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Effect of different root canal prepration and obturation methods on roots fracture resistance of endodontically treated teeth. (*In vitro* study)

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Abstract
The aim of this laboratory study was to evaluate root fracture of endodontically treated teeth after canals preparation and obturation using two different systems: Reciprocblue (R25), Mtwo (25/06) and obtured using cold lateral condensation (clc), continouas wave compaction (cwc).
Materials and Methods: fifty extracted mandibular premolars were selected with completed, straight and single canal roots and free of caries or resorption or any previous treatment. The tooth crowns were removed and root length was adjusted to 16mm. Teeth were devided into five groups of 10 teeth each. Group I (control group) is non-instrumented teeth. Group II: canals were prepared with Mtwo rotary files and obtured by continouas wave compaction Group II: canals were prepared with Mtwo rotary and obtued by cold lateral condensation Group IV: canals were prepared with Reciprocblue files and obtured by continouas wave compaction. Group V: canals were prepared with Reciprocblue files and obtured by cold lateral condensation. The root were vertically loaded with testing machine (Testometric, USA) and the load when fracture was detected and recorded in newton. ANOVA test was used to determine differences regarding the fracture load of five groups, LSD test for dual comparison between groups was used. All stastical analysis was performed at 95% level of confidence. The results showed stastically significant differences in mean of fracture load between control group and other groups, also showed stastically significant differences between Reciprocblue and Mtwo groups, while did not show stastically significant differences between Continous Wave Compaction and Cold Lateral Condensation.

Keywords: Reciprocblue, mtwo, cold lateral condensation, continuous wave compaction fracture resistance

Introduction
Endodontic treatment consists of cleaning and shaping of the root canal then obturation in order to preventing reinfection, maintaining the integrity or achieving healing of periodontium. Endodontically treated teeth are more susceptible to fracture than vital teeth because of several factors as: dehydration, loss of dentin during chemomechanical preparation, prolonged use of chemical agent during disinfection and exertion of excessive pressure during obturation.
Root canal system (RCS) instrumentation is an essential procedure of endodontic therapy, which aims to thoroughly debride it while maintaining the original shape of the root canal without harming dentine integrity. Instrumenting the RCS with motorized nickel-titanium (NiTi) files can weaken the dentin structure, resulting in vertical root fractures (VRFs) [1, 2, 3], the predisposing factors for VRFs include the loss of tissue, dehydration of dentin, effects of irrigation solutions, and use of excessive pressure during root-filling procedures [4] Over the last few decades, endodontic instrumentation has evolved on the line of technological advancements. The currently used motorized file systems consist of a solid metal core, with rotating blades, and flutes. These files designed with increasing taper, resulting in active cutting, and relative removal of more dentine. In addition, an excessive taper results in more removal of dentine reducing the fracture strength [5, 6].
One of root canal obturation purposes, therefore, is to increase the strength of the root canal and increase root fracture resistance by adhesion and mechanically interlocking root canal filling material with radicular dentin [7]. Root canal sealers bind gutta-percha to canal walls and fill up the voids, accessory canals, and irregularities within the canal and help in achieving three-dimensional sealing of the root canal system [8].

Main factor directly related to the fracture resistance is the creation of microcracks in radicular dentine [2, 4, 7]. All the currently used rotary and reciprocating files create microcracks ranging from 18% to 60% in the instrumented roots [1, 2, 7, 8]. The reciprocating files have 3 times more tendency to create microcracks when compared to the multiple sequences of rotary files [8]. Various studies have been reported on the fracture resistance of teeth and formation of microcracks in the radicular dentin [6]. Gutta-percha in combination with root canal sealers is the gold standard of root canal fillings because of its biological compatibility, lack of toxicity or allergic effects, but it has some drawbacks such as its inability to strengthen root canal as it does not bond to dentin and leads to an incomplete obliteration of root canal space [4, 5].

The aim of this study was to evaluate the fracture resistance of prepared root canals prepared using two different preparation systems: rotary system Mtwo (Mtwo; VDW, Munich, Germany), reciprocating system RECIPROCblue® (RC; VDW, Munich, Germany) And obturated using two different obturation systems (cold lateral compaction technique, continuous wave compaction technique) in endodontically treated teeth.

