CBCT analysis of apical distance between second lower premolars, first and second lower molars and mandibular canal

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SUMMARY

Introduction Mandibular canal with the associated neurovascular bundle may be closely related to the apices of mandibular teeth. In order to avoid injuries and damages to the inferior alveolar nerve during invasive dental procedures, it is important to know its localization.

The aim of this study was to determine the average vertical distances of the root apices of second premolars, first molars and second molars mesially and distally from the upper projection of the mandibular canal on the sagittal section of CBCT images, and determine if there were statistically significant differences between the age and gender groups.

Material and methods The research was conducted at the Faculty of Medicine of the University of Banja Luka, and the sample consisted of 146 CBCT images of patients. CBCT images were obtained using Planmeca ProMax 3D Mid instrument (Planmeca, Helsinki, Finland) and analyzed using Planmeca Romexis Viewer software. In the sagittal section, the vertical distance from the root apex to the upper projection of the mandibular canal was measured for each examined tooth.

Results The distal root of the first molar (4.88 mm) had the greatest average vertical distance of the root apex from the mandibular canal, and the distal root of the second molar had the smallest average vertical distance (2.76 mm). There was statistically significant difference between certain age groups in the values of individual roots, for the second molar mesially and distally (p < 0.05), while for the first molar mesially the value of p was at the limit of significance (p = 0.05).

Conclusion The results of this study showed that distal root of the mandibular second molar had the smallest vertical distance from mandibular canal, therefore an extra caution during a root canal treatment and careful planning of oral surgery in this region is recommended.

Keywords: CBCT; mandibular canal; vertical distance of tooth apex; lower premolars; lower molars

INTRODUCTION

Cone-beam computerized tomography (CBCT) is a modern radiological imaging system, designed specifically for use in the maxillofacial region. The system overcomes many limitations of conventional radiography, creating a non-distorted, three-dimensional image of the examined area. It is used in endodontics to determine the morphology and dimensions of root canals, periradicular lesions, detection and localization of resorptions, postoperative control and monitoring of treatment outcomes. It is also used in orthodontic treatment, as well as implant prosthodontics, facilitating prosthetic planning, selection of implants and the place of its installation [1, 2, 3]. Also, successful endodontic treatment largely depends on an adequate radiographic method, which should provide critical information about examined teeth and their surrounding anatomy. Since its beginning, conventional radiography has remained the mainstay of auxiliary diagnostic methods in endodontics.

Data from the literature indicate that there are differences when comparing the distances of the tips of mandibular teeth from mandibular canal in relation to gender and age. However, numerous individual variations of the position of the canal in the mandible can occur, as well as the position of teeth and their mutual relationship [4]. Mandibular canal extends through the lower jaw from the mandibular opening (foramen mandibulae). In most cases, it is bilaterally symmetrical and in the form of one main canal on each side of the mandible, but variations are also possible. The contents of the mandibular canal are inferior alveolar nerve (nervus alveolaris inferior) and blood vessels of the same name. Inferior alveolar nerve is mixed and its terminal branch with its sensitive part

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innervates teeth and gums of the lower jaw, while motor part controls mylohyoid muscle and anterior belly of digastric muscle [5, 6].

Many authors have confirmed that iatrogenic injuries of the inferior alveolar nerve are common (64.4%). Therefore, it is necessary to know the exact location of the mandibular canal and its contents for adequate endodontic treatment of lower posterior teeth as well as adequate resection of their root tips. Endodontic treatment includes mechanical use of instruments combined with chemical irrigation, medication agents and materials for final obturation of the canal system. During all these phases, the occurrence of unwanted complications is possible - mechanical, chemical or thermal injury to the nerve that can cause neuropathic pain or anesthesia in its innervation zone. During endodontic treatment of 1% of lower premolars and even 10% of the lower second molars there is possibility of an injury to lower alveolar nerve. Injury to the content of the mandibular canal is also possible during oral surgery. Such injuries sometimes require treatment in the form of microsurgical decompression of the inferior alveolar nerve [7–10].

