

Comparison of Volumetric Changes in Primary Molar Root Canals by Four Different File Systems: A Cone-beam Computed Tomography Study

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ABSTRACT

Aim and objective: To evaluate and compare the pre- and post-instrumentation canal volume using hand K-files, ProTaper Gold rotary files, Kedo-S rotary files, and One Shape rotary files in primary molars using cone-beam computed tomography (CBCT).

Materials and methods: The study was done on 40 primary molars randomly divided into four groups of 10 teeth. Samples were subjected to CBCT scan and image analysis before instrumentation, following which the teeth were instrumented with respective endo files. Post-instrumentation CBCT scan was done and volume of the canal was measured from CEJ to apex. The obtained values were statistically analyzed to find the level of significance using mean, standard deviation. Statistical analysis was further done using one-way ANOVA and a *post hoc* test.

Results: A statistically significant difference was observed in dentin removal by hand K-files when compared with rotary file groups. One Shape files removed less root dentin followed by Kedo-S rotary files, ProTaper Gold rotary files, and hand K-files, respectively.

Conclusion: It can be concluded that rotary files, mainly One Shape and Kedo-S files can be used as an acceptable instrument in roots of primary teeth as it shows the least root dentin removal.

Keywords: Cone-beam computed tomography, Pediatric endodontics, Rotary endodontics.

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INTRODUCTION

Endodontic treatment in primary teeth is considered challenging and often time-consuming especially during canal instrumentation. Hand instruments such as K files, reamers, and H files were traditionally used to prepare the body of the canal. The manual endodontic techniques have shown to cause failures like ledging, zipping, and apical blockage.¹ Pediatric endodontics has advanced much in recent years with the use of rotary instruments, thus allowing a faster and efficient treatment option in root canal therapy. The recent advances are directed toward root canal preparation techniques with various nickel-titanium rotary instruments.² They are consistent in preparing progressive taper with the original anatomy of the root canal and are found to stay better centered within the canal with fewer elbows and ledges compared to hand instrumentation with stainless steel endodontic instruments.³

Conservation of the dentinal structure is vital in preventing the fracture of endodontically treated teeth. Checking the volume of the root canal space is vital to understand the amount of tooth material removed by endodontic treatment.^{4,5} This study compares the volume of root canal space using ProTaper rotary instruments, One Shape rotary systems, Kedo-S file system instruments with manual K-files.

The main advantage of using cone-beam computed tomography (CBCT) for endodontic procedures is that it can provide 3-D views with specific root canal morphology which intraoral and panoramic radiography cannot provide.⁶ The uniqueness of this study is that no previous study has been conducted to compare these instruments in primary root canals. Hence, the purpose of this study was to compare and evaluate the volumetric changes of

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root canal thereby, the efficiency of cleaning and shaping of these rotary file systems using CBCT.

MATERIALS AND METHODS

The study sample consisted of 40 primary molar teeth extracted for therapeutic reasons. Institutional ethical committee approval was obtained before the study. The teeth were collected, handled, and preserved according to the Occupational Safety and Health Administration (OSHA) guidelines.⁷ Inclusion criteria of the samples were primary molar teeth with at least 2/3rd of the root intact. The tooth with any previous attempt of pulp therapy or failed root canal treatment and tooth with signs of pathological resorption were excluded. Access cavities were prepared with no. 4 round bur after which irrigation of root canals and pulp chamber were done

with saline to remove the debris. The patency of the root canal was determined with a 10 size K-file. As the tip of the K-file was visualized at the apex, the final working length was recorded 1 mm short of the measured length. The collected teeth were numbered and randomly divided into 4 different groups of 10 teeth each. Group I for Hand K-file, group II for ProTaper Gold files, group III for Kedo-S files, group IV for One Shape files.

The teeth were subjected to scanning using cone-beam computed tomography before instrumentation. After that, all samples were instrumented with respective files for their groups by a single operator. The specimens were then viewed from CEJ to apex under high resolution both in cross-section and longitudinal section with a thickness of 0.125 mm/slice and 120 kVp and a 360° rotation. The total volume of the root canal from CEJ to the apex was obtained by using ITK-SNAP software, Statistical Package for Social Sciences (SPSS) version 16.0 was used for analysis. The values of preoperative and postoperative root canal volume were recorded and the difference in canal volume in all the samples was calculated (Table 1). The data were expressed in mean and standard deviation, ANOVA (*post hoc*) Dunnett's *t*-test and paired *t*-test were done to find the statistical significance between the groups. $p < 0.05$ was considered statistically significant at 95% confidence interval.

