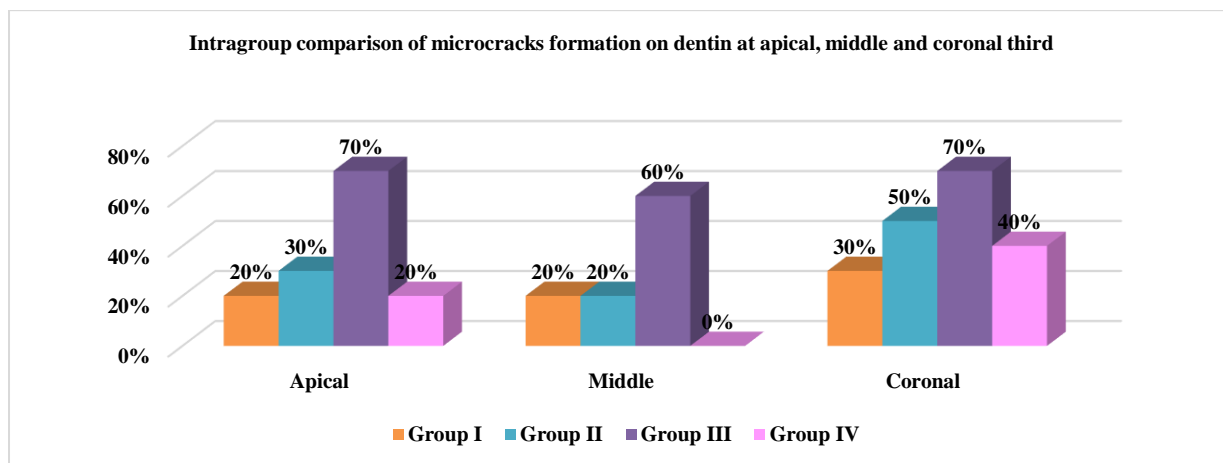


Table and graph no. 4 showed no significant difference was seen in the incidence of microcrack formation at apical, middle and coronal third when Group I, Group III, and Group IV files were used. But significant difference in incidence was seen with Group II files i.e incidence of microcrack formation was found to be significantly more at coronal third as compared to middle and apical third as  $p < 0.05$

**Table no 4:** Intragroup comparison of microcracks formation on dentin at apical, middle and coronal third

	Apical	Middle	Coronal	P value
Group I	2 (20%) <sup>a</sup>	2 (20%) <sup>a</sup>	3 (30%) <sup>a</sup>	0.128, NS
Group II	3 (30%) <sup>a</sup>	2 (20%) <sup>a</sup>	5 (50%) <sup>b</sup>	0.001*
Group III	7 (70%) <sup>a</sup>	6 (60%) <sup>a</sup>	7 (70%) <sup>a</sup>	0.778, NS
Group IV	2 (20%) <sup>b</sup>	0 (0%) <sup>a</sup>	4 (40%) <sup>b</sup>	0.001, NS

Same alphabets – Non significant, NS  
Different alphabets-significant, \*



#### IV. Discussion

The key goals of root canal therapy are to remove necrosed and inflamed pulp tissue from the radicular area, form the dentinal walls to allow for irrigation and fill them with an inert substance, protect the root canal system's structure, and maintain healthy dentin for a long time of time.

Root canal preparation with rotary files creates a variable degree of rotational force on the walls, resulting in microcracks or craze lines formation. Further progression of dentinal defects may lead to vertical root fracture, which usually requires tooth extraction. (Tsesis et al., 2010b).<sup>11</sup>

Chemomechanical preparations of primary teeth are not the same as permanent teeth because of differences in their morphology. Primary molar roots are more curved and divergent, facilitating the healthy development of succedaneous teeth. Either the coronal third of the canal or the apical third of the root are more likely to perforate into the furcation due to these curvatures. Furthermore, excessive canal enlargement can weaken the tooth's structure and reduce dentinal thickness.<sup>2</sup>

In the present investigation, complying with the guidelines for performing pulpectomy procedures on primary molars, human primary molars with at least two-thirds of their roots intact was included.

