UDC: 616.314.163-72 DOI: 10.2298/SGS1303119M

Comparative Evaluation of Various Endodontic Irrigants on Apical Extrusion of Debris

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SUMMARY

Introduction All techniques and instruments used to clean and shape canals produce some amount of apically extruded debris. The type of irrigant can affect the amount of apically extruded debris. The aim of the present study was to quantitatively compare the amount of debris extruded apically from root canals when three different irrigants were used during canal preparation with hand instruments.

Material and Methods Twenty extracted single-rooted human mandibular premolars with straight root canals were used. The teeth were randomly divided into 4 groups based on the irrigant used: Group 1: Biopure MTAD (Dentsply), Group 2: 3% NaOCl (Prima Dentalproducts), Group 3: 2% Chlorhexidine (Vishal Industries, Gujarat), Group 4: Control (no irrigation). Debris extruded through apical foramen during root canal preparation was collected into pre weighed empty guttapercha tubes. The weight of dry extruded debris was calculated by subtracting the preinstrumentation and postinstrumentation weight for each group. Obtained data was analyzed using one-way analysis of variance and Tukey test.

Results Group 2 (3% sodium hypochlorite) had the greatest amount of extruded debris which was significantly different from other groups ($p<0.05$).

Conclusion The type of used irrigant can affect the amount of apically extruded debris. Sodium hypochlorite in the concentration of 3% showed the greatest amount of extruded debris.

Keywords: apically extruded debris (AED); flare ups; irrigants; smear layer

INTRODUCTION

Root canal treatment encompasses thorough cleaning and shaping of the canal. Cleaning is achieved through proper instrumentation and irrigation for debridement and disinfection of the root canal system in addition to creating a suitable shape for complete three dimensional obturation. Various irrigants and medicaments have been used for cleaning root canals with different results. These include saline, sodium hypochlorite (NaOCl), chlorhexidine (CHX), EDTA, citric acid and MTAD. Till date, all of the techniques and instruments used to clean and shape canals produce some amount of apically extruded debris (AED). In 1968, Chapman et al. [1] demonstrated expulsion of infective material from the root canal system during endodontic instrumentation. In 1975, Vande Visse and Brilliant [2] showed that instrumentation with irrigation produced significantly more extruded debris than instrumentation alone. Extrusion of debris in periradicular tissue is one of major causes of periapical inflammation and postoperative flare-ups which have been a persistent problem over the years [3]. It is most often associated with pain and swelling during or after completion of root canal therapy.

Hence, the importance of minimizing AED needs to be emphasized. Most of previous investigations have evaluated the amount of AED obtained with various instruments or techniques and different types or concentrations of irrigants [4-11]. 5.25% solution of NaOCl has shown the greatest amount of extruded debris [12]. No study has investigated the effect of various types of irrigants on the amount of AED.

The aim of the study was to compare the effect of NaOCl, MTAD and CHX on the amount of AED following root canal preparation.

MATERIAL AND METHODS

Twenty extracted human mandibular premolars with single patent canals and mature apices were included in this study. The teeth were cleaned of debris and soft tissue remnants and stored in the saline solution. The teeth were then decoronated with a diamond disk under copious water spray to establish a uniform length of 14 mm. A K-file 15 was used to confirm patency and measure working length by Ingle's Method. For sample preparation, empty Gutta-percha plastic tubes were used. These tubes were divided in four groups based on used irrigant. Group 1: MTAD (Dentsply), Group 2: 3% NaOCl, Group 3: 2% CHX (Vishal Industries, Gujarat), Group 4: Control (no irrigation).

The test tubes in each group were pre weighed three times and the mean value was expressed in micrograms. Light weight sponge was used at the base of tooth apex to simulate periapical tissue resistance. The teeth were then

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fixed with wax inside the test tubes. A 27-gauge needle was inserted into each tube cover to balance the pressure between the inside and outside of the tube. Step back technique was used for root canal prepaation. The apex was prepared up to the number 30 K file. In all groups, 1 mL of irrigant was used between consecutive files with one side-open round-end 28-gauge needle placed 2 mm shorter to the working length. After completion of root canal preparation, the canals were dried with paper points, and the teeth removed from the tubes. All tubes were weighed 3 times again and the mean value was calculated. The differences between weights before and after preparation were calculated and statistically analyzed using one-way analysis of variance and Tukey test. The level of significance was set at 0.05.

RESULTS

The samples in the group 4 showed no significant difference in weight before and after root canal preparation (canal preparation without irrigant). Mean weights of the samples in the groups 1, 2 and 3 were significantly greater ($p<0.05$) when their pre treatment and post root canal preparation measurements were compared. Among these 3 experimental groups, the group 2 (NaOCl) showed significantly greater difference in mean weight before and after root canal preparation compared to other groups ($p<0.05$), whereas there was no significant difference between mean weights in groups 1 and 3 (Table 1).

