ORİJİNAL ARAŞTIRMA ORIGINAL RESEARCH

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Comparison of the Fracture Resistance of the Roots Retreated Using Different Techniques With or Without Guttasolv

Guttasolv Kullanılarak veya Kullanılmadan Farklı Tekniklerle Retreatment Tedavileri Gerçekleştirilen Köklerin Kırılma Dirençlerinin Karşılaştırılması

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ABSTRACT Objective: This study aims to assess the influence of Guttasolv on the fracture resistance of roots retreated with different techniques. **Material and Methods:** Seventy extracted single-rooted, human mandibular premolars were selected and randomly divided into seven groups. 10 root canals were not retreated and used as controls. Groups were assigned according to retreatment technique: Gates-Glidden drills and stainless steel H-files, Gates-Glidden drills and stainless steel H-files with Guttasolv, Protaper Universal Retreatment files, Protaper Universal Retreatment files with Guttasolv, WaveOne reciprocating system and WaveOne reciprocating system with Guttasolv. After removal of all obturation materials, root canals were obturated using a standardized master cone. For all groups, a fracture resistance value (N) was measured and recorded using a universal testing machine. **Results:** No statistically significant difference was detected among groups for fracture resistance. **Conclusion:** Within the limitations of this in vitro study, there was no significant effect of retreatment techniques tested, with or without Guttasolv, on the fracture resistance.

Keywords: Fracture resistance; Guttasolv; retreatment

ÖZET Amaç: Bu çalışmada, Guttasolv kullanılarak veya kullanılmadan farklı teknikler uygulanarak retreatment (kanal tedavisi tekrarı) gerçekleştirilmiş dişlerin kırılma dirençlerinin karşılaştırılması amaçlanmıştır. **Gereç ve Yöntemler:** Çalışmada 70 adet tek kök tek kanallı çekilmiş insan alt küçük azı dişleri kullanılmıştır. Dişler rastgele her grupta 10'ar diş olacak şekilde 7 gruba ayrılmıştır. 10 diş tedavi tekrarı yapılmadan bırakılmış ve kontrol grubu olarak seçilmiştir. Retreatment tekniğine göre gruplar: Gates-Glidden frez ve paslanmaz çelik eğe, Gates-Glidden frez ve paslanmaz çelik eğenin Guttasolv ile birlikte kullanımı, Protaper Universal tedavi tekrarı eğe sistemi, Protaper Universal tedavi tekrarı eğe sisteminin Guttasolv ile birlikte kullanımı, WaveOne resiprokal sistem ve WaveOne resiprokal sistemin Guttasolv ile birlikte kullanımı şeklinde ayrılmıştır. Tüm kanal dolgu materyali boşaltıldıktan sonra kanallar tekrardan doldurulmuş ve köklerin kırılma dirençleri Universal test cihazıyla ölçülerek kaydedilmiştir. **Bulgular:** Kırılma dirençleri açısından istatistiksel olarak gruplar arası anlamlı farklılık tespit edilmemiştir. **Sonuç:** Bu çalışmanın sınırlamaları altında, farklı tekniklerle retreatment uygulanırken Guttasolv kullanımının köklerin kırılma dirençleri üzerine anlamlı etkisinin olmadığı görülmüştür.

Anahtar Kelimeler: Kırılma direnci; Guttasolv tedavi tekrarı

Although the success of endodontic treatments is high (greater than 90%), failure may occur sometimes after endodontic therapy.[1] The most common causes are continued microbial infection within the root canal system or periapical region, related poorly treated root canals, or coronal leakage.[2-4] When endodontic therapy fails, nonsurgical endodontic retreatment requires treating the infection by removing obturation material, debris, and microorganisms.[5,6] The most common root canal filling material

is gutta-percha in conjuction with an endodontic sealer, and its sufficent removal is considered fundamental for successful retreatment.[7,8] Several methods have been used to remove root canal obturation materials, including the use of stainless steel hand files, nickel titanium (NiTi) rotary instruments, ultrasonic devices, reciprocating systems, and laser irradiation.[9-15] In addition, organic solvents have been used to make easier removing the gutta-percha and sealer.[16-18] Guttasolv is an eucalyptol-based solvent recommended for softening gutta-percha core material.[19,20]

