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XP-endo Finisher: A New Solution for Smear Layer Removal

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SUMMARY

Introduction The aim of this study was to evaluate using SEM analysis the effectiveness of a new instrument XP-endo Finisher in cleaning root canal walls after instrumentation with BioRaCe NiTi rotary instruments.

Material and Methods This *in vitro* study was conducted on 30 extracted single rooted teeth divided in two groups. Instrumentation of all canals was done using basic BioRaCe NiTi rotary instruments with copious irrigation of 2% NaOCl. In the first group, after complete instrumentation smear layer was removed using XP-endo Finisher, while the other group served as negative control. The roots were then after longitudinally cut and SEM analysis was performed. The presence of smear layer in the coronal, middle and apical third was assessed. The data were statistically analyzed using Mann–Whitney U-test ($p<0.05$).

Results The results showed that average value of smear layer on the canal walls in the XP-endo Finisher group was significantly lower than in the control group ($p<0.05$).

Conclusion XP-endo Finisher after canal instrumentation with NiTi rotary instruments effectively cleaned canal walls and removed smear layer.

Keywords: XP-endo Finisher; smear layer; NiTi rotary instruments; SEM

INTRODUCTION

The success of endodontic treatment depends significantly on the quality of cleaning and shaping the root canal system. However, adequate canal preparation, which involves mechanical (instrumentation) and chemical aspects (irrigation) is difficult to achieve due to the complex canal morphology [1].

Both hand and rotary instrumentation create smear layer of different thickness on the canal walls as a consequence of cutting dentin [2]. This layer contains reminants of dentin, pulp tissue, microorganisms and covers canal walls touched by instruments [2, 3]. The presence of smear layer and debris, especially in the apical portion of the canal, is of clinical significance because bacteria in combination with unfavorable local factors may cause endodontic failure [4]. In addition, this layer closes tubules and reduces the effect of irrigating solutions, significantly affects the quality of obturation and outcome of endodontic treatment [3, 4].

Instrumentation using rotary NiTi instriments is relatively new approach in the preparation of root canals, but effective cleaning of a complex canal system still remains a challenge for dental practitioners [2, 5]. It has been confirmed that NiTi rotary instruments provide faster and better canal preparation in the form of elongated cone and with minimal risk of transportation [6-9]. However, due to the limited efficacy of instruments alone in the cleaning root canals, it is necessary to add rinsing of canals using appropriate irrigants [3]. Endodontic irrigants by their physical and chemical actions allow dissolution of smear layer on the canal walls and its partial removal [1, 3]. It is necessary to use a combination of different irrigants and most frequently used is a combination of NaOCl and EDTA. NaOCl provides reduction of microorganisms and dissolution of organic part while EDTA acts on inorganic content and contributes significantly to the removal of dentine debris and smear layer from the root canal walls [2, 9, 10].

EDTA and various concentrations of citric acid are used as final rinse after instrumentation as well as various solutions of lactic, tannic acid, acetic acid, polyacrylic acid or tetracycline (MTAD) [3, 10, 11]. Chitosan can also be used to remove smear layer. It represents natural polysaccharide solution, which contains chlorhexidine and has a slight chelating effect [10, 12]. Another means for smear layer removal include ultrasound or laser techniques [3, 13, 14]. It has been confirmed that the use of flexible microbrushes can reduce debris and remove smear layer from root canal walls [2, 15]. Removal of smear layer from the canal walls before final obturation significantly increases sealer adhesion and reduces the incidence of microleakage along the canal walls [16, 17]. However, none available technique provides complete and efficient removal of smear layer therefore, research is directed towards finding new resources and instruments to remove smear layer effectively.

The aim of this study was to evaluate using SEM analysis the effectiveness of a new instrument XP-endo Fin-

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isher in cleaning root canal walls after instrumentation with BioRaCe NiTi rotary instruments.

MATERIAL AND METHODS

This *in vitro* study included 30 single-rooted teeth extracted for orthodontic or periodontal reasons. Prior to the experiment, teeth were stored in saline at 4°C. Access cavity in all teeth was prepared using high speed handpiece and diamond bur. Glide path was achieved using ISO 15 and working length determined 1 mm shorter than the length when the file appears at the apex. Apex of each tooth was closed with pink wax to prevent leakage of the irrigant through the apical foramen during canal preparation. The teeth were divided into two groups (15 teeth each).