The aim of this retrospective study was to determine the average vertical distances of the root apices of second premolars, first molars and second molars mesially and distally from the upper projection of the mandibular canal on the sagittal section of the CBCT, and determine whether there were statistically significant differences between the age and gender groups.

**MATERIAL AND METHODS**

The research was approved by the Ethics Committee of the Faculty of Medicine at the University of Banja Luka (18/4.141/21). The sample included 146 CBCT images of patients where the vertical canal distance of the second premolar, first molar and second molar was measured distally and mesially and statistical significance of the difference in relation to gender and age was examined. The initial database included 174 images, of which 146 met the criteria for sample selection: the presence of at least one tooth of importance for research (second mandibular premolar, first mandibular molar and second mandibular molar) and visibility of the mandibular canal on the image. Teeth with internal and external root resorption and endodontically treated teeth were not included in the study. The research included images made in the period from January 1st 2018 until December 31st 2018.

The imaging process was performed using Planmeca ProMax 3D Mid camera (Planmeca, Helsinki, Finland), and CBCT images were analyzed using Planmeca Romexis Viewer software (Figure 1). On the sagittal section, for each tooth (second mandibular premolar, first mandibular molar, second mandibular molar), vertical distance of the root apex to the upper projection of the mandibular canal was measured (Figure 2). For teeth with two roots, the distance was measured for each root separately (Figure 3).

Mandibular canal on sagittal section shows variability in appearance and usually appears as a radiolucent circle, which can be up to 4 mm in diameter. To facilitate the identification of mandibular canal, mental opening was identified on sagittal section, and the canal was followed to the level of the apex of the corresponding tooth [11].

A total of 406 measurements were performed, of which 146 for the second premolar, 42 for the first molar mesially, 42 for the first molar distally, 88 for the second molar mesially, and 88 for the second molar distally (Table 1). After the measurements, obtained values were divided according to the gender and age of the patients (Table 2). Based on age, the sample was divided into the three groups: group
were processed with a 95% significance level using The Version 3.6.2 was used to analyze the obtained data. Data were presented in tables and figures. R Studio STATISTICAL ANALYSIS

A, which included CBCT images of patients younger than 17, group B, which included CBCT images of patients aged 18 to 49, and group C, which included CBCT images of patients older than 50.

RESULTS

Analysis of the results of the average vertical distance for each root from the upper projection of mandibular canal showed that distal root of first molar (4.88 mm) had the highest average vertical distance and distal root of second molar (2.76 mm) the smallest. The average distance for first molar mesially was 4.86 mm, for second molar mesially 3.01 mm, and for second premolar 4.23 mm (Figure 4).

Observed by age groups, in the group A, second molar had the greatest distance from the mandibular canal mesially (4.69 mm), and second premolar had the smallest distance (3.2 mm).

In the group B, the greatest average vertical distance of the root apex from mandibular canal was shown in first molar mesially (4.4 mm) and the smallest in second molar distally (2.2 mm). In the group C, first molar distally had the highest average vertical distance (6.4 mm), and second molar distally had the smallest distance (3.44 mm). With statistical significance of 95% and using The Kruskal-Wallis test, the average vertical distance by types of premolars and molars in relation to age groups was observed (Table 2) but there was no statistically significant difference, p> 0.05. With statistical significance of 95% and using The Mann-Whitney U test, it was observed whether there was a statistically significant difference between age groups for each individual root and found that in the first molar mesially there was a statistically significant difference between groups B and C, with note that the value of p was at the significance limit (p = 0.05). In the second molar distally, statistically significant difference was observed between groups A and B, as well as between B and C (p < 0.05), and in second molar mesially between groups B and C (p < 0.05). No statistically significant difference was observed in other groups.

Previously mentioned groups, where statistically significant difference was found were further divided by gender in the analysis, after which persons of one gender from one age group were compared with persons of the same gender from another age group.

