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In vivo Comparison of Surface Changes between Two Nickel Titanium Rotary Single File Systems after Instrumentation in Moderately Curved Root Canals

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Aim: To compare post instrumentation surface changes between Two Nickel-Titanium Single Rotary systems (FKG XP Endo Shaper, FKG Dentaire, La Chaux-de-Fonds, Switzerland and Micromega One Curve, Micro Mega, Besancon, France using Stereomicroscope.
Materials and Methods: 40 patients requiring endodontic treatment and satisfying the inclusion criteria for the study were included and randomly divided into 4 groups having 10 patients each. Group 1: Instrumentation of root canal in 10 patients was done using FKG Endo Shaper for 15 seconds. Group 2: Instrumentation of root canal in 10 patients using FKG Endo Shaper for 30 seconds Group 3: Instrumentation of root canal in 10 patients using Micromega One Curve for 15 seconds .Group 4: Instrumentation of root canal in 10 patients using Micromega One Curve for 30seconds. After instrumentation for specified time all the files were examined at the apical and middle third under the Stereomicroscope (Labomed, Inc, United States) at 40X magnification for the presence of any surface changes(defects/ deformity). Scoring of defects was assigned to each file according to the degree of damage. Results were statistically analysed using Kruskal Wallis test and Mann Whitney Post hoc test and were used to compare the median microscopic scores

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between different groups at Apical and Middle 3rd region. The level of significance was set at P<0.05.

Results: Comparison of microscopic scoring between both the file groups at apical and middle third region using Kruskal Wallis Test revealed that a statistically significant difference was observed in the apical region with p value <o.o2, No statistical significant difference was found in the middle third region, suggesting that the apical region showed more surface changes than the middle third region. Comparison of scores between groups at the apical region using Mann Whitney Post hoc test revealed that there was statistically significant difference in Group 1 compared with group 2, group 3 and group 4 whereas, there was no statistical significant difference between other groups. Comparison of microscopic scoring between Apical and Middle region in each group using Wilcoxon Signed Rank Test revealed that a statistically significant difference was found in the middle third region of Group 4 with P value P<0.03.

Conclusion: It was concluded that More surface changes were seen in FKG XP Endo Shaper file than Micromega One curve. Apical regions showed more changes compared to the middle third region and there was statistically significant difference between groups 1 ,2 and 3. None of the instruments fractured during instrumentation.

Keywords: Surface changes; surface defects; nickel titanium; instrumentation; FKG XP endoshaper; micromega one curve; stereomicroscope.

1. INTRODUCTION

Endodontic treatment demands treating the diseased tooth so that it is retained in its functional and esthetic form [1]. A successful endodontic treatment depends on many factors among which preparation of root canal is recognized as being one of the most important stages [1].

It includes the removal of living and dead necrotic tissues from the root canal, along with infected root dentin. It aims to facilitate disinfection by irrigants and medicaments, prepare the canal space and shape the walls of the root canal to receive a filling material. Thus, canal preparation is an important step that eliminates infection. Prevention of reinfection is then achieved by sealing three dimensionally the canal; apically as well as coronally [2]. This is essential because canal preparation determines the efficacy of the subsequent procedures [3].

Instrumenting the root canal to create a continuously tapered funnel shape seems to be an important step in root canal therapy. Earlier the endodontic instruments were made of carbon steel which were prone to corrosion and hence, corrosion resistant stainless steel alloy was introduced and used extensively as a material of choice for all types of endodontic instruments. These stainless steel instruments were corrosion resistant and had good cutting efficiency, but were less flexible. This lack of flexibility leads to procedural errors because of the tendency of the instruments to sustain plastic deformation when subjected to forces leading to the change in shape permanently [4].

Recently, a newer generation of endodontic files has been manufactured of Nickel Titanium (NiTi) alloy. NiTi endodontic instruments are important adjuncts in endodontic therapy [3].

NiTi was developed by W.F Buehler in 1960 at the Naval Ordinance Laboratory. The first investigation of Nitinol was conducted by Walia et al in 1988. The unique features of this alloy are its super elasticity and its shape memory allowing them to return to their original shape upon unloading after substantial deformation [4]. It also has greater strength and high flexibility. This nickel titanium alloy which is used to manufacture root canal instruments approximately contains 56% (wt) nickel and 46%(wt) titanium. In newer NiTi alloys 2% (wt) of nickel is substituted for cobalt called Nitinol. Nitinol files have a degree of flexibility appropriate for shaping curved root canals [5].