Instrumentation of all canals was done using a basic set of NiTi rotary instrument BioRaCe (FKG Dentaire, Swiss) according to the manufacturer's instructions [18]. Handpiece with reduced number of revolutions (16: 1) and endomotor TCM ENDO V (Nouvag AG, Swiss) was used. During instrumentation, all teeth were irrigated with 2 ml of 2% sodium hypochlorite solution (Chlorax, Cerkamed, Poland) after each instrument. At the end of instrumentation canals were flushed with 5ml of 2% solution of NaOCl. Plastic syringes of 2 ml (during instrumentation) and 5 ml (for final rinse) volume and an appropriate needle size 27 bent at the angle of 30° were used for irrigaton.

In the first group of teeth, after complete instrumentation, smear layer was removed using a new instrument XP-endo Finisher (FKG Dentaire, Swiss), while the second group of teeth served as control (no smear layer removal). XP-endo Finisher was taken from sterile packaging and placed in the handpiece. Working length for each canal was determined using plastic tube and stopper. XP-endo Finisher instrument was cooled using spray ENDO Frost (RSA, Colten, Whaledent GmBH, Germany) through the plastic tube and placed in the canal filled with irrigant. Using gentle movements of insertion and withdrawal XP-endo Finisher was applied in each canal during one minute. After on minute canals were washed with the rest of the NaOCl solution.

After complete procedure, crowns of all teeth were cut using a diamond disc, roots were split longitudinally and selected halves prepared for SEM (JEOL, JSM 6460 LV, JAPAN). Dentinal wall of each tooth was observed under the SEM in the region of coronal, middle and apical thirds using different magnifications and photomicrographs were done. Qualitative assessment of smear layer on root canal walls was based on criteria given by Hulsmann et al. [19]: Grade 1 – no smear layer, dentinal tubules open; Grade 2 – there is a small amount of smear layer, open some dentinal tubules; Grade 3 – homogeneous smear layer covering canal walls, a few dentinal tubules open; Grade 4 – complete canal wall covered with homogenous smear layer, dentinal tubules closed; Grade 5 – ordinary homogeneous smear layer covering the entire canal walls.

The obtained results were analyzed using the Mann–Whitney U-test.

RESULTS

The average scores for the smear layer in a group where XP-endo Finisher was used were significantly lower than in the group where smear layer was not removed (p=0.013) (Table 1). Mann–Whitney U-test did not show statistically significant differences in smear layer scores between the two groups in the coronal, middle or apical third of canals (Table 2).

After applying XP-endo Finisher clean walls were observed in the coronal third, no smear layer and open dentinal tubules in the middle third (Figure 1) and shreds of smear layer with number of open dentinal tubules in the apical third of the canals (Figure 2). Instrumentation using BioRaCe instruments produced more smear layer on the canal walls in the middle (Figure 3) than in the apical third of the canal (Figure 4).

Table 1. Average grade of smear layer in the coronal, middle and apical third of root canals
Tabela 1. Prosečna ocena razmaznog sloja u kruničnoj, srednjoj i apeksnoj trećini kanala korena

Instrument Instrument	Canal third Trećina kanala	Smear layer Razmazni sloj			
		N	$\bar{X}$	SD	CV
Bio RaCe + XP-endo Finisher	Coronal Krunična	15	1.07	0.26	24.30
	Middle Srednja	15	1.07	0.26	24.30
	Apical Apeksna	15	1.13	0.35	30.97
	Total Ukupno	45	1.09	0.29	26.61
BioRaCe	Coronal Krunična	15	1.27	0.46	36.22
	Middle Srednja	15	1.33	0.62	46.62
	Apical Apeksna	15	1.47	0.74	50.34
	Total Ukupno	45	1.36	0.61	44.85

N – number of teeth; $\bar{X}$ – mean value; SD – standard deviationa;
CV – coefficient of variation
N – broj zuba; $\bar{X}$ – aritmetička sredina; SD – standardna devijacija;
CV – koeficijent varijacije

Table 2. Assesment of smear layer in the coronal, middle and apical third of root canals
Tabela 2. Procena razmaznog sloja u kruničnoj, srednjoj i apeksnoj trećini kanala korena

Instrument Instrument	Canal third Trećina kanala	Grade Ocena				
		1	2	3	4	5
Bio RaCe + XP-endo Finisher	Coronal Krunična	14	1	0	0	0
	Middle Srednja	14	1	0	0	0
	Apical Apeksna	13	2	0	0	0
Bio RaCe	Coronal Krunična	11	4	0	0	0
	Middle Srednja	11	3	1	0	0
	Apical Apeksna	10	3	2	0	0