Comparing the vertical distance between CBCT images of females by age groups B and C for the first molar mesially, it was found that the difference was not statistically significant (p>0.05), while in males there was significant difference (p<0.05) (Figure 5).

Comparing the vertical distance between females by age groups B and C for the second molar distally, it was found that the difference was not statistically significant.

Kruskal-Wallis and The Mann-Whitney U test. Based on the measured values, the average vertical distances for each root were determined, as well as average vertical distances for each root by age groups. It was also examined what this statistical significance is reflected in, by comparing individual groups separated by gender. In groups of teeth where significant statistical deviation was observed, CBCT images of persons of one gender, from one age group, were compared with CBCT images of persons of the same gender from another age group.

STATISTICAL ANALYSIS

All data were presented in tables and figures. R Studio Version 3.6.2 was used to analyze the obtained data. Data were processed with a 95% significance level using The

Table 1. Total number of measurements by gender and age groups for each root

| GROUP POL | GROUP | FMD | PMD | FMM | PMM | SMD | DMD | SMM | DMM | SP | DP | TOTAL UKUPNO |
|-----------|-------|-----|-----|-----|-----|-----|-----|-----|-----|----|----|--------------|
| FEMALE | A | 2 | 2 | 2 | 2 | 2 | 2 | 10 |
| | B | 9 | 9 | 9 | 9 | 9 | 9 | 91 |
| | C | 3 | 3 | 2 | 2 | 2 | 2 | 13 |
| MALE | A | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 13 |
| | B | 18 | 18 | 18 | 18 | 18 | 18 | 34 |
| | C | 7 | 7 | 7 | 7 | 7 | 7 | 14 |
| TOTAL UKUPNO | 42 | 42 | 88 | 88 | 146 | 406 |

A = ≤17 years; B = 18–49 years; C = ≥50 years; FMD = first molar distally; FMM = first molar mesially; PMD = second molar distally; PMM = second molar mesially; SP = second premolar

Table 2. Average vertical distance by age groups

| AVERAGE VERTICAL DISTANCE BY AGE GROUPS | PROSEČNA VERTIKALNA UDALJENOST PO STAROSNIM GRUPAMA |
|--------------------------------------|-----------------------------------------------|
| GROUP POL | GROUP | FMD | PMD | FMM | PMM | SMD | DMD | SMM | DMM | SP | DP |
|-----------|-------|-----|-----|-----|-----|-----|-----|-----|-----|----|----|
| FEMALE | A | 4.48 | 4.62 | 4.63 | 4.69 | 3.20 |
| | B | 4.39 | 4.40 | 2.20 | 2.56 | 4.17 |
| | C | 6.40 | 6.22 | 3.44 | 3.54 | 4.39 |
| MALE | A | 4.48 | 4.62 | 4.63 | 4.69 | 3.20 |
| | B | 4.39 | 4.40 | 2.20 | 2.56 | 4.17 |
| | C | 6.40 | 6.22 | 3.44 | 3.54 | 4.39 |

A = ≤17 years; B = 18–49 years; C = ≥50 years; FMD = first molar distally; FMM = first molar mesially; PMD = second molar distally; PMM = second molar mesially; SP = second premolar

Figure 3. Distance of the mandibular canal from the apex of the mesial root of the tooth

Slika 3. Udaljenost mandibularnog kanala od vrha mezijalnog korena zuba

Tabela 2. Prosečna vertikalna udaljenost po starosnim grupama

| GROUP POL | GROUP | FMD | PMD | FMM | PMM | SMD | DMD | SMM | DMM | SP | DP |
|-----------|-------|-----|-----|-----|-----|-----|-----|-----|-----|----|----|
| FEMALE | A | 2 | 2 | 2 | 2 | 2 | 2 | 10 |
| | B | 9 | 9 | 9 | 9 | 9 | 9 | 91 |
| | C | 3 | 3 | 2 | 2 | 2 | 2 | 13 |
| MALE | A | 2 | 2 | 2 | 2 | 2 | 2 | 13 |
| | B | 18 | 18 | 18 | 18 | 18 | 18 | 34 |
| | C | 7 | 7 | 7 | 7 | 7 | 7 | 14 |
| TOTAL UKUPNO | 42 | 42 | 88 | 88 | 146 | 406 |

