

Prevalencija ovalnih kanala korena u apeksnoj i srednjoj trećini donjih molara i premolara

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The prevalence of oval root canals in the apical and middle third of mandibular molars and premolars

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ORIGINAL ARTICLE

KRATAK SADRŽAJ

Uvod. Kanali korena gotovo svih grupa zuba su obično ovalnog oblika na poprečnom preseku. Ovakav morfološki oblik kanala predstavlja poseban izazov za potpuno instrumentaciju i opturaciju, a samim tim i za uspešan ishod terapije.

Cilj. Cilj ovog rada bio je ispitivanje oblika i dijametra korenskih kanala humanih donjih molara i premolara u apeksnoj i srednjoj trećini kako bi se utvrdila prevalencija morfoloških oblika kanala.

Materijal i metod. Istraživanje je sprovedeno na 80 ekstrahovanih humanih donjih zuba (40 molara i 40 premolara). Zubi su postavljeni u posebno dizajniran kalup i zaliveni providnim samopolimerizujućim akrilatom. Zatim su zubi sečeni mikrotomom na nivoima od 3 i 6 milimetara udaljenosti od apeksa. Poprečni preseki su fotografisani digitalnom kamerom pod uveličanjem od 30X. Na fotografijama zuba vršeno je merenje dužeg i kraćeg prečnika kanala korena i izračunavanje je njihov odnos.

Rezultati. U apeksnoj trećini korena 22% premolara i 35% molara imalo je ovalan oblik korenskog kanala. U srednjoj trećini ovakvu morfologiju pokazivalo je 36% premolara i 41% molara.

Zaključak. Korenski kanali donjih molara i premolara su u velikom procentu ovalnog poprečnog preseka. Ovako čest morfološki oblik kanala identifikovan u ovim grupama zuba je značajan podatak koji može uticati na izbor tehnike preparacije.

Ključne reči: kanal korena, dentalna anatomija

SUMMARY

Introduction. Oval root canals are predominant in all groups of human teeth.

In such canals it is a challenge to fulfill the necessary preconditions for a successful outcome of root canal therapy – complete cleaning, shaping and obturation.

Aim. The aim of this study was to investigate the shape and diameter of root canals in the apical and middle third of human mandibular molars and premolars, to determine the prevalence and extent of long oval canals.

Materials and methods. The study was carried out on 80 extracted human teeth, 40 molars and 40 premolars. The teeth were placed in a specially designed muffle mould and embedded in transparent acrylic resin. After the polymerisation of the acrylic resin, the teeth were taken out of the mould and sectioned at levels 3 and 6 mm from the apex. The cross-sections were photographed under 30X magnification using a digital camera. The long and short canal diameter were measured on the images and their ratio calculated.

Results. In the apical third 22% of the premolars and 35% of the molars had oval root canal morphology. In the middle third 36% of premolars and 41% of molars.

Conclusion. Root canals of mandibular molars and premolars are often oval in their cross-section. They seem to be more frequently oval in their cross-section than previous studies have shown.

Keywords: root canal, dental anatomy

Brojni su faktori koji mogu uticati na kvalitet i ishod endodontskog lečenja zuba. Medju onima na koje terapeut nema nikakvog uticaja je unutrašnja morfologija kanala korena zuba. Uobičajenim dijagnostičkim metodima, koji su na raspolaganju kliničaru, uglavnom se dobijaju ograničene informacije o obliku kanalnog sistema tretiranog zuba. Zbog toga su od ključne važnosti podaci o anatomiji svako pojedinalnog zuba, bilo da se radi o osnovnim ili usko specifičnim detaljima anatomskih karakteristika kanala korena zuba.¹⁻⁴ Poprečni presek kanala korena zuba često pokazuje varijacije koje se mogu pojednostavljeno prikazati u vidu približno okruglog, približno ovalnog i nepravilnog oblika kanala. Problemi u obradi, čišćenju i oblikovanju ovalnih kanala korena su dugi niz godina predmet brojnih istraživanja.⁵⁻⁶

