

Evaluation of the Efficiency to Remove the Infected Dentin via *Enterococcus faecalis* Bacterial Count and to Adequately Shape the Canal Using Hand Kedo-SH Files, Rotary Kedo-SG (Blue) and Pro AF Baby Gold Files in Primary Molars: An *In Vitro* Study

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ABSTRACT

Background: Premature loss of primary teeth results in space loss, thus affecting the integrity of the oral tissues. According to the American Academy of Pediatric Dentistry, the treatment for a carious primary molar with pulpal involvement is pulpectomy. The success of this procedure depends on the elimination of bacteria, the most common being *Enterococcus faecalis* (*E. faecalis*), by cleaning and shaping the root canals with rotary or hand instrumentation.

Aims and objectives: Evaluating and comparing the cleaning efficacy and obturation quality using Kedo-SH hand files and rotary Kedo-SG (blue) and Pro AF Baby Gold files in primary molar teeth.

Materials and methods: A total of 51 extracted primary molar teeth were selected and divided into three equal groups. Group I, the control group, was instrumented with Kedo-SH hand files. Groups II and III were instrumented with Kedo-SG (blue) and Pro AF Baby Gold files, respectively. Baseline data and postinstrumentation data were sent for microbiological analysis to check microbial levels of bacteria *E. faecalis*. Obturation quality was then scored using Barrieshi-Nusair criteria and the T-scoring system by Robia.

Results: Associating obturating length between each group, maximum samples in group I showed adequate fill. Relating to density, maximum samples in group III showed no voids present in the obturation. Distribution of the T-scoring system shows maximum samples in group III having all three qualities of ideal obturation. On comparing microbiological analysis among the groups, group I showed higher colony counts of *E. faecalis* compared to groups II and III.

Conclusion: In the present study, rotary instrumentation in the canals showed more consistent results than hand instrumentation. Among the rotary files, Pro AF Baby Gold files show a greater reduction in *E. faecalis*, with a good obturation quality. Thus, the use of nickel-titanium (Ni-Ti) files is a good option for root canal instrumentation in primary teeth.

Keywords: Kedo-SG (blue) files, Kedo-SH hand files, Nickel-titanium files, Pediatric endodontics, Pro-AF Baby Gold files, Rotary endodontics.

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INTRODUCTION

A major worry in pediatric dentistry is premature loss of milk teeth.¹ Milk teeth in children play an important role in mastication, phonetics, and esthetics and also act in the maintenance of space for permanent dentition.² If there is a lack of sufficient space when the permanent tooth reaches the eruption schedule, it will erupt in a displaced position; or remain impacted and will cause orthodontic problems.³ Thus, preserving them in a healthy state in the oral cavity is of utmost importance. Microbial reduction by removal of vital tissue, decay, infected dentin, and debris is the top goal of endodontic treatment.^{4,5} Canal preparation by hand showed errors such as ledging, zipping, apical transportation, or blockage in some cases. Rotary file systems, on the contrary, efficiently create even tapered, predetermined conical shapes with minimum risk.⁶ While treating a pediatric patient, it is a challenge to manage the behavior or understand the fearful, anxious, and uncooperative child. The duration of treatment is a major factor in the child's cooperating during treatment of deciduous teeth. Time-efficient rotary instrumentation in milk teeth with nickel-titanium (Ni-Ti) alloys has been proven to be valuable in pediatric patients.⁶

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Biomechanical rotary preparation of milk teeth was first taken up by Barrieshi-Nusair et al., with ProFile 0.04 taper rotary instruments. Steadily uniform and foreseeable obturation was then noticed when Ni-Ti instruments were used for canal preparation in milk teeth. In maximum cases of endodontic treatment failure, *Enterococcus*

faecalis (*E. faecalis*) is an important cause, primarily due to bacterial resistance. Primary teeth show accessory foramina in the furcation area. This, coupled with ectopic root resorption, poses a problem in cleaning and shaping primary root canals.⁷ Thus, the present intends to assess the cleaning efficacy and obturation quality of hand and rotary file systems in primary molar teeth.

MATERIALS AND METHODS

The study was approved by the Institutional Review Board (IRB) of SDM College of Dental Sciences and Hospital, Karnataka, India. (IRB no. 2020/P/PEDO/36).

