

“Evaluation Of Dentinal Crack Formation During Root Canal Preparation By Using Twisted File Adaptive, Wave-One Instrument And Protaper Universal System-An In-Vitro Study.”

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Abstract-

Objective: The aim of this in vitro study was to evaluate the development of micro cracks in radicular dentin by twisted file Adaptive, Wave One & Protaper Universal systems.

Materials and Methods: 70 single rooted, freshly extracted human mandibular premolar teeth were mounted in acrylic blocks with simulated periodontal ligaments.The root canals were instrumented by using Twiated file adaptive, Waveone instrument and Protaper universal system.All the specimen were cut perpendicular at 9, 6, 3 mm from the apex & observed under stereomicroscope at 25 x magnification for presence of dentinal crack.

Results: The Twisted file adaptive group showed significantly less incomplete crack in comparison with the Protaper group and Wave One group in apical and middle part of canal.Wave One group showed more number of complete cracks in comparison with the Twisted file adaptive and the protaper groups **Conclusion:** Twisted file adaptive showed least cracks compared to Waveone instrument and protaper universal system.

Keywords- Twisted file adaptive,Waveone instrument,protaper universal system,Microcrack

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I. Introduction-

The primary aims of biomechanical preparation embrace the conservation of the original shape of canal & cleaning of the whole root canal system.^[1] Generally a vertical root fracture is a prominent complication related to mechanical canal preparation that commonly results in tooth loss.^[2] Root canals are prepared with instruments which makes contact with root dentin. These contacts induce momentary stress concentration in dentin that could causes dentinal defects. These small cracks propagated into vertical root fracture because the applied stresses are created by the repeated occlusal forces, root canal obturation and retreatment procedures.^[3]

A new system known as twisted File Adaptive has recently been launched. The Twisted File Adaptive system are manufactured from an R-phase Ni-Ti alloy which works with a combination of continuous rotation and reciprocal motion,with specific clockwise and counter clockwise angles varying from 600 degrees to 0 degrees to 370 degrees to 50 degrees.^[4]

Wave one instrument are designed and marketed for shaping the root Canals by single-file reciprocation technique.^[4]

Rotary Protaper files are made from conventional Nickel- Titanium wire that are characterized by an increasing taper design, with active cutting motion that removes more dentin.^[5] The generation of cracks on the dentin are influenced by the different file systems with their design characteristics differing in rake angle, nickel titanium core diameter, flute depth, cross-sectional shape and distinct movement that could change the file's behaviour.^[6] Hence aim of the present study was to evaluate the development of micro cracks in radicular dentin by twisted file Adaptive, Wave One & Protaper Universal systems.

II. Material And Method-

70 single rooted, freshly extracted human permanent mandibular premolar teeth with mature apical foramen with straight single canal were collected (Fig.2) and observed at 12x magnification under stereomicroscope to identify any preexisting defects or cracks,if present were excluded (Fig.3). All roots were standardized at 12mm by venire calliper and marked with marker (Fig.4).Coronal parts of all the teeth have been cut perpendicular with diamond disks under water coolant leaving 12mm length of root from the apex (Fig.5).Access cavity were prepared by arotar hand piece with endoaccess bur (Fig.6). The canal length were evaluated by introducing 10 K-file into canal until the tip of file at the apex became noticeable (Fig.7).The distance from the file tip to reference plane was described as the canal length. The working length was set by reducing 1mm from previous length(Fig.8).The roots surface was coated with single layer of aluminium foil, then cold cure acrylic resin mixed and pour into the block.Tooth positioned with aluminium foil into acrylic block(Fig.9).Aluminium foil was then peeled off and hydrophilic vinyl polysiloxane material was applied into the space produced by aluminium foil to simulate the periodontal ligament space. All the roots were then positioned immediately in acrylic blocks (Fig.10).

Distribution of samples:-

70 teeth, out of which 10 teeth served as control group(Not instrumented).60 teeth were categorized as 3 groups of 20 teeth each.

