International Journal of Early Childhood Special Education (INT-JECSE)
DOI: 10.48047/INTJECSE/V14I7.342 ISSN: 1308-5581 Vol 14, Issue 07 2022

A Comparison of efficacy of three different file systems used for pulpectomy in primary mandibular molars: An in vitro study

Dr. Maya U Shinde[1], Dr. Shweta M Chaudhary, Dr. Pradnya D Pathak[1], Dr.Kimaya K Kade[1], Dr. Gandhali M Joshi[1], Dr. Amruta K Dedgaonkar[1]

[1]Postgraduate student, Department of Paediatric and Preventive Dentistry, Bharati Vidyapeeth (Deemed To Be University) Dental College and Hospital, Pune, Maharashtra, India.
[2]Associate Professor, Department of Paediatric and Preventive Dentistry Bharati Vidyapeeth (Deemed To Be University) Dental College and Hospital, Pune, Maharashtra, India.

Corresponding Author:
Dr. Maya Shinde
mayashinde0404@gmail.com

Abstract:
Context: In pediatric dentistry, the treatment duration has the utmost importance in reducing anxiety among children. Rotary endodontics in pedodontics facilitates a faster and more efficient treatment option in children.
Aims: To compare the efficacy of three different file systems used for pulpectomy in primary mandibular molars: An In Vitro study

Methods and Material: Thirty extracted primary mandibular molars were divided into three groups. Group, I was prepared with manual K flex files, II with ProTaper Next rotary files, and III with Kedo SSquare. All the teeth were prepared with respective files and instrumentation time was recorded. The pre-and post-instrumentation and post–Obturation CBCT scanning were done to compare centering ability, apical transportation, remaining dentin thickness, and Obturation quality which was assessed using Coll and Sadrian criteria.

Results: This study shows a statistically significant difference in instrumentation time between three file systems among them Kedo SSquare required less time and there was no significant difference in the quality of obturation among the three groups. There was a significant difference in presence of voids among the three groups(p=0.039).

Conclusions: Considering that rotary files are more convenient and can facilitate root canal treatment, their application may be more appropriate for children with behavior management issues.

Keywords: Rotary, pediatric dentistry, CBCT, centering ability, quality of obturation

Introduction:
The specialty of pediatric endodontics has evolved and has been revolutionized over the years from an extraction-oriented practice at the beginning to a specialty based on emphasizing the prevention of oral and dental diseases.[1]A pulpectomy is the preferred treatment for infected pulp tissue in primary teeth. As they differ from permanent teeth in canal morphology (the ribbon-shaped, blunderbuss) and the tendency for root resorption responsible for continuously changing the position of the apex which demands improvements in instruments to prevent undesirable complications like ledges, strip perforations, and transportation. Primary teeth have softer, and less dense dentin than permanent teeth and roots are shorter, thinner, and more curved, often with undetectable root resorption. So endodontic treatment of deciduous teeth demands extra concern.[2]

The most predictive factor for the success of endodontic treatment is proper root canal shaping.There is a continuous evolution in the field of pediatric endodontics, resulting in a paradigm shift from using conventional hand K files which are commonly used in primary teeth to rotary files for biomechanical preparation. There are limitations with hand files regarding effective cleaning of root canals, possible ledge formation, perforations,

dentine compaction, instrument fracture, more instrumentation time which is responsible for the increase in anxiety among children, and fatigue of an operator.[3,4] Rotary endodontics in pediatrics is expected to be a faster and more efficient treatment option in children. It has multiple file systems as well as a single file system.

Different rotary systems like ProTaper Next™, Kedo S[2,] and other NiTi file systems are recent advancements in pediatric endodontics that are intended to maintain the original canal shape and improve the instrumentation time as well as cleaning efficacy. Hence, there is a need to establish the efficacy of these rotary systems in the primary root canals.
Hence, the purpose of this study was to compare the efficacy of three different file systems used for pulpectomy in an extracted primary mandibular molar.