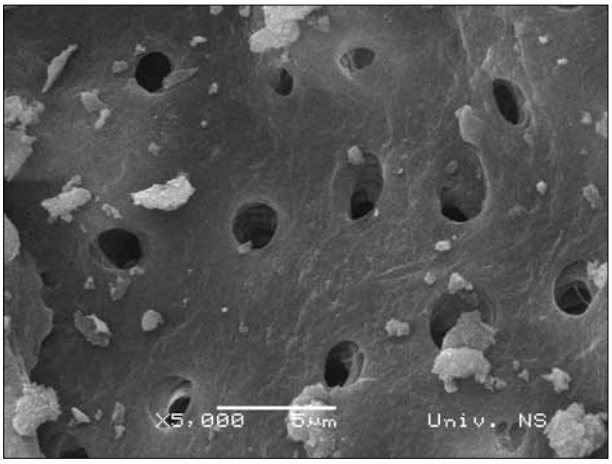

Figure 1. Middle third of the canal wall after applying XP-endo Finisher (SEM, 5000×)
Slika 1. Srednja trećina zida kanala korena nakon primene instrumenta *XP-endo Finisher* (SEM, ×5000)

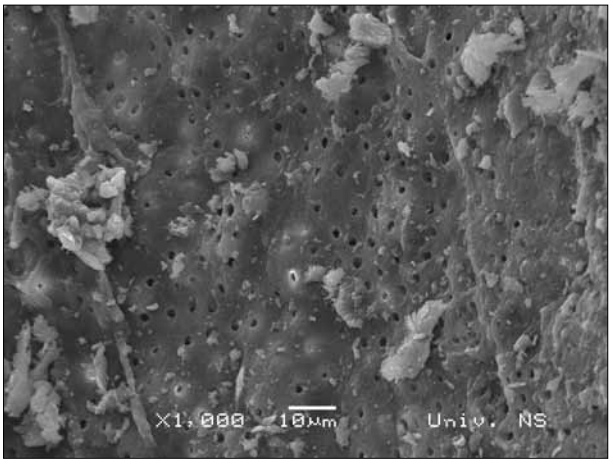

Figure 2. Apical third of the canal wall after applying XP-endo Finisher (SEM 1000×)
Slika 2. Apeksna trećina zida kanala korena nakon primene instrumenta *XP-endo Finisher* (SEM, ×1000)

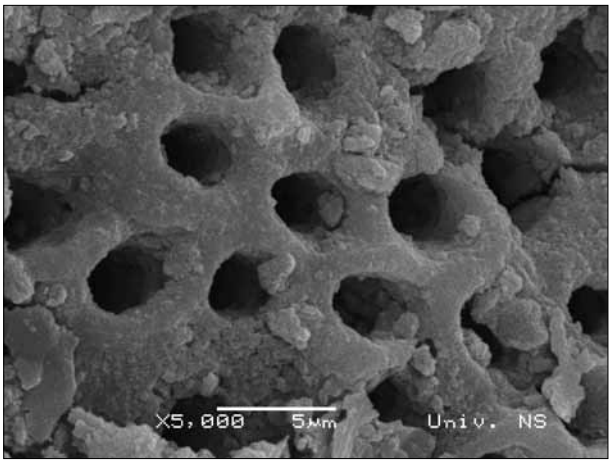

Figure 3. Smear layer in the middle third of the canal wall after instrumentation with BioRaCe rotary NiTi instruments (SEM 5000×)
Slika 3. Razmazni sloj u srednjoj trećini zida kanala korena nakon instrumentacije setom BioRaCe rotirajućih NiTi instrumenata (SEM, ×5000)

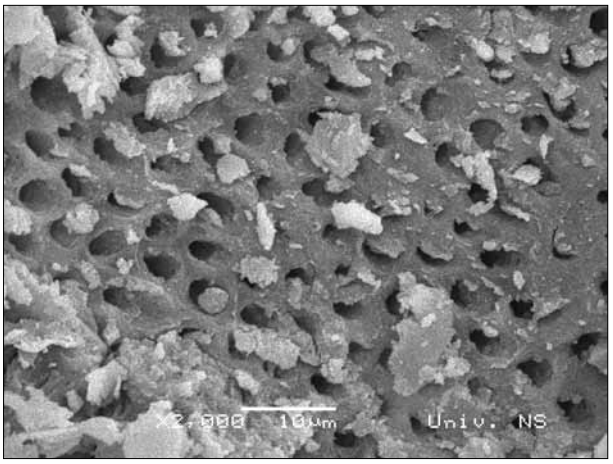

Figure 4. Smear layer in the apical third of the canal wall after instrumentation with BioRaCe rotary NiTi instruments (SEM 2000×)
Slika 4. Razmazni sloj u apeksnoj trećini zida kanala korena nakon instrumentacije setom BioRaCe rotirajućih NiTi instrumenata (SEM, ×2000)

DISCUSSION

The main goal of endodontic treatment is to instrument and irrigate root canal walls and ensure effective cleaning of endodontic space, including complete removal of necrotic or vital pulp, ie. all bacteria from the root canal system [20]. Removal of smear layer that forms along the walls during instrumentation is an important clinical parameter for the success of endodontic treatment [1, 2, 4, 21].