Inclusion Criteria

Extracted primary molar teeth with at least two-thirds of the root portion remaining.

Exclusion Criteria

- Internal resorption or more than two-thirds of external root resorption.
- Teeth that are nonrestorable or with furcation involvement.

Distribution of Samples

In study samples, 51 primary molar teeth were chosen and separated into three groups of 17 teeth each as follows:

- Group I ($n = 17$) (control group)—Kedo-SH hand files (Group I 1 to Group I 17).
- Group II ($n = 17$)—Kedo-SG (blue) rotary files (Group II 1 to Group II 17).

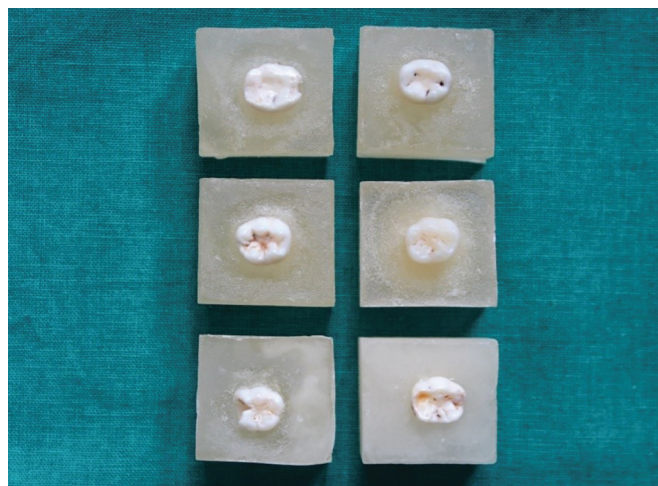


Fig. 1: Embedding of teeth in acrylic resin blocks

- Group III ($n = 17$)—Pro AF Baby Gold rotary files (Group III 1 to Group III 17).

A steady flow of running water was used to rinse the teeth. They were then immersed in 0.5% sodium hypochlorite for 7 days. Each tooth was implanted in an acrylic resin block up to the cemento-enamel junction in accordance with a study by Pinheiro et al., in 2012. (Fig. 1).⁷

The access cavity was prepared using an Ex 24C sterile safe-ended bur. All the teeth were autoclaved, and a solution containing *E. faecalis* (BHI broth) was inoculated in each tooth, and the teeth were incubated for a period of 2 weeks for formation of biofilm. For the test samples in group I, initial access to the canals, debridement, and shaping were achieved by the Kedo-SH hand files (Reegan Dental Care, India). For the group II test samples, access to the canals and shaping was achieved by the Kedo-SG (blue) rotary files (Reegan Dental Care, India), inserted on a rotary handpiece (NSK Global) used at 300 rpm and 2N torque and in autoreverse mode. For group III test samples, access to the canals and shaping was achieved by Pro AF Baby Gold rotary files (Dentalyze, India). Before beginning preparation and after complete preparation, the pre and post bio-mechanical preparation (BMP) samples, respectively, were collected and transferred to a sterile vial containing reduced transport fluid and were sent to the laboratory for microbiological analysis (Fig. 2). Any traces of moisture in the canal spaces were eliminated using sterile paper points and the root canal spaces were filled using Metapex (Meta Biomed, Korea) (Fig. 3). The coronal space was restored using type IX glass ionomer cement (GIC) (GC Fuji II, Japan). Obturation quality was checked using Barrieshi-Nusair et al., criteria⁸ and on the basis of these criteria, a T-scoring system by Robia et al.,⁹ was used, and the scoring was given as follows (Table 1).

T-scoring System

Score 3: Obturated canals have all three qualities of ideal obturation.

- Adequately filled (within 2 mm from the radiographic apex).
- Smooth coronal apical taper.
- No voids.

Score 2: Obturated canals have any two qualities of ideal obturation.

Score 1: Obturated canals have any one quality of ideal obturation.

Score 0: Obturated canals have no quality of ideal obturation.

Data Analysis

The results obtained were statistically analyzed using standardized tests:

- Kruskal–Wallis test was applied to check the statistical variance of colony-forming unit (CFU) among the groups.
- *Post hoc* Mann–Whitney test for pair-wise comparison.