Biomechanical preparation-

GROUP I –Twisted File Adaptive Group(n=20)

Twisted file Adaptive was used for preparation of root canals of teeth by using smooth in-and-out movement with Elements motor (SybronEndo) (Fig.11). The sequences of instrumentation were ML 1(medium/large) (25/.08) and ML 2(medium/large) (35/.06) and then ML3medium/large) (50/.04). The ML1 was used to prepare at 2/3rd of working length, and the ML2 and ML3 was prepared at full working length (Fig.12).^[4]

GROUP II -WaveOne Group(n=20)

Instrumentation was done in root canals by using a WaveOne single primary file (25/.08) with a smooth in & out pecking motion with x mart plus endomotor (Fig.13). in reciprocation movement according to manufacturer’s instruction(Fig.14).^[3]

GROUP III - ProTaper Universal Group(n=20)

The root canals of all specimen were instrumented in this group with Protaper Universal system in rotary motion with x mart endomotor (Fig.15) working at rpm of 300 and torque of 2 Ncm (X-Smart; Dentsply Maillefer).preparation in half of working length was done with SX file, At 2/3of working length, S1 and S2 files were used, and F1 (20/.07), F2 (25/.08) and F3 (30/.09) were used till complete working length(Fig.16).

SX, S1& S2 files were used in brushing motion. Finishing files were used with a smooth in &out motion until the instrument reached in the complete length of the canal.^[7]

In all the samples,Irrigation was done with 2ml sodium hypochlorite using a syringe inserted 1 mm away from the working length by a 27-guage needle.

SECTIONING OF SAMPLE-

All the specimen were marked by marker with the help of venire calliper and sectioned perpendicular with a diamond disk under water coolant at 9, 6 & 3 mm from the apex (Fig.17).

DENTINAL MICRO CRACK EVALUATION-

Stereomicroscope at a magnification of 25X was used to observe the section of all the sample. To determine the existence of dentinal cracks,photos of all specimens were captured with a camera. Dentinal crack formation was assessed as no-defect, incomplete crack, complete cracks & craze lines.

DEFECTS DEFINITIONS-

No defect is absence of cracks and lines or on the root's external or inner surface.

An incomplete crack- A line extends from wall of canal to the exterior surface of the dentin not involving the outer surface (Fig.18).

Complete crack-A line that extends from wall of canal to the root's outer surface. Craze lines are lines that have not reached on root surface or extended into the dentin from the outside surface but have not reached the canal wall (Fig.18).

Data were collected as absence or presence of different defect & statistically analyzed.

CRAZE LINES

Craze lines were not detected in any of the samples in all the four groups hence the chi square test shows non significant result with p value 1.00. (Table 3)

STATISTICAL ANALYSIS:-

Presence of incomplete crack, complete crack & craze lines were analyzed with Chi square test significance level ($P \leq 0.05$) and summarized in table 1,2 and 3

III. Observation & Results-

Overall, control group does not showed any crack.wave One group shows statistically more number of complete cracks in comparison with the Twisted file adaptive and the protaper groups in middle third of the canal ($\chi^2= 7.77$ and $P = 0.02$) while The difference between the groups was not statistically significant in apical third part and the coronal third part (Table 1)

The Twisted file adaptive group shows significantly less incomplete crack in comparison with the Protaper group and Wave One group in apical and middle part $\chi^2= 16.03$ and $P = 0.01$.The coronal third doesn't shows statistically significant difference among the groups. (Table 2)

IV. Discussion-

Stress on root canal wall was caused by use of rotary and reciprocating instrumentation technique that could lead to dentinal micro crack formation.^[8]These localised defects may have the potential to develop into fracture and affect prognosis of teeth.^[9]

A newly developed instrumentation technique called twisted file adaptive has been introduced by Axis Sybron Endo (Orange, CA, USA)introduced in year 2008. Twisted file adaptive utilise adaptive motion, a patented, undisclosed movement rendered by Element motor(Axis Sybron Endo).^[10]

The waveone instrument was introduced by Dentsply Maillefer, in year 2011, as a single reciprocating file system.These files works with pre-programmed motor that allows the movement of the files in back and forth reciprocal motion.^[11]

Protaper universal are made up of conventional Nickel –Titanium alloy manufactured by Dentsply Maillefer introduced in year 1990. ^[12]

Under the present experimental framework different file system revealed different degree of crack formation.

Twisted file adaptive resulted in statistically significantly least dentinal crack formation compared with wave one and protaper universal system. (Table: 1)

Overall percentage of complete crack formation was 0% and incomplete crack was 1.67%

This might be because of new adaptive reciprocating motion. When exposed to minimal or no load applied, the file utilises continuous rotation. It uses reciprocal motion, when it engages dentin. This adaptive movement with elevated flexibility could have reduced the torsional forces and concentration of stress on the wall of root canal resulting in fewer crack formation.^[13]

This result was in accordance with study conducted by **caper et al 2014** concluded that the HyFlex & ProTaper Next instruments caused less dentinal cracks in comparison with Protaper Universal instrument.^[5]

In the apical and middle portion of root canal wave one files created significantly more cracks compared with twisted adaptive file.

