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EVALUATION OF ROOT FRACTURES OF EXTREMELY DAMAGED TEETH AFTER ENDODONTIC TREATMENT

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Abstract

It is known that endodontically treated teeth are more fragile than vital teeth. Loss of each substance in the tooth due to canal treatment and opened cavities increases the brittleness of the crown of the tooth. Incomplete apex teeth, advanced caries and overdosed canals cause restorative problems for dentists. The success of endodontically treated teeth depends on the structural, aesthetic and prosthetic success of the restoration and the clinical durability of the supporting tissues. Today, post-core systems are widely used in highly coronally damaged teeth. Starting to use materials that are attached to dental tissue as adhesives made it possible to increase the resistance of the remaining tooth tissues. In the teeth whose root canal wall is thinned, it is possible to strengthen the teeth structurally and dimensionally against breaking by supporting the channels with a suitable material. With the use of composite resins, the restoration of large canals with thin walls has become possible. By the use of light-permeable plastic posts, it is possible to strengthen the thin-walled teeth by polymerizing the composite material in the root.

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Introduction

Deep caries, dental trauma, physician error and accidents developed during dental treatment or wide channels in the apex of the unresolved teeth, studies to create restorative problems for dentists have been going on for a long time. In order to restore the aesthetic and function of coronal damaged teeth due to caries, trauma and various reasons, it is necessary to apply prosthetic treatment following endodontic dental treatment. [1,2]

Use of traditional taper and casting shafts causes excessive pressure on weakened coronal structure against xiphoid strengths. Starting to use materials providing adhesion to dentine enables the reconstruction and rehabilitation of the lost dentin tissue. It has been observed that the resistance of fractures of the wide groove teeth reinforced with composite resins is increased. [3]

Frequent occurance of fractures of dental hard tissues after endodontic treatment has led to the illusion that the canal treated teeth are more fragile than the live teeth. [3,4] Although it is known that the moisture content of dentin is decreased in canal treated teeth compared to live teeth [5], this loss does not affect the hardness of dentin. [6] Trabert et al. [7] found that the weakening of the canal-treated teeth was due to loss of resistance because of deterioration in structural continuity rather than moisture loss. It is now accepted that a properly restored canal-treated tooth does not show a significant difference in resistance to chewing strengths compared to live teeth.

The resistance of endodontic treatment of the teeth to fracture is directly proportional to the amount of the remaining dentin structure. [39] Tjan [40] explained that 1 mm thick buccal dentin walled canals are more prone to fracture than 2mm and 3mm thick walled canal. In the researches which applied casting shaft and core in wide channel teeth, it was found that the loss of substance during the preparation of the teeth weakened the strength of the tooth against occlusal forces. [41] Such restorations result in root fractures and loss of teeth. [12]

The most common type of problem associated with shaft and core restorations is loss of retention and often appears to be a type of failure that can be compensated for by restoration renewal. [9] Assif and Gorfil [10] examined the biomechanics of the restorations of endodontically treated teeth and stated that shafts play a more important role in ensuring retention of the nucleus rather than maintaining the remaining tooth structure.

The ferrule effect protects the gingival dentin by acting as coping. This effect is also important for preventing movement of the post and marginal opening. It also prevents the rotation of the post and core during functional movements. Therefore, it constitutes the most important part of post core restoration. The more the remaining gingival dentin is covered, the better the occlusal loads are distributed[30] The aim of this study is to evaluate the root fracture resistance of anterior group teeth with thin root walls using different post materials and restorative materials.

Material Method

In this study, ethical rules were followed. In our study, 60 mesio-distal upper central incisors with a width of 7 mm were used. Teeth were divided into six groups: study group and two control groups. As the selection criteria, teeth without caries, without root canal treatment, no restoration, no crown damage to the enamel cement border, and no internal root resorption were selected.

