Influence of instrument taper on the fracture resistance of endodontically treated teeth - An in vitro study

ABSTRACT:

AIM: To assess and contrast the effect of rotary files with a 4% and 6% taper on the fracture resistance of teeth that have undergone endodontic treatment.

MATERIALS AND METHODS: Single rooted mandibular premolar was collected (sample size- 50). Root canal treatment was done using 4% and 6% rotary file system and obturated. The Tooth sample was subjected to a fracture test. The force required to fracture the roots was measured. The Mann Whitney test was used for statistical analysis.

RESULTS: Tooth treated with 4% tapered instrumentation had better fracture resistance when compared to 6% within its limitations. The mean fracture load for 4% taper was approximately 475 and for 6% tapered instrumentation it was 474.

DISCUSSION: In endodontically treated teeth, vertical root fracture is a problem that necessitates extraction. Vertical root fractures are predisposed to by the removal of cavities, access cavity preparations, canal instrumentation methods, and prepared canal diameter. Safety and effectiveness of rotary nickel-titanium files are jointly influenced by the file's design, its use, and its manufacturing process.

CONCLUSION: We can conclude our topic by telling more the instrument taper less the fracture resistance.

KEYWORDS: Innovation, root canal treatment, fracture resistance, rotary files, innovative technique, novel material.

INTRODUCTION:

The purpose of root canal therapy is to sterilize the infected root canal, stop the tooth from getting infected again, and preserve the healthy tooth [1,2]. A root canal treatment removes the inflamed or infected pulp and meticulously cleans and sanitizes the inside of the tooth before being filled and sealed. Rotating nickel titanium (NiTi) file technological advancements have given rise to new concepts in root canal instrumentation, including an accelerated taper of preparation[3]. The root canal can be sufficiently enlarged with a higher taper of mechanical preparation, which improves irrigant flow, the distribution of stresses during lateral and vertical gutta-percha compaction, and the elimination of debris and smear layer[4]. Moreover, worries about the vulnerability of the roots to fractures were highlighted due to possible extensive dentin removal. In both endodontically and non-endodontically treated teeth, vertical root fracture (VRF) is a problem that frequently necessitates extraction. The literature has covered root fracture predisposing factors in great detail, and different categories have been suggested [5]. The geometry and volume of the root canals are impacted by mechanical preparation, which results in strains on the root dentin and, as a result, dentinal flaws. The increased risk for root fracture during and after root canal therapy may be related to the root canal preparation tools and techniques used, as well as the apical diameter[6].

Fractures can be caused by a variety of causes, making it difficult to evaluate each one's specific contribution, especially when assessed in in vitro experimental settings [6,7]. Previous research has sought to assess the susceptibility to fracture of teeth that have had endodontic treatment and have been instrumented with rotary and manual instruments of various tapers[8]. The instruments and experimental methodologies used, along with methodological restrictions on the sample's uniformity and randomization, have led to a diversity of outcomes[9]. By reducing the

influence of all other potential parameters under in vitro experimental circumstances, the study's goal was to assess the impact of tool taper on the fracture resistance of endodontically treated roots alone [10]. The root canal can be sufficiently enlarged with a higher taper of mechanical preparation, which also results in better smear layer and debris removal, improved irrigation flow, and better stress distribution during both lateral and vertical gutta-percha compaction. However, worries about the vulnerability of roots to fractures were brought up by possible extensive dentin removal[11]. A comparison of the susceptibility to fractures of endodontically treated teeth instrumented with manual and rotary instruments of various tapers has been made in earlier research [12]. An instrument's higher taper can remove more pericervical dentin, weakening the tooth's strength[13,14]. Our team has a wealth of knowledge and research expertise, which has resulted in publications of the highest caliber[15–19].

This study used rotary files (4% and 6%) and in vitro experimental settings to investigate the impact of instrument taper on the fracture resistance of endodontically treated teeth.

MATERIALS AND METHODS:

Fifty human mandibular single rooted premolars were collected and used in this in-vitro study. Samples were collected from Oral and Maxillofacial Surgery department, Saveetha Dental College, Chennai. Post extraction of the premolars, soft tissue, bone around the teeth, calculus and stains were removed from all the 50 teeth using ultrasonic scaler. The teeth were stored in a container of distilled water until use.

Inclusion criteria:

Single-rooted, single-canal teeth with healthy roots that had to be removed for periodontal or orthodontic issues.

Exclusion criteria:

1) Caries
2) Root cracks or any perforations or any fractures.

