

## RELATIONSHIP BETWEEN ENDODONTIC TAPER AND FRACTURE RESISTANCE OF TOOTH

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### Abstract

The distribution of chewing pressure in intact tooth is from crown, across the root dentin and ends in periodontal ligament. Endodontic treatment procedure is dental procedure that is necessary when the pulp tissue is irreversible damaged, because of dental caries, dental disease or traumatic injury. When the dental structure is weakened, there is a possibility of crown or root fracture. The root vertical fracture is the third most common reason for tooth extraction in endodontic treated tooth. Endodontic procedure is successful when all the steps of dental procedure is completed.

The objective of this study was to estimate whether the low taper of endodontic instrument decreases the possibility of tooth fracture and increase the percentage of tooth fracture resistance.

To complete the aim of this study, were analyzed total number of 84 surveys, 42 of them were used for detail analysis. The electronic research was done using the databases as: Pub Med (Medline), Embase, Medscape, Web of Science and Cochrane Library. This study is based on review on published articles written in English language, reporting results related to the use of different intensity of conicity in endodontic treatment and the influence to tooth fracture resistance. Other inclusion criteria as date parameter of the articles was set from 2000 until 2022.

The research examined in this review is of in vitro studies and FEA analysis. Some results of this research have shown that fracture resistance in endodontic treated tooth depends of quantity of dental structure. In many reviewed studies the evaluated levels of fracture, have been found to be significantly lower in groups of teeth that are endodontic treated with lower conicity, compared with the other groups of teeth that are endodontic treated with high percentage of conicity. Also, The FEA method has been successfully used in endodontics, where it has proven with the in vitro methods of study.

**Key words:** Endodontic shaping, tooth fracture, fracture resistance, instrument taper, endodontic instrument, fracture straight.

### Introduction

The distribution of chewing pressure in intact tooth is from crown, across the root dentin and ends in periodontal ligament [1].

Endodontic treatment procedure is dental procedure that is necessary when the pulp tissue is irreversible damaged, because of dental caries, dental disease or traumatic injury [2].

The prognosis of endodontically treated tooth is worse than vital tooth. Increased fracture in endodontically treated tooth is associated with the quantity of remaining dental tissue, mechanical characteristics and mechanism of protection [3].

The susceptibility of endodontically treated tooth, that show higher loss of dental structure, may leads to high percentage of fracture and its mainly associated with reduced dental resistance [4].

The literature of data bases show that the root vertical fracture is the third most common reason for tooth extraction in endodontically treated tooth [5], especially more frequent in tooth with curved root [6,7,8].

Endodontic procedure is successful when all the steps of dental procedure are completed correctly [9]. Especially important is proper mechanically shaping of endodontic space to strictly prevent the risk of tooth fracture. Mechanical instrumentation must be carefully worked. In addition, not too many and not too much, to avoid bigger concentration of stress distribution and increased risk for dental fracture and consequently dental loss [10]. It goes without saying there is a need for correct irrigation to complete all the steps.

Mostly of dilemmas are about how to reach the goal: higher fracture resistance of endodontically treated tooth.

### ***Aim***

The objective of this study was to estimate whether the low taper of endodontic instrument and root preparation decreases the possibility of tooth fracture and increase the percentage of tooth fracture resistance when there is a need for endodontic treatment procedure.

### **Materials and methods**

#### ***Search strategy***

The review was performed with analyzing 84 articles. The survey was based on electronic research of literature bases: Pub Med (Medline), Embase, Medscape, Web of Science and Cochrane Library.

The articles that were reviewed are those that report results related to the influence of different taper of instruments (files) during endodontic treatment to stress distribution and tooth fracture resistance.

For the search were used the following key words: endodontic shaping, tooth fracture, fracture resistance, instrument taper and endodontic instrument, fracture straight and combination of them.

From the total 84 articles that were selected with the electronic search, 42 articles were taken for detailed analysis about our objective: Fracture resistance in treated tooth with different endodontic conicity. This review included articles that are in vitro and finite element analysis (FEA) studies with this objective.

#### ***Criteria of inclusion and exclusion***

The texts of all articles were chosen, considering protocol of defining criteria. Upon identification of an abstract for possible inclusion, the full text of the article was reviewed and subjected to predefined criteria. The electronic search was supplemented by a manual search through the references in the selected articles, and any articles found were reviewed for possible inclusion.

The eligibility criteria were inclusion and exclusion criteria. Inclusion criteria as date parameter of the articles was set from 2000 until 2022, published articles on English, full text articles, articles that include human teeth, articles with materials and methods includes in vitro or finite element analysis (FEA) studies, articles with different taper shaping of endodontic instrument.

Exclusion criteria for analyzed articles were: duplicates articles, elder articles than 2000 year, and articles with animal teeth.

After implementation of inclusion and exclusion criteria and detail screening, some articles were discarded, and some were extracted for detail analysis in the following research.

Using the search criteria, the electronic search produced 84 full text articles. After reading the abstracts, 42 articles were retained, and then the full text was studied. From this full reading, 42 articles were included in the study.