Periodontal tissue residues on the teeth were cleaned with ultrasonic scaler and the teeth were kept in 0.1% thymol solution (+ 4 ° C) for 1 week and the teeth extracted from this solution were stored in 9% saline.

The crowns of the teeth are cut with a diamond disc (Northbel 936/012, Italy) 1.5 mm above the enamel-cement boundary perpendicular to the long axis and the surfaces are smoothed under irrigation with the aid of aerator drills.

The roots of the teeth were enlarged by applying step-back technique with 70 (K-Files 45-80) canal file. After the expansion, the canals were irrigated using 2 ml 2.5% NaOCl, 2 ml 5% EDTA and 2 ml distilled water. The canals were dried with paper cones (Densply USA) and then filled with gutta-percha (DiaDent® Gutta Percha Points, Seoul, South Korea) using the lateral condensation technique.

After filling process, the samples of the study groups were expanded with the help of 5.5 mm diameter (Mega-Gen Korea) drill under irrigation with the help of handpiece (NSK Japan. The remaining root canal wall thickness was determined as 1.5 mm.

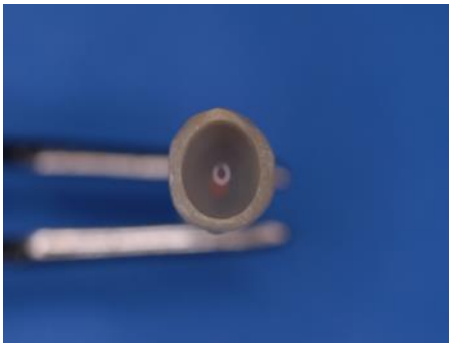


Figure 1

To ensure standardization, the canals of the teeth of the study group were enlarged, and X-ray films (RVG) were taken in bucco lingual direction and the root wall thicknesses were measured and the non-standard ones were excluded from the study group. (Figure 2)

Figure 2

Samples of the control group were expanded under irrigation with a 1.35 mm diameter reamer (Dentatus, USA). In this group, the root wall thickness was determined as approximately 3 mm.

(Figure 3)

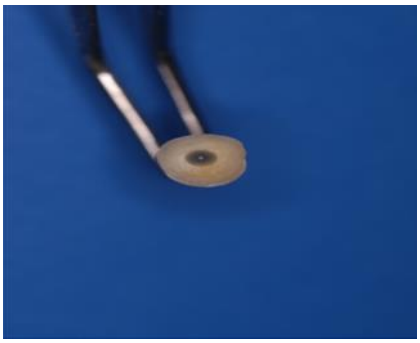


Figure 3

Root canals of the samples belonging to all groups were washed with 9% physiological saline during preparation. All teeth were then disinfected in 0.1% thymol solution (+ 4 ° C) and stored in 9% physiological saline until the experimental stage.

40 of 60 samples were used in the study group and 20 of them were used in the control group. Samples with a root canal wall thickness of 1 mm were randomly divided into 10 groups.These groups consist of the samples of 1.Group; Luminex - fiber (LF), 2. Group; Luminex – metal (LM), 3. Group; Panavia – Fiber (PF) and 4. Group; Panavia – Metal (PM).

After the root canal walls of the samples belonging to Group 1 (LF) are dried with Dia dent absorbent paper point,a self-etch adhesive (Ivoclar, Vivadent AG, Schaan / Liechtenstein) was applied in two layers. After the excess adhesive (Ivoclar, Vivadent AG, Schaan / Liechtenstein) has been removed with Dia dent absorbent paper point, plastic post(Dentatus luminex smooth plastic post) which transmits light was placed into the root canals(Figure 4) and the adhesive was polymerized with light (Woodpaker, FlashSoft Led beam device 1200 W / cm 2) for 20 sec.