In our study, all teeth were instrumented and irrigated using the same protocol (done by the same practitioner), therefore, results can be regarded solely as a function of the final cleaning of the canal system. The results showed a significantly more efficient removal of the smear layer from the root canal walls after using XP-endo Finisher. The use of this instrument resulted in more efficient cleaning of the canal system and considerably less smear layer at all levels (coronal, middle, apical). Instrumentation techniques [6, 9, 16, 22] and the choice of irrigants and irrigation techniques [3, 10, 22, 23, 24] are the key factors for the success of endodontic treatment. Although due to the complex anatomy it is difficult to achieve the shape of an elongated cone [25], crown-down technique using NiTi rotary instruments provides efficient cleaning and shaping of canals for significantly shorter time [21, 22, 26, 27].

In the current study, the efficacy of NiTi rotary files in the cleaning of root canals was evaluated using numerical evaluation of smear layer in coronal, middle and apical third of the canal, which is consistent with the findings of other researchers [7, 10, 17, 19, 27]. In the control group BioRaCe rotary files produced a small amount of smear layer along the canal walls. This result can be attributed primarily to their flexibility, design and electrochemically polished surface [28, 29]. File design with alternating active (to cut) and non-active parts (to eliminate dentin debris) and copious irrigation provide efficient cleaning of canal walls [29, 30, 31]. Small amount of smear layer also could be attributed to the fact that instrumentation was done in straight canals only and with copious irrigation. File design also had influence on low ammount of smear layer [17, 21, 22]. Coronal and middle third of canals were cleaner and showed less smear layer than apical third.

This can be attributed primarily to larger diameter of the coronal part and better tissue-chemical contact during instrumentation and the fact that dentin is exposed to larger volume of irrigant [15, 22, 32]. Also, BioRaCe NiTi rotary files provide wide and funnel shaped canal with larger apical conicity (6%) allowing deeper aplication of needle and irrigants [15, 22, 31, 33, 34]. This endodontic system also shows significantly less transportation in the apical portion of the canal compared to other rotary NiTi systems [31]. Low amount of smear layer and dentinal debris found could be the consequence of the speed of file rotation. It has been shown earlier that slightly faster file rotation produce better cleaning effect (BioRaCe rotation speed is 600 r/min) compared to other rotary NiTi instruments (300-400 r/min) [17, 34].

Although combination of NaOCl and EDTA is gold standard in chemomechanical instrumentation of canals [11, 13, 21, 24, 32] in the current study only NaOCl was used [31, 35, 36]. As the main goal of the current study was to evaluate cleaning effect of BioRaCe NiTi rotary files, to avoid the effect of chelating agents in smear layer removal [21, 31, 36] only sodium hypochlorite was used as irrigant. Sodium hypochlorite shows dissolving efficacy on the organic part of dentin, but also extraordinary antibacterial activity [11, 31]. Although complete cleaning was not achieved, effective cleaning and removal of smear layer was noticed at all levels of the canal. It is important to note that with the use of EDTA results would have been better and smear layer removed more effectively in the apical portion of canals [21, 31, 32, 35, 36].

After canal instrumentation using BioRaCe NiTi rotary files, XP-endo Finisher was used to remove smear layer and effective action at all canal levels was found. Noticable in the current study was effective removal of smear layer in the apical portion of the canal. This can be attributed to wider diameter of used files (ISO40) and better efficiency of irrigants [11, 15, 31, 35, 36]. It has been confirmed that rotary NiTi files during instrumentation come into contact with only 40-45% of the canal walls, therefore, large portion of the canal surface remains untreated [21, 27]. Instrumentation removes only dentin that comes in contact with rotating file and at the same time a large portion of dentin debris stays in these untreated areas [21, 26]. It can be removed only using copious and effective irrigation [11, 32]. Due to specific design, XP-endo Finisher can reach those inaccessible parts of the canal and provide better cleaning [18]. Small diameter (ISO 25) and the fact that it can change its shape during rotation in the canal (M and A phase) allow this file to reach inaccessible areas of the canal wall and efficiently remove dentin debris and smear layer [18]. XP-endo Finisher is rotary NiTi file without taper which with efficient irrigation in instrumented canals can remove smear layer and dentin debris from inaccessible areas.

CONCLUSION

Within the limits of this study it can be concluded that chemomechanical instrumentation with BioRaCe rotary NiTi files provided good cleaning of the root canal walls. Application of XP-endo Finisher after instrumentation in a single-rooted teeth removed smear layer from root canal walls in all segments.