Table 1: Scoring system by Barrieshi-Nusair

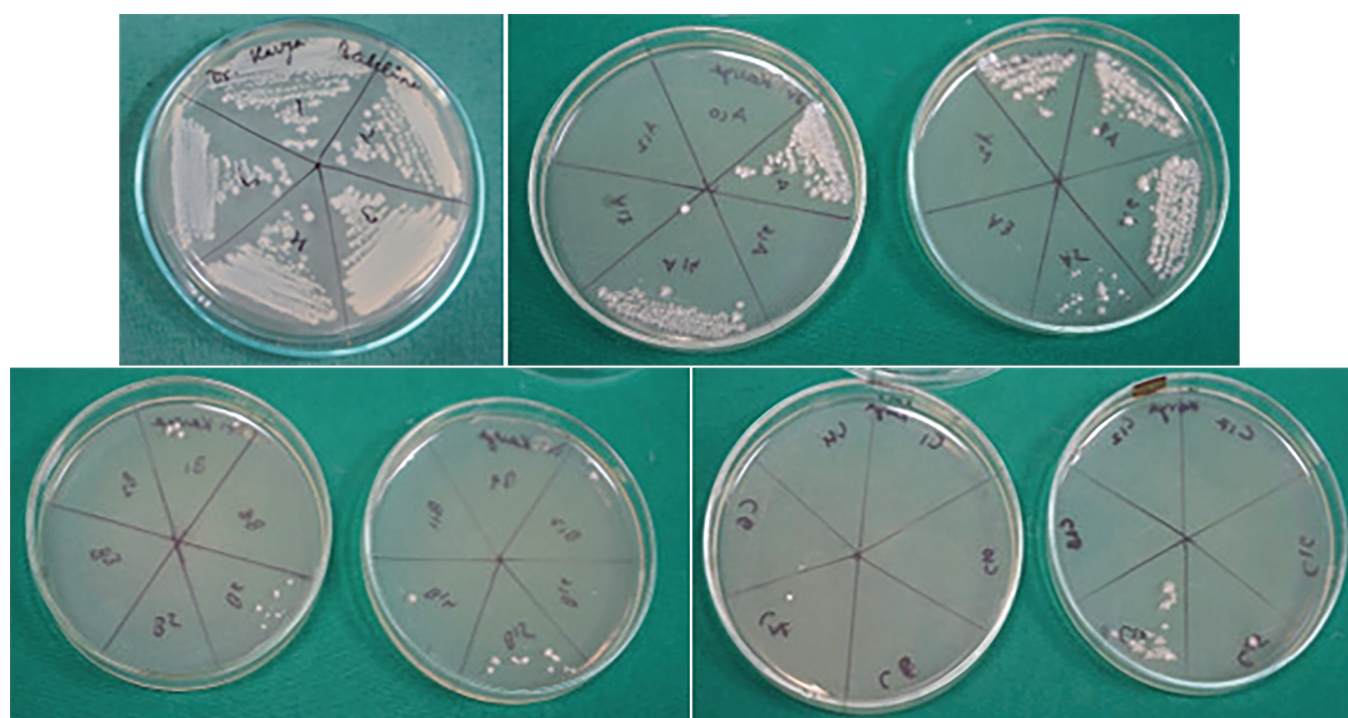
Criteria	Score	Description
Length of root filling	A	Adequate
	B	Overfilling
	C	Short filling
	D	Flush
Density of root filling	A	Adequate
	B	Inadequate
Taper of root filling	A	Adequate
	B	Inadequate

Table 2: Comparison between three different file systems for T-scoring using Kruskal–Wallis test

Group	N	Mean	Standard deviation	Percentiles			Chi-square	Degree of freedom	p-value
				25 th	50 th (median)	75 th			
Group I Kedo-SH hand files	17	1.65	1.06	1.00	1.00	3.00	3.37	2	0.18; NS
Group II Kedo-SG (blue) files	17	1.76	0.97	1.00	2.00	2.50			
Group III- Pro AF Baby Gold files	17	2.24	0.75	2.00	2.00	3.00			

Table 3: Intergroup comparison between three different file systems using *post hoc* Bonferroni test

