



A Comparative Evaluation of Remaining Dentin Thickness Following Instrumentation of Teeth Using Different Rotary File Systems: An In-Vitro Study

Dr. Sushma k¹, Dr. B.S.Keshava Prasad², Dr.Tarun G S³, Dr. Rashmi shetty⁴
D A Pandu Memorial R V Dental College, Bangalore

Date of Submission: 01-12-2023

Date of Acceptance: 10-12-2023

ABSTRACT

INTRODUCTION: A number of factors influence endodontic success, including canal preparation, disinfection, and three-dimensional obturation. Root canal cleaning and shaping is the most important phase in endodontic success. The amount of dentin that remains after instrumentation has a direct impact on root fracture resistance. As a result, choosing a file system is important and crucial.

OBJECTIVE: To compare and evaluate the remaining dentin thickness following instrumentation of teeth using different rotary file systems- ProTaper Gold, Hyflex EDM and Mani JIZAI.

METHODOLOGY: A total of 20 extracted mandibular premolar teeth were randomly divided into 3 experimental and 1 control group of 5 specimens each. Pre-instrumentation cone-beam computed tomography (CBCT) scan was taken for all the samples which served as a baseline. Group I - ProTaper Gold, Group II - Hyflex (EDM), Group III - Mani Jizai, Group IV – Control group – No preparation was done. After instrumentation, post-instrumentation CBCT scan was obtained and compared with pre-instrumentation CBCT scan at three different levels – 3 mm, 5 mm and 7 mm from the apex and evaluated for remaining dentin thickness following root canal preparation.

RESULTS: The mean remaining dentin thickness in Buccolingual direction at 3 mm distance from apex was significantly highest in Group 3 (Mani JIZAI), followed by Group 2 (Hyflex EDM) and least in Group 1 (Pro Taper Gold) and the mean dentin removal in Buccolingual direction at 3 mm distance from apex was significantly highest in Group 1 (Pro Taper Gold), followed by Group 2 (Hyflex EDM) and least in Group 3 (Mani JIZAI).

CONCLUSION: It was discovered that different file systems resulted in varying amounts of dentin removal at the coronal, middle, and apical levels, and the amount of residual dentin determines the tooth's fracture resistance.

KEYWORDS: Remaining dentin thickness, Cone-beam computed tomography(CBCT), Pro Taper Gold, Hyflex EDM, Mani JIZAI.

I. INTRODUCTION:

Endodontic success is determined by a variety of parameters, including canal preparation, disinfection, and three-dimensional obturation.¹ The most crucial step in endodontic success is root canal cleaning and shaping. The remaining dentin thickness after instrumentation has a direct influence on root fracture resistance. The majority of dentin removal happens during root canal instrumentation.²

Maintaining residual dentin thickness during instrumentation is critical for the strength and longevity of an endodontically treated tooth. For resistance against lateral stresses, researchers concluded that a minimum of 0.3 mm of residual dentin should be present following root canal treatment. Endodontic instrumentation was traditionally done with hand files. However, the first carbon steel files were prone to fracture, tarnish, and corrosion, necessitating the use of stainless-steel files, which had their own set of issues such as breakage, inflexibility, and taper. Nickel Titanium (NiTi) devices were introduced to circumvent these restrictions. However, getting an acceptable canal taper without cutting extra dentin is a significant difficulty for any file system. As a result, the choice of file system is significant and critical.^{1,11}

Therefore, the current study was carried out to investigate the cutting efficiency of three distinct file systems in relation to the residual dentin thickness. Pro Taper Gold, Hyflex electro-discharge machining (EDM) and Mani JIZAI file systems were used in this study.

II. MATERIALS AND METHODOLOGY:

This was an in-vitro experimental study.

Preparation of the sample:

A total of 40 non-carious extracted human mandibular premolar teeth (Fig-1) were collected



and sterilized in 5.25% sodium hypochlorite (NaOCl) for 30 minutes and stored in 0.9% normal saline.



Fig-1

Methodology:

Firstly, patency of the canals was confirmed with preoperative radiographs (Fig-2). De-coronation of teeth at the level of cemento-enamel junction (CEJ) was done with a diamond disc using slow speed straight hand piece (Fig-4).

All the specimens were randomly divided into 3 experimental and 1 control group of 10 specimens each.