A revolutionary concept of single file system has been developed for shaping a vast majority of canals, regardless of their length, diameter or curvature. This concept was introduced by Dr. Ghussan Yared. The concept behind this concept was to achieve the whole canal preparation by the use of a single NiTi rotary file.

The advantage of this file system was cost effectiveness, reduced risk of cross-contamination [6]. This can encourage the

practitioners to use such instruments for a single case.

Despite their advantages, these NiTi files have the tendency to separate in the root canal and affect the treatment outcome.

Stainless steel instruments show signs of distortion before fracture while NiTi instruments fracture without warning [7]. It is impractical to predict instrument separation upon naked eye inspection [8]. The major clinical concern with the use of rotary Ni-Ti instruments is the unexpected fracture that occurs without any visible defects of previous permanent derformation [9].

Stress buildup within the files caused fatigue during its use in the root canals. Fatigue of NiTi instruments occurs in two ways:

1. Flexural/ cyclic fatigue
2. Torsional fatigue

Flexural fatigue is caused because of repeated compressive and tensile stresses at the point of maximum flexure when the file is used within the curved root canals.

Torsional fatigue is another form of stress buildup in the file that occurs during its rotation in the canal [10].

Torsional fatigue generally occurs in three situations:

1. If a large surface of the instrument rubs excessively against the canal walls.
2. If instrument tip is larger than the canal section to be shaped.
3. If the operator exerts excessive pressure on the handpiece during filing.

It is further classified into two types:

a. Dynamic torsional fatigue: Occurs due to frictional forces caused by the resistance of dentin to cutting by the file.
b. Static torsional fatigue: Occurs due to continuous rotation of the file at one end while the other end stops spinning, i.e., when the tip or a part of file binds in the root canal and handpiece continues to rotate torsional failure occurs [11].

Thus, in order to reduce the risk of instrument separation within the root canals, all files should be examined after each use and files showing any kind of surface change or deformity must be discarded immediately [8].

Hence, the purpose of this study was to observe and compare the surface changes in FKG XP Endo Shaper and Micromega One Curve Nickel Titanium files post root canal instrumentation under the stereomicroscope and to minimize the risk of instrument separation, thus preventing iatrogenic procedural errors.

1.1 Objectives of the Study

1. To compare post instrumentation surface changes of Nickel-Titanium Endodontic Instruments - FKG XP Endo Shaper (FKG Dentaire, La Chaux-de-Fonds, Switzerland) and Micromega One Curve (Micro Mega, Besancon, France) under the stereomicroscope.
2. To assess the tendency of fracture of Nickel-Titanium endodontic instruments within the root canals.

To help the clinicians identify such changes or deformities during its clinical use and discard the instrument at right time and prevent its separation within the root canal

2. MATERIALS AND METHODS

Sample Size: total of 40 samples, 4 groups, each with 10 samples.

2.1 Sample Size Estimation

The sample size has been estimated using the GPower software v. 3.1.92 (Department of Psychoogy, Heinrich Heine university Dusseldorf, Germany).

Considering the effect size to be measured (d) at 80% for Two-tailed hypothesis, power of the study at 80% and the margin of the error at 10%, the total sample size needed is 40. Hence each study group will comprise of 20 samples.

Further, in each study group, the files will be divided as 10 each for assessment at two different time intervals.

[10 samples x 2 groups x 2 time intervals]

2.2 Source of the Sample

40 patients visiting the Department of Conservative Dentistry and Endodontics Dental

college ,Bangalore, India and satisfying the inclusion criteria were selected for the study

2.2.1 Inclusion criteria

- Patients willing to participate in the study
- Patients presenting with a non contributing medical history that will not affect the outcome of the results.
- Patients between the age group 18-35
- Patients having low to moderate caries rate, normal periodontal status with good home care and possess an uncompromised dentition
- Patients with irreversible pulpitis indicated for root canal treatment
- Mesial Root canals of mandibular molars which are moderately curved. (having degree of curvature of 10-20 degrees according to Schneiders classification)

2.2.2 Excluding criteria

- Patients who are not willing to participate in the study
- Patients presenting with a chronic disease having oral manifestations.
- Patients who exhibit gross oral pathology, poor hygiene or poor dental health.
- Patients with poor periodontal status that could compromise the results of the study.
- Subjects who are allergic to any of the materials being used in the study
- Severely curved root canals(degree of curvature >20 degree)
- Teeth with open apex
- Teeth having internal or external resorption
- Teeth with any developmental anomalies in root canal shape

Clinical and radiographic examination of OPD (Out Patient Department) Patients presenting with irreversible pulpitis of Mandibular molars indicated for root canal treatment to the department of Conservative Dentistry and Endodontics was done. IOPA (Intra Oral Periapical) radiographs taken for each tooth of interest were examined for root canal curvature. Schneider's method (Table 1) was used to identify / classify the canals having moderate curvature.