Groups	Mean difference	p-value
Group I Kedo-SH hand files Group II Kedo-SG (blue) files	38.47	<0.01; significant
Group I Kedo-SH hand files Group III Pro AF Baby Gold files	40.29	<0.01; significant
Group II Kedo-SG (blue) files Group III Pro AF Baby Gold files	1.82	>0.05, not significant

**Fig. 2:** Culture plates—at baseline, groups I, II, and III

The level of significance was set at 5%. The statistical analysis was performed using Statistical Package for the Social Sciences (SPSS) version 20 [IBM SPSS statistics (IBM corp. Armonk, New York, United States of America released 2011)].

RESULTS

- Obturation quality (Table 2 and Figs 4 to 7). Comparison of the three file systems by Kruskal–Wallis test shows no significant difference (p -value—0.18) in T-scoring between the groups shown in (Table 2).
- Microbiological analysis.
Fig. 8—mean CFU when compared using analysis of variance, no statistically significant difference (p -value—0.6) in CFU was found between the three groups at baseline.
Fig. 9—on comparing the follow-up CFU scores between the three groups, the mean difference in CFU between the three

groups was found to be statistically significant (p -value < 0.01). The difference remained statistically significant even after adjusting for baseline differences by analysis of covariance (p -value < 0.01). Hence, *post hoc* comparisons were done using the Bonferroni test.

Table 3 and Fig. 10—significantly higher CFUs were seen in group I as compared to groups II and III.

Table 4—When compared by *t*-test, the reduction in CFU was statistically significant (p -value < 0.01) in group I. Similarly for group II, the difference was significant (p -value < 0.01). For group III too, the result was found to be statistically significant (p -value < 0.01).

DISCUSSION

In the present study, each of the teeth was rinsed in running water and immersed in 0.5% sodium hypochlorite for 7 days, similar to a study by Musale et al., in 2014.⁶ The embedding of the teeth in

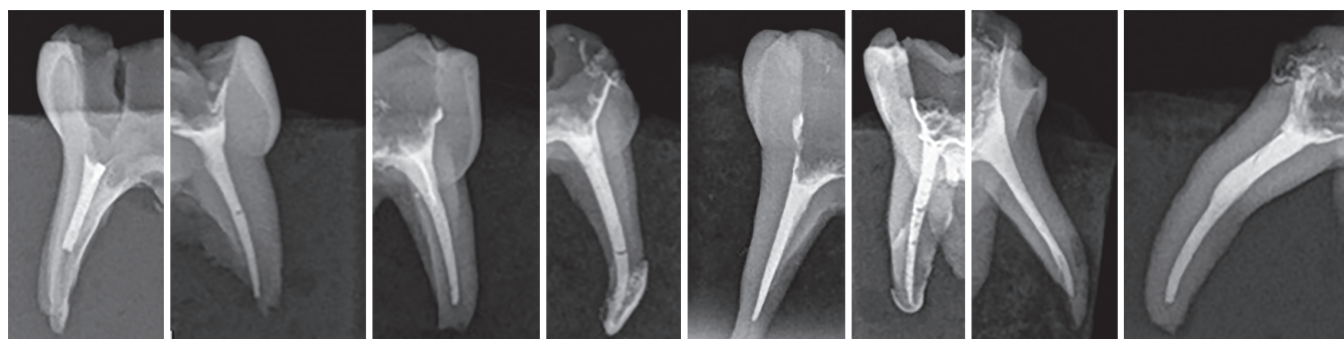


Fig. 3: Variations in obturation—short filling, flush filling, adequate filling, overfilling, absence of voids, presence of voids, smooth taper, and irregular taper

