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To check the fracture resistance of teeth cervically after preparation of canals with different tapers- An In vitro study

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Abstract

Introduction: Minimal invasive Endodontics in the form of minimal root canal taper preparation have been devised to preserve tooth structure and increase fracture resistance.

Aim: The aim of this study was to examine the fracture resistance of teeth cervically after preparation of canals with different tapers.

Method: In total, 40 human teeth with straight single root canals complying with the inclusion criteria were selected from a pool of teeth. The roots were randomly distributed into 3 experimental Groups (n = 10) and 1 control group (n = 10). The roots in group 1 were instrumented with hand files up to file 25/.02 and groups 2 and 3 with Dentsply rotary file up to files 25/.04 and 25/.06, respectively. After mechanical preparation, the roots were obturated with gutta-percha and sealer. Roots in group 4 acted as uninstrumented controls. A vertical load was applied to each specimen using a universal testing machine until the cervical part of tooth fractured. Data were statistically analysed by one way ANOVA test.

Results: The mean fracture resistance was 156.19 N for the control group, 143.0 N for group 1, 129.94 N for group 2, and 117.55 N for group 3. Pair wise comparison using Tukey’s post hoc test showed significant difference in Fracture Resistance among all groups.

Conclusion: It was concluded in the study that Fracture Resistance was maximum in 2% taper whereas least in 6% taper group. Also instrumented teeth have a higher risk to fracture than uninstrumented counterparts. The generated stress is greatest at the cervical portion of the root surface, and increases slightly as taper increases.

Keywords: Endodontics, Cervical Portion, Human Teeth.

Introduction

Proper cleaning and shaping of the root canal space with the objective of total removal of vital tissue, necrotic debris, and microorganisms from within a root canal system is considered to be essential for success in

endodontic therapy[1]. Teeth managed endodontically are known to be weak due to loss of tooth structure during caries removal, access cavity preparation and use of rotary instrumentation during biomechanical preparation.

Technological innovations in rotary nickel titanium (NiTi) files have led to new concepts of root canal instrumentation including an increased taper of preparation. A higher taper of mechanical preparation offers sufficient enlargement of the root canal resulting in better removal of debris and smear layer, improvement in irrigant flow, and better distribution of stresses during both lateral and vertical gutta-percha compaction[2].

However, possible excessive removal of dentin with higher tapered files raised concerns regarding the susceptibility of roots to fractures. The use of high tapered rotary instruments can cause changes in both the canal volume and geometry, which increases the risk of vertical root fracture due to the removal of excessive dentin from the middle and coronal third of the root canal[3]. Thus, the use of less tapered instruments that allow the apical size to be increased while protecting the dentin has been recommended.

The aim of the study is to evaluate and compare fracture resistance of cervical tooth structure after preparation with 2%, 4%, 6% taper instrument.

Null hypothesisis that there is no difference in the fracture resistance of teeth cervically when prepared with 2%, 4%, 6% root canal taper.

Methods

Forty human extracted teeth were selected randomly from a pool of teeth. Only teeth with straight single root canals, intact closed apices, a minimum tooth length of 18 mm and no previous root canal treatment were included.

Samples were randomly divided into 3 groups based on taper of file system used and 1 control group without any preparation.

Group 1- the root canals were shaped with stainless steel hand K-files (Dentsply M Access) up to file # 25, which served as the master apical file, and then flared using a step-back technique in 2-mm increments up to size # 60. The roots were obturated using the lateral condensation technique with gutta-percha (Dentsply Gutta Percha) 25/.02

Group 2 - instrumentation rotary files (Dentsply Protaper Rotary Files) up to file 25/.04 in crown down fashion following the manufacturer's protocol. Roots were obturated using the single-cone technique with gutta-percha25/.04

Group 3 - instrumentation with rotary files up to file 25/.06 in crown down fashion following the manufacturer's protocol. Roots were obturated using the single-cone technique with gutta-percha 25/.06

Group 4 (Control) - the samples were not instrumented or filled.

The samples were tested with a universal testing machine. A steel conical tip was aligned with the Centre of the canal orifice of each specimen. Force was applied with a 1-mm/min crosshead speed until cervical fracture occurred. The load necessary to cause fracture was recorded in Newton. Measurement of fracture resistance was performed blindly by the other dentist and lab technician.

Statistics

Data entries were done in Microsoft Office Excel 2010 and analyses of results was done using Statistical product and service solution (SPSS) version 22 software. Descriptive statistics such as mean and standard deviation was calculated for quantitative variables. Percentage was used for representing qualitative

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variables. The p value was fixed at 0.05. Data normality was checked using Shapiro Wilk test. One way Anova F test was used for comparison in respect to overall fracture resistance between four study groups. Tukeys post hoc test was used for pairwise comparison between groups.