Groups:-

Group – 1 : ProTaper Gold file system was used (Fig-5).

Group – 2 : Hyflex EDM file system was used (Fig-6).

Group – 3 : Mani JIZAI file system was used (Fig-7).

Glide path was established with no. 10 K file (Fig-8) and a no. 15 K file was used to take the working length of the canal (Fig-9,10). Samples from each group were mounted on a modeling wax sheet. Pre-instrumentation cone-beam computed tomography (CBCT) scan was taken for all the samples at 3mm, 5mm and 7mm from the apex, which served as a baseline against which remaining dentin thickness following instrumentation by various file systems would be calculated (Fig-11-a,b,c,d,e,f).



Fig-2



Fig-3



Fig-4



Fig-5



Fig-6



Fig-7



Fig-8

Fig-9

Fig-10

PRE – INSTRUMENTATION CBCT IMAGES

At 3mm from the apex

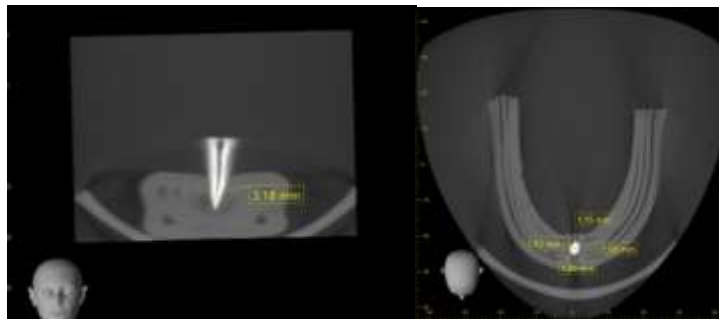


Fig-11a

Fig-11b

At 5mm from the apex

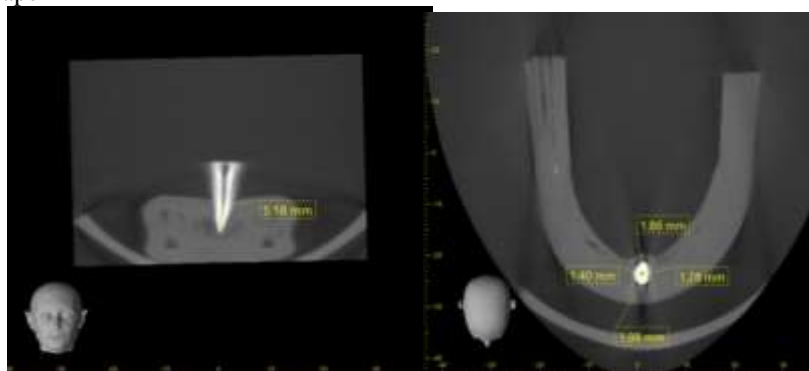


Fig-11c

Fig-11d

At 7mm from the apex

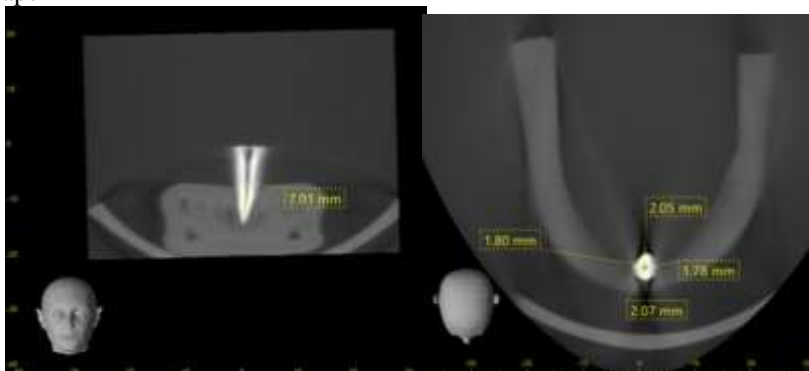


Fig-11e

Fig-11f



In all the groups, cleaning and shaping was carried out using respective file systems (Fig-12) and irrigation was performed with 3% Sodium hypochlorite between every file. For the control group, the teeth were left unprepared.