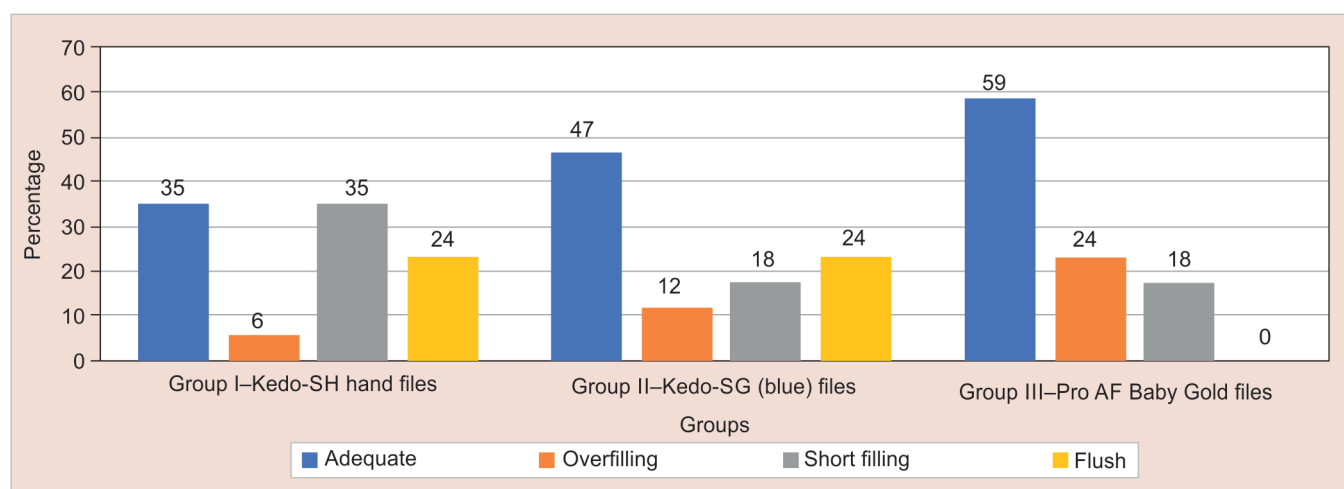


Fig. 4: Comparison of length between the three filling systems

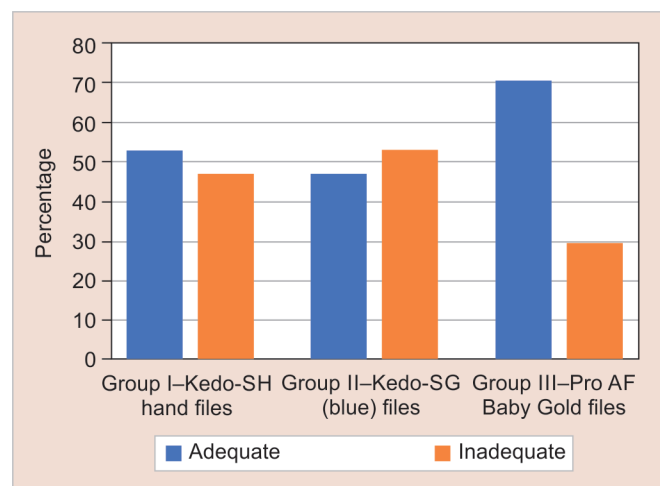


Fig. 5: Comparison of density between the three filling systems

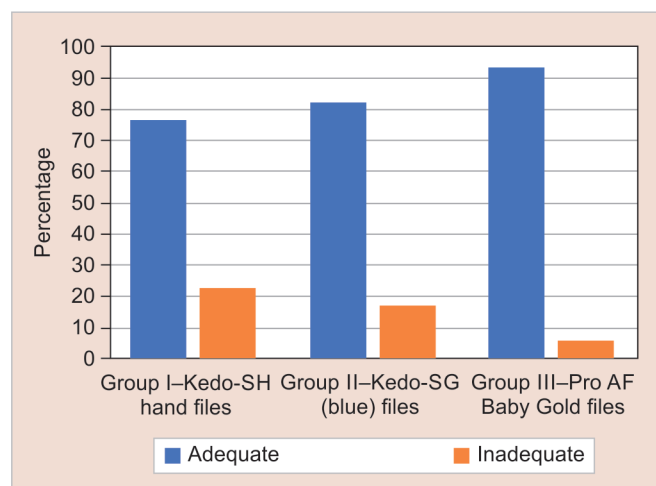


Fig. 6: Comparison of taper between the three filling systems

Table 4: Within-group comparison of mean CFU between baseline and follow-up

Group		Mean	N	Standard deviation	t-value	Degree of freedom	p-value
Group I Kedo-SH hand files	Baseline CFU	329.41	17	90.24	11.91	16	<0.01, significant
	Follow-up CFU	41.82	17	37.49			
Group II Kedo-SG (blue) files	Baseline CFU	311.76	17	96.06	12.93	16	<0.01, significant
	Follow-up CFU	3.35	17	5.00			
Group III Pro AF Baby Gold files	Baseline CFU	300.00	17	84.78	14.95	16	<0.01, significant
	Follow-up CFU	1.53	17	3.50			