40 subjects satisfying the inclusion criteria were selected for the study.

The subjects selected were then divided into 4 groups depending on file used and duration of instrumentation within the root canal.

A single clinician evaluated all the patients and also provided treatment to eliminate or minimize the interpersonal variability. Firstly, all the files were examined before use (pre instrumentation) for any manufacturing defects under the stereomicroscope at 40X magnification. Files with the defects were not used further for the study and discarded. Root canal therapy indicated for the particular tooth in subjects was initiated. Prior to the start of root canal treatment, Local anesthetic solution (2% LIGNOX with 1:80000 adrenaline, Apexion Dental products and services, India)was administered using Inferior Alveolar Nerve block to achieve local anesthesia .The tooth of interest was isolated with Rubber dam (Coltene, India). Access opening was done using access opening burs (Endo access burs, Endo Z burs, Denstply Maillefer, North America) After gaining access to the pulp chamber the canal orifices were located using DG 16 endodontic explorer (GDC, India). Canal orifices were enlarged using orifice opener (Neo Endo, Orikham, India), used according to the manufacturer instructions.

Working length determination was done using Propex ii apex locator, (Dentsply , China) NiTi file and for specific duration of time in each group according to the manufacturer's instructions.

The following are the 4 groups into which the instrumentation of mesial root canals of mandibular molar teeth were done for different time intervals using different NiTi files.

Table 1. Schneiders's classification of root canal curvature

Classification	Degree of curvature
Straight	5 degree or less
Moderate curvature	10-20 degree
Severe curvature	25- 75 degree

Table 2. Grouping of subjects

Group	No of samples	Instrument used	Duration of instrumentation
1	10	FKG XP Endo Shaper (FKG Dentaire, La Chaux-de-Fonds, Switzerland)	15 seconds
2	10	FKG XP Endo Shaper (FKG Dentaire, La Chaux-de-Fonds, Switzerland)	30 seconds
3	10	MicroMega One Curve (Micro Mega, Besancon, France)	15 seconds
4	10	MicroMega One Curve Micro Mega, Besancon, France)	30 seconds

Total number of samples= 40

Group 1: Instrumentation of root canal was done in 10 patients using XP Endo Shaper File for 15 seconds according to the manufacturer's instructions.

Group 2: Instrumentation of root canal was done in 10 patients using XP Endo Shaper File for 30 seconds according to the manufacturer's instructions.

Group 3 : Instrumentation of root canal was done in 10 patients using Micro Mega One Curve File (25mm, 6%) for 15 seconds according to the manufacturer's instructions.

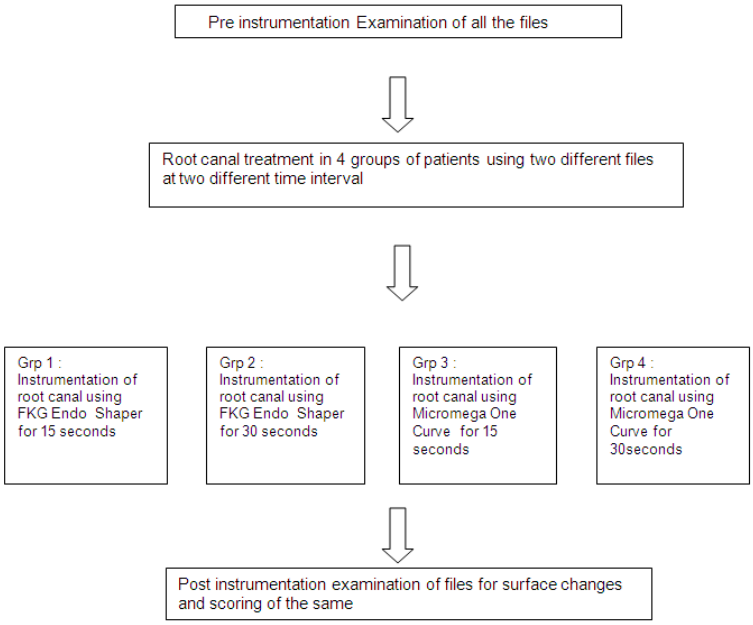
Group 4: Instrumentation of root canal was done in 10 patients using Micro Mega One Curve File (25mm, 6%) for 30 seconds according to the manufacturer's instructions.