RESULTS

Table 1 shows comparisons of pre- and post-volumetric changes between the groups. The pre- and post-volumetric changes in the group show K-files has the maximum pre- and post-volumetric difference followed by ProTaper Gold files, Kedo-S files, and One Shape file, respectively.

Table 2 shows multiple comparisons of pre- and post-volumetric changes between the groups. K-files showed a significant difference compared with all other groups ($p < 0.05$). ProTaper Gold files, Kedo-S files, and One Shape files showed similar volumetric changes but it was not statistically significant.

Figure 1 shows the cross-section and longitudinal section CBCT images of pre- and post-instrumentation volumes using K files. Figure 2 shows the cross-section and longitudinal section CBCT

images of pre- and post-instrumentation volumes using ProTaper files. Figure 3 shows the cross-section and longitudinal section CBCT images of pre- and post-instrumentation volumes using Kedo-S files. Figure 4 shows the cross-section and longitudinal section CBCT images of pre- and post-instrumentation volumes using One Shape files.

DISCUSSION

Applying the permanent molar rotary instrumentation protocols for primary molars instrumentation leads to the lateral perforation on the inner root surface, more so in curved roots of the primary molar.^{8,9} Kuo et al.¹⁰ stated that rotary Ni-Ti files can be safely and efficiently used for root canal preparation in primary molars. The literature search does not show any clear guidelines for the instrumentation of primary teeth root canals with rotary files. CBCT has been used in this study the volume of root canal space by various files. Previous research studies by Musale and Mujawar¹¹ and Selvakumar et al.¹² have successfully used CBCT for measurements for instrumentation of the root canals and have proved it to be a non-destructive and reproducible tool.

While cleaning and shaping in primary tooth maintaining the remaining dentin thickness is important as there is a direct correlation between the root thickness and the fracture resistance.^{3,4} Lim and Stock¹³ have suggested that a minimum 0.3 mm thickness of canal walls should remain after canal preparation, which allows adequate resistance against lateral and occlusal forces. As the amount of dentin removal indicates the aggressiveness of the instrument, the volume of removed dentin was evaluated in this study.

In the present study, all the hand and rotary instruments were able to produce a considerable and predictable amount of canal shaping. It was observed that there was a significant statistical difference in pre- and post-canal instrumentation volume between both groups. The reason attributed to the increased dentin removal could be due to the tendency of the operator to perform more intensive instrumentation, resorption pattern, and also because instrumentation time for hand filing is more when compared with rotary files.¹⁴ Kummer et al.¹⁵ observed that manual instrumentation

Table 1: Comparison of pre- and post-volumetric changes of groups

Groups	Pre-volumetric changes (mean \pm SD)	Post-volumetric changes (mean \pm SD)	<i>t</i> value	<i>p</i> value
Group I (K-files)	27.52 \pm 1.61	35.24 \pm 2.02*	2.89	0.001
Group II (ProTaper Gold files)	23.73 \pm 1.62	27.59 \pm 1.20	11.89	0.79
Group-III (Kedo-S files)	24.70 \pm 2.98	27.57 \pm 3.51	8.63	0.92
Group-IV (One Shape files)	25.45 \pm 4.25	27.90 \pm 4.34	7.51	0.96

* $p < 0.05$ significant compared pre- and post-test values

Table 2: Multiple comparisons of pre- and post-volumetric changes between the groups

Groups	Volumetric changes (mean \pm SD)		<i>f</i> value	<i>p</i> value
	Pre	Post		
Group I (pre)	27.52 \pm 1.61*	35.24 \pm 2.02	7.67	0.02
Group II (pre)	23.73 \pm 1.62*	27.59 \pm 1.20*		
Group III (pre)	24.70 \pm 2.98*	27.57 \pm 3.51*		
Group IV (pre)	25.45 \pm 4.25*	27.90 \pm 4.34*		