Fig-12

After cleaning and shaping, post-instrumentation CBCT scan was obtained and compared with pre-instrumentation CBCT scan at three different levels – 3 mm, 5 mm, 7 mm from the apex and evaluated for remaining dentin thickness following root canal preparation (Fig-13-a,b,c,d,e,f)

POST – INSTRUMENTATION CBCT IMAGES

At 3mm from the apex

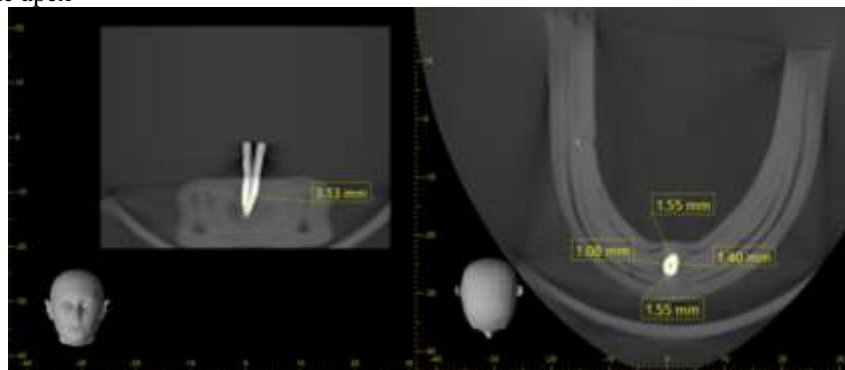


Fig-13a

Fig-13b

At 5mm from the apex

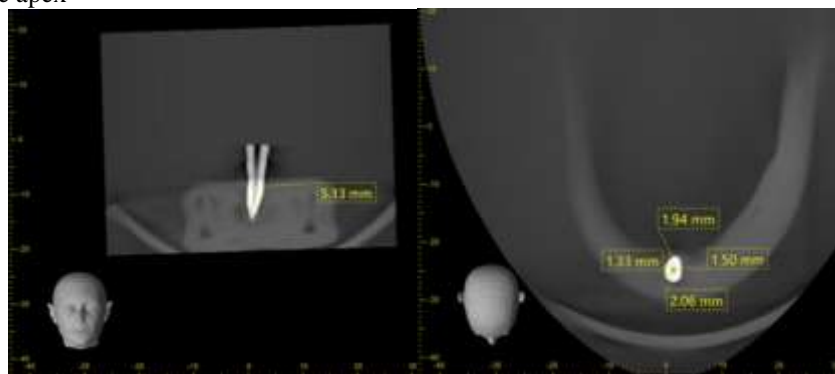


Fig-13c

Fig-13d

At 7mm from the apex

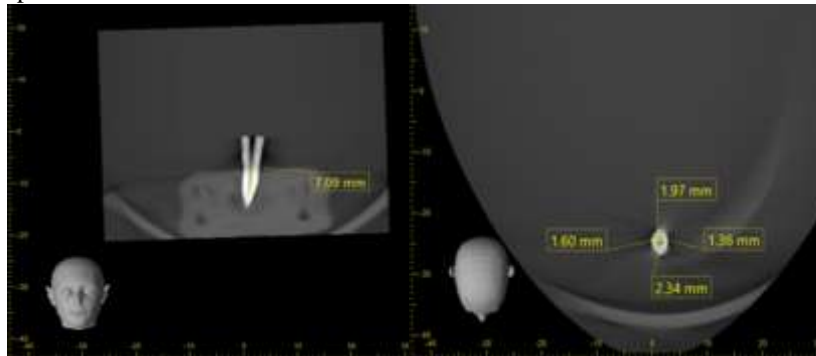
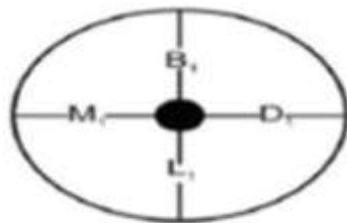


Fig-13e

Fig-13f

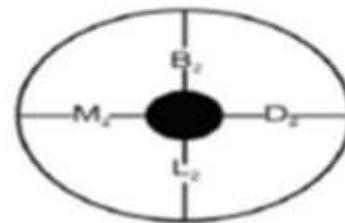
Diagrammatic representation of pre-instrumentation and post-instrumentation measurement in mesiodistal and buccolingual direction

PRE-INSTRUMENTATION POST-INSTRUMENTATION



$$\text{Mean: } MD_1 = \frac{M_1 + D_1}{2}$$

$$BL_1 = \frac{B_1 + L_1}{2}$$



$$MD_2 = \frac{M_2 + D_2}{2}$$

$$BL_2 = \frac{B_2 + L_2}{2}$$

Removed dentin in mesiodistal direction (MD) = MD₁-MD₂

Removed dentin in buccolingual direction (BL) = BL₁-BL₂

STATISTICAL ANALYSIS

Descriptive Statistics:

Descriptive analysis includes expression of study parameters in terms of Mean & SD for each group.