Instrumentation was done using 15% EDTA (RC HELP, Prime Dental, India) as lubricant and during instrumentation the canals were irrigated with 3% sodium hypochlorite (Prime Dental, India) and recapitulated. Normal saline was used a final irrigant. The instrumented files in each group were cleared off the debris and stored separately for further examination.

These files were taken for examination under the stereomicroscope to observe any surface change/ defect. The defects observed were assigned scores were obtained.

Further, Root canal preparation was completed using newer different files for remaining canals and the treatment was completed for each patient.

2.3 Study Design



2.4 Stereomicroscopic Examination

Each file was examined after instrumentation in root canals**,** after 15 seconds and 30 seconds as described in the groups. Examination was done by a single observer at the apical and middle third region of the file separately under the Stereomicroscope(Labomed, Inc, United States) in 40X magnification at 90-360 degrees for the presence of any surface change (defect or deformity). Photographs were taken of each file using a digital camera attached to the stereomicroscope. The observations/data obtained were recorded and maintained for data analysis.

Scoring of surface changes was assigned to each file according to the degree of changes using the below criteria

2.5 Criteria for Scoring [12]

1. No defect (no plastic deformation or bending or other deformation of the cutting edge is visible)
2. Minor plastic deformation(the cutting edge or flute of the instrument is curved or deformed with the disruption of cutting edge)
3. Blunting of cutting edges / Micro cracks (the flute or the cutting edge of the instrument is blunt with or without microcracks)
4. Craters (some part of the flute or the cutting edge of the instrument is missing as indicated by a crater on the surface)
5. Fracture

The scores obtained for each group were submitted for statistical analysis.

3. RESULTS AND DISCUSSION

3.1 Descriptive Statistics

Descriptive analysis includes expression of Microscopic Findings scores for different groups in terms of Medial and Inter Quartile Range.

3.2 Inferential Statistics

Kruskal Wallis test followed by Mann Whitney Post hoc test was used to compare the median microscopic scores between different groups at Apical and Middle 3rd region.

Wilcoxon Signed Rank test was used to compare the median microscopic scores between Apical and Middle 3rd regions in each group.

The level of significance was set at $P<0.05$.
The scores obtained after microscopic examination for each group are:

Table 3. Scoring for Group 1 (Fkg XP Endo Shaper for 15 seconds)

Sample No	Apical third score	Middle third score
1	2	4
2	3	1
3	2	1
4	4	2
5	1	2
6	2	1
7	2	1
8	3	2
9	2	1
10	2	1

Table 4. Scoring for Group 2 (Fkg XP Endo Shaper for 30 seconds)

Sample No	Apical third score	Middle third score
1	3	3
2	1	1
3	2	1
4	1	1
5	2	1
6	1	1
7	1	2

Sample No	Apical third score	Middle third score
8	2	2
9	2	2
10	1	1

Table 5. Scoring for Group 3 (Micro Mega One Curve for 15 seconds)

Sample No	Apical third score	Middle third score
1	1	1
2	2	1
3	2	1
4	2	2
5	1	1
6	1	1
7	1	1
8	1	4
9	1	2
10	1	1

Table 6. Scoring for Group 4 (Micro Mega One Curve for 30 seconds)

Sample No	Apical third score	Middle third score
1	2	2
2	2	3
3	2	2
4	1	1
5	2	2
6	2	3
7	1	2
8	1	1
9	2	3
10	1	2

After performing statistical analyses for the data obtained from all the 4 groups, the following results were obtained.