(Defending statement- Kolmogorov–Smirnov test and Shapiro wilk test both have shown that data follows normality both known from p value and shape of distribution and hence parametric test like anova test were used by biostatistician)

Results

Control group (Uninstrumented) showed highest fracture resistance than instrumented group (Group1, Group2, Group3). Between experimental group, lowest fracture resistance was seen in Group 3 (6% taper) followed by Group 2 (4% taper) and highest in Group 1 (2% taper). Pair wise comparison using Tukey's post hoc test showed significant difference in Fracture Resistance among all groups.

Table1: Descriptive statistics of fracture resistance of four study group with different taper inclination.

25 no. file size	Mean	SD	SE	Minimum	Maximum
Group A (Unprepared)	156.19	7.48	2.361	143.98	167.69
Group B (2%)	143.0	8.44	2.67	127.68	155.92
Group C (4%)	129.94	5.67	1.794	122.3	138.4
Group D (6%)	117.55	6.84	2.166	109.83	128.46

Table 2: Comparative statistic of fracture resistance of four study groups with different taper inclination using One way Anova F test.

	Mean	SD	Repeated Anova F test	P value , Significance
Group A (Unprepared)	156.19	7.48	F = 53.736	P< 0.001**
Group B (2%)	143.0	8.44		
Group C (4%)	129.94	5.67		
Group D (6%)	117.55	6.84		

Table 3: Pairwise comparative statistics of fracture resistance of four study groups with different taper inclination using Tukey's post hoc test

Group	Comparison Group	Mean Difference	P value
Group A (Unprepared) vs	Group B (2%)	13.18	p =0.001*
	Group C (4%)	26.24	p<0.001**
	Group D (6%)	38.63	p< 0.001**
Group B (2%) vs	Group C (4%)	13.06	p =0.001*
	Group D (6%)	25.45	p< 0.001**
Group C (4%) vs	Group D (6%)	12.39	p=0.002*

Discussion

To the best of our knowledge the fracture resistance of the root after biomechanical preparation with different taper files has been tested before but its effect at the cervical level of the tooth has not been studied till now.

In the present study, null hypothesis was rejected as there was difference in fracture resistance of teeth at the

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cervical level after canal preparation with 2 %, 4 % & 6 % taper files.

In our study, the samples in control group (no instrumentation) showed highest fracture resistance than instrumented group(Group 1, 2 and 3).

Amongst instrumented groups, lowest fracture resistance was in group 3 (6% taper), followed by group 2 (4% taper),and highest resistance in group 1(2 % taper). The result of the present study indicates that instrumented teeth have a higher risk to fracture than un-instrumented counterparts. The generated stress is greatest at the cervical portion of the root surface, and increases slightly as taper increases. The contact and motion of instruments induce stresses on the canal walls, producing dentinal defects that can increase the susceptibility of the tooth to fracture. This creates problem of fracture of crown cervically and indicates mindful rehabilitation of endodontically treated tooth.

Study conducted by Nandini et al reported that canal preparation with less tapered file system renderedhigher fracture resistance values in comparison to other groups, which confirms the results of the present study.[4]

Also, a study conducted by Sayali H. Khandale et al concluded that roots of single rooted teeth were significantly weakened by the preparation with instruments having greater tapers[5]

However, study by Munari et al. used finite element analysis to show that as the root canal diameter increases, there will be a bigger circumferential area for distributing the contact pressure, leading to lower fracture-causing stresses. This result is contrary to the results of the present study[6]

In clinical situations, both periapical pathology and root canal anatomy should be taken into consideration when the apical size preparation and taper of the canalis planned. Specimen preparation and the direction of the force applied in this study may be different from clinical conditions; therefore, any direct correlation between fracture load values and clinical reality should be interpreted with caution,hence, the present results can only serve as a reasonable predictor of clinical performance.

Conclusion

Within the limitations of the present in-vitro study and based on the results it can be concluded that fracture resistance was maximum in 2% taper and least in 6% taper group. As the null hypothesis is that there is no difference in the fracture resistance of teeth cervically when prepared with 2%, 4%, 6% root canal taper, when the p-value is less than 0.05, the null hypothesis is rejected and it is valid to make conclusions that there are differences between each groups. Hence, it can be concluded that choosing a smaller taper may reduce the risk of fracture of the instrumented tooth and untoward events during cleaning and shaping, while choosing too large a taper may increase the potential for strip perforations, other procedural accidents[3].

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