* $p < 0.05$ significant compared between the groups

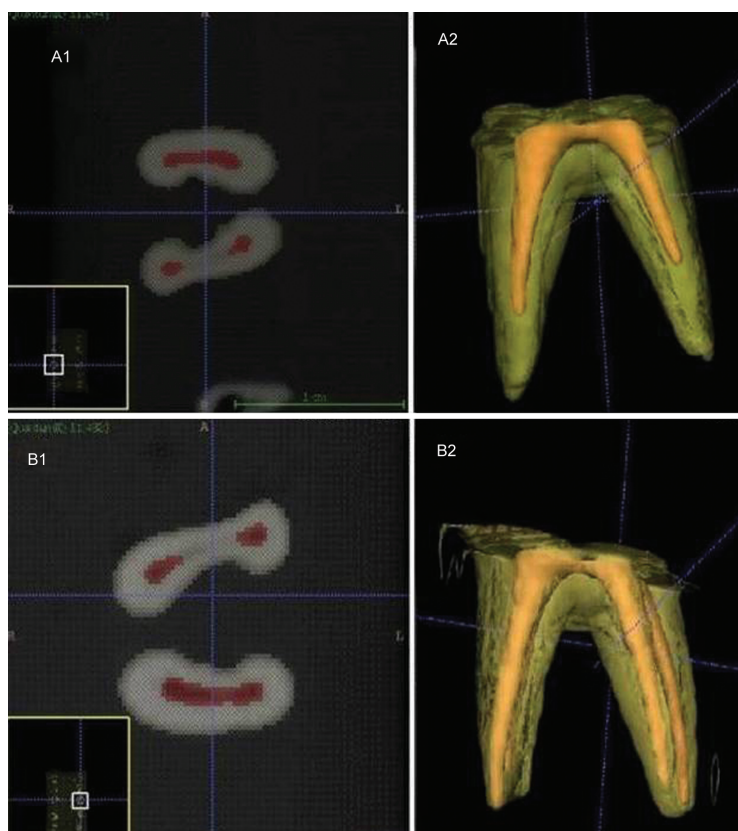


Fig. 1: K files—A1 pre-instrumentation cross-sectional, A2 shows pre-instrumentation longitudinal, B1 shows post-instrumentation cross-sectional, B2 shows post-instrumentation longitudinal

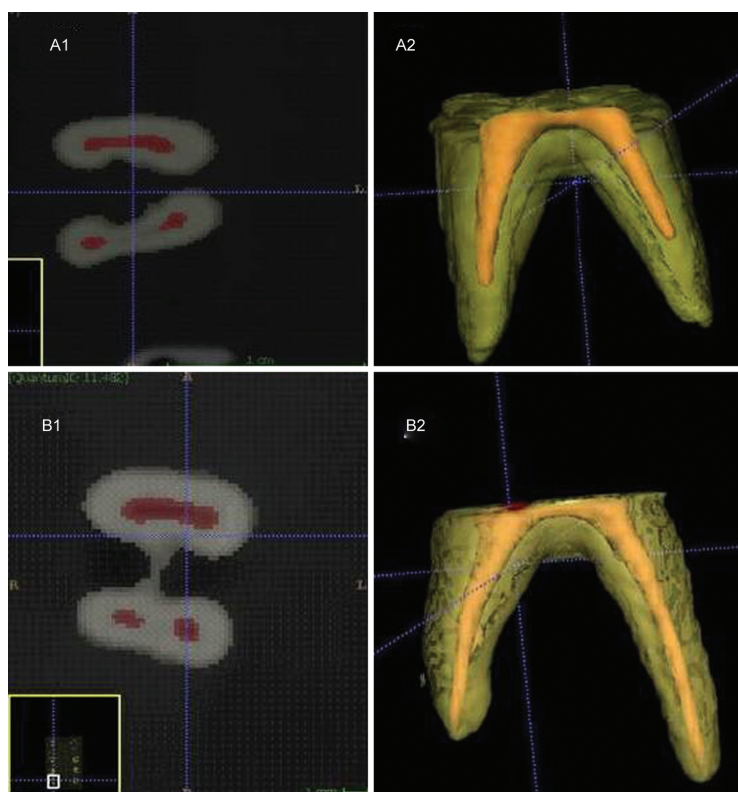


Fig. 2: Protaper Gold files—A1 pre-instrumentation cross-sectional, A2 shows pre-instrumentation longitudinal, B1 shows post-instrumentation cross-sectional, B2 shows post-instrumentation longitudinal