The major causes of root fracture due to endodontic treatment are access cavity preparation, root canal shaping, pressure applied during obturation, and post placement, and retreatment procedures.[21-27] A limited studies have evaluated the effect of retreatment procedures on fracture resistance of roots, but, to the best our knowledge, no study has investigated the effect of using solvent with different retreatment techniques on the fracture resistance.[28-30]

The purpose of this study was to evaluate the effect of Guttasolv on the fracture resistance of the retreated roots using manual technique, Protaper Universal Retreatment instruments, and WaveOne reciprocating system.

MATERIAL AND METHODS

Seventy extracted, single-rooted human mandibular premolars with similar root diameter and length were used. The teeth had been extracted following obtaining written informed consents from all participants. The study was ethically certified by the instutional review board of the university (KU GOKAEK 2016/109) according to the World Medical Association Declaration of Helsinki. Teeth were kept in 0.12% chloramine until needed. All teeth were decoronated under water spray in order to adjust the remaining root length to 14 mm. A size 15 K-file (Mani Inc., Toshigi-Ken, Japan) was placed passively until it reached the apical foramen under 2.5x loupe magnification (Heine USA Ltd, Dover,NH). The working length was established as 0.5 mm shorter than the measured length. All root canals were instrumented by the same operator with Protaper Universal (Dentsply Maillefer, Baillagues, Switzerland) NiTi rotary instruments till size F2. The root canals were irrigated with 2 ml of 2.5% sodium hypoclorite after each change of instrument and dried with paper points.

Root canals were obturated using cold lateral compaction with gutta-percha (Diadent, ChoongchongBuk Do, Korea) and AH Plus (Dentsply-De-Trey,Konstanz, Germany) root canal sealer. To ensure settlement of the materials, teeth were stored in 100% humidity at 37°C for one week.

The specimens were randomly divided into seven groups of 10 for seven retreatment procedures.

Control Group, The root canals were not retreated.

Group 1, Retreatment with Gates Glidden drills and stainless steel H-files- Coronal root filling material was removed using size 2 and 3 Gates-Glidden drills (Mani Inc., Toshigi-Ken, Japan). Gutta-percha removal was initiated by Crown-down instrumentation using a size 60 H-file (Mani Inc., Toshigi-Ken, Japan). The endpoint of instrumentation was carried out with a size 30 H-file that reached the working length.

Group 2, Retreatment with Gates Glidden drills and stainless steel H-files with Guttasolv- Coronal root filling material was removed using a similar technique as Group 1. After the Gates Glidden drills created a reservoir for the solvent, 0.2 mL of Guttasolv (Septodont, Cedex, France) was injected into the root canal, followed by a one minute wait.

Group 3, Retreatment with Protaper Universal Retreatment instruments- Coronal root filling material was removed with Protaper Universal retreatment D1, D2, and D3 instruments (Dentsply Maillefer, Ballaigues, Switzerland) at 350 rpm and 3N/cm torque. Root canal filling was removed by the crown-down technique until the working length was reached.

Group 4, Retreatment with Protaper Universal Retreatment instruments used with Guttasolv- Coronal root filling material was removed using a similar technique as Group 3. After creating a reservoir for the solvent using D1 instrument, 0.2

mL of Guttasolv was injected into the root canal, followed by a one minute wait.

Group 5, Retreatment with WaveOne reciprocating system- Coronal root filling material was removed using a Wave One Primary file (Dentsply Maillefer, Ballaigues, Switzerland) in reciprocating motion at 350 rpm. The file was used in a passive manner and cleaned after three in-and-out movements.