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XP-endo Finisher: novo rešenje za uklanjanje razmaznog sloja nakon instrumentacije kanala

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KRATAK SADRŽAJ

Uvod Cilj ovog rada je bio da se SEM analizom proveri efikasnost novog instrumenta XP-endo Finisher na kvalitet čišćenja zidova kanala korena zuba nakon instrumentacije BioRaCe NiTi rotirajućim instrumentima.

Materijal i metode rada Istraživanja su izvedena u uslovima *in vitro* na 30 ekstrahovanih jednokorenih zuba podeljenih u dve grupe. Instrumentacija svih kanala je realizovana osnovnim setom BioRaCe NiTi rotirajućih instrumenata uz irigaciju dvoprocentnim rastvorom NaOCl. U prvoj grupi je nakon instrumentacije za uklanjanje razmaznog sloja korišćen XP-endo Finisher, a druga grupa je služila kao kontrolna. Korenovi svih zuba su uzdužno podeljeni i SEM metodom je analiziran kvalitet čišćenja kanala korena, odnosno postojanje razmaznog sloja u kruničnoj, srednjoj i apeksnoj trećini. Podaci su statistički analizirani Man–Vitnijevim (Mann–Whitney) U-testom ($p<0,05$).

Rezultati Dobijeni rezultati su pokazali da je ukupna srednja vrednost postojanja razmaznog sloja na zidovima kanala u grupi gde je korišćen XP-endo Finisher bila statistički značajno manja nego u kontrolnoj grupi uzoraka ($p<0,05$).

Zaključak XP-endo Finisher posle obrade kanala NiTi rotirajućim instrumentima efikasno čisti kanal i uklanja razmazni sloj sa zidova kanala.

Ključne reči: XP-endo Finisher; razmazni sloj; NiTi rotirajući instrumenti; SEM

UVOD

Uspeh endodontskog lečenja umnogome zavisi od kvaliteta čišćenja i oblikovanja kanalnog sistema zuba. Međutim, odgovarajuću preparaciju kanala, koja podrazumeva mehanički (instrumentacija) i hemijski aspekt (irigacija), uglavnom je teško ostvariti zbog složene morfologije kanala [1].

Ručnom ili mašinskom instrumentacijom se kao posledica sečenja dentina na površini zidova kanala stvara razmazni sloj različite debljine [2]. Ovaj sloj sadrži ostatke dentina pulpnog tkiva, mikroorganizme i uglavnom pokriva instrumentirane zidove kanala [2, 3]. Postojanje razmaznog sloja i debrisa, posebno u apeksnom delu kanala, od kliničkog je značaja jer bakterije u kombinaciji s nepovoljnim lokalnim faktorima mogu biti uzrok neuspeha endodontskog lečenja [4]. Osim toga, ovaj sloj zatvara dentinske tubule i umanjuje efekat sredstva za irigaciju, a bitno utiče i na kvalitet opturacije i ishod endodontskog lečenja [3, 4].

Rotirajući instrumenti od nikl-titanijuma (NiTi) jesu relativno nova sredstva u preparaciji kanala, ali efikasno čišćenje kompleksnog kanalnog sistema je i dalje izazov za većinu stomatologa praktičara [2, 5]. Potvrđeno je da ovi instrumenti mogu da obezbede bržu i kvalitetniju preparaciju kanala u obliku izduženog konusa i sa veoma malim rizikom od transportacije [6-9]. Međutim, zbog ograničene efikasnosti instrumenata u čišćenju kanala korena, neophodno je tokom i posle mehaničkih procedura kanale isprati odgovarajućim hemijskim agensima [3]. Irigansi, između ostalog, svojim fizičkim i hemijskim delovanjem omogućavaju rastvaranje razmaznog sloja na zidovima kanala i njegovo delimično uklanjanje [1, 3]. Tokom irigacije je neophodno koristiti kombinaciju različitih irigansa, a najčešće primenjivana je kombinacija rastvora NaOCl i EDTA. Rastvor NaOCl obezbeđuje redukciju mikroorganizama i rastvaranje organskog dela, a EDTA svoje delovanje ispoljava na neorganskom sadržaju i znatno doprinosi uklanjanju dentinskog debrisa i razmaznog sloja sa zidova kanala korena [2, 9, 10].

