Impact Of Different Taper On Fracture Resistance Of Endodontically Treated Teeth: An In Vitro Study

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Abstract: Background: Various taper file systems are available and it is considered that by reduction in taper of the preparation might reduce the chances of fracture. Therefore, this study is performed. Objective: To assess the influence of different taper of root canal preparation on the fracture resistance of endodontically treated mandibular premolars. Material And Methods: Twenty extracted mandibular premolars with single canals were selected and randomly divided into two groups (n = 20). In group 1 (n = 10) canals were prepared with 4 % taper. In group 2 (n = 10) canals were prepared with 6 % taper, with apical diameter 25 using Hyflex CM file system. Irrigation was done with 5.25% NaOCl, EDTA and saline. Obturation was done with Gutta-percha using single cone obturation technique followed by restoration of access cavity with resin composite. Teeth were mounted in acrylic resin and fracture resistance was checked using UTM, data examined statistically. Result: Significant difference was registered between 4% taper (269.6 N) and 6% taper (249.3 N) of root canal preparation regarding the fracture resistance of premolars tested (p =0.005). Conclusion: It can be concluded that, minimizing the taper of the preparation, fracture resistance increases by preserving the amount of tooth structure loss during root canal treatment.
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Key Words: Fracture Resistance, Hyflex CM, Root Canal Taper

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Introduction: One of the main steps in the root canal treatment is mechanical instrumentation to create sufficient space for irrigating agents, intracanal medicaments, and obturating materials[1]. It is well established that endodontically treated teeth has a reduced resistance and higher susceptibility to fracture and this is mainly associated with the loss of dentinal structures following root canal treatment[2,3,4].Minimally invasive endodontics has been consequently suggested, consisting of keeping access cavities smaller, minimal root canal taper with minimal apical diameter[2,5,6].

Taper of the root canal preparation is a factor that determines the final root canal dimensions. Since, the relationship between root canal taper and fracture resistance is not yet well established, the aim of the present study was to assess the influence of the root canal taper on the fracture resistance of endodontically treated mandibular premolars[7,8]. Using stainless steel hand instruments for root canal preparation is generally time consuming and difficult in curved canals. Nickel titanium (NiTi) alloy has increased flexibility and shape memory, potentially allow shaping of narrow, curved root canals without causing aberrations[9]. The stresses on the root are affected by geometric design of various rotary file systems.

Hyflex(Coltene Whaledent,Allstetten,Switzerland) files are manufactured utilizing a unique process in which the crystallographic phase transitions from austenite to martensite occurs at the room temperature in contrast to conventional NiTi files, making the files extremely flexible and fracture resistant[9].

Therefore, Hyflex CM file system was used in this study. The null hypothesis tested was that, there is no difference in the fracture resistance of mandibular premolars treated with a final preparation taper of 4% and 6%.

Material & Methods: This in-vitro study was carried out in the department of conservative dentistry and endodontics.

Selection Of Specimen And Preparation: Twenty recently extracted intact human permanent mandibular premolars with single root and canal

were selected for the study. Carious teeth, previously restored teeth, cracked teeth, teeth with open apices and fractured teeth were excluded. Teeth with approximately similar dimensions were selected to minimize the influence of variations on the results. Samples were cleaned with ultrasonic scaling and kept in normal saline. Access cavities were prepared using round bur and safe end bur. canal orifices were located and working length was established with 10 K file 17% EDTA gel and established a glide path. Then samples were randomly divided into two groups. Each group containing 10 samples.

Cleaning And Shaping Of Root Canal System: In group 1 (n = 10) canals were prepared with 4 % taper and apical diameter 25 using HyFlex CM file. The sequence followed for instrumentation was 0.08/#25 (orifice shaper) →0.04/#20 (apical enlargement/working length)→0.04/#25(apical enlargement/working length).

In group 2 (n = 10) canals were prepared with 6 % taper and apical diameter 25 using Hyflex CM file system following manufacturer's instructions at 500 rpm and torque set at 2.5 N cm. The sequence followed for instrumentation was 0.08/#25 (orifice shaper) → 0.04/#20 (apical enlargement/working length) → 0.04/#25(apical enlargement/working length) → 0.06/#25(apical enlargement/working length). Canal patency was checked with 10 K file, and irrigation with 2.5 mL of 5.25% NaOCl was performed with a syringe and an endodontic needle after each instrument used. After shaping of root canals, final flush of root canal was done with 3 mL of distilled water to remove the remaining sodium hypochlorite. Root canals were washed with 3mL saline solution and dried with paper points.