Examples, after the root surface application, a fluid composite (Ivoclar tetric evoflow Vivadent AG, Schaan / Liechtenstein) was filled into the root canal with the aid of lentilo. A light-transmitting post (Ø 1.3 mm, Dentatus luminex smooth plastic post) from the Luminex system was placed in a central position within the root canal and the composite material (Ivoclar tetric evoflow Vivadent AG, Schaan / Liechtenstein) was polymerized with light (FlashSoft Led beam device 1200W / cm2Woodpecker) for 20s. After polymerization, the plastic posts were removed and the cavities were cemented with self-

adhesive resin cement (SmartCEM2 Densply USA) with fiber posts (Ø 1.3 mm, Dentatus Lusence fiber USA) that were compatible with the channel diameter.

The root canal surface treatment of the samples of Group 2 (LM) (Figure 3.23,3.234), composite (Ivoclar tetric evoflow Vivadent AG, Schaan / Liechtenstein) application and preparation of space for the canal shaft were performed as in Group 1. The metal shaft (Dentatus Surtex titanium, Ø 1.3 mm) (Figure 3.22), which is compatible with the root canal width of the luminex system, was then bonded with self-adhesive resin cement (SmartCEM2 Densply USA).

In the examples of Group 3 (PF), An adhesive resin cement paste A&B (Panavia Kuraray Japan) was filled into the canal with the help of lentilo without any surface treatment on the root canal walls. A 1.30 mm diameter fiber shaft (Luminex, Dentatus lusence fiber) was then fixed in the central position within the root canal. To provide adhesive resin cement polymerization, an oxygen inhibiting material (Oxyguard II Kuraray) was applied to the cement surface. In addition, light (Woodpecker) (FlashSoft Led beam device 1200 W / cm2) was applied for 20s.

In the examples of Group 4 (PM), An adhesive resin cement paste A&B (Panavia Kuraray Japan) was filled into the canal with the help of lentilo without any surface treatment on the root canal walls.A metal shaft (Dentatus Surtec titanium) with a diameter of 1.30 mm was then fixed in the central position in the root canal.To provide adhesive resin cement polymerization, an oxygen inhibiting material (Oxyguard II Kuraray) was applied to the cement surface.Twenty samples of the control group with 3 mm root canal wall thickness were randomly divided into 2 groups of 10 (Group 5 and 6). In Group 5; 1.30 mm diameter fiber shafts (Dentatus lusence fiber) were inserted into the root canal using lentilo using self-adhesive cement (SmartCEM2 Densply USA) and light (Woodpecker) (FlashSoft Led beam device 1200 W / cm 2) was applied for 20 seconds.In group 6, metal shafts of 1.30 mm diameter (Dentatus Surtec titanium) were applied to the canal with self-adhesive cement (SmartCEM2 Densply USA).

Self-etch binding agent (Adhese one viva pen, Ivoclar, Vivadent AG, Schaan / Liechtenstein) was applied directly to the surface of the teeth of the teeth in each of the six groups prepared and left on the surface to which it is applied, not less than 30 s;

Bonding excess was removed with high pressure air and the binding agent (Woodpecker) (FlashSoft Led beam device 1200 W / cm2) was polymerized with 10 s light.Polycarbonate temporary crowns (Swedish

Dental) were used to shape the crown of the tooth in the form of a cut tooth and to standardize the core.The crowns were filled with composite material (Ivoclar MultiCore Flow) and polymerized with 40s light (Woodpecker) (Flash Soft Led beam device 1200 W / cm2)After the polycarbonate crown was removed, the excess was removed and ferrul preparation was performed on the prepared samplesFor the preparation of metal crowns of the samples belonging to each group, the measurement of the coronal part of the samples (Panasil Putty Fast, Kettenbach) was taken and false roots were obtained from Type IV hard plaster. Each of the false roots was assigned a number so that the groups and specimens did not interfere..

After the die spacer (cement cavity leaving material) (Durolan) (Germany) was applied on the false roots (except for a portion of about 1 mm in the root area), it was immersed in melted wax (Mega-Dip Flexi, Germany) in a preheated chamber and wax copings were obtained.