DISCUSSION

The present study showed that different root canal irrigants can produce different amounts of AED with the same root canal preparation technique and instruments. Hülsmann et al. [13] stated that in endodontic treatment, an instrument used in apical direction acts as a plunger resulting in periapical extrusion of dentine chips, tissue remnants and root canal irrigant. The frequency of apical extrusion is dependent on the type of root canal irrigation system and apical preparation size [14]. Teeth with open apices, resorption and those damaged by iatrogenic errors during instrumentation are at elevated risk for extrusion of NaOCl.

In the present study different irrigant solutions with different tissue-dissolving ability were used. That might influence the amount of AED produced during root canal preparation. MTAD, used in the Group 1, is a combination of doxycycline (3%), citric acid (4.25%) and polysorbate 80 (0.5%) and is used as final rinse after chemical and mechanical debridement of the root canal. It is the most effective agent for smear layer removal in the apical third of root canals. MTAD is the first irrigant that can both remove smear layer and disinfect root canal [15-19]. This group showed minimal amount of AED of the first three groups. This can be attributed to its smear layer dissolving ability especially in the apical third of the root canal.

In the group 2, NaOCl was used. It is the most frequently used irrigant in endodontic treatment. There has been much controversy over the concentration of hypochlorite solution to be used in endodontics [20, 21, 22]. In this study we used 3% NaOCl. This group showed maximum amount of AED which may be explained by its ability to dissolve organic debris.

In the group 3, 2% CHX was used. It has a broad spectrum antimicrobial action with unique property of substantivity [23, 24]. No significant difference was observed between pre and post canal preparation weights of the samples.

In the present study, root canals in the group 4 were prepared without using an irrigant to determine whether canal preparation procedure itself results in AED. No significant difference was observed before and after root canal preparation in these samples. This is in accordance with the study of Vande Visse and Brilliant [2], who reported no AED when no irrigant was used during root canal preparation. This can be explained by the fact that root canal preparation without using an irrigant may result in some debris accumulation at the apical end of root canal and formation of apical plug. It has been shown that root canal curvature and length can influence the amount of AED [25]. Therefore, in the present study only straight root canals of similar lengths were used. Camoes et al. [26] reported that 5.25% NaOCl has the ability to penetrate through root canal foramen when canals were prepared with both patency and no patency techniques. The results of the present study confirmed that even with just "one time patency" at the time of working length determination, 3% NaOCl produced significantly more AED compared with either MTAD or CHX.

Table 1. Average weight of apically extruded debris (AED)
Tabela 1. Prosečna težina apikalno potisnutog debrisa (AED)

Group Grupa	Average weight of AED (mg) Prosečna težina AED (mg)
1 (MTAD)	9.1
2 (NaOCl)	22
3 (CHX)	8.2
Control (no irrigant) Kontrolna (bez irigansa)	1.3

CONCLUSION

Under the conditions of the present study, the type of irrigant affected the amount of AED. NaOCl produced the greatest amount of debris followed by MTAD, 2% CHX and control group, respectively.

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Received: 07/03/2013 • Accepted: 10/06/2013

Uticaj različitih endodontskih irigansa na potiskivanje debrisa iz kanala korena zuba u periapikalni prostor

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KRATAK SADRŽAJ

Uvod Sve metode i svi instrumenti koji su danas u upotrebi u endodontskoj terapiji kanala korena zuba dovode do potiskivanja određene količine debrisa u periapeks. Vrsta irigansa utiče na količinu periapikalno potisnutog debrisa. Cilj ovog istraživanja bio je da se uporedi količina debrisa koji je potisnut iz kanala korena u periapikalni prostor tokom obrade kanala ručnim instrumentima i uz primenu tri različita irigansa.

Materijal i metode rada Analizirano je dvadeset ekstrahovanih jednokorenih zuba (mandibularnih premolara). Zubi su metodom slučajnog izbora svrstani u četiri grupe prema irigansu koji je korišćen za ispiranje kanala: u prvoj grupi upotrebljen je Biopure MTAD (*Dentsply*), u drugoj grupi troprocentni natrijum-hipohlorit (*Prima Dentalproducts*), u trećoj grupi dvoprocentni hlorheksidin (*Vishal Industries*, Gudžarat), dok je četvrta grupa bila kontrolna (bez irigansa). Debris koji je bio potisnut u periapikalni prostor prikupljen je u prethodno izmerene prazne kutijice gutaperke. Masa suvog debrisa dobijena je kao razlika periapikalne mase pre i posle instrumentacije kanala. Dobijeni podaci su analizirani pomoću jednofaktorske analize varijanse i Tukijevog (*Tukey*) testa.

