ORAL HEALTH

ENDODONTIC TREATMENT AS A RISK FACTOR AFFECTING THE TOOTH STRENGTH

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Abstract

Endodontic instrumentation is a critical step in root canal therapy that involves cleaning and shaping the canal system. While it effectively removes infected tissue and shapes the canal for obturation, it also impacts the fracture strength of the treated tooth. So, endodontically treated teeth are considered to have a lower survival rate compared to vital teeth. Objective: This study aimed to evaluate the rate of influence of the factor endodontic treated and root-filling to the fracture strength of the tooth compared to the intact tooth. Materials and methods: After applying criteria for selection, fifty extracted single-root noncarious teeth were randomly divided into 2 groups and 4 subgroups: 1a) intact teeth, 1b) decoronated teeth, 2a) instrumented with Hedstrom file and obturated, 2b) instrumented with Hedstrom file and insert fiber post. After instrumentation, irrigation and obturation, all specimens were placed into EXMAL 1 models. Then, the fracture strength was tested with the Universal testing machine. Results: The intact teeth had the highest mean value of the fracture pressure among the specimen groups, i.e. 1346.9± 320.25 (min 954, max 2030), while the endodontic instrumentation decreased the tooth strength. At the same time, they had (instrumented and obturated group of specimens) the lowest rate of pressure 867.23± 108.76 (min 647, max 1051). Fiber post subgroup had 802.13± 95.04 (min 647, max 963) force of fracture pressure in comparison to instrumented and obturated subgroup 932.33± 79.93 (min 806, max 1051), which had a higher rate of fracture resistance. Conclusion: The major risk factor that influence on the fracture resistance of the tooth is the endodontic instrumentation. Intact teeth have the highest rate of strength. Gutta-percha/Endometasone N single cone technique showed higher strength than obturated teeth and reinforced with fiberglass post.

ОРАЛНО ЗДРАВЈЕ

ЕНДОДОНТСКИОТ ТРЕТМАН КАКО РИЗИК ФАКТОР КОЈ ВЛИЈАЕ ВРЗ ЦВРСТИНАТА НА ЗАБИТЕ

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Клучни зборови: цврстина на заб, отпорност на заб на кршење, ендодонтска инструментација, ризик-фактори за фрактура на заб

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Извадок

Ендодонтската инструментација е важен чекор во коренската канална терапија која вклучува чистење и обликување на каналниот систем. Додека од една страна ефикасно го отстранува инфицираното ткиво и го обликува каналот за оптурација, од друга страна влијае врз фрактурната цврстина на третираниот заб. Па така, ендодонтски третираните заби се сметаат дека имаат пониска стапка на преживување во споредба со виталните заби. Цел: Оваа студија има за цел да го евалуира влијанието на факторот ендодонтско обработување и полнење на забот врз фрактурната цврстина на забот во споредба со интактните заби. Материјал и методи: По примената на селективни критериуми, 50 извадени еднокорени, некариозни заби, по пат на случаен избор беа поделени во 2 групи и 4 подгрупи: 1а) интактни заби, 1б) декоронирани заби, 2а) инструментирани со Hedstrom file и оптурирани, 2б) инструментирани со Hedstrom file и поставено фиберглас колче. По направената инструментација, иригација и оптурација, сите примероци беа поставени во EXMAL 1 модели. Потоа беше тестирана фрактурната цврстина со универзална тестирачка машина. Резултати: Интактните заби имаа најголема средна вредност на сила на притисок на кршење меѓу сите испитувани групи, т.е. 1346,9± 320,25 (min 954, max 2030), додека, пак, ендодонтската инструментација ја намали цврстината на забот. Исто така, тие имаа (инструментирана и оптурирана група на примероци) најниска просечна сила на притисок на кршење 867,23± 108,76 (min 647, max 1051). Подгрупата со фибер колче имаше 802,13± 95,04 (min 647, max 963) сила на притисок на кршење во споредба со иструментирана и оптурирана подгрупа 932,33± 79,93 (min 806, max 1051), која споредбено имаше повисока стапка на фрактурна резистенција. Заклучок: Главен ризик-фактор кој влијае врз фрактурната резистенција на забот е ендодонтската инструментација. Интактните заби имаат повисока стапка на цврстина. Gutta-percha/Endometasone N single cone техниката покажа повисока цврстина на забите отколку оптурираните и зајакнати заби со фиберглас колче.