Za uklanjanje razmaznog sloja posle završene instrumentacije kanala najčešće se koriste rastvor EDTA i različite koncentracije limunske kiseline, a mogu se koristiti i rastvori mlečne, taninske, sirćetne i poliakrilne kiseline, odnosno rastvori tetraciklina (MTAD) [3, 10, 11]. Kao sredstvo za uklanjanje razmaznog sloja koristi se i hitosan, rastvor prirodnog polisaharida, koji sadrži hlorheksidin i ima blago helirajuće dejstvo [10, 12]. Važno mesto u uklanjanju razmaznog sloja pripada i ultrazvučnim, odnosno laserskim tehnikama [3, 13, 14]. Potvrđeno je da i korišćenje fleksibilnih mikročetkica može pomoći u smanjenju debrisa i razmaznog sloja na zidovima kanala [2, 15]. Brojna sredstva i tehnike za njegovo uklanjanje sa zidova kanala pre konačne opturacije značajno povećavaju prianjanje paste za zidove i smanjuju pojavu mikrocurenja duž zidova kanala korena [16, 17]. Međutim, kako nijedno sredstvo i nijedna tehnika ne obezbeđuju potpuno i efikasno uklanjanje razmaznog sloja sa zidova kanala, danas je posebna pažnja usmerena ka pronalaženju novih sredstava i instrumenata za uklanjanje ovog sloja.

Cilj ovog rada je bio da se SEM analizom proveri efikasnost novog instrumenta XP-endo Finisher na kvalitet čišćenja zidova kanala korena zuba nakon instrumentacije BioRaCe NiTi rotirajućim instrumentima.

MATERIJAL I METODE RADA

Ispitivanja su izvedena u uslovima *in vitro* na 30 jednokorenih zuba ekstrahovanih iz ortodontksih ili parodontoloških razloga. Do početka eksperimenta zubi su čuvani u fiziološkom rastvoru na 4°C. Pristupni kavitet kod svih zuba je formiran visokoturažnom bušilicom i dijamantskim svrdlom. Prohodnost kanala proveravana je instrumentom ISO15, a radna dužina preparacije određena je 1 mm kraće od dužine na kojoj se vrh turpije pojavljuje na apeksu. Vrh korena svakog zuba je prekriven roze

voskom, kako bi se sprečilo isticanje irigansa kroz apeksni otvor tokom preparacije kanala. Zubi su svrstani u dve grupe od po 15 zuba.

Svi kanali su obrađeni primenom osnovnog seta NiTi rotirajućih instrumenta BioRaCe (*FKG Dentaire*, Švajcarska) uz poštovanje uputstva proizvođača o načinu i redosledu njihovog korišćenja tokom preparacije [18]. Korišćeni su kolenjak s redukovanim brojem obrtaja (16:1) i endomotor TCM ENDO V (*Nouvag, AG*, Švajcarska). Tokom instrumentacije svi zubi su ispirani dvoprocentnim rastvorom NaOCl (*Chlorax, Cerkamed*, Poljska) u količini od 2 ml između svakog instrumenta. Po završenoj instrumentaciji kanal je ispiran sa još 5 ml dvoprocentnog rastvora NaOCl. Za ispiranje su korišćeni plastični špricevi zapremine 2 ml (tokom instrumentacije) i 5 ml (tokom finalnog ispiranja) i odgovarajuće igle veličine 27 savijene pod uglom od 30 stepeni.

U prvoj grupi je nakon mašinske instrumentacije razmazni sloj uklanjan korišćenjem novog instrumenta XP-endo Finisher (*FKG Dentaire*, Švajcarska), a druga grupa instrumentiranih zuba je služila kao kontrolna. U prvoj grupi je svaki kanal posle instrumentacije ispunjavan irigansom, a potom uziman XP-endo Finisher iz sterilnog pakovanja i postavljen u kolenjak. Radna dužina je za svaki kanal određivana pomoću plastične tube i stopera. Pre svakog unošenja instrument je ohlađen sprejom Endo Frost (*Roeko, Colten, Whaledent GmbH*, Nemačka) preko plastične tube i postavljen u kanal. XP-endo Finisher je korišćen nežnim pokretima uvlačenja i izvlačenja tokom jednog minuta u kanalu. Posle izvlačenja instrumenta kanal je ispran ostatkom rastvora NaOCl.

Krunice zuba su potom uklonjene dijamantskim diskom, a korenovi uzdužno podeljeni i odabrane polovine pripremljene za posmatranje na svetlosnoelektronskom mikroskopu (*JEOL, JSM 6460 LV*, Japan). Dentinski zid svakog zuba je posmatran u predelu krunične, srednje i apeksne trećine na različitim uveličanjima i napravljene su fotomikrografije. Za kvalitativnu procenu postojanja razmaznog sloja na zidovima kanala korena korišćeni su kriterijumi Hilsmana (*Hülsmann*) i saradnika [19]: ocena 1 označavala je da nema razmaznog sloja i da su dentinski tubuli otvoreni; ocena 2 – zastupljena mala količina razmaznog sloja, otvoreno nekoliko dentinskih tubula; ocena 3 – homogeni razmazni sloj prekriva zid kanala korena, otvoreno samo nekoliko dentinskih tubula; ocena 4 – celokupan zid kanala prekriven homogenim razmaznim slojem, dentinski tubuli nisu otvoreni; ocena 5 – običan nehomogeni razmazni sloj prekriva celokupan zid kanala korena.