A = ≤17 years; B = 18–49 years; C = ≥50 years; FMD = first molar distally; FMM = first molar mesially; PMD = second molar distally; PMM = second molar mesially; SP = second premolar

Table 1. Ukupan broj merenja po polnim i starosnim grupama za svaki koren
(p>0.05), while for the same groups in males statistically significant difference was found (p<0.05) (Figure 6).

Although there is a statistically significant difference for the whole age groups B and C in the second molar mesially, observing the same by gender, and from different age groups no statistically significant difference was found (p > 0.05) (Figure 7).

No statistically significant difference between different age groups in women was found, while in men it was observed only in the first molar mesially and the second molar distally, between groups A and B.

Comparing the average vertical distances for each root by gender, it was observed that all average values were higher in males. For men, the greatest average vertical distance was present in the root of first molar distally (5.57 mm) and the smallest in second molar distally (3.52 mm). In women, also, first molar distally had the greatest average vertical distance (3.50 mm), and second molar mesially had the smallest (1.64 mm) (Figure 8).

**DISCUSSION**

Development of modern radiological imaging system and CBCT, designed specifically for use in maxillofacial region, allowed obtaining timely information relevant to endodontic, surgical or endodontic-surgical treatment [12, 13, 14]. CBCT overcomes many of the limitations of conventional radiography, creating a non-distorted, three-dimensional image of the examined area and allowing visualization of the images by layers and sections in all three dimensions [15].

The results of our study showed that distal root of the first molar (4.88 mm) had the greatest average vertical distance of the apex from mandibular canal. Distal root of second molar (2.76 mm) had the smallest average vertical distance, it is more gracile than the mesial and slightly distally oriented, and its close relationship with the mandibular canal can be attributed to the trajectory and its position in the mandible.

Uğur Aydın et al. obtained partially similar results in Turkish population, where they found, based on CBCT images, that distal root of second molar (2.75 mm) had the smallest average distance from mandibular canal, while the greatest average distance was registered in the mesial root of the first molar (4.98 mm) [16].

In their study on CBCT images, Lvovsky et al. concluded that mesial root of the first molar (6.18 mm) had the greatest average distance, and distal root of the second molar (3.42 mm) had the smallest distance to mandibular canal [17]. The mean value for the mesial root of the first molar in our study was 4.86 mm.

Aksoy et al., by measuring the shortest distance from the mandibular canal, also found that the roots of the
second molar were significantly closer to mandibular canal than the roots of the first molars, first, and second premolars [18]. In the study of Denio et al. that analyzed anatomical relationships of the mandibular canal and lateral teeth by dissecting 22 mandibles, it was concluded that second mandibular premolar and second mandibular molar had the smallest distance from mandibular canal [19].

Using CBCT images, Kosumarl et al. found that mesial root of the first molar had the greatest average distance from mandibular canal, while the shortest was in distal root of second molar, both in persons with normal skeletal jaw ratio or skeletal open bite [20]. With the exception of the third molar, Pucilo et al. concluded in a systematic review that distal root of the second molar was closest to the mandibular canal, which coincided with the results of our study [21]. Littner et al. measured the average values of the distance from the apex of first and second molars from the canal on radiographic images of the cadaver and they were between 3.50 and 5.40 mm, and according to a study conducted by Kovisto et al. on CBCT images, these average values were between 1.51 and 3.43 mm [22, 23]. In our study, the average values of the distance of the apices in lower lateral teeth from the mandibular canal ranged between 2.76 and 4.88 mm.

Observing the average vertical distances for each root by gender, it was noticed that all average values were higher in males, which could be related to more gracile constitution of women and smaller dimensions of the lower jaw. Similar findings were reported by other researchers (Aksoy et al. 2017; Simonton et al. 2009), who found that distances between the apices of the lower premolars and lower molars and mandibular canal were smaller in female population [18, 24].