Group 6, Retreatment with WaveOne reciprocating system used with Guttasolv- Coronal root filling material was removed using a similar technique as Group 5. After creating a reservoir for the solvent, 0.2 mL of Guttasolv was injected into the root canal, followed by a one minute wait.

For all groups, root canals were abundantly irrigated with 2.5% NaOCl during the retreatment process. After removal of all root canal materials, and F2 Protaper rotary instrument was gently applied on root canals to remove residual filling materials with NaOCl irrigation, and the root canals were obturated as described above.

Tooth roots were surrounded with a 0.2-mm thick layer of a polyether substance (Impregum Garant L DuoSoft; 3M ESPE AG, Seefeld, Germany) and embedded in an autopolymerizing acrylic resin block (Duralay, Reliance Dental, Worth, IL) up to 2 mm below the cemento-enamel junction in order to mimic the periodontal ligament. To determine fracture resistance, teeth were forced to axial compressive loading using a 3-mm diameter steel rod placed at the center of the roots at 0.5 mm/min crosshead speed in a universal testing machine (Instron 4411; Instron Ltd., High Wycombe, UK) (Figure 1). Fracture resistance (N) was recorded for each tooth.

Data were analyzed statistically using the Kruskal-Wallis test at a significance level of $p<0.05$.

RESULTS

Fracture resistance values are shown in Table 1. No statistically significant difference was detected among groups for the fracture resistance values ($p>0.05$).

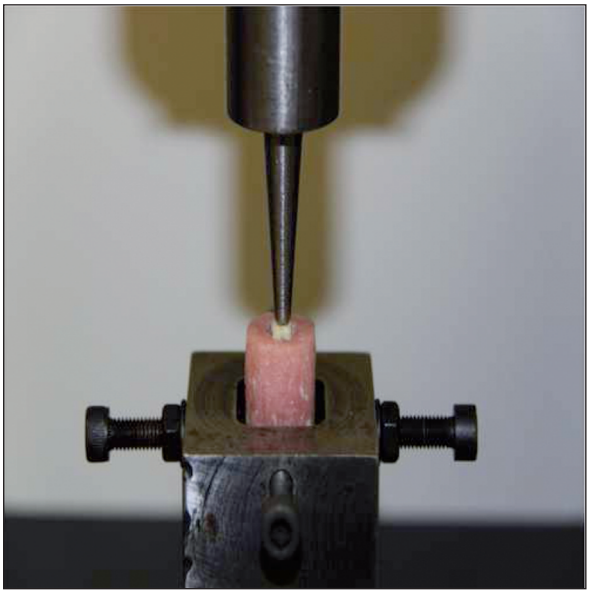

FIGURE 1: Spacemen placed on universal testing machine.

DISCUSSION

Successful retreatment depends upon thoroughly removing obturation material, necrotic tissues, and bacteria from the root canal.[28]

A limited number of studies have evaluated the effect of retreatment procedure on fracture resistance of roots, but, to the best our knowledge, no study has investigated the effect of using solvents with different retreatment techniques on fracture resistance.[29-31]

Because many previous studies have shown that root canal preparation and obturation procedures decrease the fracture resistance of roots, unprepared teeth were not considered necessary as a control; rather prepared, obturated teeth without further retreatment were used as the control group in the present study.[22-25,32]

Khalap et al. compared the fracture resistance of endodontically-treated teeth shaped with Protaper NEXT versus WaveOne and obturated with warm lateral compaction, and then retreated using Protaper Universal Retreatment files.[30] Ganesh et al. assessed the fracture resistance of endodontically-treated teeth shaped with a Protaper Universal NiTi rotary system and obturated with cold lateral compaction.[29] In both studies, Endosolv R

TABLE 1: Mean and standard deviation values of fracture resistance (N).