Dobijeni rezultati su analizirani primenom Man–Vitnijevog (Mann–Whitney) U-testa.

REZULTATI

Ukupne srednje vrednosti skorova za razmazni sloj u grupi gde je korišćen XP-endo Finisher bile su statistički značajno manje nego u grupi gde je instrumentacija urađena samo NiTi rotirajućim instrumentima BioRaCe ($p=0,013$) (Tabela 1). Man–Vitnijev U-test nije pokazao statistički značajne razlike u skorovima razmaznog sloja između grupa ni u kruničnim, ni u srednjim, niti u apeksnim trećinama kanala (Tabela 2).

Posle primene XP-endo Finisher uočeni su čisti zidovi u kruničnoj trećini, bez razmaznog sloja i s otvorenim dentinskim kanalićima u srednjoj (Slika 1), odnosno s opiljcima razmaznog sloja i sa dosta otvorenih dentinskim kanalića u apeksnoj trećini kanala (Slika 2).

Instrumentacija kanala BioRaCe rotirajućim instrumentima je proizvela nešto više razmaznog sloja na zidovima kanala u srednjoj (Slika 3), odnosno apeksnoj trećini kanala (Slika 4).

DISKUSIJA

Osnovni zadatak endodontskog lečenja je da se instrumentacijom i irigacijom obezbedi efikasno čišćenje endodontskog prostora, koje podrazumeva potpuno uklanjanje nekrotičnog ili vitalnog tkiva, odnosno svih bakterija iz kanalnog sistema zuba [20]. Eliminacija razmaznog sloja koji se stvara duž zidova kanala korena tokom instrumentacije značajan je klinički parametar za uspeh endodontskog lečenja [1, 2, 4, 21].

U ovom istraživanju svi uzorci su instrumentisani i ispirani prema istom protokolu (a uradio ih je isti praktičar), tako da se dobijeni rezultati mogu posmatrati jedino u funkciji finalnog čišćenja kanalnog sistema. Dobijeni rezultati su ukazali na značajno efikasnije uklanjanje razmaznog sloja sa zidova kanala korena nakon korišćenja XP-endo Finisher. Primena ovog instrumenta dovela je do efikasnijeg čišćenja kanalnog sistema i znatno manje količine razmaznog sloja na svim nivoima kanala (krunična, srednja, apeksna). Ključni deo čišćenja kanalnog sistema zuba zavisi od tehnike instrumentacije [6, 9, 16, 22] i izbora irigansa i tehnike irigacije kanala korena [3, 10, 22, 23, 24]. Iako je zbog kompleksne anatomije teško ostvariti formu izduženog, levkasto oblikovanog konusa [25], sigurno je da se tzv. *crown-down* tehnikom preparacije i primenom NiTi rotirajućih instrumenata može ostvariti vrlo efikasno čišćenje i oblikovanje kanala za značajno kraće vreme [21, 22, 26, 27].

U ovoj studiji je efikasnost čišćenja kanala korena primenom seta NiTi rotirajućih instrumenata proveravana na osnovu numeričke procene postojanja razmaznog sloja u kruničnoj, srednjoj i apeksnoj trećini kanala, što je u saglasnosti s nalazima drugih istraživača [7, 10, 17, 19, 27]. U kontrolnoj grupi set BioRaCe rotirajućih instrumenata je stvarao manje količine razmaznog sloja u svim segmentima kanala korena. Ovakav rezultat se može pripisati, pre svega, velikoj fleksibilnosti, odnosno dizajnu i elektrohemijski poliranoj površini radnog dela instrumenta [28, 29]. Naime, dizajn aktivnog dela ove turpije s naizmeničnim kosim (koji seku) i ravnim delovima (koji eliminišu sečeni dentin) uz obilnu irigaciju, obezbeđuje efikasno čišćenje zidova kanalnog sistema [29, 30, 31]. Manja količina razmaznog sloja može biti i posledica činjenice da je instrumentacija izvedena isključivo kod pravih kanala i uz obilnu irigaciju, gde je dizajn instrumenta posebno uticao na izostanak formiranja ovog sloja na zidovima kanala [17, 21, 22].