Table 7. Distribution of microscopic scoring in apical and middle third region

Distribution of Microscopic scoring of different file groups in Apical & Middle Region								
Region	**Scores**	**Group 1**		**Group 2**		**Group 3**		**Group 4**	
		n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Apical	Score 1	1	10%	5	50%	7	70%	4	40%
	Score 2	6	60%	4	40%	3	30%	6	60%
	Score 3	2	20%	1	10%	0	0%	0	0%
	Score 4	1	10%	0	0%	0	0%	0	0%
Middle	Score 1	6	60%	6	60%	7	70%	2	20%
	Score 2	3	30%	3	30%	2	20%	5	50%
	Score 3	0	0%	1	10%	0	0%	3	30%
	Score 4	1	10%	0	0%	1	10%	0	0%

Table 8. Comparison of score between different files at apical and middle third region

Comparison of Microscopic scoring between different files at Apical and Middle region using Kruskal Wallis Test						
Region	**Groups**	**Median**	**IQR**	**Min**	**Max**	**p-value**
Apical	Group 1	2.0	1	1	4	0.02*
	Group 2	1.5	1	1	3	
	Group 3	1.0	1	1	2	
	Group 4	2.0	1	1	2	
Middle	Group 1	1.0	1	1	4	0.14
	Group 2	1.0	1	1	3	
	Group 3	1.0	1	1	4	
	Group 4	2.0	1	1	3	

** - statistically significant*

Greater number of surface changes were seen under the stereomicroscope when compared to the naked eye observation.

Comparison of microscopic scoring between different files at apical and middle third region using Kruskal Wallis Test revealed that a statistically significant difference was observed in the apical region with p value <o.o2.

No statistical significant difference was found in the middle third region.

Comparison of scores between groups at apical region using Mann Whitney Post hoc test revealed that there was statistically significant difference in Group 1 compared with group 2, group 3 and group 4

The difference between group 1 and group 2 was of borderline significance with p value P<0.05 and the difference between group 1 and group 3 was statistically significant with P <0.005 and between group 1 and group 4 was P<0.04

Whereas, there was no statistical significant difference between other groups.

Comparison of microscopic scoring between Apical and Middle region in each group using Wilcoxon Signed Rank Test revealed that a statistically significant difference was found in the middle third region of Group 4 with P value P<0.03

The following are the stereomicroscopic photographs of surface changes seen in FKG XP Endo shaper files

Table 9. Comparison between groups at apical region

Multiple comparison of scores b/w groups at Apical region using Mann Whitney Post hoc Test						
Groups	1 vs 2	1 vs 3	1 vs 4	2 vs 3	2 vs 4	3 vs 4
p-value	0.05[#]	0.005*	0.04*	0.31	0.87	0.19

** - Statistically Significant, # - Borderline Significance*

Table 10. Comparison between apical and middle third region in each group

Comparison of Microscopic scoring between Apical and Middle region in each group using Wilcoxon Signed Rank Test						
Groups	**Region**	**Median**	**IQR**	**Min**	**Max**	**P-Value**
Group 1	Apical	2.0	1	1	4	0.12
	Middle	1.0	1	1	4	
Group 2	Apical	1.5	1	1	3	0.56
	Middle	1.0	1	1	3	
Group 3	Apical	1.0	1	1	2	0.71
	Middle	1.0	1	1	4	
Group 4	Apical	2.0	1	1	2	0.03*
	Middle	2.0	1	1	3	