Inferential Statistics:

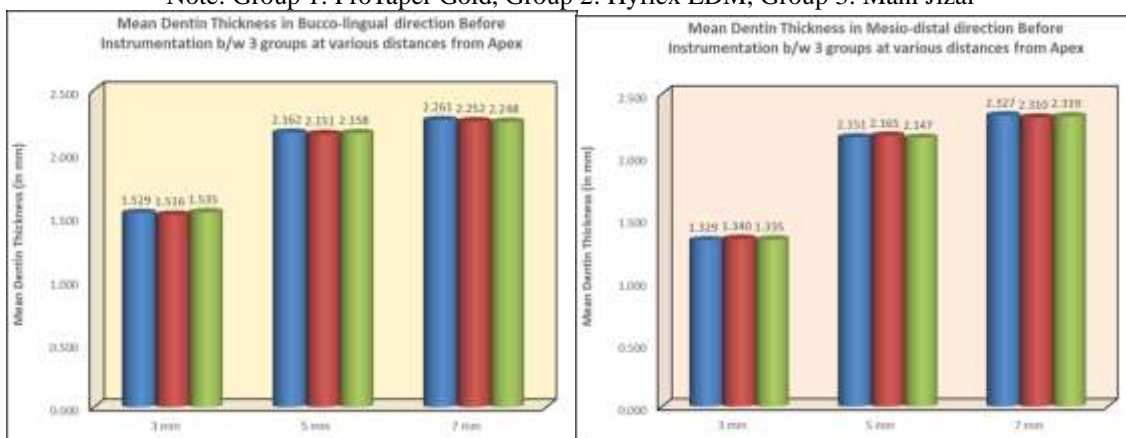
One-way ANOVA Test followed by Tukey's post hoc test was used to compare the mean dentin thickness before and after instrumentation and also the dentin removed between 3 groups at different distances from apex. The level of significance was set at P<0.05.

III. RESULTS:- COMPARISON OF MEAN DENTIN THICKNESS BEFORE INSTRUMENTATION



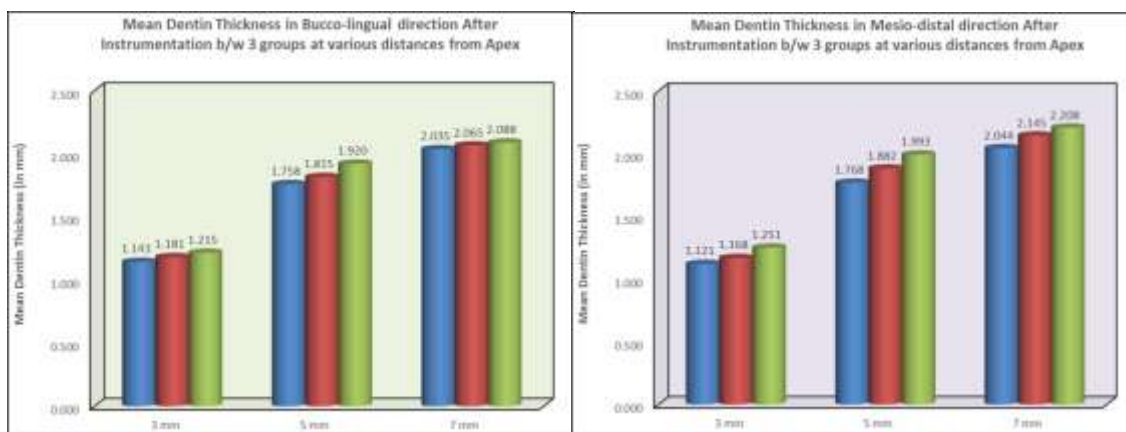
| Comparison of mean Dentin Thickness Before Instrumentation b/w 3 groups at various distances from Apex using One-way ANOVA Test | | | | | | | | |
|---|----------|----------------|-------|----------------|-------|----------------|-------|---------|
| Region | Distance | Group 1 (n=10) | | Group 2 (n=10) | | Group 3 (n=10) | | p-value |
| | | Mean | SD | Mean | SD | Mean | SD | |
| Bucco-Lingual | 3 mm | 1.529 | 0.054 | 1.516 | 0.028 | 1.535 | 0.010 | 0.48 |
| | 5 mm | 2.162 | 0.132 | 2.151 | 0.026 | 2.158 | 0.018 | 0.95 |
| | 7 mm | 2.261 | 0.064 | 2.252 | 0.009 | 2.248 | 0.012 | 0.74 |
| Mesio-Distal | 3 mm | 1.329 | 0.010 | 1.340 | 0.019 | 1.335 | 0.006 | 0.18 |
| | 5 mm | 2.151 | 0.112 | 2.165 | 0.040 | 2.147 | 0.018 | 0.83 |
| | 7 mm | 2.327 | 0.160 | 2.310 | 0.024 | 2.319 | 0.021 | 0.92 |