Material and Methods:

The study was initiated after the approval of the Institutional Research and Ethical Committee. Thirty extracted primary mandibular molars were selected with at least two-thirds of the root remaining, absence of perforation in the furcation area, and teeth without showing developmental anomalies. (Fig.2)
Selected teeth were stored in formalin after washing and removal of soft tissue from the crown and root surface and divided into three groups i.e., Group I - 10 Group II- 10, and Group III-10.
For pre-instrumentation CBCT scanning of the samples, a template of modeling wax was made. Roots were embedded till the cervical region so that constant position would be obtained. (Fig.2)
A pre-operative CBCT scanning was done with all the teeth and stored for further comparisons between pre and post-instrumentation. (Fig.3)

Access opening was initiated by using No. 4 round carbide bur and the roof of the access cavity was removed using safe ended diamond tapered fissure. The canals were located and extirpation of the pulp was done with a 10-k file.The working length was determined by using the radiographic method and was kept 1 mm short of the radiographic apex.For group I manual technique, teeth were prepared using the conventional step-back method with manual k flex files up to #35 and quarter-turn “watch winding” motion and vertical pull technique. For group, II using ProTaper Next rotary file system was used in which canals were explored using small-sized hand files. After a smooth, reproducible glide path was produced the X1 (17/04) followed by X2 (25/06) file was used with brushing motion along a glide path until the working length is reached. For group III Kedo S^2 single file system was used which has only one file for all canals of posterior teeth i.e., P_1, 16 mm in length, 4-8% variable taper.

These files were inspected for unwinding or distortion of flutes with a handheld illuminated magnifying glass under 3x magnification every time after removal from the canal and distorted files were discarded whereas the files without any deformation were discarded after three uses.
Irrigation with 2.5% sodium hypochlorite solution, saline, and recapitulation of the canal using the No 10 file was performed. The instrumentation timing was noted in minutes from the start of instrumentation till the completion of cleaning and shaping of the canals using a stopwatch.
After instrumentation post- instrumentation scanning was done similarly to pre-instrumentation scanning. The pre and post-instrumentation images of all the samples were then compared for centering ability, apical transportation, and remaining dentin thickness.

The canal centering ratio was calculated with the formula $(a_1-a_2)/ (b_1-b_2)$ where a_1 is the distance from the outer surface of a mesial portion of the root to the mesial wall of the unprepared canal, a_2 is the distance from the outer root surface of the mesial portion of the root to the mesial wall of the canal after preparation. b_1 is the distance from the outer surface of the distal portion of the root to the distal wall of the unprepared canal, and b_2 is the distance from the outer surface of the distal portion of the root to the distal surface of the canal after preparation.

The canal centering ratio is the difference between the instrumented and un-instrumented canals, which measures the ability of the instrument to stay centered. If the number is not equal the lower figures were considered as the numerator and the result of 1 indicates perfect canal centering capacity and the closer the result to 0, the worse canal centering capacity will be there.
Apical transportation was calculated with the formula introduced by Gambill et al i.e
($[a_1-a_2]-[b_1-b_2]$). Result of ''0''indicate no canal transportation and other than 0 means that transportation has occurred in the canal.

The RDT was determined by subtracting the instrumented canal, that is the shortest distance from the outer wall to the inside canal wall was calculated pre-and post- instrumentation.
For all three groups after final irrigation, the canals were dried with absorbent paper points and obturated with Metapex. A post-operative CBCT scan was taken to determine the quality of obturation with the help of Coll and Sadrian criteria as the length of filling as optimal, underfilled and overfilled, and density for presence or absence of voids. (Fig.4)

Results:

There was a significant difference found in instrumentation time among the three groups in which canals instrumented with Kedo S Square had a lesser instrumentation time followed by ProTaper Next followed by K-flex (P = 0.001). (Fig.5)The mean (SD) time spent for instrumentation was 2.413 (0.79) minutes and 5.153 (2.47) minutes, 10.922 (5.27) minutes in the Kedo S Square, ProTaper Next, and K-flex file system respectively (P=0.0001). A significant difference was found in remaining dentin thickness from the distal wall among the three groups in which more RDT was seen with ProTaper Next followed by Kedo S Square followed by K-flex (P= 0.001). (Fig.6)