Materials and Methods

Fifty freshly extracted mandibular premolars with single canal and similar root sizes, without root curvature, free from caries, cracks, restoration, fracture, dilacerations, root resorption, or open apices were selected. All debris and remaining tissues were removed from the teeth, then disinfected with 5% sodium hypochlorite solution and then kept in normal saline solution. All samples were subsequently examined under a stereomicroscope at ×10 magnification to detect any cracks.

Teeth were decoronated at the level of cementoenamel junction (CEJ) using a diamond disc and obtained a standardized root length of 16 mm [figure 1]. Root length was established using size #15 K-files (VDW GmbH, Munich Germany). Working length was determined 1.0 mm shorter than the actual root canal length using digital radiography.

Fig 1: Teeth after obtained a standardized root length of 16 mm

Group 1 control

The samples in this group remained untreated,so no instrumentation or filling was performed.

Group 2: MTWo system and CWC. The samples in this group were instrumented using Mtwo rotary files (Mtwo; VDW Silver, Munich, Germany) with a preprogramed X Smart Plus (Dentsply Maillefer) at 300 rpm speed and 2-Ncm torque. The prepration in all files was till working length (WL) (#10.04), (#15.05), (#20.06), (#25.06). Before introducing a new file each time, the root canal was irrigated with 5.25% sodium hypochlorite (NaOCl) and recapitulated with a #15 K-file, and then the subsequent rotary file was introduced. Ethylenediaminetetraacetic acid (EDTA) paste (RC Help, Prime Dental Products, Mumbai, India) was used as lubricant for the file with every reinsertion.

Obturation was done using continuous wave compaction technique with dia-duo system ([diadent] [korea]). Gutta-percha pellet (Metabiomed Co., LTD, Korea) was inserted into the gutta-percha slot of the cordless obturation gun by pulling out the plunger. Turn on the power button and adjusted the temperature at 200°C. After 3 min, the warm gutta-percha flow out. The master gutta-percha cone (size #25/0.06 taper) that matched with prepared root canal and confirmed the tug back was coated with Zincoxide eugenol sealer and inserted into the canal.

The excess gutta-percha was cut by heated obturating pen tip. The heated pen tip with gutta-percha was inserted to 4 mm short of the working length. The warmed gutta- percha was compacted with hand plugger (Dentsply Maillefer, Switzerland). Rest of the canal was filled with obturating gun and compacted with bigger plugger.

Group 3: MTWO system and CLC

The samples in this group were instrumented using the same way described in group 2 Root canal Obturation was done using cold lateral compaction: a master gutta-perch cone size #25/0.02 taper (Metabiomed Co., LTD, Korea) was selected and adjusted to fit with tug back at working length, The master gutta-percha cone was coated with (Zincoxide eugenol) sealer and inserted into the canal. A finger spreader was used to condensation, accessory cones (0.02 taper) were coated with sealer and placed in the canal. The excess gutta-percha cone was cutted at the canal orifice with heated instrument 1 mm below the CEJ.

Group 4: RECIPROCblue® system And CWC

The samples in this group were instrumented using RC® R25 files,. The R25 was The RC file was introduced in the canal with a reciprocating and pecking (in and out) motion On meeting obstruction the file was removed, the canal was irrigated, recapitulated by a #15 K-file and the file was reintroduced into the canal. EDTA Gel (RC Help) as used as lubricant for the file. Instrumentation was continued in the aforementioned manner until the file reached the WL.

Then the obturation was carried of using the same way described in group2.

Group 5: Reciprocblue® system And CLC

The samples in this group were instrumented using the same way described in group 4. Then the obturation was carried of using the same way described in group3 4and obturated like group 3.

Final irrigation protocol

After instrumentation, a final flush was applied using 17% aqueous EDTA (Dent Wash, Prime Dental Products) for 1-min (for removal of smear layer) and 5.25% NaOCl for 1-min followed by the final rinse with distilled water.