Note: Group 1: ProTaper Gold, Group 2: Hyflex EDM, Group 3: Mani Jizai



AFTER INSTRUMENTATION

| Comparison of mean Dentin Thickness After Instrumentation b/w 3 groups at various distances from Apex using One-way ANOVA Test followed by Tukey's post hoc Test | | | | | | | | | | | |
|--|----------|---------|-------|---------|-------|---------|-------|---------|-----------------------|----------|----------|
| Region | Distance | Group 1 | | Group 2 | | Group 3 | | p-value | Tukey's Post hoc Test | | |
| | | Mean | SD | Mean | SD | Mean | SD | | G1 vs G2 | G1 vs G3 | G2 vs G3 |
| Bucco-Lingual | 3 mm | 1.143 | 0.030 | 1.140 | 0.015 | 1.120 | 0.022 | <0.001* | <0.001* | <0.001* | |
| | 5 mm | 1.758 | 0.088 | 1.815 | 0.032 | 1.920 | 0.027 | 0.01* | 0.009* | 0.007* | |
| | 7 mm | 2.035 | 0.015 | 2.065 | 0.014 | 2.088 | 0.014 | 0.23 | .. | .. | .. |
| Mesio-Distal | 3 mm | 1.121 | 0.053 | 1.168 | 0.017 | 1.251 | 0.026 | <0.001* | <0.001* | <0.001* | |
| | 5 mm | 1.768 | 0.020 | 1.823 | 0.039 | 1.930 | 0.030 | <0.001* | <0.001* | <0.001* | |
| | 7 mm | 2.044 | 0.019 | 2.145 | 0.10 | 2.208 | 0.191 | 0.01* | 0.04* | 0.01* | |



SAMPLE INTERPRETATION:

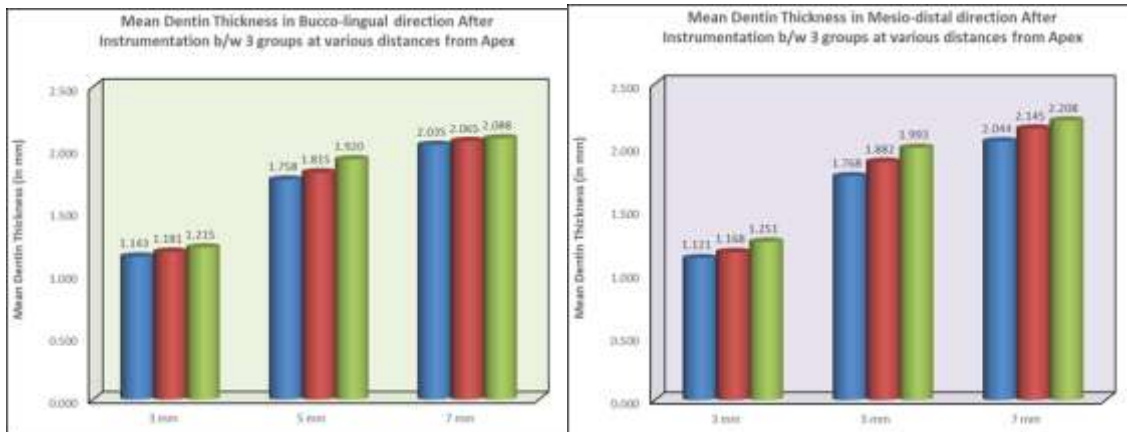
At 3 mm distance from the apex, the mean remaining dentin thickness in the Bucco-lingual direction showed statistically significant difference between 3 groups at $p < 0.001$. The mean remaining dentin thickness at 3 mm was significantly higher in Group 3 compared to Group 2 & Group 1 and it was statistically significant at $p = 0.01$ & $p < 0.001$. Later, Group 2 showed significantly higher mean