There was no significant difference found in remaining dentin thickness from the mesial wall, among the three groups in which more RDT was seen with ProTaper Next followed by Kedo S Square followed by K-flex (P=0.981). (Fig.6) No significant difference was found in canal centering capacity, among the three groups (P =0.282). (Fig.7) No significant difference (P=0.922) was found in apical transportation among the three groups including ProTaper Next (-0.015) followed by Kedo S Square (0.001) followed by K-flex (0.058). (Fig.8)
A comparison of variables among three groups of the study is given (Table 1). Pairwise comparisons of variables of the study are tabulated (Table 2). A comparison of obturation quality among three groups was assessed by using the Kruskal Wallis test, in which no significant difference was found among the three groups (p=0.255). (Table.3). For pairwise comparison of obturation quality between three groups, the Mann-Whitney test was used, and no significant difference was found among the three groups (Table.4). The current study found a significant difference (0.039) in the presence of voids among three groups which was assessed by a chi-square test. (Table.5). In a pairwise comparison of the presence of voids between three groups with the help of the chi-square test, there was a non-significant difference in the presence or absence of voids between K flex files and ProTaper next files. There was a significant difference (0.033) in the presence or absence of voids between K flex files and Kedo S Square files. There was a non-significant difference in the presence or absence of voids between ProTaper next files and Kedo SSquare files. (Table.6)

Discussion:
The utmost goals of modern pediatric dentistry are to bring children into permanent dentition after natural exfoliation of their healthy and/or appropriately treated primary teeth and engrain a positive attitude toward keeping habits of optimal dental and oral health. A pulpectomy is the treatment of choice for the pulpally involved primary teeth. Literature regarding the in vitro use of single rotary files and comparing them with conventional hand files and multiple rotary files is scarce in primary teeth. Hence in this study K flex, ProTaper Next, and Kedo S Square were compared for instrumentation time and quality of obturation.

In the present study, a total of 30 primary mandibular molars were randomly allocated into three groups after meeting inclusion criteria. Primary mandibular molars were selected for standardization and the presence of 2 roots. In the current study, a single file system was used (P1) which has 4-8% variable taper, 16 mm length, 12mm cutting edge, 0.28 mm non-cutting tip, heat-treated, titanium coated Ni-Ti file which is a single file for

all canals of the tooth. Kou C et al. reported that NiTi rotary preparation for extracted primary molars was faster than hand preparation, similar to the present study.[5]

Similar to the current study, in one of the studies there was a significant difference between hand files and rotary files which required less instrumentation time, this valuable time can be used for other procedures, such as irrigation which is most important in primary teeth while performing pulpectomy.[6]
Similar to the present study, a study was done by Mankar et al in 2019, all the groups, ProTaper Universal (PTU), ProTaper Next (PTN), self-adjusting file (SAF), and stainless-steel hand K files in deciduous root canals were similar in canal transportation. [7]
Rotary Kedo-S Square files required less instrumentation time than manual K- and H-files.[8]
Contrary to the current study, Giuseppe Troiano et al 2016, showed a better centering ability with ProTaper Next when compared with the wave one file system.[9]Lídia Regina da (2017)[10]observed greater canal transportation in the hand file group compared with the ProTaper Next and Self adjusting files groups, which exhibited more centered preparations whereas in the present study no statistically significant difference was observed between the three groups. One of the in vitro studies found that the Manual instrumentation removed more dentin in all groups compared with rotary instrumentation which is similar to the present study ($P < .05$)[11.12]

According to Mohamed, R.H., et al (2022) Kedo-S Square removed a significantly less amount of dentin in both apical ($P < 0.002$) and coronal thirds ($P < 0.014$) which is similar to the current study. The taper of the preparations showed significant differences as the Kedo-S Square file showed a good taper in a maximum number of root canals, while manual K- and H-files showed poor taper in a maximum number of root canals.[8] In a study done by Govindaraju et al 2017, results showed that no significant difference was observed in the quality of obturation among the rotary and hand files groups which is similar to the present study.[13]Similar to the present study, Juliet S et al observed no significant difference concerning the quality of obturation using S2 ProTaper files, Kedo-S files, and RaCe files in primary teeth.Contrary to the present study, a study done by Divya S et al 2019 showed that the Kedo-S pediatric rotary file system shows a considerably better quality of obturation when compared to that of the K3 rotary and hand K file systems.[14]In contrast to the present study, a study done by Parameswarappa Pet al, there was no significant difference found in the Rotary (Mtwo) file and hand file (K file) for the presence of voids whereas in the present study there was a significant difference found between Kedo S Square file system and K flex file system.[15]