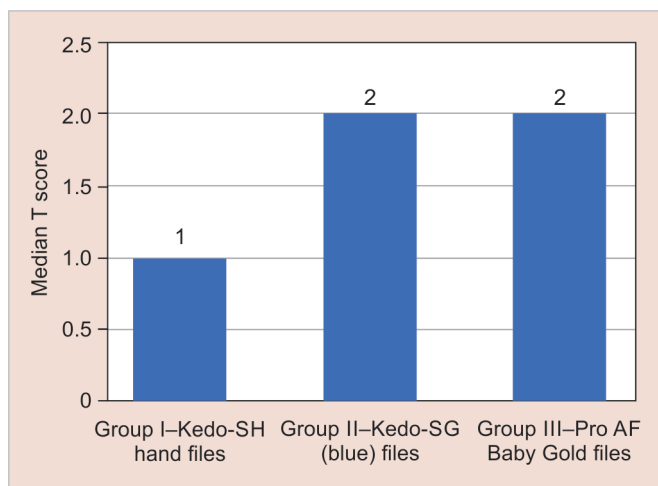


Fig. 7: Comparison of T-scores between the threefiling systems

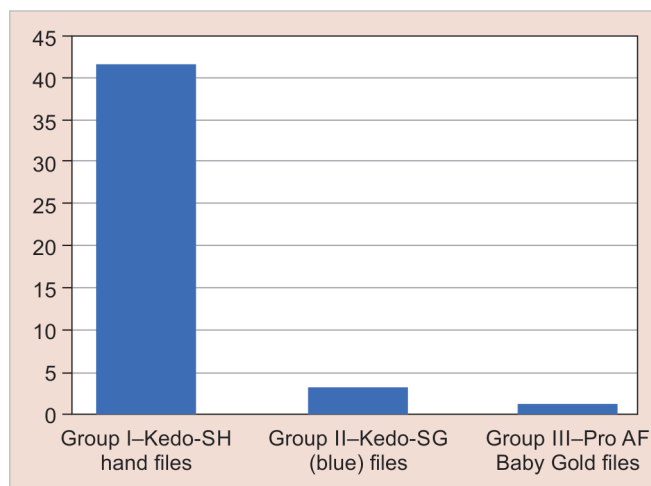


Fig. 9: Follow-up CFU scores of the threefiling systems

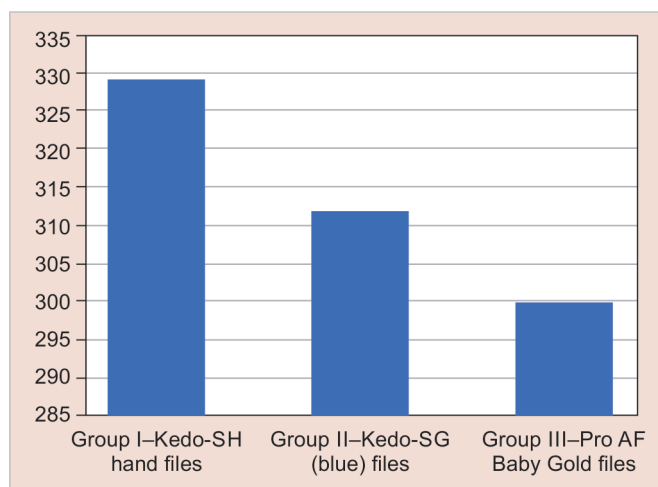


Fig. 8: Baseline CFU scores of the threefiling systems

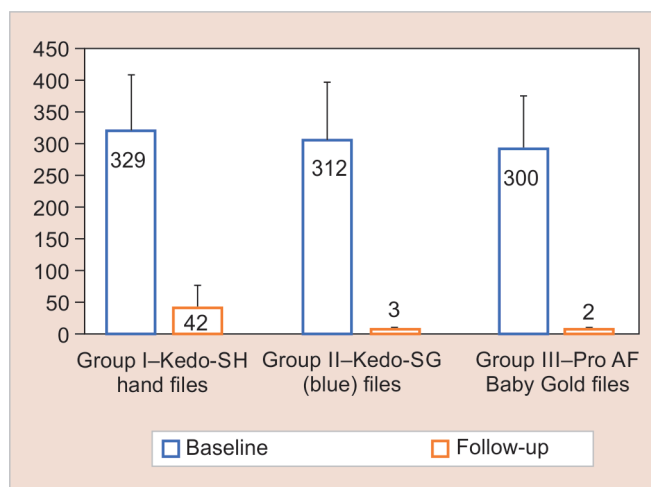


Fig. 10: Comparison of baseline and follow-up CFU scores between the threefiling systems

acrylic resin blocks (Fig. 1) and the removal of *E. faecalis* from canals followed the method used by Pinheiro et al in 2012.⁷

Several studies in literature by Musale and Mujawar, Pinheiro et al., Silva et al., Panchal et al., and Farhin et al., to name a few, have been done comparing stainless steel files (K-files or H-files) and Ni-Ti files.^{6,7,10-12} However, there are few studies in the literature comparing hand Ni-Ti files to rotary Ni-Ti files.

Thus, Kedo-SH files, being a hand Ni-Ti file system, were compared with rotary Ni-Ti files, namely, Pro AF Baby Gold and Kedo-SG (blue) in the present study.

Each file was used for a maximum of five samples before it was changed according to the manufacturer's instructions and by Farhin et al., in 2014.¹² For each canal prepared, a particular file was inserted a maximum of four times until smooth patency was achieved before proceeding to the next canal, as a method of standardization and as per manufacturer's instructions.

Metapex was chosen as the obturating material for the present study due to it being bactericidal and a syringe material, thus promoting ease of usage and faster treatment.^{13,14}

The success of root canal therapy depended on the technique of preparing canals and the length of the material filled in the canal in relation to the root tip radiographically as reported by Smith et al.¹⁵ The quality of obturation depends on the length of the filling

material with respect to the radiographic apex, the compactness of the material used (presence of voids) and the taper of the canal.