Introduction

The strength of instrumented teeth is affected by several predisposing factors such as excessive loss of tooth structure due to endodontic instrumentation, dehydration of teeth, trepanation preparation, negative effects of irrigation and preparation for intraradicular post[1-3]. Experimental studies have shown that excessive removal of dentin during root canal preparation, preparation for the intracanal post and obturation increase susceptibility to root fracture[4,5]. Clinically, the fracture may decrease the long-term survival rate of the tooth. Although the reasons are multifactorial, the loss of tooth structure during root canal treatment plays a major role in the long-term survival of the tooth. Endodontic instrumentation is a critical step in root canal therapy that involves cleaning and shaping the canal system. While it effectively removes infected tissue and shapes the canal for obturation, it also impacts the fracture strength of the treated tooth. So, endodontically treated teeth are considered to have a lower survival rate compared to vital teeth[6]. Instrumentation removes dentin from the canal walls, which directly weakens the tooth structure. Over-preparation, especially with wide tapers or excessive coronal flaring, leads to thinner dentin walls, making the tooth more susceptible to fracture. The dentin near the cervical third (pericervical dentin) of the root is critical standing occlusal forces. Aggressive preparation in this area significantly compromises fracture strength. Preservation of a larger amount of tooth structure not only increases fracture resistance, but also maintains the structural integrity of post-endodontically-restored teeth[7-10]. This study aimed to evaluate the rate of influence of the factor endodontic treated and root-filling to the fracture strength of the tooth compared to the intact tooth.

Material and methods

Fifty extracted single-root noncarious, permanent teeth were selected. After their extraction, they were stored in a medium with 100% humidity and at room temperature. After applying selective inclusion and exclusion criteria, the teeth were examined in detail with magnification and transillumination. During preparation and testing phases of the experiment, care was taken to prevent dehydration. Teeth were randomly divided into two groups:

- I group/negative control group (G1) (n=20) – intact teeth that were neither trepanned nor instrumented;
- II group/experimental group (G2) (n=30) – endodontically treated teeth with endodontic hand instrument Hedstrom file and obturated.

Then, the first group was subdivided into: 1a) and 1b).

1a) were completely intact with no prior preparation. They were not decoronated, trepanned, or instrumented. (n=10);

1b) were only decoronated (n=10).

The second group was subdivided into: 2a) and 2b).

2a) endodontically treated with endodontic hand instrument Hedstrom file and obturated with gutta-percha single cone-technique and Endomethasone N (n=15);

2b) endodontically treated with endodontic hand instrument Hedstrom file and obturated with gutta-percha single cone-technique and Endomethasone N and insert fiber post 2/3 of the length of the canal. The cement used for fiber post was SpeedCEM®Plus translucent (Ivoclar, Vivadent). (n=15)

The decoronation was made for 1b, 2a, and 2b specimens. A diamond separator (Rotary Dental Instruments, NTI-Kahla GmbH, Germany) was used for decoronation. In those subgroups, after trepanation, depulping was performed with a nerve extirpator (Dentsply Maillefer, Ballaigues, Switzerland), the glide path was established and the working length was determined. The glide path was achieved with a #10 size K-file (Dentsply Maillefer, Ballaigues, Switzerland). The working length was determined by inserting a size #15 K-file (Dentsply Maillefer, Ballaigues, Switzerland) into the canal until the tip of the instrument was visible at the apical opening, after which the working length was established by retracting it back for 1 mm.

Parallel to the instrumentation with Hedstrom files, irrigation was made. Irrigation was carried out according to a classic modern protocol. Then, the samples were dried with paper points. Obturation was performed according to the principle of the single cone technique.

Figure 1. Ethnicity and age of parturient women

After that, the samples were placed in blocks of the EXMAL 1 (ADING AD, Skopje) material and were properly coated with 2 layers of varnish to isolate them from humidity. In order to avoid dehydration of the samples, they were kept at room temperature and 100% humidity until the time of testing.

The samples were subjected to static, compressive and vertical pressure using a universal testing machine fully automatic in Geodesign Engineering Laboratory, Skopje. Each sample was individually subjected to pressure.