By using rotary files during root canal preparation can create microcracks or craze lines by applying varying amounts of rotational force to the walls. The severity of these flaws is dependent on a number of precipitating factors, including the instrument's flute form, cross-sectional geometry, tip shape, progressive or constant taper, and variable or constant pitch, and other factors (Yoldas O et al., 2012).<sup>19</sup>

In the present study, Group I (Hand H - file) exhibited the lowest incidence of microcracks (30%) followed by Group IV (Kedo SG Blue) showed 40%, Group II (NT Pedo Gold) showed 50% and Group III (ProTaper Gold) showed the maximum incidence of microcracks formation (70%) in coronal third root section. This might be because there is no continuous rotation action with consistent speed and torque. Panda et al. (2021)<sup>2</sup> and M Ali et al (2020)<sup>21</sup> suggested that fixed small tapers (2%) of manual files could lead to a minimum amount of dentin removed from the root canal wall, therefore minimum chances of dentinal defects.

A different protocol for chemomechanical preparation using Group III (ProTaper Gold files) was employed in our study because of anatomical differences between primary and permanent teeth, such as the former having less dentinal thickness and density than the latter.<sup>15</sup>

In our study, Group III (ProTaper Gold) showed maximum number of microcracks (60%) followed by Group I (Hand H - file), II (NT Pedo Gold) showed 20% and Group IV (Kedo SG Blue) which showed least number of microcracks (0 %) in the middle third root section. This might be the result of the root's apical third canals experiencing the highest amount of stress during rotary file cleaning and shaping.

NT Pedo Gold file has a convex rectangular cross section, whereas Protaper Gold file has a convex triangular cross section which makes three point contacts with the root canal dentinal wall while rotating in the canal during biomechanical preparation, transmitting more tensile stresses to the dentinal wall. Protaper Gold exhibits more dentinal microcrack formation compared to NT Pedo Gold and Kedo SG Blue files.

M Ali et al (2020)<sup>21</sup> suggested that ProTaper Gold has no radial land which increase deviation of the file from the center of the root while rotating which in turn may exert more forces and stress on the dentin leading to microcracks formation. These microcracks may propagate into complete cracks or vertical root fracture after cyclic masticatory forces.

In the present study, Group III (ProTaper Gold) showed maximum number of microcracks (70%) followed by Group II (NT Pedo Gold) showed 30%, Group I (Hand H - file) and Group IV (Kedo SG Blue) showed lowest number of microcracks (20 %) in the apical third root section. This may be due to maximum stress in the apical third of the root canals during cleaning and shaping by rotary files.

Deopujari J et al. (2022)<sup>22</sup> and Tomer AK et al. (2019)<sup>23</sup> conducted the study comparing ProTaper Gold with Mani Silk and WaveOne Gold rotary files in permanent teeth they observed maximum number of defects with ProTaper Gold group since excessive dentin removal may result from uncontrolled pressure. Kim et al. (2010)<sup>24</sup> stated that during the shaping process, Stress on the root canals increased along with the taper of files.

On contrary, Nagy MM et al. (2021)<sup>25</sup>, Fra'ter M et al. (2020)<sup>26</sup> and Nishad SV et al. (2018)<sup>27</sup> conducted the study comparing ProTaper Gold with ProTaper Universal and ProTaper Next rotary files in permanent teeth. They observed that minimum number of defects with ProTaper Gold group, and it might be as a result of their two distinct transformation behavior and elevated temperature of austenite finish, which offer the file more flexibility.

In the present study, compared to other groups, roots instrumented with Group IV (Kedo SG Blue files) revealed a reduced micro-crack formation percentage. This could be clarified by looking at the cross-sectional layout differs and variable taper.

Although, further study on the paediatric rotary filing technique involving primary teeth is needed to substantiate the results.

## V. Conclusion

Thus, within the limitation of this study, it can be concluded that all file systems produce some amount of microcracks. Kedo SG Blue showed a minimal incidence of microcracks formation whereas ProTaper Gold showed the maximum incidence of microcracks formation after root canal preparation in primary molars.

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