Conclusion
The results showed less instrumentation time with a rotary group than a manual one and have variable results in obturation quality but more favor towards the Kedo S Square file due to comparative less instrumentation time and no significant difference with obturation quality means showing near about similar quality of obturation.However, more studies are highly essential to prove it a boon for estimating obturation quality in primary teeth.

Groups	K-flex		ProTaper Next		Kedo S Square		p-value
	Mean	SD	Mean	SD	Mean	SD	
IT	10.922	5.27	5.153	2.47	2.413	0.79	0.001*
AT	0.058	0.28	-0.015	0.46	0.001	0.50	0.922 (NS)
CCA	1.298	1.40	1.688	2.83	0.326	1.08	0.282 (NS)
RDT_M	0.873	0.14	0.881	0.27	0.894	0.29	0.981 (NS)
RDT_D	0.788	0.22	1.073	0.24	1.013	0.17	0.014*

One-way ANOVA test; * indicates a significant difference at $p \leq 0.05$; NS: Non-significant difference
Table.1 Comparison of variables among three groups of the study

Groups	K-flex vs ProTaper Next		K-flex vs Kedo S Square		ProTaper Next vs Kedo S Square	
	Difference	p-value	Difference	p-value	Difference	p-value
IT	5.769	0.002*	8.509	0.001*	2.740	0.187 (NS)
AT	0.073	0.922 (NS)	0.057	0.952 (NS)	-0.016	0.996 (NS)
CCA	-0.390	0.894 (NS)	0.972	0.505 (NS)	1.362	0.271 (NS)
RDT_M	-0.008	0.997 (NS)	-0.021	0.980 (NS)	-0.013	0.992 (NS)
RDT_D	-0.285	0.015*	-0.225	0.062 (NS)	0.060	0.802 (NS)

Post-Hoc Tukey test; * indicates significant difference at p≤0.05; NS: Non-significant difference

Table 2. Pairwise comparison of variables of the study

Groups	Obturation quality				p value
	Underfilled (1)	Optimal (2)	Overfilled (3)	Total	
K flex	1 (10%)	6 (60%)	3 (30%)	10 (100%)	0.255 (NS)
ProTaper Next	3 (30%)	5 (50%)	2 (20%)	10 (100%)	
Kedo S Square	0 (0%)	6 (60%)	4 (40%)	10 (100%)	

Kruskal-Wallis test; NS: Non-significant difference

Table.3 Comparison of obturation quality among three groups

Groups	p-value
K flex vs ProTaper Next	0.335 (NS)
K flex vs Kedo S Square	0.483 (NS)
ProTaper Next vs Kedo S Square	0.109 (NS)

Mann-Whitney test; NS: Non-significant difference

Table.4 Pairwise comparison of obturation quality between three groups

Groups	Presence of voids			p-value
	Present	Absent	Total	
K flex	0 (0%)	10 (100%)	10 (100%)	0.039*
ProTaper Next	3 (30%)	7 (70%)	10 (100%)	
Kedo S Square	5 (50%)	5 (50%)	10 (100%)	

Chi-square test; * indicates a significant difference at p≤0.05

Table. 5 Comparison of presence of voids among three groups

Groups	p-value
K flex vs ProTaper Next	0.211 (NS)
K flex vs Kedo S Square	0.033*
ProTaper next vs Kedo S Square	0.650 (NS)

Chi-square test; * indicates a significant difference at p≤0.05; NS: Non-significant difference