Copings poured from Ni-Cr alloy (Wiron 99; Bego, Bremen, Germany).After the casting process was carried out in an induction type furnace (Gmg Infra Therm-2AT), metal surpluses were removed and placed on each crown, the prepared crowns were checked on the samples (Figure 3.41) and cemented with glass ionomer cement (Voco-meron).

All sample surfaces (Digital 3-Well Wax Pot) were immersed in 92^0 degree melted wax container to obtain 0.2-0.3 periodontal ligament thickness. All samples were then embedded in autopolymerizing acrylic resin using molds made of triangular metal, 2mm below the enamel cementation line (Heraus Kulzer Germany). After the polymerization of the acrylic, the waxes on the root surface were cleaned. In order to mimic periodic ligaments, polyvinyl siloxane measuring material (Bisico S4 Germany) was injected into the remaining cavity and the samples were placed again.

1 mm / min force was applied to the notch region prepared in the cingulum of the crowns which were cemented on the samples with the vertical arm of the universal tester (Shimadzu, Japan).The fracture values obtained were recorded in N (Newton),

Statistical analysis was performed using SPSS (SPSS for Windows 15.0, Chicago IL, USA).Firstly, the standard deviations of the groups that were used fiber post and metal post were examined, then one-way analysis of variance (ONE WAY ANOVA) and two-way analysis of variance (TOO WAY ANOVA)

were used to determine the difference causing (POST-HOC TUKEY HDS) test.Significance was evaluated at p <0.05.

Results

The arithmetic means of the fiber post groups were firstly obtained and then their standard deviations were found.When we examine the tables and graphs, one of the groups is different from the others.The smallest standard deviation in the table is seen in the panavia fiber group (PF) and then in the Luminex fiber group (LF).The differences in the samples in these two groups are small and the fracture values are close to each other, ie a homogeneous structure is observed.In the control group, fiber diffraction values with large standard deviations are far from each other.The variation in the samples in this group is high, ie there is a heterogeneous structure.

When we look at the fracture resistance of the teeth, the highest resistance was observed in the control groups, the lowest resistance was seen in Group PF and PM.However, Group LF and LM break resistance is higher than Group PF PM.

ONE WAY ANOVA test was applied to these three groups in order to find meaningful relationship between fiber post treated groups. The Anova test can be found alone or by cumulative comparison of the arithmetic means of three or more groups.In this comparison, if at least one group was found to be significant, Anova would be significant.

In the test performed, X group was found to be significantly different in the analysis of variance between the groups and within the groups dF=59,964 ; S.d=2;27 p<0,001. This was due to the fact that the group KF was more resistant and also the difference between the study groups LF and PF groups.

In the applied test, p <, 001 results were significant. Multiple comparison test (POST-HOC TUKEY HSD) was applied to determine where the significant difference between the groups originated. In the fiber post groups, the control group was significantly more resistant than the study groups.

Standard deviations of the arithmetic mean of the metal post groups (Group PM and KM) were found.The highest fracture resistance average KM (1195,671) standard deviation (200,327), the lowest fracture resistance average Group PM (350,957) standard deviation (50,092). (ONE WAY ANOVA) test was

used to find a significant relationship between the groups containing metal post. P <, 001 results were found to be significant.

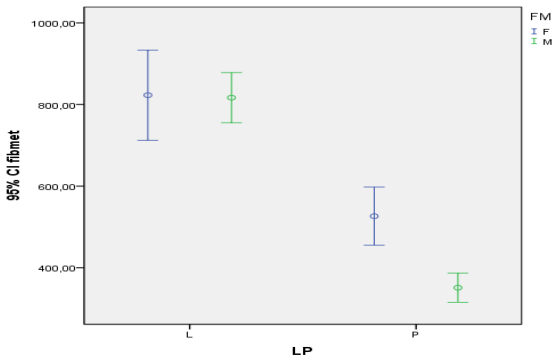
In the test performed, X group was found to be significantly different between the groups and in the variance analysis calculations within the groups (dF=107,330 ; S.d=2;27); The results of the test were p <0.001, meaningful (p <0.001). Multiple comparison (POST-HOC TUKEY HSD) test was used to determine where the significant difference between the groups originated.In the metal shaft groups, the control group was significantly more resistant than the study groups.The LM group was significantly more resistant than the PM group.