Rezultati U drugoj grupi, gde je primenjen troprocentni natrijum-hipohlorit, izmerena je najveća količina debrisa, što je bilo statistički značajno različito u odnosu na ostale grupe ($p<0,05$).

Zaključak Vrsta irigansa može uticati na količinu apikalno potisnutog debrisa. Najveća količina debrisa bila je potisnuta u periapeks kada je korišćen natrijum-hipohlorit u koncentraciji od 3%.

Ključne reči: apikalno potisnut debris (AED); upala; irigansi; razmazni sloj

UVOD

Endodontsko lečenje kanala korena zuba obuhvata čišćenje i oblikovanje kanalnog prostora. Čišćenje kanala postiže se pomoću odgovarajućih instrumenata i irigansa koji pored omogućavanja davanja adekvatnog oblika kanalu korena pomažu debridman i dezinfekciju, kako bi se postigla potpuna trodimenzionalna opturacija. Različiti irigansi i lekovi se primenjuju za čišćenje kanala korena s različitim rezultatima. To su: fiziološki rastvor, natrijum-hipohlorit (NaOCl), hlorheksidin (CHX), EDTA, limunska kiselina i MTAD. Sve metode i instrumenti koji se danas koriste za čišćenje i oblikovanje kanala dovode do postiskivanja određene količine debrisa u periapeks. Još 1968. godine Čepman (*Chapman*) i saradnici [1] su pokazali potiskivanje infektivnog materijala iz kanala korena u periapeks. Godine 1975. Vand Vis (*Vande Visse*) i Brilijant (*Brilliant*) [2] su pokazali da preparacija kanala uz irigaciju stvara znatno veću količinu debrisa nego preparacija kanala bez irigacije. Potiskivanje debrisa iz kanala korena u periapeks može dovesti do upalnog procesa u periapeksu i postoperacionog bola ili otoka tokom ili po završetku endodontskog lečenja [3].

Dakle, debris potisnut u periapeks (engl. *apically extruded debris – AED*) ima veliki značaj. U ranijim istraživanjima procenjivana je količina AED kada su korišćeni različiti instrumenti, tehnike i irigansi [4-11]. NaOCl u koncentraciji od 5,25% daje najveću količinu AED [12]. Nijedna studija se još nije bavila ispitivanjem uticaja različitih irigansa na količinu AED.

Cilj istraživanja je bio da se uporedi uticaj NaOCl, MTAD i CHX na količinu AED tokom preparacije kanala korena zuba.

MATERIJAL I METODE RADA

Studijom je obuhvaćeno dvadeset ekstrahovanih jednokorenih zuba, i to mandibularnih premolara sa završenim rastom korena. Zubi su pre analize očišćeni od debrisa i mekih tkiva i potopljeni u fiziološki rastvor. Krunica zuba je uklonjena dijamantskim diskom s obilnom količinom vode, da bi se dobila jednaka dužina korena od 14 mm. Pomoću K-proširivača veličine 15 potvrđena je prohodnost kanala i određena radna dužina po Inglovoj (*Ingle*) metodi. Za izradu uzoraka korišćene su prazne kutijice od gutaperka-kočića. Formirane su četiri grupe u odnosu na vrstu irigansa koji je primenjen: u prvoj grupi korišćen je Biopure MTAD (*Dentsply*), u drugoj grupi troprocentni NaOCl (*Prima Dentalproducts*), u trećoj grupi dvoprocentni CHX (*Vishal Industries*, Gudžarat), dok je četvrta grupa bila kontrolna (bez irigansa).

Prazne kutijice su izmerene tri puta, a srednja vrednost njihove mase izražena u mikrogramima. Lagani sunđeri su postavljeni na apeksu zuba, kako bi simulirali otpor periapeksa. Potom su zubi fiksirani voskom unutar kutijica. Igla debljine 27 G postavljena je u poklopac svake kutijice, da bi se održao jednak pritisak između unutrašnjosti i spoljašnosti kutijice. Kanali su obrađeni tzv. *step-back* tehnikom. Apeks je bio obrađen do veličine 30. Između dva instrumenta kanal je ispiran sa 1 ml irigansa uz primenu igle sa bočnim otvorom veličine 28, postavljenom na 2 mm kraće od radne dužine. Nakon obrade kanali su posušeni papirnim poenima a zubi uklonjeni iz kutijica. Sve kutijice su ponovo izmerene tri puta i izračunata je srednja vrednost. Nakon izračunavanja razlike u težini pre i nakon obrade kanala rezultati su statistički obrađeni jednostrukom analizom varijanse i Tukijevim (*Tukey*) testom. Značajnost je postavljena na nivo od 0,05.