Table 6. Pairwise comparison of the presence of voids between three groups

DOI: 10.48047/INTJECSE/V14I7.342 ISSN: 1308-5581 Vol 14, Issue 07 2022

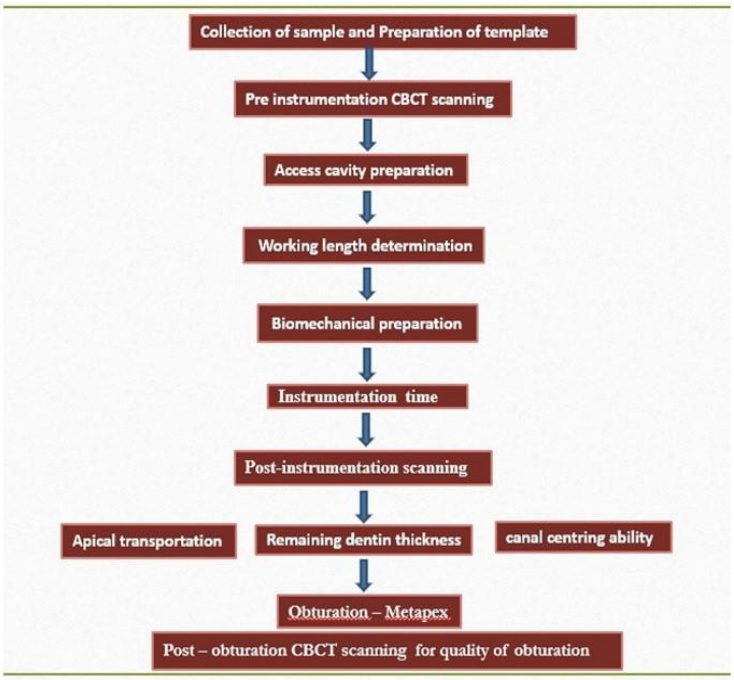

Fig.1: Consolidated flowchart of the methodology

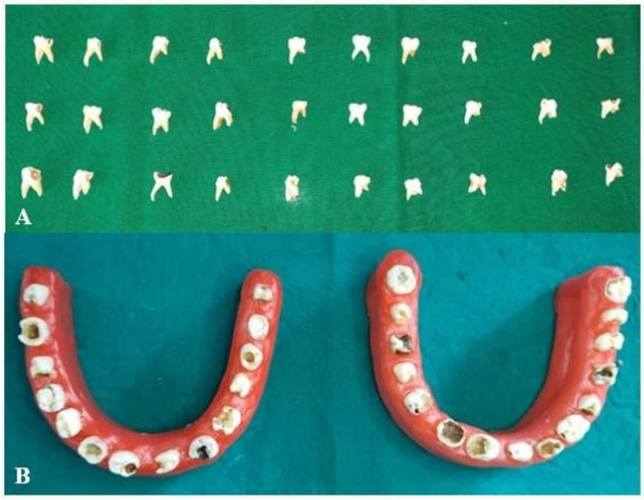

Fig.2: A. Extracted primary mandibular molars selected for the study B. Template of modeling wax on which teeth are mounted for CBCT scanning