As a result of the two-way analysis of variance (Two WAY ANOVA) the following results were obtained:

- There is a significant difference between the materials used (Lumineks + composite resin and Panavia). (P <0.00).
- The interaction between the shaft and material used (Fiber, Metal and Luminex, Panavia) is significant. (F = 6.539, S.d. = 1; 36, p = 0.015).
- • There is a significant difference between the shaft used (Fiber post: 674,38). (F=7,52, S.d.=1;36, p=0,009).
- • The difference between Luminex Fiber Post and Metal Post (819,86) and Panavia Fiber Post and Metal Post (438,59) was found to be statistically significant. (F = 132.91 S.d = 1; 36, p <0.05) (Table 1, Graph 1).

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1607398,978	3	535799,659	48,990	,000
Intercept	15836947,665	1	15836947,665	1448,023	,000
LP	1453604,458	1	1453604,458	132,908	,000
FM	82282,043	1	82282,043	7,523	,009
LP * FM	71512,477	1	71512,477	6,539	,015
Error	393730,121	36	10936,948		
Total	17838076,764	40			
Corrected Total	2001129,099	39			

Table 1 Two way variance (TOU WAY ANOVA) test of LP, FM fracture changes,



Graph 1,LP, FM Interactions graph,

There is no significant difference between Luminex Fiber (822,9277) and Metal (816,7833).There is a significant difference between Panavia Fiber (526,2311) and Metal (350,9566).Paired Samples Test (Paired Samples Test) was used to find the source of significant difference between the groups.In the (t) test analysis, t = 5,116 p <0.001, there is a significant difference between the groups.

The fractures were observed in the cervical in KF and KM control groups, in the study groups Group LF and LM were observed in the cervical part, Group PF and PM were observed in the apical direction.

In our study, taking these definitions into consideration, we classified root fractures after fracture experiments. In fiber post group (Control); 4 pieces can be repaired and 6 pieces can not be repaired, Metal post group (Check); 5 pieces are repaired and 5 pieces can not be repaired; 3 units are repairable 7 units can not be repaired; 5 are repairable and 5 can not be repaired; 2 pieces can be repaired and 8 pieces can not be repaired; There are 10 irreparable root fractures.

Discussion

Root fractures encountered in the clinic cause serious problems and cause the tooth to become unusable and withdrawal.[11,12] In our study, the fracture strength of the roots was examined and the results were evaluated in terms of repairable and non-repairable root fractures.

In the studies on the resistance of the teeth restored with shaft and core systems due to material loss, when the teeth are examined in terms of localization, it is seen that most of the researches are done on the anterior region teeth [13,14,15,16] Therefore, in our study, upper central teeth were used in accordance with the literature. As the size of the teeth is an important variable in fracture resistance [17], In our study, special efforts were made to select and distribute the teeth in equal sizes in groups close to each other. According to this information, all teeth were cut and enameled from the enamel-cement boundary and all root lengths were prepared as 15 mm. The mesiodistal dimensions and buccolingual

dimensions of the teeth were then measured and the teeth were divided into 10 groups so that there was no difference between the groups. Thus, the effect of the variables depending on the tooth sizes was tried to be eliminated as much as possible.