Overall percentage of complete crack formation was 10% and incomplete crack was 25%.

This was attributed to the technique of preparation and cross sectional design of wave one instrument. It has greater taper of 8% which is used in full canal length. Wilcox et al found that removal of more root dentin, the greater will be the likelihood of a root being fractured.^[14]

This result was in accordance with study conducted by **Gorgi et al 2015** concluded that single file reciprocal files created more incomplete dentinal cracks than full sequence adaptive rotary motion.^[15]

Protaper universal files significantly resulted in more cracks compared with twisted adaptive file and wave one file. (Table: 2)

Overall percentage of complete crack formation was 5%, and incomplete crack was 26.67% respectively.

Protaper universal system has an active rotating movement which uses continuous rotation motion that might have resulted in increased stress concentrations on walls of root canal.^[16]

Souza bier et al showed that the root prepared by using rotary files which had at least 0.06 taper resulting in crack. Protaper F3 has 0.09 large apical taper that is used in present study which could explain the reason for higher crack generation compared to other files. ⁽¹⁴⁾ This result was in accordance with the previous study by **Liu et al 2013** ^[17]

This stereomicroscopic study concluded that twisted file adaptive generated significantly less cracks on the root dentin in comparison with waveone instrument and protaper universal system.

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Table-1 -Complete Cracks Number / Percentage of Sample with Complete Cracks

	Complete Cracks Number / Percentage of Sample with Complete Cracks			
	Apical Third	Middle Third	Coronal Third	Total
Protaper	2(10%)	1(5%)	0(0%)	3(5%)
Wave one	1(5%)	5 (25%)	0(0%)	6(10%)
TFA	0(0%)	0(0%)	0(0%)	0(0%)
Control	0(0%)	0(0%)	0(0%)	0(0%)
Chi square	2.10	7.77	-	7.05
P value	0.35	0.02*	1.00	0.03*

Table-2.-Incomplete Cracks Number / Percentage of Sample with incomplete Cracks

	Incomplete Cracks Number / Percentage of Samples with Incomplete Cracks			
	Apical Third	Middle Third	Coronal Third	Total
Protaper	14 (70%)	2(10%)	0(0%)	16 (26.67%)
Waveone	8 (40%)	6 (30%)	1 (5%)	15 (25%)
TFA	1 (5%)	0 (0%)	0(0%)	1 (1.67%)
Control	0(0%)	0(0%)	0(0%)	0(0%)
Chi square	17.90	8.07	2.03	16.03
P value	0.01	0.02	0.37	0.01

Table-3 .Craze line number / percentage of samples with craze lines

	Craze line number / percentage of samples with craze lines			
	Apical Third	Middle Third	Coronal Third	Total
Protaper	0(0%)	0(0%)	0(0%)	0(0%)
Waveone	0(0%)	0(0%)	0(0%)	0(0%)
TFA	0(0%)	0(0%)	0(0%)	0(0%)
Control	0(0%)	0(0%)	0(0%)	0(0%)
Chi square	-	-	-	-
P value	1.00	1.00	1.00	1.00