DOI: 10.48047/INTJECSE/V14I7.342 ISSN: 1308-5581 Vol 14, Issue 07 2022

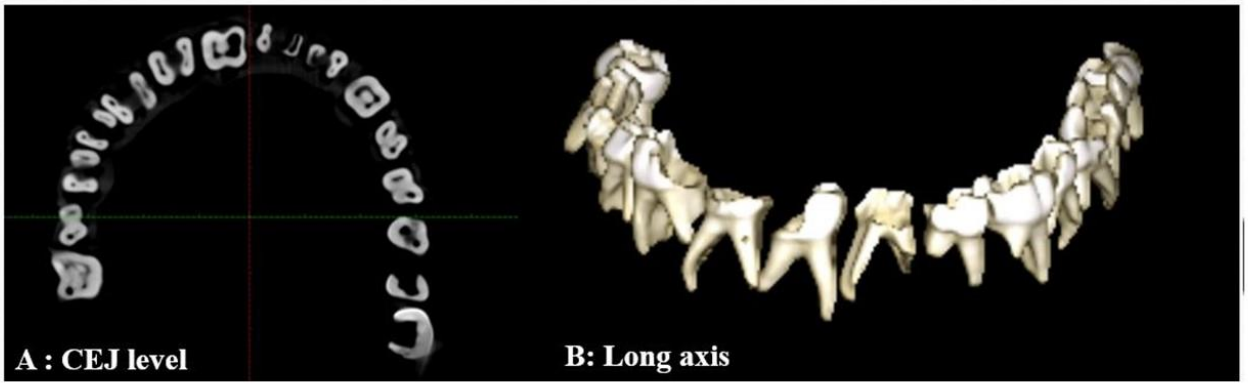

Fig.3: Slice of CBCT image of an arch with mounted teeth

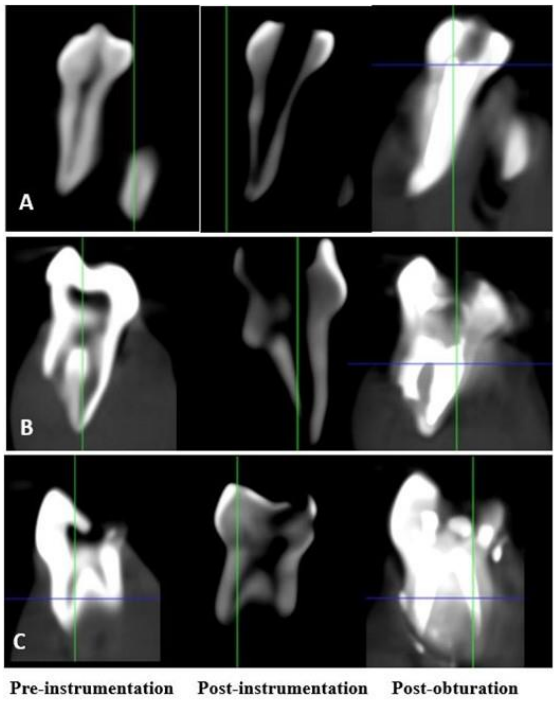

Fig.4: CBCT image of A. K-flex file B. ProTaper Next file C. Kedo S^2 file respectively