Sample preparation:

Pre operative radiographs were taken. Access cavity preparation was done with endo access bur and access refinement was done with endo z bur. We used Neo Endo blue rotary files which was an assorted pack of both 4% and 6% files. A Woodpecker E-com plus endo motor was used. Orifice enlargement followed by a glide path file. Cleaning and shaping with the working length of the tooth was started in which 25 samples cleaning and shaping was done with 4% rotary files and other 25 were 6% rotary files from the assorted pack. Obturation of the root canal was done with 4% and 6% gutta percha respectively. The Gutta Percha was sheared till the cementoenamel junction and entrance filling was done with the help of composite. Resin blocks were made with the root canal treated premolars (fig:1).

Figure:1: Tooth blocks made to assess the fracture resistance.

Experimental group:

The teeth were separated into 2 groups based on the file taper.

1) Group I - 4% taper
2) Group II- 6% taper

Fracture testing:

The Universal Testing Machine was used to test every sample. An all-purpose testing device was used to evaluate the teeth. Each specimen's center was lined up with a steel conical tip that tapered at a 60° angle. Till tooth fracture, force was delivered at a crosshead speed of 1 mm/min. The jig used was 2mm. The Newton value of the load required to fracture was recorded.

Statistical analysis:

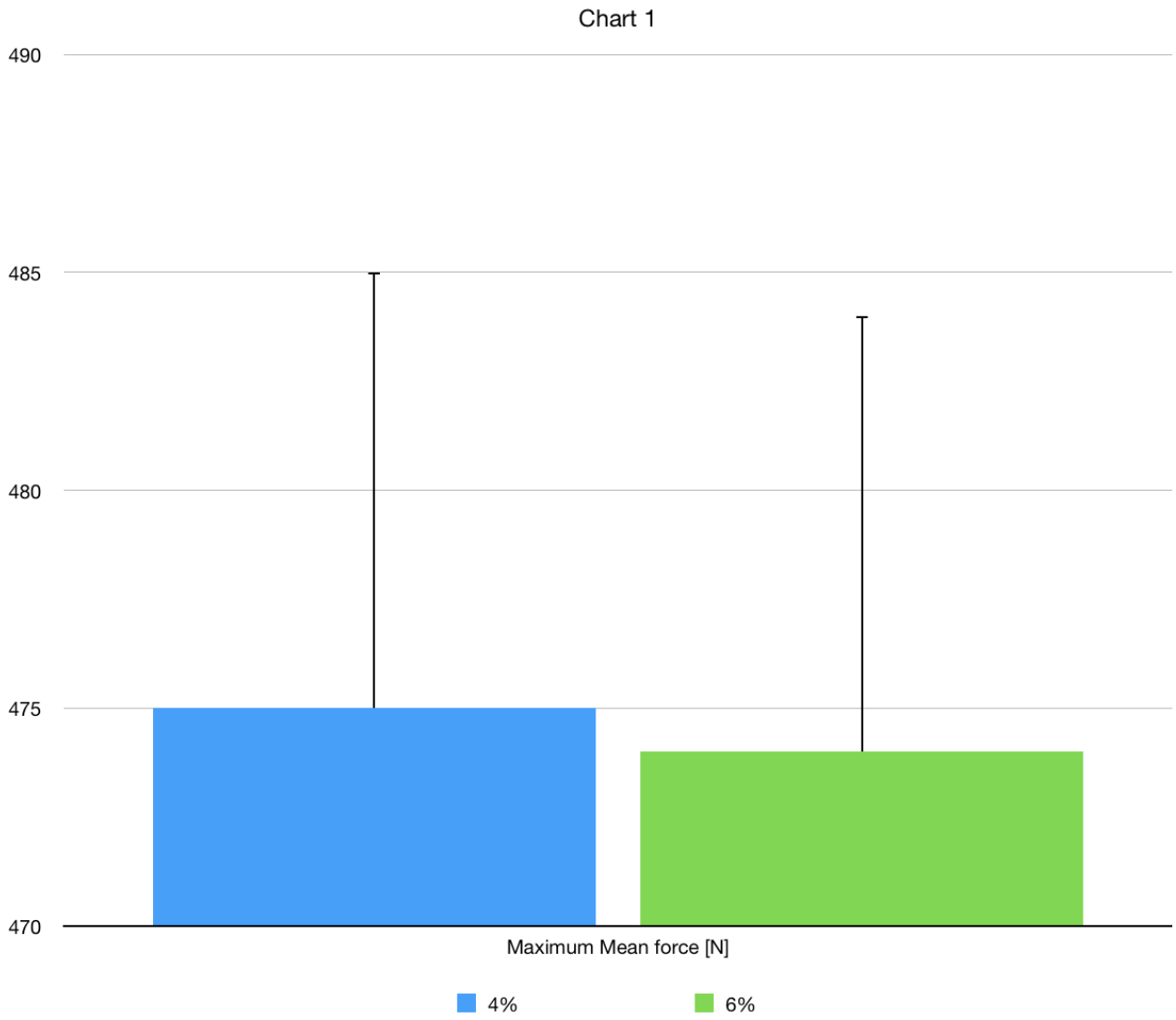
Microsoft Word and Excel were used to create graphs, tables, and other output while IBM SPSS statistics 20.0 was used to analyze the data.