Sato et al. performed research on cadavers, and with the help of CT images and panoramic radiography measured the distances from the root apex to the upper projection of the mandibular canal. Data were grouped by gender and side of mouth. They recorded slightly lower values of the distance in first and second molars from the mandibular canal in women, compared to men [25].

It has been shown that there is four times higher possibility of developing chronic pain after endodontic treatment, if the patient is a female person, as the incidence of postoperative pain in women is also higher [26].

For a definitive conclusion on the reliability of such measurements of the distance of the tooth apices from the mandibular canal, verification in a larger group of teeth is necessary. The deviations in the measurements can be explained by the fact that they were obtained through different sagittal sections of the CBCT, which could affect the repeatability of these measurements.

**CONCLUSION**

Measurements obtained in our study and statistical analyses showed that distal root of mandibular second molars had the smallest vertical distance from the mandibular canal, so careful canal instrumentation and careful planning of oral surgery in this region is recommended.

Interventions in the lateral region of the mandible can lead to damage of the neurovascular bundle of the canal, and unwanted complications, such as paresthesia or neuropathic pain. Therefore, it is important that the therapist is familiar with these relations and performs treatment in compliance with biological principles.

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Primena CBCT analize u proceni udaljenosti korenova drugih donjih premolara, prvih i drugih donjih molara od mandibularnog kanala

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UVOD
Kompiuterizovana tomografija Cone-beam (CBCT) savremeni je radiološki sistem za snimanje, dizajniran posebno za upotrebu u maksilofacialnoj regiji. Sistem prevazilazi mnoge ograničenja konvencionalne radiografije, stvaranjem neiskrivljenje, trodimenzionalne slike područja koje se ispituje. Koristi se u endodonciji za određivanje morfologije i dimenzija kanala kojeg se ispituje, izbor implantata i mesta njegove ugradnje [1, 2, 3].

Uspešan endodontski tretman uveliko zavisi od adekvatne resekcije vrhova korena donjih bočnih zuba, kao i adekvatne resekcije vrhova korena donjih bočnih zuba. U okviru protokola endodontske terapije koriste se instrumeti za mehaničku obradu kanala, kombinovani sa hemijskim sredstvima za irigaciju, medikamentozna sredstva i materijali za definitivnu opturaciju kanalnog sistema. U toku svih ovih faza moguće je nastanak neželjenih komplikacija – mehanička, hemijska i inerviše zuba, kao i adekvatna resekcije vrhova korena donjih bočnih zuba. U okviru protokola endodontske terapije koriste se instrumenti za mehaničku obradu kanala, kombinovani sa hemijskim sredstvima za irigaciju, medicamentosne sredstva i materijali za definitivnu opturaciju kanalnog sistema. U toku svih ovih faza moguće je nastanak neželjenih komplikacija – mehanička, hemijska i inerviše zuba, kao i adekvatna resekcije vrhova korena donjih bočnih zuba.

Zaključak
Rezultati ovog istraživanja pokazuju da najmanju vertikalnu udaljenost od mandibularnog kanala ima distalni koren prvog molara (4,88 mm), a najmanju distalnu koren drugog molara (2,76 mm). Statistički značajna razlika postoji između određenih starosnih grupa kod vrednosti pojedinih korenova i to za drugi molar mezijalno i drugi molar distalno (p<0,05), za prvi molar mezijalno (p<0,05) i distalno (p=0,05). Statistički značajna razlika postoji između određenih starosnih grupa kod vrednosti pojedinih korenova i to za drugi molar mezijalno i drugi molar distalno (p<0,05), za prvi molar mezijalno (p<0,05) i distalno (p=0,05). Statistički značajna razlika postoji između određenih starosnih grupa kod vrednosti pojedinih korenova i to za drugi molar mezijalno i drugi molar distalno (p<0,05), za prvi molar mezijalno (p<0,05) i distalno (p=0,05).