** - statistically significant*

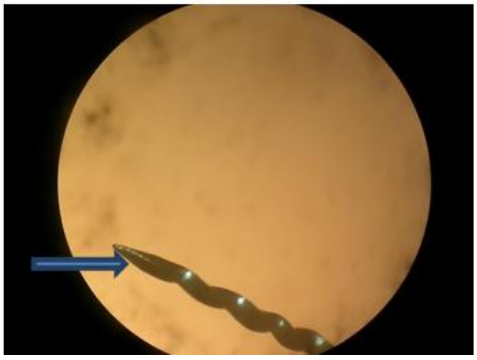


Fig. 1.Minor plastic deformation at apical region

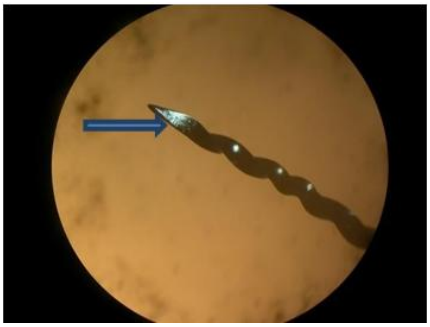


Fig. 2. Blunting of cutting edges

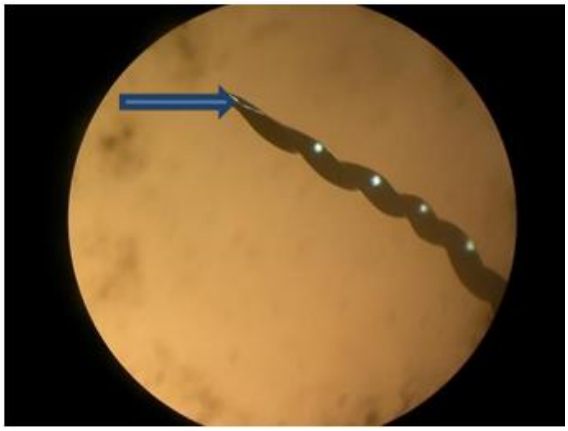


Fig. 3. Crater

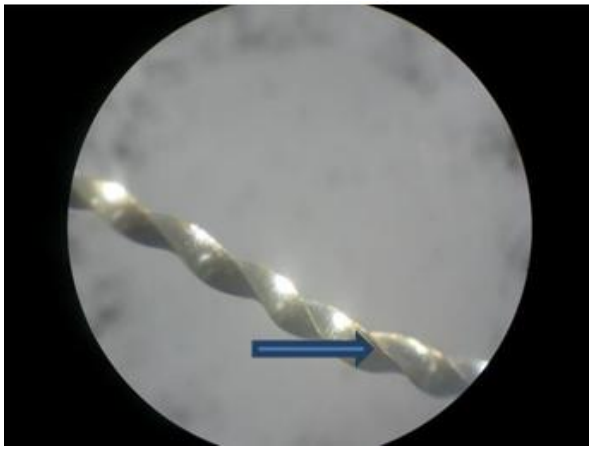


Fig. 4. Minor plastic deformation at middle 3rd region

The following are the stereomicroscopic photographs of surface changes seen in Micro Mega One Curve files.