U više eksperimentalnih studija proveravan je kvalitet preparacije ovalnih kanala korena upravo na donjim premolarima i distalnim korenovima donjih molara. Međutim, osnovni problem u endodontskom lečenju zuba je upravo nemogućnost tačne identifikacije oblika kanala korena. U nekim studijama se ovalna morfologija kanala praktično podrazumevala i verifikovana je samo inspekcijom otvora kanala.⁷ Za očekivati je da neki od ispitivanih zuba i nisu ispunjavali kriterijum ovalnosti u celoj svojoj dužini. Drugi autori su rendgenografijom zuba iz dva pravca određivali njegovu unutrašnju morfologiju i tako ih uključivali u studiju.^{8,9} Korelacija između stepena izraženosti ovalne morfologije kanala korena i efikasnosti preparacije nije zapažena ni u jednom ispitivanju. Ovakav stav se može smatrati mehanicističkim pristupom bez punog uvažavanja specifičnosti anatomskih karakteristika. Wu i saradnici su 2000.g ispitivali prevalenciju i izraženost izduženih ovalnih kanala korena u svim grupama zuba.³ Oni u radu ukazuju na moguć značaj stepena izduženosti poprečnog preseka kanala na kvalitet i mogućnosti preparacije i opturacije kanala.

Materijal i metod

U ispitivanju je korišten uzorak od 80 ekstrahovanih humanih zuba, i to 40 donjih molara i 40 donjih premolara odabranih metodom slučajnog izbora. Zubi su po ekstrakciji čuvani u 5% rastvoru formalina. Zubi korišćeni u eksperimentu bili su bez prisustva eksternih i internih resorpcija na korenu zuba. Za analizu unutrašnje morfologije kanala korena zuba korišćena je modifikacija Bramanteove tehnike. Ekstrahovani zubi su fiksirani unutar posebno dizajniranog kalupa (sl 1,2) i zatim zalivani u providni autopolimerizujući akrilat.

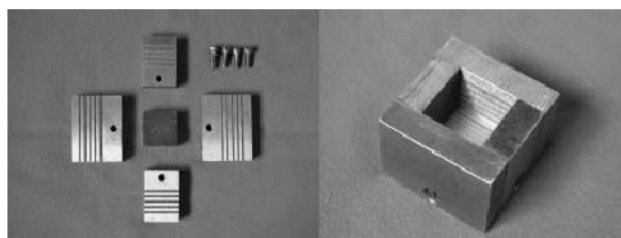
Slika 1. Kalup
Figure 1. The mould

Numerous factors can influence the quality and outcome of endodontic therapy. Among those that cannot be controlled by the therapist is the inner morphology of the root canal system. Usual diagnostic methods provide only limited information about the shape of the treated root canal system. Therefore, previously established information regarding the anatomy of each group of teeth is of utmost value, including basic as well as much more detailed characteristics of root canals.^{1,4} There are many variations in shape of the root canal cross-section. They can be simplified as near round, near oval and irregular shape. Difficulties in shaping oval root canals have been noted in practice and are subject to scientific investigations for many years.^{5,6}

Several experimental studies assessed the quality of preparation of oval root canals using lower premolars and distal roots of lower molars. In some of the studies the oval root canal morphology of these teeth was taken for granted and was verified only by inspection of the canal opening.⁷ It can be expected that some of the root canals did not meet the criteria to be assessed as oval, at least not in all their length. Other authors used two directional radiographic images to assess inner canal morphology and decide which teeth to include in the experiment.^{8,9} Correlation between the extent of oval shape and efficiency of the preparation was not given in any investigation. Wu *et al* (2000) investigated the prevalence and extent of long oval canals in all groups of teeth.³ In the same paper they pointed out that there was a possible correlation between the extent of the oval root canal shape and the chance for complete preparation and obturation.

Material and Method

Eighty extracted adult human teeth, which had been stored in 5% formalin solution, were randomly selected for this investigation. The teeth with present external or detectable internal root resorptions were excluded from the experiment. Root canal morphology was evaluated using a modification of the Bramante technique. The extracted teeth were mounted in a specially designed muffle mould and embedded in transparent acrylic resin



Kalup se sastoji od baze i četiri strane koje se šrafovim pričvršćuju na bazu čineći na taj način kocku koja je s jedne strane otvorena. Na stranicama kalupa okrenutim unutrašnjosti kocke su na istim nivoima urezani žlebovi širine 1mm.