Materijal i metode
Istraživanje je sprovedeno na Medicinskom fakultetu Univerziteta u Banjoj Luci, a uzorak je činilo 146 CBCT snimaka pacijenata. CBCT snimci su dobijeni sa aparatom Planmeca ProMax 3D Mid (Planmeca, Helsinki, Finska) i analizirani pomoću softvera Planmeca Romexis Viewer. Na sagitalnom preseku je za svaki zub izmerena vertikalna udaljenost vrha korena od mandibularnog kanala. Rezultati Rezultati ovog istraživanja pokazuju da najmanju vertikalnu udaljenost od mandibularnog kanala ima distalni koren drugih mandibularnog kanala.

Saša Marin

KRATAK SADRŽAJ
Uvod Mandibularni kanal sa pripadajućim neurovaskularnim snopom može biti u bliskom odnosu sa vrhovima mandibularnih zuba. Da bi se izbegle povrede i oštećenja donjeg zubnog živca tokom invazivnih dentalnih procedura, važno je poznavati njegovu lokalizaciju. Cilj ovog istraživanja je bio da se na osnovu sagitalnog preseka CBCT snimka odrede prosečne vrednosti udaljenosti korenova drugih donjih premolara, prvih i drugih donjih molara mezijalno i distalno od gornje projekcije mandibularnog kanala, te utvrdi da li postoji statistička značajnost u odnosu na pol i starosnu dobu.

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Rezultati Najveću prosečnu vertikalnu udaljenost apekse korena zuba od mandibularnog kanala imao je distalni koren prvog molara (4,88 mm), a najmanju distalnu koren drugog molara (2,76 mm). Statistički značajna razlika postoji između određenih starosnih grupa kod vrednosti pojedinačnih korenova i to za drugi molar mezijalno i drugi molar distalno (p<0,05), za prvi molar mezijalno (p<0,05) i distalno (p=0,05).

Zaključak
Rezultati ovog istraživanja pokazuju da najmanju vertikalnu udaljenost od mandibularnog kanala ima distalni koren mandibularnih drugih molara, pa se preporučuje pažljiva obrada korenova i zaživljivanje prve faze endodontske terapije za određivanje morfologije i dimenzija kanala koje se ispituje. Zbog manjih vertikalnih udaljenosti korenova drugih molara do mandibularnog kanala, postoji manja varijacija vertikalne udaljenosti korenova drugih molara od mandibularnog kanala.

Ključne reči: CBCT; mandibularni kanal; vertikalna udaljenost apekse zuba; donji premolari; donji molari

UBOD
Kompiuterizovana tomografija Cone-beam (CBCT) savremeni je radiološki sistem za snimanje, dizajniran posebno za upotrebu u maksilofacialnoj regiji. Sistem prevazilazi mnoge ograničenja konvencionalne radiografije, stvaranjem neiskrivljenje, trodimenzionalne slike područja koje se ispituje. Koristi se u endodonciji za određivanje morfologije i dimenzija kanala zuba, periapikalnih lezija, otkrivanje i lokalizaciju resorpcija, za postoperativnu kontrolu i praćenje ishoda terapije. Primenu je našao i u ortodontskoj terapiji, kao i u implantoprotetici, bez obzira na egzistenciju vrednosti r je na granici značajnosti (p=0,05).

Obzirom na to da su mnogi autorii potvrdili da su jatrogene povrede donjiviličnog živca najčešće (64,4%), neophodno je poznavanje tačne lokalizacije mandibularnog kanala i njegovog sadržaja radi adekvatne endodontske terapije donjih bočnih zuba, kao i adekvatne resekcije vrhova korena donjih bočnih zuba. U okviru protokola endodontske terapije koriste se instrumenti za mehaničku obradu kanala, kombinovani sa hemijskim sredstvima za irigaciju, medicamentosne sredstva i materijali za definitivnu opturaciju kanalnog sistema. U toku svih ovih faza moguće je nastanak neželjenih komplikacija – mehanička, hemijska ili termalna povreda nerva, što može izazvati neuropatski bol ili anesteziju u njegovoj inervacionalnoj zoni. Kod endodontske terapije 1% donjih premolara i čak kod 10% donjih drugih molara zabeležena je mogućnost povrede donjiviličnog živca.