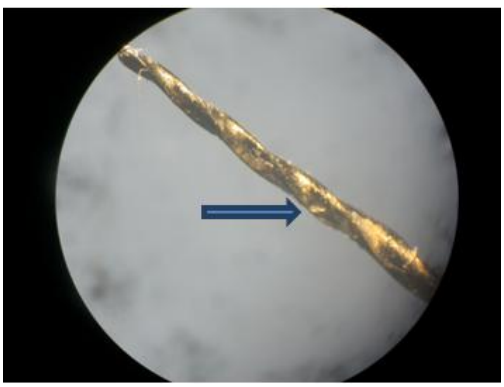


Fig. 5. Minor plastic deformation at apical

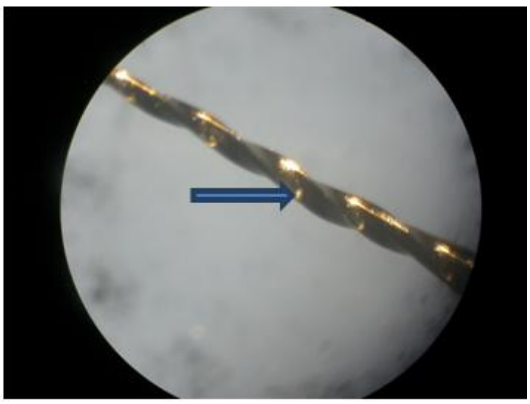


Fig. 6. Minor plastic deformation at middle 3rd region

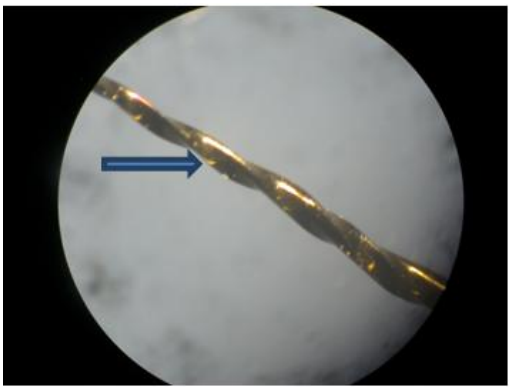


Fig. 7. Blunting of cutting edges

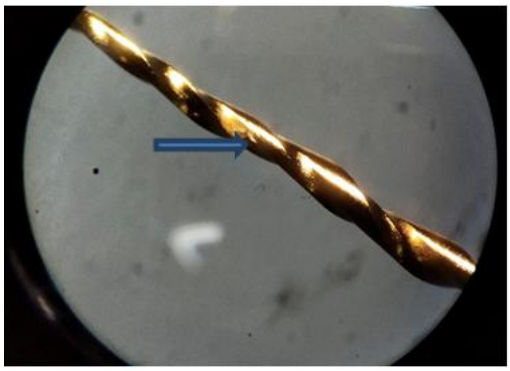


Fig. 8. Crater

4. DISCUSSION

Endodontic instruments and irrigants are used to shape and clean the root canals.It is not uncommon to find curved roots and root canals and preparation of such canals is challenging [13]. Instruments which are more flexible and possess a low modulus of elasticity are used to prepare a curved canal, thus, preserving the original canal curvature. The inherent stiffness of stainless-steel instruments increases as the instrument size increases. The restoring forces strive to return the instrument to its original shape while preparing a curved root canal . As a result, stainless steel instruments must be pre-curved before being used in curved canals. While doing so these instruments have a tendency to straighten the canal as they cut more on the convex side than the concave side and result in unwanted procedural errors thereby preventing them from being used in curved canal preparation [3].

Instruments made of a nickel–titanium (NiTi) alloy have proven to be an effective addition to endodontic treatment. NiTi instruments have inundated the market in recent decades. These devices have greatly enhanced the quality of root canal cleaning and shaping. Instruments made of NiTi have an advantage over stainless steel in that they are exceedingly flexible and elastic [4]. They offer the right amount of flexibility for shaping curved root canals [6]. The type of alloy, degree of taper, and cross-sectional design all influence the properties of instruments. Despite their benefits, these NiTi files have a tendency to fracture/separate in the root canal during clinical use, and it may be at times impossible to remove the separated fragment which can hinder effective disinfection of root canals. Instrument fracture is a potentially catastrophic blunder that can complicate and limit endodontic therapy, especially if the separated fragment prevents access to the uncleaned apical root canal [14].

The most common causes of rotational Ni- Ti instrument fracture are cyclic, static torsional, and dynamic torsional fatigue. When the tip or any component of the instrument is locked in a canal while the shaft continues to rotate, the metal surpasses its elastic limit, causing plastic deformation and breakage [15]. Unlike cyclic fatigue, which is mostly determined by the canal's original morphology and is difficult to change.

Thus, we can intervene in cases of torsional fatigue by using the instruments correctly and discarding them before they separate while in use.

In the present study, two different rotary file systems, FKG XP Endo shaper and Micromega One Curve were used for the preparation of moderately curved canals.

It has been observed that fracture of nickel-titanium files could occur with little or no visible evidence of accompanying plastic deformation [16,17]. Surface changes in NiTi files and their fracture on clinical usage have been reported in a number of studies [15,18,30-35].

NiTi alloy may be stressed much further than stainless steel before becoming irreversibly deformed due to its wide range of elastic deformation.

Deformation of spirals, scraping, pitting, disruption of the cutting edge and blunt edge, and instrument breakage are all sorts of defects of nickel-titanium instruments. Sattapan B ,2000

[18] conducted a study to analyze the type and frequency of defects of nickel-titanium rotary files discarded after routine clinical use. From this study two main characteristics of the fractured instruments were disclosed. One characteristic was demonstration of a visible defect and the other characteristic was fracture without having any visible surface defects.

Classification of the different types of defects was given by Sotokawa [15], Bonetti [36]. Another classification was also given by Chakka NV [36] which indicated the severity of the defect or damage in the file . This study used the criteria for scoring the defects which was recently given by Purayil [12] The changes/ defects observed after clinical usage were scored accordingly and the data obtained was subjected to statistical analysis.

The question of how many times nickel-titanium rotary instruments can be used before being discarded cannot be answered definitively. The performance and clinical safety of NiTi equipment are influenced by a number of factors. These include aspects of the instrument, the root canal system, and the technique of canal cleaning and shaping. Given the wide range of clinical conditions, the unpredictable nature of breakage, and the implications of breakage, a "safe" number of uses should be determined and closely adhered to by the clinicians.

The manufacturers of rotary instruments urge that they be checked on a regular basis for defects that could warn the user before a fracture occurs. However, it remains a concern that rotary nickel- titanium instruments might break without warning.

Several studies were previously conducted to evaluate deterioration of NiTi instruments with usage. These studies focused to assess the maximum number of times a NiTi instrument can be used within the canal. This study emphasizes on the duration of time an instrument can be usedsafely without fracture in the canal.