The results of the present study with respect to obturation quality showed that (Figs 3 and 4) adequate root filling was highest in group III, followed by groups II and I (groups III > II > I). According to Bołtacz-Rzepkowska et al., teeth with obturation material filled within 0–2 mm of the radiographic root tip show lesser number of failures than those >2 mm from the radiographic root tip.¹⁶ The plausible cause for a larger number of adequate fillings with Pro AF Baby Gold files could be due to this file system having a specific orifice enlarger file, due to which the tip of the syringe material is able to reach adequate length in the canal prior to injecting the material in the canal. Maximum samples in group III, that is, Pro AF Baby gold files showed overfilling, followed by groups II and I (Figs 3 and 4) (groups III > II > I). In primary teeth, perforations occur more often due to thin dentinal walls as physiological resorption sets in. Thus, enlargement of the apical foramen and excess obturation paste beyond it results from an apical overextension of Ni-Ti.¹²

Morphological differences are observed with respect to the shape of the canal in each primary tooth. The amount of dentin covering the canal walls is different at each length

of the root, especially at the apical one-third when viewed three-dimensionally. Hence, higher chances of lateral or apical perforations due to these thin dentinal walls occur in primary teeth, leading to overfilling.

Short fillings were maximum in group I, followed by an equal score for groups II and III (Figs 3 and 4) (groups I > II and III). According to a study by Smith et al.,¹⁵ root fillings placed >2 mm away from the root tip radiographically and fillings extending beyond the apex were associated with slower healing rates. A higher number of short fillings in group I could be attributed to the fact that hand filing does not allow for a funnel-shaped canal preparation uniformly as much as rotary filing does. This quality of rotary filing is what eventually results in a uniform paste filling.¹⁷ Pro AF Baby Gold files and Kedo-SG (blue) files have controlled memory technology in the files and the latter has an additional titanium oxide coating on the files, both of which promote a smooth flow of filling material and thus ideal obturation.¹⁸ This could be attributed to the lesser number of short fillings in both the rotary file groups.