In our study, “fluid composite” and “dual cure adhesive resin cement” were applied with lentilo into the root canal to support dentin tissue,it is stated that this application prevents the air gap that may form inside the resin material and creates a more homogeneous film thickness and forms a more resistant structure. [18] Especially when working with dual-cure resin cement used in our study, it is necessary to pay attention to filling the channel with lentulo, considering that cement will harden in anaerobic environment[19,20,21]In addition to this disadvantage, the use of lentulo allows the full adaptation of cement to the channel walls by centrifugal effect and prevents the formation of air bubbles. [22] In the studies, It is stated that the polymerization depth and bond strength obtained with II. generation LED light source together with self-etching primers are higher than other light sources. [23,24] Therefore, to reduce the possibility of failure, in our study, self-etch primary and II. Generation LED light source is preferred

In addition, self etching / self priming adhesive systems have been observed to provide a good connection to dentin in the cervical, middle and apical triad of the root.In the studies using self-etching systems, no statistical difference was observed between the connection strengths in the cervical, middle and apical triple regions of the root. [23] However, the self-etching smear layer can often adversely affect adhesion.In adhesion processes where acidification is not applied, penetration into dentin tubules cannot be achieved sufficiently.

The coronal smear layer contains the dentin matrix composition, while the endodontic smear layer contains odontoblastic activity fragments, microorganisms and necrotic residues. It has been reported that the application of self-etch adhesives as a thick adhesive layer increases the bonding and the presence of a thick layer in total-etch systems reduces the bonding. [25,26]

In this study, finger pressure was applied for 1 minute in order to simulate the clinical environment in the bonding of shafts[27,28,29] in all groups, 2 mm ferrule was prepared at the level of the cole and samples were prepared and crushed. In order to increase the retention of the core and the resistance of the teeth in the endodontically treated teeth with severe substance loss, some clinicians have suggested that ferrule of different sizes in the cervical of the tooth should be used in post-core applications. [30.11]

Ferrule effect also prevents breakage due to lateral forces,Fracture can be seen in the root when ferrule is not formed [31] As stated in the studies on core materials, when plastic formers are used in core making, the core material is more homogeneous, thereby preventing the formation of air bubbles[32,33] In this study, in order to show the homogeneous structure of the core material, the core structure was formed by using the inner surface of the plastic polycarbonate temporary crowns.

When the effects of press and stress forces applied on shafts are examined, force applications are made on crown prosthesis applied on shaft and core system.[34,35,36,37] In this study, full metal crown prostheses were prepared in order to reflect the clinical conditions on the samples better.

In our study, it is thought that embedding of test specimens in a rigid material such as acrylic resin affects loading forces and failure values of the specimens.[17] Therefore, in order to atclit the elasticity of the periodontium, in all samples, polyvinyl siloxane-based II.measurement material was applied at equal thickness around the root surface.[13, 35] [13, 35] The periodontal ligament of polyvinyl siloxane mimics alveoli of acrylic resin, while blocks mimic bone socket. [13]Thus, rigid forces on the root surfaces are avoided.In addition, a 135-degree angle, which is the contact angle of the lower and upper front groups, is provided by a device created in our study to simulate the diogonal contact angle [38].

In our study, it is essential to support the root canal by using prefabricated metal shaft and adhesive resin materials in teeth with thin root dentin wall. For this purpose, “fluid composite” and resin adhesive resin cement ”were used.Fluid composites contain smaller particle size and less particle ratio than hybrid composites.As the organic matrix ratio increases, a low viscosity composite is obtained.Yoldaş et al. [42] reported that reinforcing with composite resin in endodontically treated highly destructive teeth reduces stresses in the cervical part, thereby reducing the risk of root fractures.The composite material absorbs the forces due to its elastic modulus and gives good results especially in periodic loading tests.

[43,44]Carvalho CAT et al. [47], in a study, strengthened dentin thickness with composite resin showed that the fracture resistance of fine roots was greatly increased. Katebzadeh [48] observed that this technique greatly strengthens teeth against breakage when comparing resin strengthening techniques to all negative control groups. El-Khodery [49] confirmed that composite resin and spindle-bonded

dentin and core crowned teeth had higher resistance to pressure at 45 degrees, with 59% extra resistance compared to the group without root reinforcement.