All the articles examined in this review are in vitro studies and FEA analysis. It was decided to group together studies that analyzed similar parameters.

All extracted data were recorded and standardized according to the following parameters: first author's surname, year of publication, study type, number of specimens, testing parameters and outcomes.

### **Evaluation and results**

Today, the FEA method has been successfully used in dentistry and has results that are valuable to physical methods. FEA in dentistry has implementation in: implantology [11], prosthetics [12], orthodontics [13], restorative dentistry and endodontics [14].

In study done by Lee et al. [15], it was made finite element models (FEM) and finite element analysis of stress distribution in intact premolars. The place where there is the higher pressure, is the cervical part of the tooth. With this result is confirmed stress-induction theory about occurrence of abfraction.

In study done by Soares et al., is used software package of finite element analysis methods.

They concluded that pressure that came from palatal, generate higher stress in gingival edges of the lesions [16].

3D FEA analysis is used in study by Arola et al., in restorative dentistry. Fracture resistance in teeth restored with two materials is the same. The higher force is on the pulpal bottom and lingual part in amalgam restoration, while in composite restoration, in the edges of the restoration [17].

In endodontics, is found that there is no difference between the 4% taper of preparation and 6% taper of preparation, in study by Zogheib et al., when they tested compressive strength fracture with a mechanical material testing machine [18].

The literature reports reducing the risk of stress concentration sides and tooth fracture with lower taper of shaping below 6%. [19]

Munari et al., in their study used finite element analysis to show that as the root canal diameter increases, there will be lower fracture-causing stresses areas. [20]

The in vitro study by Wu et al., has shown that access cavity and root canal preparations significantly reduce the fracture resistance of the premolar tooth.

They used universal testing machine and analyzed the tooth straight under pressure. The result from the compressive strength test was that the most common fracture was vertical. [21]

The constatation fiber-reinforced teeth can improve the fracture resistance of the endodontically treated teeth, is confirmed in study by Shi, R et al. [22]

In in vitro study by Kılıç, et al., was found that increasing the apical diameter and taper in the endodontic treated canal reduces the fracture strength of the tooth. [23]

In the following studies by Tian et al. [24], Aksoy et al. [25], Zogheib et al. [26] and Capar et al. [27], they concluded that when teeth were shaped with higher root canal taper, the root straight increased. (Table 1)

According to the studies by Kılıç et al. [28], Yıldız et al. [29], Sabeti et al. [30] and Örs et al. [31], the teeth that were shaped with higher root canal taper, have decreased root resistance. (Table 1)

**Table 1.** Results from studies about fracture resistance and instrument taper

Author	Year	Type of study	Higher fracture and higher instrument taper	dental and instrument	Higher fracture and lower instrument taper
Tian S.Y.	2019	In vitro			✓
Aksoy Ç	2018	In vitro			✓
Zogheib C	2018	In vitro			✓
Capar I.D.	2014	In vitro			✓
Kılıç Y.	2021	In vitro		✓	
Yıldız E.D.	2020	In vitro		✓	
Sabeti M.	2018	In vitro		✓	
Örs S.A.	2017	In vitro		✓	

### Discussion

The attitudes towards this problem are divided. Some authors think that taper of the instrument affects the tooth straight, others think that there isn't any relationship between them.

Aidasi et al. [32], used different systems of endodontic preparation. They tested fracture resistance after obturation. According the results, the authors recommend endodontic instruments with reciprocal movements, because they decrease the damage of tooth. The same results are in Saber et al. [33], study. They found that apical transportation is lower when reciprocal instruments are used.

Contrary to those results, there is a study of Burklein et al. [34]. They used reciprocal and rotatory instruments for endodontic shaping. The defects of endodontic preparation are bigger with reciprocal movement, especially in apical part of the tooth.

Some in vitro studies that were included in this review, don't agree among themselves in comparing their results from their researches. Some authors show how increasing the root canal taper does not produce root resistance reduction [24, 25, 26, 27].

Others, show how increasing the root canal taper decreases the root resistance [28, 29, 30, 31]. (Table 1)

Kfir et al. study and Arias et al. study, showed how increasing the root canal taper does not determine an increased frequency of tooth damage [35, 36].

Other authors instead showed how increased root canal taper, can lead to tooth damage [37, 38, 39].

Excellent survival rates have been reported in teeth shaped with low taper. This constatation is the same in both studies done by Clark et al. [19, 40].

Contrary to study by Wu et al. [21], are the findings of Steele and study Reeh et al. [41, 42] about root canal shaping, tooth straight and possibility to fracture.

### Conclusion

Mechanical instrumentation affects the fracture resistance of roots. Authors don't agree among themselves in comparing their results from their researches. Some authors said that increasing the taper of endodontic instrument could detrimentally affect tooth straight and of course leads to tooth fracture. In those researches especially important is stress distribution of the tooth. Others, said that increasing the endodontic taper does not affect to decrease root straight.

When all the dilemmas about this question are clarify, it'll improve the clinical practice and will carry on the state of tooth in oral cavity. More studies are needed to further analyze the correlation among taper of the file and tooth straight and tooth resistance.

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