Po vezivanju akrilata zubi su sečeni na dva nivoa, na tri i šest milimetara od vrha korena pod pravim uglom u odnosu na uzdužnu osovinu korena mikrotomom Leica SP1600 (*Leica microsystems Gmbh, Wetzlar, Germany*). Svaki od poprečnih preseka fotografisan je digitalnim fotoaparatom (*Olympus E-500, Olympus corporation, Tokyo, Japan*) uz pomoć mikroskopa na uvećanju od 30x. Na fotografijama je vršeno procenjivanje oblika poprečnog preseka korenskog kanala i određivanje njegovih prečnika. Na fotografijama donjih molara vršena je analiza samo distalnog korena. Određivana je linija najdužeg dugog prečnika kanala (P1) i najdužeg kraćeg prečnika (P2) koje su bile urpavne jedna na drugu. Linije su određene usaglašavanjem dva ispitivača. Dužine linija prečnika merene su na digitalnim fotografijama u pikselima i izračunat je njihov odnos. Odnos dužeg prečnika kanala korena P1 (koji se obično proteže u vestibulo-oralnom pravcu) i kraćeg prečnika P2 (koji se obično pruža u mezio-distalnom pravcu), je određivao indeks ovalnosti kanala $P1/P2=IO$. Ta numerička vrednost pokazuje do koje mere je poprečni presek kanala ovalnog ili spljoštenog oblika.

The mould consisted of a base plate and four sides which are screwed on to the base plate thus forming a cube open on one side. Sides of the mould had 1mm deep grooves facing the inner side of the cube. After the setting of the resin, teeth were sectioned at levels 3 and 6mm from the apex at a straight angle on the root axis using Leica SP1600 microtome saw (*Leica microsystems Gmbh, Wetzlar, Germany*). Each cross-section was photographed using a digital camera (*Olympus E-500, Olympus corporation, Tokyo, Japan*) and a microscope under 30X magnification. Evaluation of the shape of root canal cross-sections was done on the photographs as well as the measurement of the root canal diameters. On the photographs of the lower molars only the distal root was analysed. The lines of the longest long canal diameter (P1) and the longest short canal diameter (P2), at right angles at each other, were determined and agreed on by two investigators. Length of the diameter lines was measured on the digital photographs in pixels and their ratio was calculated. The ratio between the length of the longer root canal diameter (P1, usually in the vestibulo-oral projection), and the short root canal diameter (usually in the mesio-distal projection), gave the IO index. That number indicated the extent to which the canal was oval or flattened.



Slika 2. Ovalan kanal korena
Figure 2. An oval root canal



Slika 3. Kanal korena kružnog prečnika
Figure 3. A round root canal

Ukoliko je $IO \geq 2$, odnosno ukoliko je duži prečnik kanala bar dva puta duži od kraćeg, kanal je kvalifikovan kao ovalan. Kanali sa $IO \geq 4$ kvalifikovani su kao izrazito ovalni ili spljošteni. Prema veličini IO indeksa na određenom nivou preseka zubi su raspoređivani u grupama, od blaže ka izraženoj spljoštenosti.

Rezultati

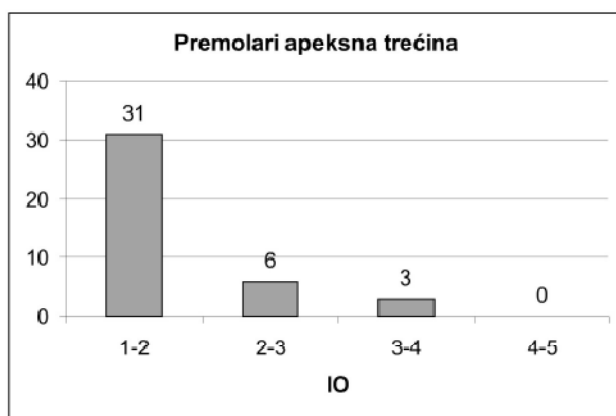
Na 36% premolara je u srednjoj trećini korena identifikovana ovalna morfologija kanala. Od toga je u pet slučajeva, ili 12.5% bio prisutan izražen ovalan izgled kanala a u dva slučaja spljošten oblik sa $IO > 4$. U apeksnoj trećini ovalnu morfologiju imalo je 22% premolara od čega je u 3 slučaja bilo sa izraženijim IO indeksom od 3-4.