Measurement of fracture resistance

All samples were vertically set in self-cure acrylic resin

(Pyrax) blocks. The apical 6mm of each root was kept in side blocks, After 24 h, the acrylic resin was set and the blocks were stored in 100% humidity before mechanical tests.
Fracture resistance was evaluated in a Universal Testing Machine (Testometric) (fig 2). A cross-head speed of 1 mm/min at an angle of 90° was set, and the compressive load was applied perpendicular to the long axis of the tooth at the canal orifice until fracture occurred. The force necessary to fracture each tooth was recorded in Newtons (N) (fig3)

Fig 2: Universal Testing Machine (Test metric)

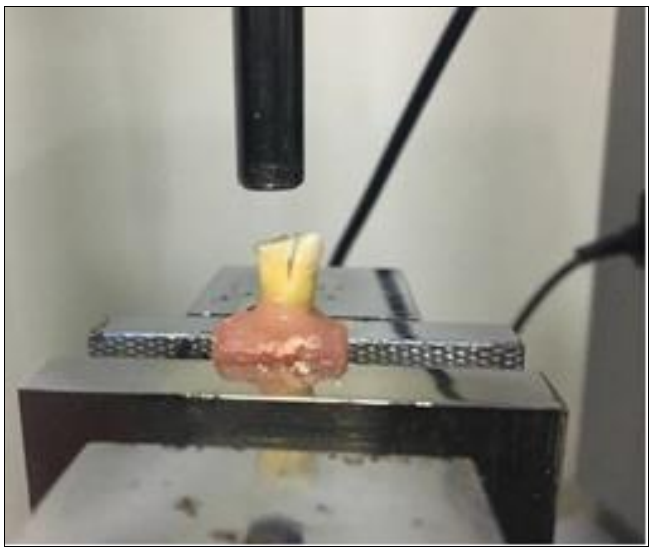

Fig 3: one of the Sampels after being broken

Results and stastical analysis
The fracture load for Group 1 to Group 5 was analyzed using one-way analysis of variance (ANOVA) and Tukey's multiple comparisons using (SPSS, v20; SPSS Inc. Chicago, IL).

Discussion
Lower premolars were chosen in our study because of the high incidence of vertical root fractures. The occlusal forces on the lower premolars are three times higher than other teeth. In our study Preparation systems were chosen based on the similarity of the cross section, in addition to the different preparation technique. The experimental method used to generate force within the root canal space is similar to occlusal forces as recommended (Lertchirakarn1999. Holcomb1987 Lindauer1989 Wilcox1997 Pitts1983). The speed of the productive head of the force was set to a value of 1 mm/m, according to (Sedgeley *et al*.; 1992, Chen *et al*.; 2003). The results of the present study indicate that the instrumentation decreases the fracture resistance of teeth by either rotary or reciprocating files.
Cracks formed during instrumentation may develop into fractures during retreatment or after long-term functional stresses such as chewing [12]. Rotary and reciprocating files create microcracks in the radicular dentin ranging from 15% to 60%. These files are associated tapers of varying sizes (0.06-0.09), which may contribute to the dentinal crack formation, which has been observed at various levels including the apical thirds [1, 2, 4, 8, 9]. These cracks become high-stress concentration areas and gradually propagate from these areas to the root canal surface, thus causing VRFs. [13, 14].

Results
Instrumentation of samples using the rotary and reciprocating files remarkably reduced the fracture resistance of the instrumented teeth compared with the control, the fracture resistance of samples in the Mtwo group was bigger than the samples in the Reciprocblue group, No statistically significant difference was found between continuas wave compaction and lateral condensation on fracture resistance of the sampels.
Our results agree with the results of (Saeed.*et al*. 2014 Cohen 2003, Bier 2009) studys who show prepration of the root canal Decrease fracture resistance Comparison with teeth without prepration.
Also our results agree with the results of (Gergi 2015) study who show reciprocation creat more cracks and deafets than rotation during canals prepration.
Our results agree with the results of (Hüseyin 2012) study who showed obturation methods CWC and CLC didn't have any effect on teeth fracture resistance.
Our results disagree with the results of (Monga 2015) study who showed reciprocation motion showed less cracks than rotary motion This difference may be due to the difference of instruments that used in the study we used reciprocblue and mtwo while he used wave one and protaper. Additional studies are required to assess the short- and long-term impacts of instrumentation on microcrack formation and VRFs.

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