Obturation The Root Canal System: Group 1 root canals were obturated with the single cone obturation technique using a gutta percha cone tip size 25 and 4% taper with AHPlus® (Dentsply Maillefer) root canal sealer.

Group 2 canals were filled with the single cone technique using a gutta percha cone tip size 25 and 6% taper with AHPlus® (Dentsply Maillefer) root canal sealer. All teeth were stored at 37°C with 100% humidity for 72 h).

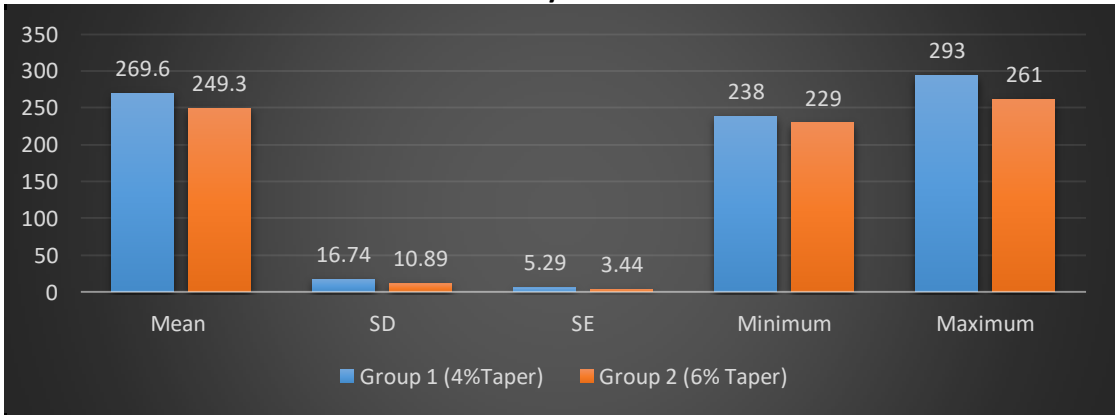
Specimen Preparation For The Universal Testing Machine: Access cavities of all the samples were cleaned and filled with a resin composite (3M – ESPE). For simulation of periodontal ligament Specimen's roots were covered with 1 mm layer of wax. To replace the alveolar bone, teeth were placed into a mold of acryl resin, with a light apical pressure completely covering the wax.

Fracture Test: The specimens were loaded to the universal testing machine equipped with a 500 N cell load and loaded through a stainless steel ball 3 mm in diameter at their central fossa, along with their long axis. Compressive strength force was applied at a crosshead speed of 1 mm/min. Data was collected using software which is connected to UTM.

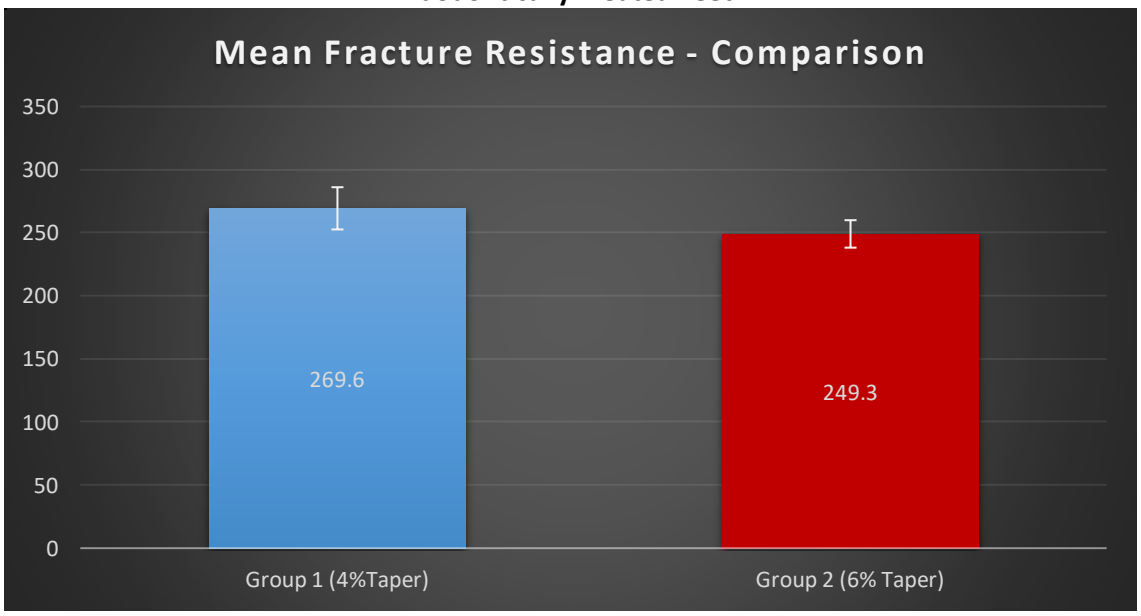
Statistical Analysis: The "Statistical Package Software for Social Science" (SPSS for Windows, Version 20.0, and Chicago, IL, USA) was used for the statistical analysis. The level of significance was set at P 0.005. The unpaired t test was performed to compare the mean value of fracture resistance between 4% and 6% taper.