In our study, cervical fractures were caused by failure of the control group while apical root fractures were caused by failure of the study group.These results are in line with the results of Lyons [50].A similar study suggests that the strength of a tooth is directly related to the amount of dentin tissue around the post.[51]

Dual-polymerized cements are both light and chemically curing cement.The biggest advantage of the system is the control of hardening and working times.In such cements, the reaction begins with irradiation.It reaches its maximum power after 24 hours.[52] Resin cements have been reported to be mechanically deformed by lateral masticatory forces to the teeth. [53] However, after intraradicular restoration of large canal teeth with composite resins, they are not affected by such mechanical deformations due to the modulus of elasticity of the composite close to dentin [54].In our study, groups reinforced with composite resin showed more resistance to fracture and root fracture resistance than adhesive resin cements.

Balkaya M.C. and Birdal S. [55] observed similar results in a study using fiber posts of different diameters. These researchers, in their work, have reported that reinforcement with composite resin has significantly greater fracture strength than adhesive resin cement. [55]

In our study, the polymerization of the composite resin is achieved by special channel shafts that transmit the initiating light through the root canal walls to the apical.This ensures that the polymerization is fully assured throughout the entire composite mass. This may be one of the reasons why the bond strength is obtained at the desired level in the composite material. [56]

O.Yoldaş,T.Akkova, in a study investigating the bonding resistance of resin materials to root canal walls, found that composite resins have a higher bond strength than adhesive resin cements.[42] Considering the results of this study and the results of our study, it can be said that a strong connection with dental tissues is a very important factor in strengthening dental tissues.

Vaidya Vidya N, Chitnis Deepa P, in a study in which control group was chosen as casting shaft, no significant difference was observed between prefabricated metal and fiber shafts in reinforcing with composite resin in roots with thinned dentin walls. As a result, it was determined that composite resin

provides reinforcement in thin root canals.In our study, similar to the results of this study, no significant difference was observed between prefabricated fiber and metal shaft in terms of resistance in composite resin-reinforced roots.However, there was a significant difference in root resistance between prefabricated fiber and metal shafts in the groups that we reinforced with adhesive resin cement.

Borelli et al. [61] divided the root fracture etiology into two.The first is occlusal traumas and the second is endodontically treated teeth fractures.The most common of these are fractures in endodontically treated teeth.Andreasen et al. [62] classified root fractures as horizontal fractures (horizantal: multiple fractures (oblique), cervical fractures, (apical midline, and apical fractures) and vertical fractures (vertical).

Andreasen , Sousa et al. Stated that while describing horizontal fractures, they usually occur with rupture and that they affect the dentin and cementum of the tooth. [63,64] Andreasen et al. Reported that horizontal fractures usually occur more often in the maxillary incisors. [65] Caliskan and Pehlivan in their study on maxillary incisors found fractures in 4 of the apical and cervical fractures.[66] In our study, cervical and apical fractures were also found. Cvek et al. reported that cervical and chronal fractures are easier to repair, but apical 1/3 and apical fractures are difficult to repair [69,70]

According to Andreasen et al., The diagnosis of apical fractures was difficult because the chronal segment was not separated. [67] Balkaya M. C. and Birdal S. in their root strengthening work,cervical and apical fractures similar to our study were found in the fracture experiments of the groups they used. [55] In one of the study groups, Khalid .H et al applied composite resin reinforcement on roots with thin root walls. In the fracture test, similar to our study, repairable cervical fractures were found in the groups reinforced with composite resins. [68]

Result

In our study, supporting the root canal walls with composite resin significantly increased fracture resistance,

The fact that the shafts used in the reinforcement process with composite resin being fiber or metal did not create a significant difference in fracture resistance,

Reinforcing with composite resin resulted in significantly greater fracture resistance increase than supporting root canal walls using adhesive resin.

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