	Fracture resistance (N)				
	N	Min	Max	Median	Mean±SD
Group 1	10	640.00	1313.00	751.05	871.92±228.93
Group 2	10	584.70	1750.00	984.90	977.58±329.38
Group 3	10	733.20	1400.00	1104.50	1073.39±227.32
Group 4	10	465.00	1577.00	1193.50	1061.01±407.86
Group 5	10	517.90	1400.00	687.40	835.95±334.84
Group 6	10	535.80	1266.00	876.70	854.37±240.97
Control	10	360.40	1600.00	783.40	977.66±520.09
	p	***0,499***			

Kruskal-Wallis test

was used as solvent in all roots for softening guttapercha; however, the effect of Endosolv R on fracture resistance was not evaluated. Both studies reported that endodontic retreatment significantly lowers fracture resistance. In contrast, we found that when root canals shaped and obdurated identically to Ganesh et al. were then retreated with Gates-Glidden drills and stainless steel H-files, Protaper Universal Retreatment files, or WaveOne (with or without Guttasolv), there were no statistically significant differences in fracture resistance values among the control and all study groups ($p>0.05$). Distinct from the present study, Khalap et al. and Ganesh et al. performed final shaping (after removal of the root canal filling materials) with larger files than ours.[29,30] This difference could account for the different results between our study and the two studies.

Er et al. compared fracture resistance of endodontically-treated teeth shaped with K-files, using a step-back technique, and obturated with cold lateral compaction, and then retreated using Protaper Universal, R-Endo, or Mtwo rotary systems.[31] They found statistically significant differences among the control and experimental groups, but no significant difference among the experimental groups. It is worth noting that their control group specimens were only shaped and not obturated. In contrast, in the present study, root canals were shaped with rotary instruments and the control group was also obturated.

Helvacıoğlu-Yiğit et al. evaluated the fracture resistance of endodontically-treated teeth shaped by the Protaper Universal NiTi rotary system and filled with cold lateral compaction, and then retreated using Protaper Universal Retreatment files or hand files.[33] Retreated groups had lower fracture resistances when compared to the control group. However, in agreement with the present study, no significant difference was found among the experimental groups. In the Helvacıoğlu-Yiğit et al.'s study, final shaping in the rotary group (after removal of the root canal filling materials) was performed with larger files than those used in this study.

In endodontic retreatment cases, solvent use is advised for easier removal of root canal filling.[16-18] Chloroform is the most commonly used solvent in the literature; however its uncontrolled use was reported to be potentially carcinogenic.[34-37] Guttasolv was therefore used as organic solvent in the present study.

The effect of solvents on the microhardness of dentine is an important factor for fracture resistance because the microhardness value can be indirect indicator of mineral loss or deposition.[38] Rotstein et al. showed that chloroform, xylene, and halothane may cause a significant softening effect on both enamel and dentin.[39] However, Erdemir et al. indicated that chloroform and halothane did not affect the microhardness of root dentin.[40] Also, Khedman et al. found no significant difference in dentin microhardness in any of the orange oil, eucalyptol, chloroform.[41]

Within the limitations of this in vitro study, endodontic retreatment had no significant negative effect on fracture resistance of the roots, regardless of instrumentation technique used or the presence or absence of Guttasolv.

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Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Seda Aydemir;* ***Design:*** *Seda Aydemir;* ***Supervision/Consultancy:*** *Seda Aydemir, Göze Arukaslan;* ***Data Collection and/or Processing:*** *Seda Aydemir, Göze Arukaslan;* ***Analysis and/or Interpretation:*** *Seda Aydemir, Göze Arukaslan;* ***Source Browsing:*** *Seda Aydemir, Göze Arukaslan;* ***Writing of the Makalene:*** *Seda Aydemir;* ***Critical Review:*** *Seda Aydemir, Göze Arukaslan;* ***Sources and Funding:*** *Seda Aydemir, Göze Arukaslan;* ***Materials:*** *Seda Aydemir, Göze Arukaslan.*

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