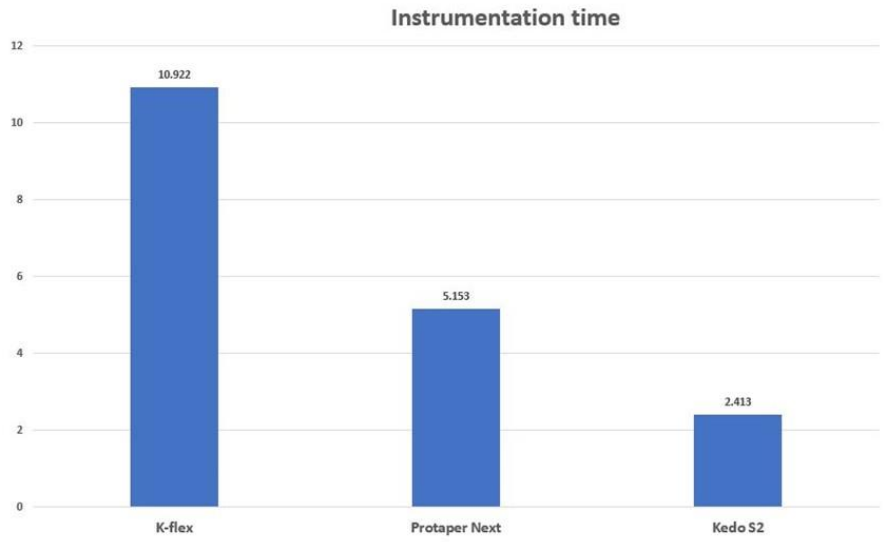

Fig.5: Graphical presentation of instrumentation time

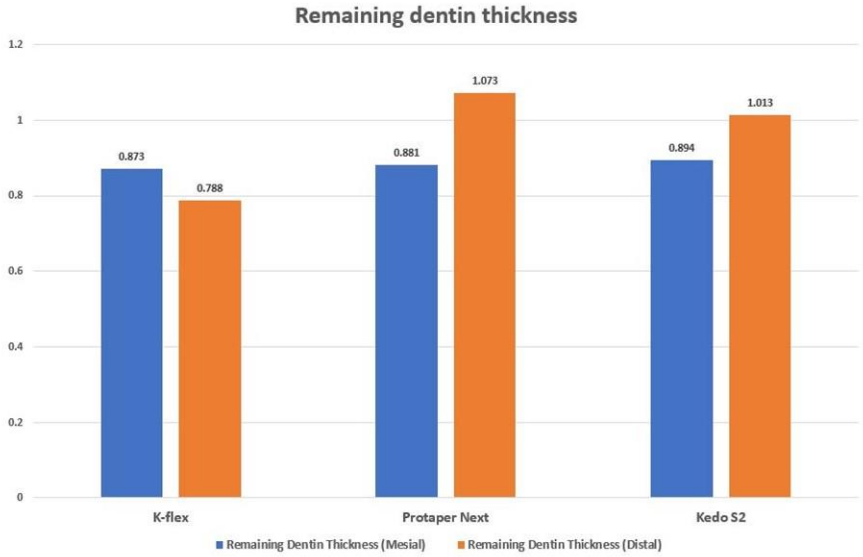

Fig.6: Graphical presentation of remaining dentin thickness

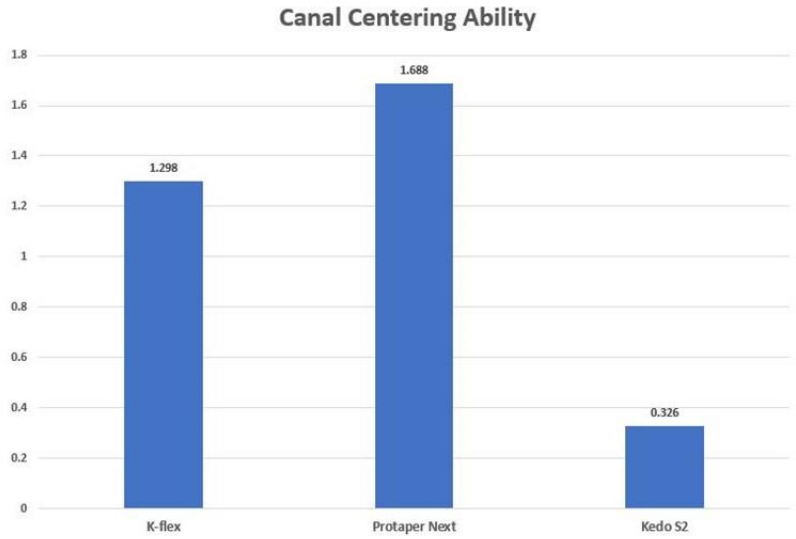

Fig.7: Graphical presentation of canal centering capacity

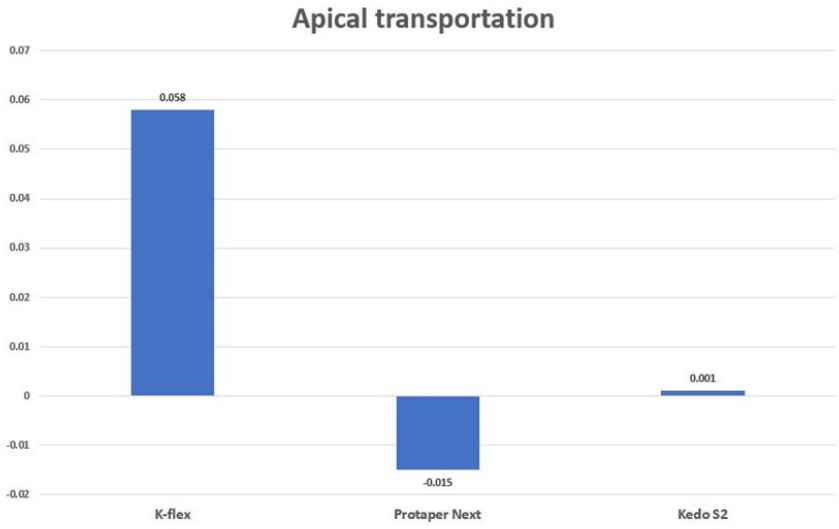

Fig.8: Graphical presentation of apical transportation

References:

1.A. B. Fuks, Benjamin Peretz Pediatric Endodontics Current Concepts in Pulp Therapy for Primary and Young Permanent Teeth ISBN 978-3-319-27551-2 DOI 10.1007/978-3-319-27553-6