Kod 41% molara je bila prisutna ovalna morfologija kanala korena u srednjoj trećini. U šest slučajeva donjih molara (15%) morfologija je bila izraženije ovalna, a dva kanala su kvalifikovana kao spljošten oblik. U apeksnoj trećini 35% molara je bilo ovalnog oblika, tri sa IO 3-4, a nijedan nije bio spljoštenog oblika.

The canal was identified as oval if $IO \geq 2$, i.e the longer root canal diameter was at least two times longer than the short. The canals with $IO \geq 4$ were qualified as extremely oval or flattened. According to the IO values at sectioned levels the teeth were grouped as to the extent of their flatness.

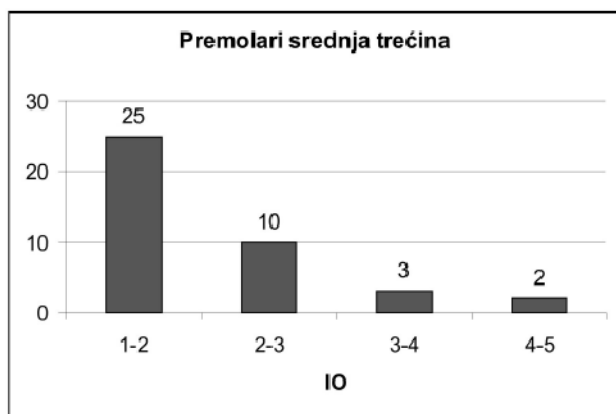
Results

36% of premolars had oval cross-sections in the middle third of the root. In five cases, or 12.5%, the canals were more oval, two of which were flattened with $IO \geq 4$. In the apical third, 22% of the premolars had oval morphology, with only 3 cases of pronounced oval morphology with IO 3-4. 41% of the molars had oval morphology in the middle third. In six cases, or 15%, their shape was more oval and two canals were qualified as flattened. In the apical third, 35% of the molars had oval shape of their root canals, three with IO 3-4 and none flattened.



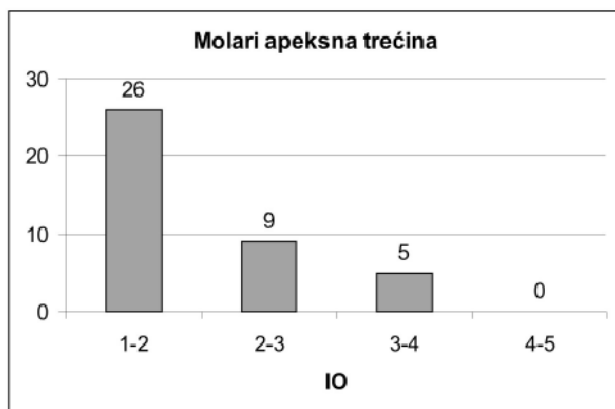
Grafikon 1. Prevalencija ovalnih kanala korena u apeksnoj trećini premolara.

Graph 1. The prevalence of oval root canals in the apical third in premolars.



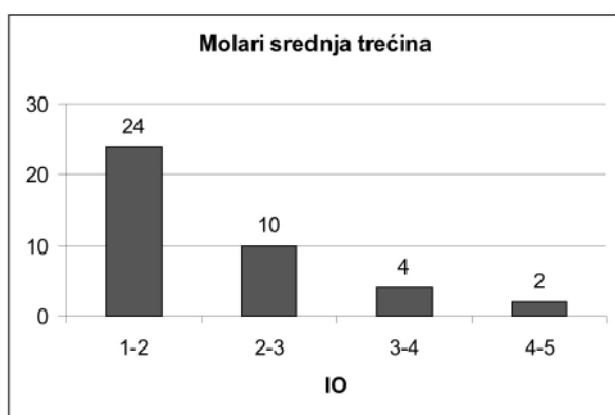
Grafikon 2. Prevalencija ovalnih kanala korena u srednjoj trećini premolara.