It would appear that the resistance of files differ depending on whether the canals are relatively straight or slightly curved or, conversely, whether the curvature of the canals is pronounced and acute. Mesial canals of lower molar with moderate curvature were chosen because they possess relatively complicated curve and are typically smaller in diameter than distal canals, offering a larger challenge to rotary instrumentation. Aydin et al [19] and Beasley et al [20] both agree on this. Endodontic instruments made of nickel-titanium were created to make instrumenting of curved canals easier with fewer or no procedural errors.

In this study no manufacturing defects were observed which is also in agreement to Herold et al 2007 [21] and Chianello et al 2008 [22] who found that newer files with polished surfaces were free of defects.

Comparison of microscopic scoring between different files at apical and middle third region using Kruskal Wallis Test revealed that a statistically significant difference was observed in the apical region with p value <o.o2 and no statistical significant difference was found in the middle third region. More surface changes in the apical region of the instrument could be due to narrow apical area in curved root canals. As stated by Peter OA et at,2003 , the torque that is generated during canal instrumentation was found to have been related to the preoperative canal volume. As a result, rotating instruments may be subjected to increased torsional loads when preparing small and confined channels [23].

A file is compressed (compressive stress) on the inner curved surface and lengthened (tensile stress) on the outer curve when it is cycled around a curve. This bending and unbending of the file may result in the creation of surface cracks in these areas of high tensile stress, culminating in breaking.

Comparative evaluation of scores between groups at apical region using Mann Whitney Post hoc test revealed that there was statistically significant difference in Group 1 compared with group 2 ,group 3 and group 4 . This result could be due to an outlier obtained in group 1 i.e, presence of crater (score 4) in middle third region of the instrument (figure 3) . The reason for the appearance of this outlier is unknown but probably lack of straight coronal access or excessive apical pressure during instrumentation might have caused such deformation on the surface of the instrument .

There are a number of factors that are associated with rotary instrument separation such as the speed of rotation in canal, the curvature angle and the radius of the canals in which they are being used [24].

The present study used FKG XP Endoshaper instrument owing to its unique design features, greater flexibility ,increased cyclic fatigue resistance, effective cleaning efficiency [25] and maintenance of the original root canal anatomy [26]. This instrument has the advantage of an unique programmed shape and great flexibility, allowing it to contract and expand within the canal , as well as reach locations where traditional instruments cannot. Furthermore, their small ISO diameter and tight taper provide them with exceptional cyclic fatigue resistance. Amr E and Shaymaa E in 2018 showed that XP Endoshaper had higher fatigue resistance and they could be used safely within curved canals [27].

Micromega one curve instrument has shown efficient ability for canal shaping and relatively lesser canal transportation. It was also considered safe to be used in mandibular mesial canals [28]. This study reveals that micromega one curve instrument had lesser surface changes when compared to XP Endo shaper.

According to manufacturer, Micromega one curve has a variable cross sectional design and can be used efficiently in root canals which are severely curved or have S shape. The manufacturers also claim that this file has 2.4 times more cyclic fatigue resistance. This is in accordance with studies conducted by Serafin et al in 2018 . According to Mehmat A et al's comparative study published in 2020 [29], Micromega One curve exhibited higher fracture resistance when instrumented in S shaped (double curved canal) than one shape and two shape instruments.

No defect was seen in a majority of samples in apical or middle third region. This indicates that the instruments can be used safely for duration upto 30 seconds to instrument moderately curved root canals and not show any surface change thereby preventing the risk of instrument separation and promoting a safer use of such instruments to clean and shape the canals. Most common defect seen was minor plastic deformation .None of the instruments used in this study fractured during their clinical use. This emphasizes that the lesser the duration of instrumentation within the canal, lesser will be the incidence of fracture of instrument. Thus , both the NiTi Rotary instruments can be safely used for instrumentation in moderately curved canal for upto a duration of 30 seconds which does no show major surface changes for an instrument to fracture.

However, to support the results of this study, further studies with more number of samples should be conducted.

5. CONCLUSION

Within the limitations of this study it can be concluded that micromega One Curve instrument showed less surface changes compared to FKG XP Endo Shaper file and that the changes in apical regions were more than the middle third region. None of the instruments fractured within the root canals.

CONSENT

A witten informed consent was obtained from the patients willing to participate in the study.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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