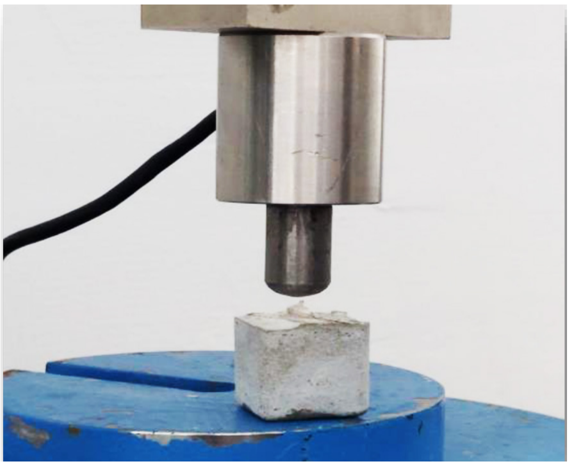

Figure 2. Testing the specimen strength

After receiving the data, a statistical analysis was made with IBM SPSS 27.

Results

The distribution of examined teeth according to groups and subgroups is summarized in Table 1.

Table 1. Distribution of examined teeth according to groups and subgroups

Specimens			N
Groups	N1	Intact teeth	20
	N2	Instrumented teeth	30
Subgroups	N1a	Intact teeth	10
	N1b	Decoronated teeth	10
	N2a	Instrumented and obturated teeth	15
	N2b	Instrumented teeth and place fiber post	15

Table 2 shows the mean value, standard deviation, minimum and maximum force of pressure among the specimens of the groups. The intact teeth had the higher mean value of the fracture pressure among the specimen groups, i.e. 1346.9 ±320.25 (min 954, max 2030), while the endodontic instrumentation decreased the tooth strength. At the same time, they had (instrumented and obturated group of specimens) the lowest rate of pressure 867.23 ±108.76 (min 647, max 1051).

Table 2. Mean value of force of fracture pressure according to tooth samples

Specimens	Mean value of fracture pressure				
	n	$\overline{X}$	σ	min	max
N1 – intact group	20	1346.9	320.25	954	2030
N2 - instrumented group with Hedstrom file 2% and obturated	30	867.23	108.76	647	1051

n-number, $\overline{X}$ – mean value, σ - standard deviation, min – minimum, max - maximum

Regarding the subgroups, although we expected the fiber post subgroup to be on the better position than the obturated subgroup, it was not the case. Fiber post subgroup had 802.13±95.04 (min 647, max 963) force of fracture pressure in comparison to instrumented and obturated subgroup 932,33±79.93 (min 806, max 1051). As we expected, the intact subgroup of teeth had the highest value of fracture force 1624.4±186.68 (min 1323, max 2030). This is shown in Table 3 and Figure 3.

Table 3. Distribution of examined teeth according to groups and subgroups

Subgroups	Mean value of force of fracture pressure				
	N	$\overline{X}$	**σ**	**min**	**max**
Intact teeth **(1a)**	10	1624.4	186.68	1323	2030
Decoronated teeth **(1b)**	10	1069.4	102.66	954	1323
Instrumented with Hedstrom and obturated **(2a)**	15	932.33	79.93	806	1051
Instrumented with Hedstrom and place fiber post **(2b)**	15	802.13	95.04	647	963

n-number, $\overline{X}$ – mean value, σ - standard deviation, min – minimum, max – maximum