Rezultati ovog retrospektivnog istraživanja je bio da se na sagitalnom preseku CBCT-a odrede prosečne vertikalne udaljenosti...
vrhova korenova drugih premolara, prvih molara i drugih molara mežijalno i distalno od gornje projekcije mandibularnog kanala, te utvrdi da li postoji statistička značajnost u odnosu na pol i starosnu dob.

MATERIJAL I METODE

Istraživanje je odobreno od strane Etičkog komiteta Medicinskog fakulteta Univerziteta u Banjoj Luci (18/4.141/21).

Uzorak je obuhvatio 146 CBCT snimaka pacijenata pomoću kojih je merena vertikalna udaljenost kanala drugog premolera, prvog molara i drugog molara distalno i mežijalno i ispitivana statistička značajnost razlike u odnosu na pol i starosnu dob. Početna baza podataka obuhvatala je 174 snimka, od kojih je 146 ispunilo kriterijume za izbor uzorka: prisustvo najmanjeg jednog zuba od značaja za istraživanje (drugi mandibularni premolar, prvi mandibularni molar i drugi mandibularni molar) i vidljivost mandibularnog kanala na snimku. Zubi sa internom i eksternom resorpcijom korena i enodontski lečeni zubi nisu bili uključeni u istraživanje. Istraživanje je obuhvatilo smije u periodu od 1. 1. 2018. do 31. 12. 2018. godine.

Proces snimanja je obavljan sa aparatom Planmeca ProMax 3D Mid (Planmeca, Helsinki, Finska), a CBCT snimci su analizirani pomoću softvera Planmeca Romexis Viewer (Slika 1). Na sagitalnom preseku je za svaki zub (drugi mandibularni premolar, prvi mandibularni molar, drugi mandibularni molar) izmerena vertikalna udaljenost vrha korena do gornje projekcije mandibularnog kanala (Slika 2). Za zube sa dva korena merena je udaljenost za svaki koren posebno (Slika 3).

Mandibularni kanal na sagitalnom preseku pokazuje varijabilnost u izgledu i obično se pojavljuje kao radiolucentni krug, koji može biti do 4 mm u prečniku. Za lažje identifikovanje mandibularnog kanala, na sagitalnom preseku je identifikovan mentalni otvor, te je kanal praćen do nivoa apeksa odgovarajućeg zuba [11].

Ukupno je izvršeno 406 merenja, od toga 146 za drugi premolar, 42 za prvi molar mežijalno, 42 za prvi molar distalno, 88 za drugi molar mežijalno i 88 za drugi molar distalno (Tabela 1). Nakon izvršenih merenja su dobijene srednje vrednosti koje su podeljene prema polu i starosnoj dobi pacijenata (Tabela 2). Na osnovu starosne dobi, uzorak je podeljen u tri grupe: grupa A, koja je obuhvatala CBCT snimke pacijenata mladih od 17 godina, grupa B, koja je obuhvatala CBCT snimke pacijenata starosti od 18 do 49 godina i grupa C, koja je obuhvatala CBCT snimke pacijenata starijih od 50 godina.

Statistička analiza

Svi podaci su prikazani tabelarno i grafički. Za analizu dobijenih podataka korišćen je program R Studio Version 3.6.2. Podaci su obrađeni uz stepen značajnosti od 95% korišćenjem testova Kruskal –Wallis i Mann–Whitney U. Na osnovu izmerenih vrednosti određene su prosečne vertikalne udaljenosti za svaki koren, kao i za svaki koren po starosnim grupama. Takođe je ispitivana u čemu se ogledaju ove statističke značajnosti, poređenje pojedine grupe razdvojene po polu. Kod grupa zuba gde je uočeno značajno statističko odstupanje, CBCT snimci osoba jednog pola iz jedne starosne grupe poređene su sa CBCT snimcima osoba istog pola iz druge starosne grupe.