RESULTS:

It was discovered that there was no statistical difference between Group I and Group II.

Instrument taper	Mean	P value
4%	474	.690
6%	472	

Table1: The above tabulation represents comparison of fracture resistance of 4% and 6% tapered root canal treatment using Mann Whitney test. The p value was 0.690, >0.05, Statistically not significant.



Graph:1: The above graph represents the comparison between the maximum mean force obtained on both 4% and 6% tapered instrumentation. Blue is 4% taper and green is 6% taper. 4% tapered endodontically treated teeth had more resistance to fracture when compared to 6% tapered endodontically treated teeth. Increasing the taper will make the tooth more weak.

DISCUSSION:

There was a previously done study by Krishna et al.,2021, Only the last rotary file used after instrumentation with hand files up to file 40/.04 and 40/.06 appeared to alter the fracture resistance of roots that had undergone endodontic treatment. In our study both 4% and 6%

endodontically treated teeth don't have any significant difference. The fundamental goal of root canal therapy is to properly shape and clean the root canal system while preserving the canal's original shape[14]. In order to allow efficient irrigation and three-dimensional obturation of the root canal space, it also seeks to construct tapering funnel preparation with increased diameter[20]. It is widely acknowledged that the amount of sound tooth structure still present in an endodontically treated tooth directly correlates with the tooth's resistance to fracture. The residual dentin thickness following the instrumentation with different tapers may vary depending on the root dimensions[21]. Safety and effectiveness of rotary nickel-titanium files are jointly influenced by the file's design, its use, and its manufacturing process[22]. An excessive taper might weaken the root and cause an excessive amount of dentin to be removed. New design ideas for better root canal shaping and success have emerged in recent years as a result of advancements in rotary nickel-titanium equipment[23]. Today's endodontic procedures rely heavily on using NiTi engine-driven devices for the biomechanical preparation of the root canal[24].

The numerous brief contacts between the files and the dentinal walls during instrumentation result in the root canal geometry. These contacts put stress on the canal walls, resulting in dentinal defects that can make the tooth more brittle [24]. The magnitude of these contact stresses is influenced by the files' mechanical behavior, which is primarily dictated by the files' cross-sectional and longitudinal design, torque settings, number of rotations, and kinematics. Additionally, fractures do not happen right away following canal preparation, according to Bier et al. Despite the fact that craze lines (4% to 6%) may turn into fractures during retreatment or following prolonged functional stressors like chewing and uneven occlusal forces[25]. Because such fractures may lower the long-term survival rate, resistance to tooth fracture is a key endodontic goal. Experiments have demonstrated that excessive dentin removal during obturation with a spreader, post space preparation, and root canal preparation can result in tooth fractures[25,26].

Safety and effectiveness of rotary nickel-titanium files are jointly influenced by the file's design, its use, and its manufacturing process[27,28]. An excessive taper might weaken the root and cause an excessive amount of dentin to be removed[29]. Numerous advantages of these tools include shorter operating times, fewer procedure-related mishaps, and cleaner root canal walls[30–32]. They are being used more frequently because they make the dentist's job easier

and take less time. We can conclude our study by telling there is no significant difference in the 4% and 6% rotary system but it's always best to be as conservative as possible and every increase in taper has more removal of the dentin thickness..

CONCLUSION:

With increasing taper, root stresses decreased during root filling but tended to increase for masticatory loading. Within the constraints of this in-vitro study, it can be deduced that teeth that

have been instrumented with 4% rotary file system and 6% rotary instrumentation don't have any significant difference. Furthermore research has to be done to determine its significance in clinical scenarios.

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CONFLICT OF INTEREST:

None declared

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