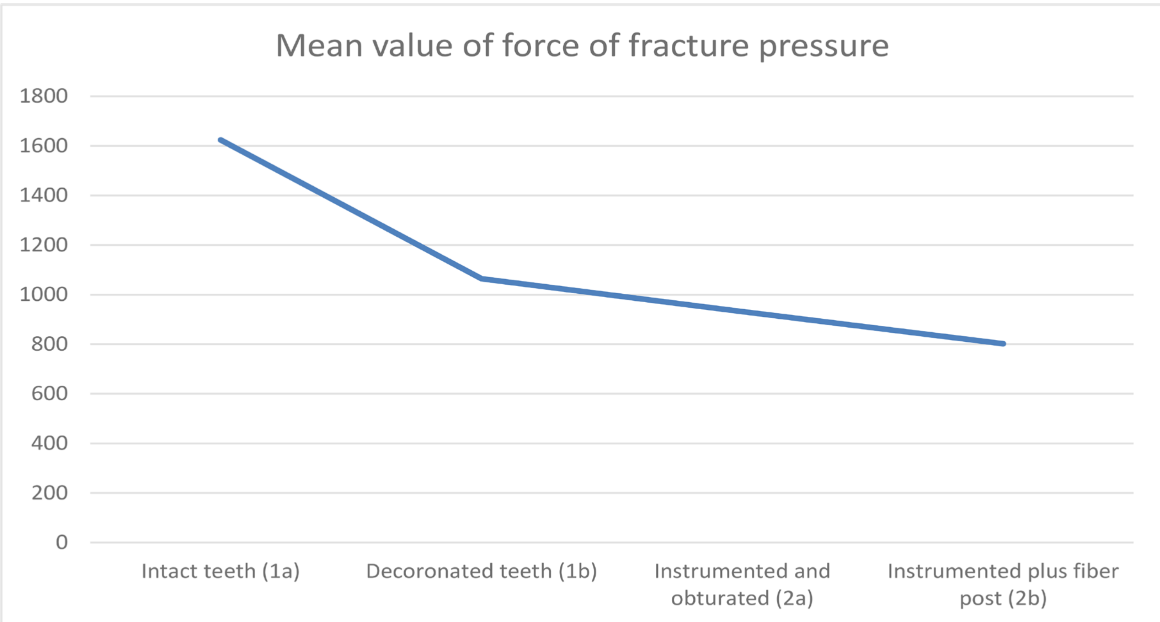

Figure 3. Mean value of force of fracture pressure according to subgroups

Discussion

The fracture strength of a tooth is a critical factor in its longevity, especially after endodontic treatment[11]. Endodontic preparation, which involves access cavity creation and canal instrumentation, directly influences the structural integrity of the tooth. Fracture strength refers to the tooth's ability to resist breaking under masticatory or occlusal forces[12]. After endodontic treatment, teeth are inherently weaker. This is because of loss of natural dentin and enamel during cavity access and shaping altered structural properties of dentin due to dehydration and exposure to irrigants and the absence of pulp, which provides internal support and hydration to dentin[13]. If not managed well, these changes can lead to catastrophic failures, such as vertical root fractures[14]. Endodontic procedures produce substantial effects on the relative stiffness of the tooth, so endodontic procedures appear to be the major contributor to clinical fractures. Although long-term functional survival rates can be high for initial endodontically-treated permanent teeth, they are generally more susceptible to fracture intact teeth[14,15]. As we saw from the results obtained in our study, the roots were significantly weakened by the instrument preparation. Similar conclusions were made by Zandbiglari *et al.*,[16]. Another study found that although there was no statistically significant difference in the average value of the pressure, there was higher fracture pressure in the control group than in the instrumented group[17].

On the other hand, the type of obturation interference to the fracture strength of the tooth[18]. According to Amal *et el.*, the total fill group showed slightly better fracture resistance (734.62 N) than AH Plus group (728.29 N), but with no statistically significant difference between them. This would suggest that the total effect of endodontic obturation is not great and in fact it makes no big difference in the choice of canal obturation.

According to placement of the fiber post, contrary to our view is the view of Bitter et al. They think that root-filled teeth without post placement show lower fracture resistance compared to the others[19]. The same opinion share Jurema *et al.*[20] They, as well as many other authors, think that use of glass fiber posts increases the fracture resistance of endodontically treated and restored teeth[21,22]. However, there is a need for reinforcing the tooth soon after root canal therapy to prevent fractures and reduce the incidence of fracture occurrence. No matter the type of treatment, conventional obturation or fiber post insertion, one is certain, tooth stiffness is reduced as a result of endodontic procedure.

Conclusion

As a result of this investigation, the following conclusions can be drawn: Canal instrumentation can significantly impact the fracture strength of a tooth by removing dentin, inducing increase in the fracture rate, and altering its mechanical properties. Adopting minimally invasive techniques and timely obturation helps preserve tooth integrity and reduce the risk of fractures. The major risk factor that influences on the fracture resistance of the tooth is the endodontic instrumentation. Intact teeth have the highest rate of strength and more restorable fractures than all the other ones. Gutta-percha/Endometasone N single cone technique showed higher strength than obturated teeth and reinforced with fiberglass post.

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