Kruničnа i srednja trećina kanala su bile čistije i s manje razmaznog sloja nego apeksna. Ovo se može pripisati, pre svega, većem prečniku ovog regiona i boljem tkivnohemijskom kontaktu tokom instrumentacije, odnosno činjenici da je dentin izložen većoj količini irigansa [15, 22, 32]. Takođe, preparacija setom BioRaCe NiTi rotirajućih instrumenata obezbeđuje širok i levkast kanal s većom apeksnom koničnošću (6%), što omogućava bolje prodiranje igle i rastvora za irigaciju, a time i efikasnije uklanjanje razmaznog sloja [15, 22, 31, 33, 34]. Preparacija kanala RaCe instrumentima dovodi do značajno manje transportacije u apeksnom delu kanala u odnosu na druge NiTi

rotirajuće instrumente [31]. Na formiranje manjih količina razmaznog sloja i dentinskog debrisa mogla je uticati i brzina rotacije instrumenta. Potvrđeno je da nešto veće brzine ostvaruju bolji efekat čišćenja (brzina rotacije BioRaCe je 600 obrtaja u minuti) u odnosu na najčešće brzine rotirajućih NiTi instrumenata (300–400 obrtaja u minuti) [17, 34].

Iako je kombinacija rastvora NaOCl i EDTA zlatni standard u hemomehaničkoj preparaciji kanala [11, 13, 21, 24, 32], u ovoj studiji je izabran jednostavan irigacioni protokol i tokom instrumentacije je korišćen samo rastvor NaOCl [31, 35, 36]. Osnovni cilj je bio da se proveri efekat čišćenja kanala setom BioRaCe NiTi rotirajućih instrumenata i izbegne nesumnjiv uticaj helatnih agensa na uklanjanje razmaznog sloja [21, 31, 36]. Rastvor NaOCl je najčešće korišćeno sredstvo za irigaciju kanala korena, prvenstveno zbog svog rastvaračkog efekta na organski deo dentina, ali i izvanrednog antibakterijskog delovanja [11, 31]. Iako nisu obezbeđeni potpuno čisti kanali, ovakvim protokolom je potvrđeno dosta efikasno čišćenje i uklanjanje razmaznog sloja na svim nivoima kanala. Važno je napomenuti da bi korišćenjem rastvora EDTA dobijeni rezultat bio sigurno bolji, a uklanjanje razmaznog sloja verovatno još efikasnije i u apeksnom delu kanala [21, 31, 32, 35, 36].

U grupi gde je nakon preparacije kanala setom BioRaCe NiTi rotirajućih instrumenata za uklanjanje razmaznog sloja korišćen novi instrument XP-endo Finisher ostvareno je vrlo efikasno čišćenje na svim nivoima kanala. Ono što se na osnovu ove studije može zapaziti jeste vrlo efikasno uklanjanje razmaznog sloja i u apeksnom delu kanala. To se može pripisati širem prečniku ovog regiona (ISO40) i većoj efikasnosti korišćenog irigansa u uklanjanju razmaznog sloja [11, 15, 31, 35, 36]. Potvrđeno je takođe da standardni rotirajući NiTi instrumenti pri obradi kanala dolaze u kontakt sa samo 40–45% zidova kanala, tako da veliki deo kanalne površine ostaje neobrađen [21, 27]. Preparacijom kanala se uklanja samo sloj dentina koji dolazi u kontakt s rotirajućim instrumentom i pri tome veliki deo sečenog dentina zaostaje upravo u tim neobrađenim segmentima kanalnog zida [21, 26]. Ovaj deo dentina se može ukloniti samo obilnom i efikasnom irigacijom [11, 32]. Zahvaljujući specifičnom dizajnu, instrument XP-endo Finisher bolje čisti kanal, jer može da dopre i do tih nepristupačnih delova kanala [18]. Mali prečnik ovog NiTi instrumenta (ISO25) i činjenica da može da menja svoj oblik tokom rotacije u kanalu (M i A faza) omogućava mu da u fazi rotacije može dopreti do nepristupačnih mesta u kanalnom sistemu i obezbediti efikasno uklanjanje debrisa i razmaznog sloja [18]. XP-endo Finisher je rotirajući NiTi instrument bez koničnosti koji uz efikasnu irigaciju dobro proširenog kanalnog sistema dobro čisti zidove kanala i uklanja razmazni sloj sa zidova kanala, ali i sečeni dentin iz nepristupačnih segmenata kanalnog sistema.

ZAKLJUČAK

U okviru ograničenja ove studije može se zaključiti da se nakon instrumentacije kanala korena BioRaCe NiTi rotirajućim instrumentima obezbeđuje dobro hemomehaničko čišćenje kanalnog sistema zuba i njegovih zidova. Primena XP-endo Finisher nakon instrumentacije kanala jednokorenih zuba obezbeđuje efikasno uklanjanje razmaznog sloja sa zidova kanala u svim njegovim segmentima.