2. George S, Anandaraj S, Issac JS, John SA, Harris A. Rotary endodontics in primary teeth - A review. Saudi Dent J. 2016;28(1):12-17. DOI: 10.1016/j.sdentj.2015.08.004

3. GovindarajuL, JeevanandanG,Subramanian EM. Application of rotary endodontics in pediatric dentistry - A review of literature. J PharmRes2018;12:480

4. Farhin K, Devendra P, Jitesh P, Mayur W, Pooja S, Shagufta D Rotary instrumentation in paediatric Endodontics - A Review I J Pre Clin Dent Res 2014;1(3):48-52 July-September

5. Kuo C, Wang Y, Chang H, Huang G, Lin C, Li U, et al. Application of Ni-Ti rotary files for pulpectomy in primary molars. J Dent Sci 2006;1:10-5

6. Govindaraju L, Jeevanandan G, Subramanian E. Clinical Evaluation of Quality of Obturation and Instrumentation Time using Two Modified Rotary File Systems with Manual Instrumentation in Primary Teeth. J Clin Diagn Res. 2017 Sep;11(9):ZC55-ZC58. DOI: 10.7860/JCDR/2017/30069.10602.

7. Mankar A et al Biomechanical preparation in primary molars using manual and three NiTi instruments: a cone-beam-computed tomographic in vitro study September 2019 EJPDDOI:10.1007/s40368-019-00474-0

8. Mohamed, R.H., Abdelrahman, A.M. & Sharaf, A.A. Evaluation of rotary file system (Kedo- S-Square) in root canal preparation of primary anterior teeth using cone-beam computed tomography (CBCT)-in vitro study. BMC Oral Health **22,** 13 (2022) https://doi.org/10.1186/s12903-021-02021-0

9. Giuseppe Troiano et al Centering Ability of ProTaper Next and WaveOne Classic in J-Shape Simulated Root Canals, the Scientific World Journal Volume 2016, Article ID 1606013, 5 pages http://dx.doi.org/10.1155/2016/1606013

10. Hidalgo L, Silva L, Leoni GB, Mazzi-Chaves JF, Carvalho E, Consolaro A, et al. Mechanical preparation showed superior shaping ability than manual technique in primary molars-a micro-computed tomography study. Braz Dent J. 2017;28(4):453-60. doi: 10.1590/0103-6440201601552

11. Kummer, T., Calvo, M.C., Cordeiro, M., de Sousa Vieira, R., & de Carvalho Rocha, M.J. (2008). Ex vivo study of manual and rotary instrumentation techniques in human primary teeth. *Oral surgery, oral medicine, oral pathology, oral radiology, and endodontics, 105 4*, e84-92.

12. Musale PK, Jain KR, Kothare SS. Comparative assessment of dentin removal following hand and rotary instrumentation in primary molars using cone-beam computed tomography. J Indian Soc Pedod Prev Dent 2019;37:80-6.

13. Govindaraju, L., Jeevanandan, G., & Subramanian, E. (2017). Comparison of quality of obturation and instrumentation time using hand files and two rotary file systems in primary molars: A single-blinded randomized controlled trial. European journal of dentistry, 11(3), 376–379. https://doi.org/10.4103/ejd.ejd_345_16

14. Juliet S, Jeevanandan G, Govindaraju L, Ravindran V, Subramanian EM. Comparison Between Three Rotary Files on Quality of Obturation and Instrumentation Time in Primary Teeth − A Double Blinded Randomized Controlled Trial. J Orofac Sci 2020;12:30-4.

15. Divya S, Jeevanandan G, Sujatha S, Subramanian EMG, Ravindran V. Comparison of quality of obturation and post-operative pain using manual vs rotary files in primary teeth - A randomized clinical trial. Indian J Dent Res. 2019 Nov-Dec;30(6):904-908. DOI: 10.4103/ijdr.IJDR_37_18. PMID: 31939369.

16. Parameswarappa P et al Volumetric analysis of hand and rotary root canal instrumentation and filling in primary teeth using Spiral Computed Tomography' – an in-vitro study IJPD Volume26, Issue 3 May 2016 ; 193-198