Results: Results are as follows.

Graph 1: Descriptive Statistics Of Various Taper Of Hyflex CM File On Fracture Resistance Of Endodontically Treated Teeth



Graph 2: Comparative Statistics Of Various Taper Of Hyflex CM File On Fracture Resistance Of Endodontically Treated Teeth



Discussion: Endodontically treated teeth has higher susceptibility and reduced resistance to fracture as compared to natural intact teeth, so they are proved to be weaker than the vital natural teeth and prone to fracture. This is mainly due to loss of tooth structure. Hence attention should be paid to unnecessary dentin removal during endodontic treatment, in order to maintain the strength of the teeth[10]. Structural loss of a tooth is one of the risk factors for fracture in endodontically treated teeth[11].

The aim of this study was to assess the influence of the final preparation taper on the fracture resistance of endodontically treated mandibular premolars.

According to current results obtained in our study, a significant difference was registered between 4% taper (269.6 N) and 6% taper (249.3 N) of preparation about the fracture resistance of premolar tested (p =0.005).

Result shows fracture resistance of endodontically treated teeth with 4 % taper are higher than teeth prepared 6 % taper. Therefore, the null hypothesis was rejected.

Studies done by Monaco et al and Sharath Chandra et al showed that, premolars are more prone to fracture[12,13].

Hence in the present study premolars are selected to assess the influence of taper. Loss of tooth structure is the most common reason for fracture of endodontically treated teeth. This can happen during every procedure of an endodontic treatment from the access cavity preparation to biomechanical preparation mainly depending on the taper and apical size of the preparation. Every procedure in endodontic treatment can lead to crack formation and breakage of the corresponding tooth[14].

The prepared canal diameter and taper may also influence propensity for VRFs. In general, taper should be sufficient to permit the deep penetration of spreaders or pluggers during filling but should not be excessive to the point where procedural errors occur, and the root is unnecessarily weakened.

Holcomb et al. remarked that there must be a point at which increased canal width and taper begin to weaken the root.

It can be theorized that increasing the taper of the canal preparation by removing more dentine from the canal wall would diminish the structural integrity of the root[15].

Hyflex file system was used in this study because of its property of controlled memory (CM). CM Wire is the first thermo-mechanically treated NiTi endodontic alloy that does not possess super elastic properties at neither room nor body temperature. In contrast to austenitic NiTi files, CM wire instruments do not tend to fully straighten during the preparation of curved root canals.

In spite of increased flexibility, which affects the cutting efficiency negatively, Hyflex CM instruments have an enhanced cutting efficiency in lateral action compared to electro polished and conventional NiTi instruments.

Therefore, controlled memory and super elasticity property of Hyflex cm file system makes them more advantageous[16].

According to Richard Mouce, larger and less complex roots are candidates for a larger prepared final taper (.06 throughout the length of the root).

Roots with curved and complex canals are candidates minimal final preparation taper (.04 taper throughout the length of the root).

Because of excessive dentin removal root becomes more susceptible for vertical fracture. In addition, excess dentin removal, even without perforation, leaves a root susceptible to vertical fracture[17].

There are some goals for canal preparation, they are as follows:

- To maintain the size of the apical foramen and original position of the canal.
- To prepare a tapering funnel with narrow cross section diameter apically.
- To prepare a taper that is proportional to the external dimensions of the root that does not predispose the root to vertical root fracture
- To prepare a taper that allows cone fit with tug back and ideal obturation hydraulics during obturation.
- To prepare a taper that optimizes the necessary volume and space for activation of endodontic irrigants[17].

The old concept of big, aggressive canal-flaring is no more in practice. More conservative designs lead to the tooth less susceptible for fracture, there is limited evidence that wider canal shapes provide a better seal and fewer endodontic failures[18,19.] Enhanced instrumentation in the apical area and larger apical diameters weakens the root due to loss of apical dentin and also a loss of control over the obturation. Hence, minimal apical preparations and continuous taper are choice of preparation. This kind of preparation helps in preservation of root dentin and promotes resistance from which provides a tight apical seal to create sufficient shape for adequate disinfection[20,21,22].

Conclusion: It can be concluded that, minimizing the taper of the preparation, fracture resistance increases by preserving the amount of tooth structure.

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