Graph 2. The prevalence of oval root canals in the middle third in premolars.



Grafikon 3. Prevalencija ovalnih kanala korena u apeksnoj trećini molara.

Graph 3. The prevalence of oval root canals in the apical third in molars.



Grafikon 4. Prevalencija ovalnih kanala korena u srednjoj trećini molara.

Graph 4. The prevalence of oval root canals in the middle third in molars.

Diskusija

Prilikom odabira eksperimentalnog modela odlučeno je da se prihvati sopstvena modifikacija Bramanteovog modela.^{10,11} Bramanteov model je tokom godina dosta korišten od brojnih autora i postao je neka vrsta standarda zbog svoje pouzdanosti i jednostavnosti.¹²⁻¹⁵ Pored ostalog ovaj izbor pruža mogućnost eventualnog nastavka istraživanja na jedinstvenoj platformi. Eliminacija zuba sa prisutnim eksternim i internim resorpcijama korena zuba logična je posledica činjenice da prirodna unutrašnja i spoljna morfologija zuba može biti izmenjena patološkim procesom. Obzirom na to da eksperimentalni uzorak čine zubi ekstrahovani zbog opravdanih stomatoloških indikacija, broj tako odbačenih zuba bio je relativno visok (4).

Odabrane grupe zuba za ovo ispitivanje su pored donjih inciziva najčešće korišćene u ispitivanjima kvaliteta preparacije i čišćenja kanala s ovalnim poprečnim presekom.⁷⁻⁹ Međutim, malo je studija koje na većem uzorku procenjuju morfologiju ovih zuba i definišu procenat i izraženost spljoštene morfologije. Wu i saradnici su sproveli ispitivanje poprečnih preseka kanala korena u apeksnih 5mm na svim grupama zuba. Pronašli su oval-

Discussion

When choosing the model for this experiment we opted for our own modification of the Bramante model.^{10,11} Such model was used many times over the years by various authors and became a sort of a standard due to its reliability and simplicity.¹²⁻¹⁵ Besides, that model gives us the opportunity to pursue further investigations on the same platform. The elimination of teeth with present external or internal root resorptions reflects the fact that natural inner and outer anatomy of the tooth has been changed by the pathological process. Since the teeth used in the experiment were already extracted due to various otherwise untreatable conditions, the number of such teeth was relatively high, four altogether.

Groups of teeth chosen for this investigation were, along with lower incisors, most commonly used in previous studies investigating the quality of preparation and disinfection of oval root canals.⁷⁻⁹ Even so there are no studies that would investigate the morphology of these teeth on larger scale and define the percentage and extent of flattened root canals. Wu *et al.* investigated the cross-sections of the apical 5mm of root canals in all teeth

nu morfologiju u 25% slučajeva na distalnim kanalima donjih molara i uočili da se taj procenat i odnos praktično ne menja približavanjem kanala apeksu.³ Kod premolara je pronađeno 27% ovalnih kanala, ali je ta ovalnost opadala na 13% na udaljenosti 1mm od apeksa. Prilikom istog ispitivanja uočene su značajne morfološke razlike između kanala srednje izražene ovalnosti sa IO od 2-4 i izraženo ovalnih sa IO \geq 4 ili spljoštenih kanala. Takve kanale su otkrili u donjim sekutićima, mezijalnim korenovima donjih molara, gornjim premolarima i mezijalnim korenovima gornjih molara. U ovom ispitivanju takvi kanali su pronađeni i u srednjoj trećini donjih premolara i distalnim korenovima donjih molara u 5% slučajeva. Spljošteni kanali korena sa svojim izduženim recesusima predstavljaju veliki problem za potpunu preparaciju, uklanjanje organskog sadržaja i trodimenzionalnu opturaciju. Ukoliko se uzme u obzir da su najčešće veoma uzani i zakrivljeni problem preparacije postaje još kompleksniji.