remaining dentin thickness as compared to Group 1 and it was statistically significant at $p = 0.003$.

This infers that the mean remaining dentin thickness in Buccolingual direction at 3 mm distance from apex was significantly highest in Group 3 (Mani JIZAI), followed by Group 2 (Hyflex EDM) and least in Group 1 (Pro Taper Gold).

COMPARISON OF MEAN DENTIN REMOVAL

| Comparison of mean Dentin removal b/w 3 groups at various distances from Apex using One-way ANOVA Test followed by Tukey's post hoc Test | | | | | | | | | | | |
|--|----------|---------|-------|---------|-------|---------|-------|---------|-----------------------|----------|----------|
| Region | Distance | Group 1 | | Group 2 | | Group 3 | | p-value | Tukey's Post hoc Test | | |
| | | Mean | SD | Mean | SD | Mean | SD | | G1 vs G2 | G1 vs G3 | G2 vs G3 |
| Bucco-Lingua | 3 mm | 0.386 | 0.049 | 0.335 | 0.032 | 0.320 | 0.014 | 0.001* | 0.001* | 0.001* | 0.004* |
| | 5 mm | 0.404 | 0.043 | 0.336 | 0.049 | 0.238 | 0.025 | 0.001* | 0.001* | 0.001* | 0.001* |
| | 7 mm | 0.226 | 0.086 | 0.187 | 0.016 | 0.160 | 0.015 | 0.03* | 0.01* | 0.009* | 0.10 |
| Mesio-Distal | 3 mm | 0.208 | 0.054 | 0.172 | 0.029 | 0.084 | 0.019 | <0.001* | <0.001* | <0.001* | <0.001* |
| | 5 mm | 0.383 | 0.027 | 0.283 | 0.044 | 0.154 | 0.029 | <0.001* | <0.001* | <0.001* | <0.001* |
| | 7 mm | 0.283 | 0.018 | 0.165 | 0.015 | 0.111 | 0.022 | <0.001* | <0.001* | <0.001* | 0.002* |



SAMPLE INTERPRETATION:

At 3 mm distance from the apex, the mean dentin removal in the Bucco-lingual direction showed statistically significant difference between 3 groups at $p=0.001$. The mean dentin removal at 3 mm was significantly higher in Group 1 compared to Group 2 & Group 3 and it was statistically significant at $p=0.001$ in both groups. Later, Group 2 showed significantly higher mean dentin removal as compared to Group 1 and it was statistically significant at $p=0.004$.

This infers that the mean dentin removal in Buccolingual direction at 3 mm distance from apex was significantly highest in Group 1 (Pro Taper Gold), followed by Group 2 (Hyflex EDM) and least in Group 3 (Mani JIZAI).

IV. DISCUSSION:-

Endodontic therapy's success is founded on three factors: root canal debridement, effective disinfection, and three-dimensional obturation of root canal space. The success of all subsequent processes is determined by the cleaning and shaping of the root canal system.³ The entire root canal space should have appropriate taper to allow for proper irrigation and obturation, but over-enlargement undermines the root structure unnecessarily. As a result, selecting an appropriate instrument for instrumentation is critical for the success of root canal therapy.⁴ Moore, Walter, and Parashos (2009) demonstrated that hand instrumentation is not as conservative of apical root dentin as rotary NiTi instruments, and that NiTi instruments prepared the canal to larger apical diameters with little iatrogenic mistakes. The remaining dentin thickness after instrumentation may be the most important iatrogenic factor influencing tooth fracture resistance.⁵

Raiden et al. 2001 discovered that radiographs frequently show more dentin thickness than is actually there. CBCT was utilised in this

study because it provides for three-dimensional views of the root canal space (transverse, axial, and tangent) as well as pre- and post-instrumentation measurements of the amount of dentin removed following instrumentation.^{7,10} Three areas of root canal system were evaluated: 3 mm, 5 mm, and 7 mm which represent the apical, middle, and coronal thirds of root canal respectively, wherein there is a high vulnerability of occurrence of iatrogenic mishaps.