FIGURE -



Fig.1: Collected Specimens divided into four groups

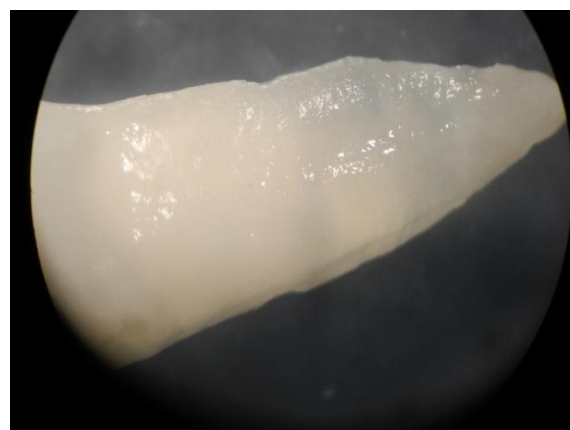


Fig 2: specimen without external crack at 12 x magnification



Fig.3: standardization of the sample at 12mm by using vernier caliper



Fig.4: Decoronation of the sample



Fig.5: Access cavity prepared with endo-access bur



Fig.6: Working length determination

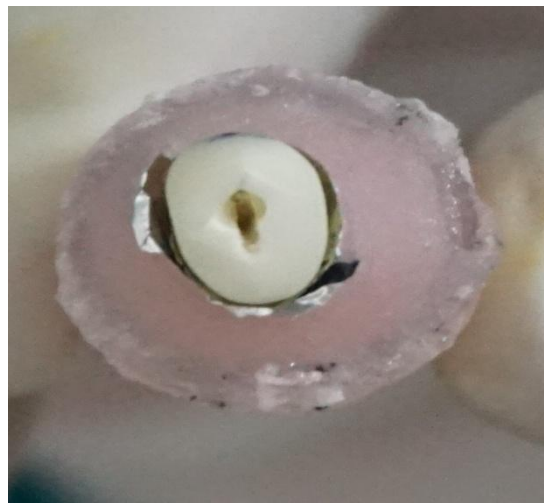


Fig.7: specimen wrapped in aluminium foil & placed in acrylic block

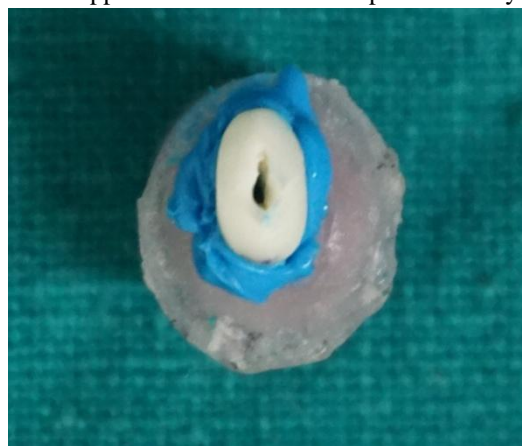


Fig.8: Aluminium foil replaced with vinyl polysiloxane material



Fig.9: Twisted file adaptive with endomotor



Fig.10: Biomechanical preparation with twisted adaptive file



Fig.11: Waveone file with X Smart plus endomotor

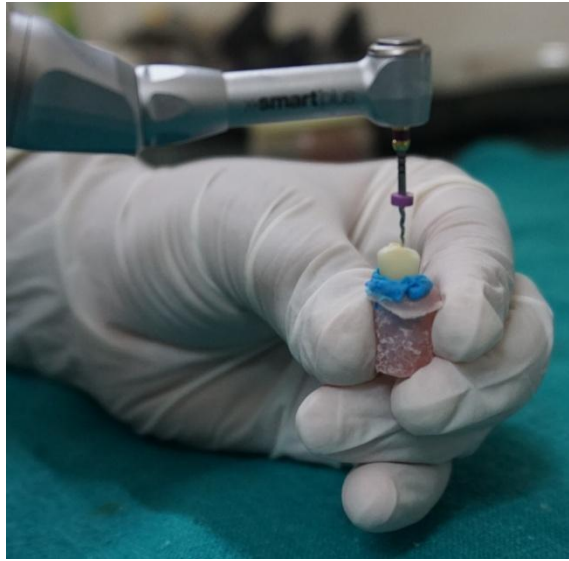


Fig.12: Biomechanical preparation with Waveone file



Fig.13: Protaper universal file with X Smart plus endomotor



Fig.14: Sectioning of sample done at 3, 6 & 9mm

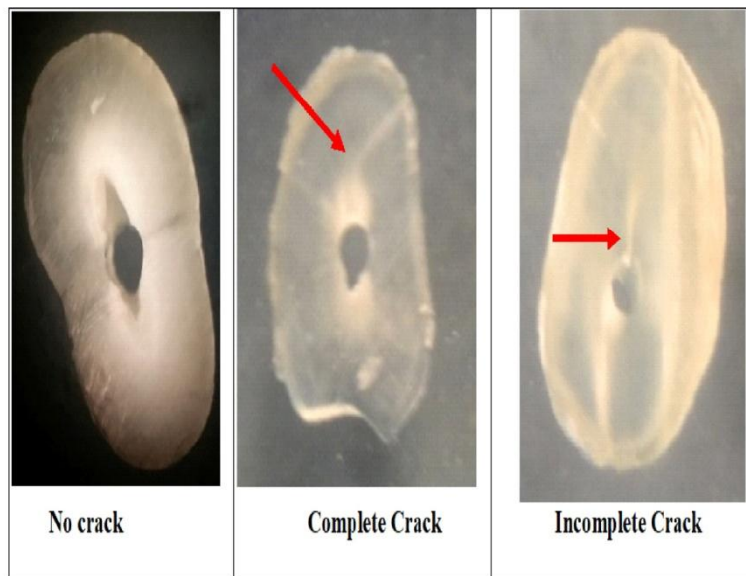


Fig.15: Specimen showing dentinal defect (red arrows)

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