Adequate density, that is, no voids in the obturation, was seen in maximum samples in group III, followed by groups I and II (Figs 3 and 5) (group III > I > II). One of the important causes of pulpectomy failure is the percolation of fluids from short obturations, which acts as a base for the growth of microorganisms or localization of bacteria in such empty spaces leading to further sequelae of inflammation.¹⁹ Pro AF Baby Gold files have advanced Ni-Ti M-wire with heat treatment providing improved centricity in the canal, due to which ledge formation is prevented, thus leading to a flow of obturating material smoothly throughout the length of the root without voids.²⁰

Adequate taper from orifice to the apex was seen in maximum samples in group III, followed by groups II and I (Figs 3 and 6) (groups III > II > I). Thus, the least consistent taper in the present study was seen in group I followed by groups II and III. This could be because the probability of root canal deformation with Ni-Ti rotary files is reduced due to their inactive tips and radial aspect that centers the file in the canal system via wall support.²¹ Also, in Kedo-SH hand files, a greater number of files of different natures are used for instrumentation (stainless steel K-files and H-files along with files of Ni-Ti nature) compared to rotary Groups where only Ni-Ti files were used. Pro AF Baby Gold files are controlled memory files, a study by Guy et al., concluded that amongst the heat-treated Ni-Ti instruments, the controlled memory wire-based instruments created more favorable canal-centered preparation in S-shaped canals.²² This could be why there was a higher score obtained by group III samples with respect to the taper of obturation.

Comparison of the three file systems; however, shows no significant difference (*p*-value 0.18) in T-scoring between the groups (Fig. 7).

The outcome of pulpectomy in milk teeth depends on chemomechanical preparation, which leads to microbial reduction. Persistent endodontic infections in primary teeth are most commonly caused by *E. faecalis*.²³ A standard strain of this bacteria was hence chosen for the study and stored in brain heart infusion broth similar to a study by Gallardo-Moreno et al., in 2001.²⁴

The results of the present study with respect to microbiological analysis showed that the mean baseline CFU score (Figs 2, 3 and 8) showed no statistically significant difference among the three groups. This proved that the baseline CFU values did not affect the postinstrumentation CFU values.

When follow-up CFU values were assessed, (Figs 2, 9, and 10) (Groups III > II > I). Thus, it was found that the difference remained statistically significant, even adjusting for differences in baseline CFU values.

Intergroup comparison of the three groups showed that (Table 3) significantly higher CFUs were seen in Group I as compared to groups II and III (Groups III > II > I). This could be due to third-generation Ni-Ti instruments having controlled memory wires, hence being able to maintain canal centricity. Due to this, the file doesn't straighten in the canal and is able to contact completely the anticurvature portion of the canal, having 360° contact with the canal eventually leading to better cleaning efficacy.²²

Groupwise comparison between baseline and follow-up CFU scores showed that the highest mean reduction in CFU was seen in (Groups III > II > I) (Table 4 and Fig. 2). Devi et al.,²⁵ said that when variable taper files were used, maximum part of the file contacts the coronal and middle parts of the root canal system, leaving the apical one-third uninstrumented. Smaller size constant taper files, which thoroughly engage the canal walls showed complete three-dimensional filing of the root canal space. Ha and Park 2012 mentioned about "taper-lock" effect which states that Ni-Ti instruments over-prepare the root canal system leading to high torsional stress and causing lesser efficiency in cleaning the canal space.²⁶ The highest mean reduction in CFU in group I could be due to these reasons.

CONCLUSION

Within the parameters of this study, it can be concluded that:

- Rotary instrumentation was found to be superior to hand instrumentation in terms of cleaning capacity and obturation quality.
- Among the rotary files tested, Pro AF Baby Gold files showed more consistent results as compared to Kedo-SG (blue) rotary files.
- Adequate length, taper, and density of obturation were seen more with Pro AF Baby Gold files as compared to the other two file groups.
- The CFU scores for Pro AF Baby Gold files were lower than those of Kedo-SG (blue) files or Kedo-SH hand files.
- Further research with a larger sample size and an *in vivo* study can be done to extrapolate the results of the present study.

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