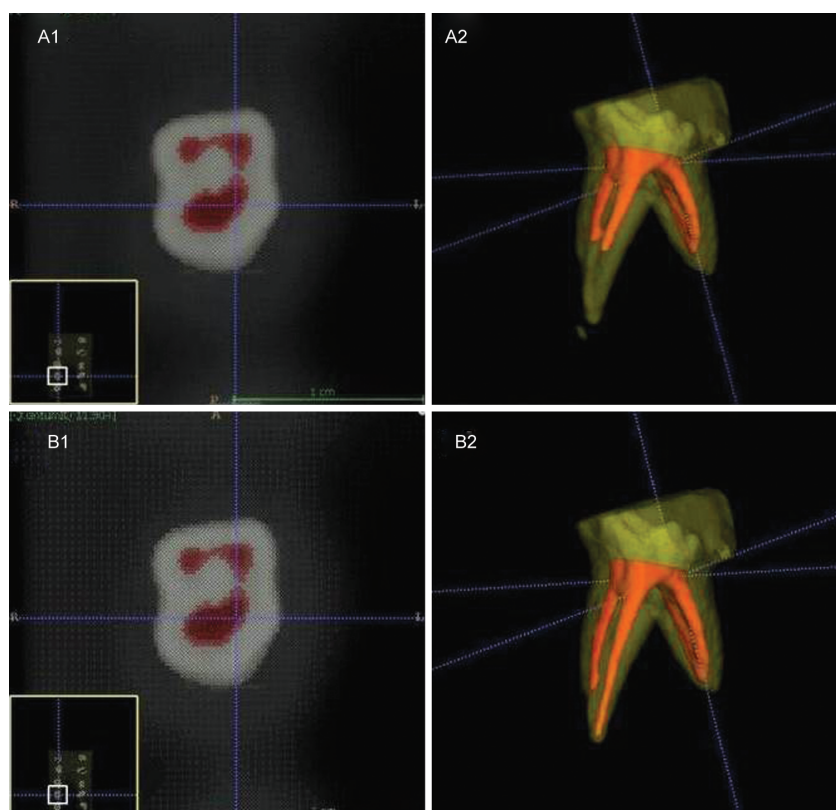


Fig. 3: Kedo S Files—A1 pre-instrumentation cross-sectional, A2 shows pre-instrumentation longitudinal, B1 shows post-instrumentation cross-sectional, B2 shows post-instrumentation longitudinal