Savremene rotirajuće tehnike uz upotrebu Ni-Ti instrumenata pokazale su se neefikasne u preparisanju čitave cirkumferencije kanala i često je dolazilo do otvaranja uzanih recesusa.^{7,9,16,17} Objašnjenje je traženo u superelastičnosti materijala koji ne dozvoljava kontrolisan pritisak na bočne zidove kanala, odnosno u aktivaciji instrumenta isključivo rotirajućim pokretima. S druge strane ni čelični endodontski instrumenti uz pokrete turpijanja duž vestibulo-oralnih recesusa nisu dali zadovoljavajuće rezultate.^{8,12} Ekstremno širenje apeksne trećine kanala pored rizika perforacije zidova kanala i razaranja apeksne konstrikcije je takođe veliki problem u čišćenju i oblikovanju kanala.¹²

Većina autora se slaže da naglasak u endodontskoj terapiji kod ovakve morfologije kanala treba staviti na sistem i tehniku irigacije.^{9,12,16,17} Irigansi treba da doprinese razlaganju organskog sadržaja uzanih recesusa kanala i njegovoj eliminaciji, utičući na oblikovanje i dezinfekciju kanala. Kao irigansi izbora u mnogim istraživanjima potenciran je natrijum hipohlorit. U cilju povećanja njegove efikasnosti preporučuje se povećanje njegove temperature, koncentracije i količine. Kao ultimativni metod ostaje ultrazvučna agitacija irigansa bilo da je preparacija sprovedena ultrazvučnim tehnikama bilo da se ona realizuje nakon preparacije nekim drugim sistemom⁶.

Zaključak

Kanali korena donjih premolara i distalnih korenova donjih molara često imaju ovalnu morfologiju na poprečnom preseku. Izrazito ovalna, spljoštena morfologija nije otkrivena u apeksnoj trećini analiziranih kanala korena. Relativno česta pojava ovakvog morfološkog oblika kanala korena ovih grupa zuba je značajan podatak koji može imati uticaja na izbor tehnike čišćenja i oblikovanja ovako kompleksnih kanalskih sistema.

They found oval morphology to be present in 25% of the cases on the distal roots of lower molars. It was interesting that the percentage practically did not change as the canal approached the apex.³ In premolars, such morphology was identified in 27% of teeth and decreased to 13% 1mm from the apex. The same authors noticed significant morphological differences between moderate oval canals with IO 2-4 and extremely oval with IO \geq 4, which they called flattened. Such canals were identified in lower incisors, mesial roots of lower molars, upper premolars and mesial roots of upper molars. In the present study, we found flattened canal shape in the middle third of premolars and molars in 5% of teeth which may indicate greater prevalence of that shape. Flattened root canals with their long recessuses present a great challenge for complete instrumentation, elimination of the organic debris and obturation. Bearing in mind that such canals are very often narrow and curved, the problem of their preparation becomes even more complex.

Contemporary rotary Ni-Ti techniques have proven to be inefficient in preparing the entire circumference of the canals and opening up the narrow recessuses.^{7,9,16,17} The explanation was sought in the superelasticity of the material that did not allow the controlled pressure to be applied on canal walls and exclusively rotating instrument motion. On the other hand, stainless steel endodontic instruments used in the filing motion along the vestibulo-oral recessuses did not prove to be efficient either.^{8,12} Extreme enlargement of the apical third of the root bares the risk of perforating the canal walls and destroying the apical constriction, and still does not yield significantly better results.¹²

Most authors agree that the emphasis in endodontic treatment of teeth with flattened root canal morphology should be on the irrigation.^{9,12,16,17} Irrigating solution should enhance dissolving of the organic debris and its evacuation, contributing to the desinfection of the canal and possibility of hermetic obturation. All the authors agree that the irrigant of choice is sodium hypochlorite. Increase in its concentration, temperature and volume used is recommended. As the ultimate method, there is ultrasonic irrigation whether the preparation had been performed with ultrasonic techniques or not.⁶

Conclusion

Root canals of lower premolars and distal roots of lower molars are often oval in cross-section. Extremely oval, flattened morphology was not detected in the apical third of the analyzed root canals. Relatively frequent presence of such morphological shape of root canals in lower molars and premolars is an important finding that can influence the choice of cleaning and shaping technique.

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