In the present study, the mean dentin removal was highest with Protaper Gold file system owing to the file system having a convex triangular cross-section, sharp cutting edges with positive angle, progressive taper and advanced U-shaped flute design to increase flexibility, noncutting tip design, more positive rake angle variable taper among the length of the instrument making removal of dentin higher.⁶

HyFlex EDM instruments are manufactured by a process called Electro-discharge machining. This process produces rough surface, sharp cutting edges built-in abrasive properties which result in faster preparation of root canal system, progressive flexibility and variable changing profiles.^{8,9}

Mani JIZAI files are fully heat treated, highly flexible and designed to cut smoothly and efficiently. The rhomboidal cross-sectional shape and flute pitch helps to prevent over instrumentation and file binding making removal of dentin lesser compared to the other two groups.

The results of this in vitro study must be verified by larger sample size in in-vivo studies.

V. CONCLUSION:-

The design and metallurgy of NiTi endodontic instruments require constant refinement in order to reduce the amount of dentin removed during instrumentation and the number of endodontic failures.



Keeping all the limitations of the present study in mind, it was discovered that the design elements of some rotary files have a negative effect on the remaining dentin thickness, but the benefits of these rotary instruments outweigh these negative impacts.

It was discovered that different file systems resulted in varying amounts of dentin removal at the coronal, middle, and apical levels, and the amount of residual dentin determines the tooth's fracture resistance.

REFERENCES:-

- [1]. Kumar T, Mittal S, Keshav V, Kaur R, Maakhni E. A comparative evaluation of remaining dentin thickness following biomechanical preparation of teeth using different rotary file systems: An in vitro study. *J Conserv Dent* 2022;25:32-6.
- [2]. Shaheen NA, Farag AM, Alhadainy HA, Darrag AM. Fracture resistance of endodontically treated roots using different preparation-obturation combinations. *Tanta Dent J* 2013;10:97-102.
- [3]. Bier CA, Shemesh H, Tanomaru-Filho M, Wesselink PR, Wu MK. The ability of different nickel-titanium rotary instruments to induce dentinal damage during canal preparation. *J Endod* 2009;35:236-8.
- [4]. Zandbiglari T, Davids H, Schäfer E. Influence of instrument taper on the resistance to fracture of endodontically treated roots. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2006;101:126-31.
- [5]. Pilo R, Corcino G, Tamse A. Residual dentin thickness in mandibular premolars prepared with hand and rotatory instruments. *J Endod* 1998;24:401-4
- [6]. Kandari S, Madan M, Dua P, Saini S, Mangla R. Comparison of the cleaning efficiency and instrumentation time in primary and permanent teeth by using k-file, ProTaper and HyFlex file systems: An in-vitro study. *Indian J Dent Sci.* 2016;8:1-5.
- [7]. Tomer AK, Miglani A, Chauhan P, Nagarjuna P, Rana S, Kumari A. An in-vitro evaluation of remaining dentine thickness through Cbct using different files. *IOSR J Dent Med Sci.* 2017;16:121-4.
- [8]. Ghoneim WM, Farag AM, Labib AH, Darrag AM. Cleaning efficacy of different root canal preparation systems and irrigation regimens. *Tanta Dent J.* 2014;11:36-41.
- [9]. Venino PM, Citterio CL, Pellegatta A, Ciccarelli M, Maddalone M. A micro-computed tomography evaluation of the shaping ability of two nickel-titanium instruments, HyFlex EDM and ProTaper Next. *J Endod* 2017;43:628-32.
- [10]. Scarfe WC, Farman AG. Cone beam computed tomography. In: White SC, Pharoah MJ, editors. *Oral Radiology: Principles and Interpretation.* 6th ed. Mosby, 2009, 225-43.
- [11]. Rubio J, Zarzosa JJ, Pallarés A. Comparison of shaping ability of 10 rotary and reciprocating systems: An in vitro study with AutoCad. *Acta Stomatol Croat* 2017;51:207-16.