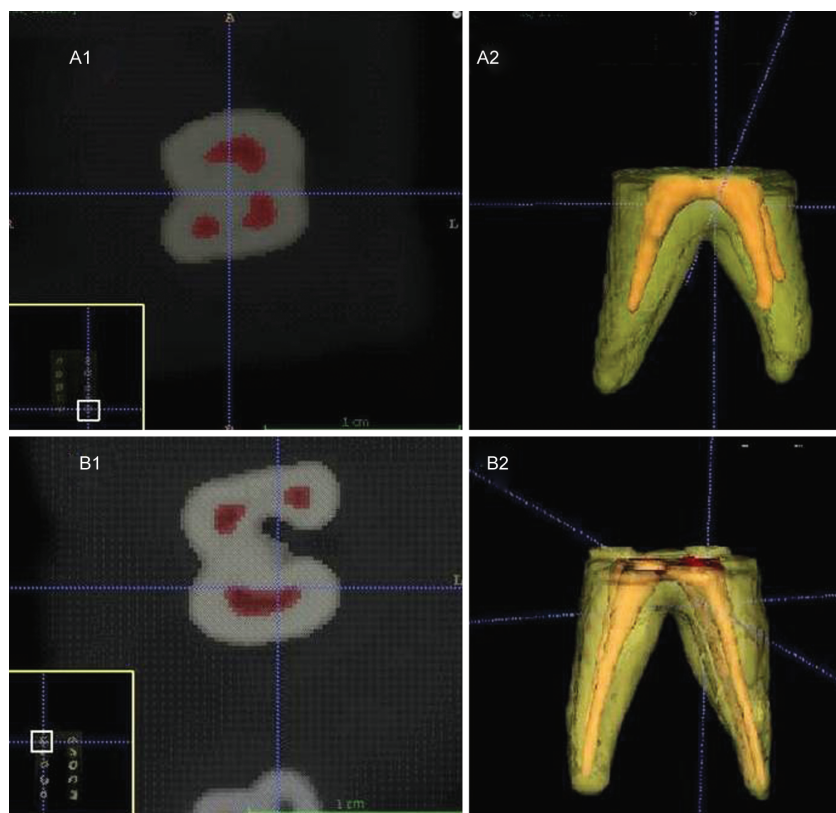


Fig. 4: One Shape file—A1 pre-instrumentation cross-sectional, A2 shows pre-instrumentation longitudinal, B1 shows post-instrumentation cross-sectional, B2 shows post-instrumentation longitudinal

technique caused more removal of dentin at the coronal and middle thirds of all roots of teeth compared with rotary instrumentation.

In the comparison of hand K-files with One Shape files, hand K-files removed more dentin. This could be also due to the stiffness of the K-file instrument and multiple files used to prepare the canal. On contrary, One Shape files is a single file system and they have a favorable design at the tip, and its cross-sectional design characterizes three symmetrical cutting edges. While in the middle part, the cross-sectional design progressively changes from a three-cutting edge design to two cutting edges. The results of our study about the dentin removal efficacy of K-files are in accordance with studies conducted by Rashid and Saleh¹⁶ and Saleh et al.¹⁷

With ProTaper Gold has progressively changing helical angle and pitch. The sharp cutting edges with convex triangular cross-sectional design along with its flute design combines multiple tapers within the shaft up to 19%. The variable tip diameters help for aggressive cutting and hence the excessive volume of dentin removal. The results of our study are in accordance with various studies.^{18–20}

Lesser removal of dentin by Kedo-S files may be due to the gradual taper of these files which helps in easy coronal enlargement and also for straight-line access. Gradual tapering helps in effective canal shaping and avoids the instrumentation of root canals.²¹

The literature is deficient regarding the use of One Shape files in primary teeth. Musale and Mujawar¹¹ observed that a moderately tapered preparation of 4–6% with apical preparation up to size 20–30 can be considered ideal in primary molar endodontic treatment. Therefore, weakening of the root canal walls can be avoided in primary molars. Hence, One Shape files can be used as an alternative to other rotary files in primary teeth.⁸

In the present study, it was observed that there was a significant statistical difference in pre- and post-canal instrumentation volume between hand and rotary groups. The reason attributed to the increased dentin removal could be due to the tendency to perform more intensive instrumentation by the clinician, resorption pattern of primary molars, and may also because instrumentation time is more for hand filing than rotary files.^{1,9}

CONCLUSION

This study showed that Hand K-files has the highest volumetric change followed by ProTaper Gold rotary files, Kedo-S rotary files, and One Shape rotary files. Therefore, within the limitations of this study, it can be concluded that One Shape rotary files and Kedo-S rotary files can be an efficient and safer instruments in primary molar canals.