REZULTATI

Nije bilo statistički značajne razlike u težini uzoraka pre i posle endodontske obrade kanala korena u kontrolnoj grupi uzoraka (preparacija kanala bez irigacije). Prosečne mase uzoraka u ostale tri grupe bile su značajno veće ($p<0,05$) posle završene preparacije kanala korena u odnosu na masu pre obrade kanala.

U drugoj grupi (NaOCl) utvrđena razlika u težini AED pre i posle preparacije kanala korena bila je statistički značajno različita u odnosu na prvu i treću grupu ($p<0,05$), između kojih nije bilo statistički značajne razlike (Tabela 1).

DISKUSIJA

Istraživanje je pokazalo da upotreba različitih irigansa istom metodom obrade kanala korena i uz iste instrumente može dovesti do potiskivanja različite količine debrisa u periapeks. Hilsman (*Hülsmann*) i saradnici [13] navode da tokom endodontskog lečenja pokreti instrumenta u apikalnom smeru deluju kao klip koji dovodi do periapikalnog potiskivanja dentinskih strugotina, ostataka tkiva i irigansa. Potiskivanje irigansa u periapeks zavisi od vrste irigansa i veličine apikalnog otvora [14]. Zubi s otvorenim apeksom, resorpcijom i oni oštećeni tokom obrade kanala su pod većim rizikom od potiskivanja NaOCl u periapeks.

U ovom istraživanju su korišćeni irigansi koji se razlikuju po sposobnosti rastvaranja tkiva, što može uticati na količinu AED nastalog tokom preparacije kanala korena. MTAD, koji je primenjen u prvoj grupi, jeste kombinacija doksiciklina (3%), limunske kiseline (4,25%) i polisorbata 80 (0,5%), a koristi se kao rastvor za završno ispiranje nakon preparacije kanala. On je najbolje sredstvo za uklanjanje razmaznog sloja u apikalnoj trećini kanala. MTAD je prvi irigans koji može ukloniti razmazni sloj i istovremeno dezinfikovati kanal [15-19]. U ovoj grupi uzoraka uočeno je vrlo malo potiskivanje debrisa u poređenju sa drugom i trećom grupom. To se može pripisati njegovoj sposobnosti uklanjanja razmaznog sloja, naročito u apikalnoj trećini kanala korena.

NaOCl je kao irigans korišćen u drugoj grupi. On je najčešće primenjivan irigans u endodontskoj terapiji. Bilo je puno polemike oko koncentracije NaOCl koju bi trebalo upotrebljavati za ispiranje kanala [20, 21, 22]. U ovom istraživanju korišćen je troprocentni NaOCl. On je ujedno i pokazao maksimalno potiskivanje debrisa iz kanala preko apeksa, što se može objasniti njegovom sposobnošću rastvaranja organske materije.

Dvoprocentni CHX je korišćen kao irigans u trećoj grupi. On ima širok spektar antimikrobnog delovanja s jedinstvenom osobinom zadržavanja na supstratu [23, 24]. U ovoj grupi nije bilo značajne razlike između mase periapeksa pre i posle preparacije kanala korena.

Kanali korena uzoraka zuba kontrolne grupe obrađeni su bez upotrebe irigansa, da bi se utvrdilo da li preparacija bez primene irigansa dovodi do potiskivanja debrisa u periapeks. Rezultati su pokazali da nije bilo statistički značajne razlike pre i posle preparacije kanala u ovog grupi. Oni su u skladu s nalazima studije Vand Visa i Brilijanta [2], koji su pokazali da nije došlo do potiskivanja debrisa u periapeks kada tokom obrade kanala korena nije korišćen irigans. To se može objasniti time da je najverovatnije došlo do akumulacije debrisa u apikalnom delu kanala i stvaranja čepa. Pokazano je takođe da zakrivljenost i dužina kanala mogu biti značajni faktori koji određuju količinu AED [25]. Stoga su u ovo istraživanje bili uključeni samo pravi koreni slične dužine. Kamos (*Camoes*) i saradnici [26] su utvrdili da NaOCl u koncentraciji od 5,25% prolazi kroz apikalni foramen u periapeks kada je korišćen tokom obrade kanala tehnikama koje daju prohodan, ali i onima koje ne daju prohodan apeks. Rezultati ovog istraživanja su potvrdili da čak i sa jedanput proverenom prohodnošću kanala korena u trenutku određivanja radne dužine troprocentni NaOCl je doveo do potiskivanja znatno veće količine debrisa u periapeks nego MTAD ili CHX.

ZAKLJUČAK

U uslovima pod kojima je izvedena ova studija vrsta irigansa je uticala na količinu AED. NaOCl je doveo do potiskivanja najveće količine debrisa, potom MTAD i dvoprocentni CHX, dok je u kontrolnoj grupi najmanje debrisa potisnuto u periapeks.