REFERENCES

- Ochoa-Romero T, Mendez-Gonzalez V, Flores-Reyes H, et al. Comparison between rotary and manual techniques on duration of instrumentation and obturation times in primary teeth. *J Clin Pediatr Dent* 2011;35(4):359–364. DOI: 10.17796/jcpd.35.4.8k013k21t39245n8.
- Venkateshbabu N, Porkodi I, Pradeep G. Canal-centering ability: an endodontic challenge. *J Conserv Dent* 2009;12(1):3–9. DOI: 10.4103/0972-0707.53334.
- Tomer AK, Miglani A, Chauhan P, et al. An *in vitro* evaluation of remaining dentine thickness through CBCT using different files. *IOSR J Dent Med Sci* 2017;16(2):121–124. DOI: 10.9790/0853-160201121124.
- Suneetha MG, Moiz AA, Sharief H, et al. Residual root dentin thickness for three different rotary systems: a comparative cone beam computed tomography *in vitro* study. *J Indian Soc Pedod Prev Dent* 2020;38(1):48–55. DOI: 10.4103/JISPPD.JISPPD_190_19.
- Singh S, Gupta T, Pandey V, et al. Shaping ability of two-shape and ProTaper gold files by using cone-beam computed tomography. *J Contemp Dent Pract* 2019;20(3):330–334. DOI: 10.5005/jp-journals-10024-2518.
- Durack C, Patel S. Cone beam computed tomography in endodontics. *Braz Dent J* 2012;23(3):179–191. DOI: 10.1590/s0103-64402012000300001.
- Cuny E, Carpenter WM. Extracted teeth: decontamination, disposal and use. *J Calif Dent Assoc* 1997;25(11):801–804.
- Reddy PJ, Kumar VS, Aravind K, et al. Canal shaping with one shape file and twisted files: a comparative study. *J Clin Diagn Res* 2014;8(12):ZF01–ZF03. DOI: 10.7860/JCDR/2014/11126.5333.
- Jeevanandan G, Govindaraju L. Clinical comparison of Kedo-S paediatric rotary files vs manual instrumentation for root canal preparation in primary molars: a double blinded randomised clinical trial. *Eur Arch Paediatr Dent* 2018;19(4):273–278. DOI: 10.1007/s40368-018-0356-6.
- Kuo CI, Wang YL, Chang HH, et al. Application of Ni-Ti rotary files for pulpectomy in primary molars. *J Dent Sci* 2006;1:10–15.
- Musale PK, Mujawar SAV. Evaluation of the efficacy of rotary vs. hand files in root canal preparation of primary teeth *in vitro* using CBCT. *Eur Arch Paediatr Dent* 2014; 15(2):113–120. DOI: 10.1007/s40368-013-0072-1.
- Selvakumar H, Anandhan V, Thomas E, et al. Evaluation of canal transportation and centering ability of K 3 (0.02%) and K 3 (0.04%) with hand K files in primary teeth using spiral computed tomography. *J Indian Soc Pedod Prev Dent* 2014;32(4):286. DOI: 10.4103/0970-4388.140943.
- Lim SS, Stock CJ. The risk of perforation in the curved canal. Anticurvatures filing compared with the stepback technique. *Int Endod J* 1987;20(1):33–39. DOI: 10.1111/j.1365-2591.1987.tb00586.x.
- 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(1):80. DOI: 10.4103/JISPPD.JISPPD_210_18.
- Kummer TR, Calvo MC, Cordeiro MM, et al. Ex vivo study of manual and rotary instrumentation techniques in human primary teeth. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2008;105(4):e84–e92. DOI: 10.1016/j.tripleo.2007.12.008.
- Rashid AA, Saleh AR. Shaping ability of different endodontic single-file systems using simulated resin blocks. *Int J Multidiscip Dent* 2016;6(2):61. DOI: 10.4103/2229-6360.197745.
- Saleh AM, Gilani PV, Tavanafar S, et al. Shaping ability of 4 different single-file systems in simulated S-shaped canals. *J Endod* 2015;41(4):548–552. DOI: 10.1016/j.joen.2014.11.019.
- Arias A, de Vasconcelos RA, Hernández A, et al. Torsional performance of ProTaper gold rotary instruments during shaping of small root canals after 2 different glide path preparations. *J Endod* 2017;43(3):447–451. DOI: 10.1016/j.joen.2016.10.034.
- Bayram HM, Bayram E, Ocak M, et al. Effect of ProTaper gold, self-adjusting file, and XP-endo shaper instruments on dentinal microcrack formation: a micro-computed tomographic study. *J Endod* 2017;43(7):1166–1169. DOI: 10.1016/j.joen.2017.02.005.
- Arslan H, Yildiz E, Gunduz H, et al. Comparative study of ProTaper gold, reciproc, and ProTaper universal for root canal preparation in severely curved root canals. *J Conserv Dent* 2017;20(4):222–224. DOI: 10.4103/JCD.JCD_94_17.
- Jeevanandan G. Kedo-S paediatric rotary files for root canal preparation in primary teeth – case report. *J Clin Diagn Res* 2017;11(3):ZR03–ZR05. DOI: 10.7860/JCDR/2017/25856.9508.