REZULTATI

Analiza rezultata prosečne vertikalne udaljenosti za svaki koren od gornje projekcije mandibularnog kanala je pokazala da najveću prosečnu vertikalnu udaljenost ima distalni koren prvog molara (4,88 mm), a najmanju distalni koren drugog molara (2,76 mm). Prosečna udaljenost za prvi molar mežijalno je 4,86 mm, za drugi molar mežijalno 3,01 mm, a za drugi premolar 4,23 mm (Slika 4).

Posmatrano po starosnim grupama, u grupi A najveću udaljenost od mandibularnog kanala imao je drugi molar mežijalno (4,69 mm), a najmanju drugi premolar (3,2 mm).

U grupi B najveću prosečnu vertikalnu udaljenost apsoka korena od mandibularnog kanala pokazao je prvi molar mežijalno (4,4 mm), a najmanju drugi molar distalno (2,2 mm).

U grupi C je najveću prosečnu vertikalnu udaljenost imao prvi molar distalno (6,4 mm), a najmanju drugi molar distalno (3,44 mm).

Sa statističkom značajnosti od 95% i koristeći Kruskal–Wallis test, posmatrano je prosečna vertikalna udaljenost po vrstama premolera i molara u odnosu na starosne grupe (Tabela 2) i utvrđeno je da ne postoji statistički značajna razlika, p > 0,05.

Sa statističkom značajnosti od 95% i koristeći Mann–Whitney U test, posmatrali smo da li postoji statistički značajna razlika između pojedinih starosnih grupa za svaki pojedinačni koren i utvrđeno je da kod prvog molara mežijalno postoji statistički značajna razlika između grupa B i C, uz napomenu da je vrednost p na granici značajnosti (p = 0,05). Kod drugog molara distalno uočena je statistički značajna razlika između grupa A i B, kao i između B i C (p < 0,05), a kod drugog molara mežijalno između grupa B i C (p < 0,05). Kod ostalih grupa nije uočena statistički značajna razlika.

Prethodno pomene grupe, kod kojih je uočena statistički značajna razlika, u daljoj analizi su razdvojene prema polu, nakon čega su osobe jednog pola iz jedne starosne grupe poredene sa osobama istog pola iz druge starosne grupe.

Poređeci vertikalnu udaljenost između CBCT snimaka osoba ženskog pola po starosnim grupama B i C za prvi molar mezijalno, utvrđeno je da razlika nije statistički značajna (p > 0,05), dok kod osoba muškog pola postoji značajna statistička razlika (p < 0,05) (Slika 5).

Poređeci vertikalnu udaljenost između osoba ženskog pola po starosnim grupama B i C za drugi molar distalno, utvrđeno je da razlika nije statistički značajna (p > 0,05), dok je za iste grupe kod osoba muškog pola utvrđeno da postoji značajna statistička razlika (p < 0,05) (Slika 6).

Iako postoji statistički značajna razlika za cele starosne grupe B i C kod drugog molara mežijalno, posmatrajuci iste po polu, a iz različitih starosnih grupa, utvrđeno je da razlika nije statistički značajna (p > 0,05) (Slika 7).

Uočeno je da ne postoji statistički značajna razlika između različitih starosnih grupa kod žena, dok je kod muškaraca ona uočena samo kod prvog molara mezijalno i drugog molara distalno, između grupe A i B.

Posmatrajući prosečne vertikalne udaljenosti za svaki koren po polu, uočeno je da su sve prosečne vrednosti veće kod osoba muškog pola. Za muškarce je najveća prosečna vertikalna udaljenost prisutna kod korenja prvog molara distalno (5,57 mm), a najmanja kod drugog molara distalno (3,52 mm). Kod žena je najveću prosečnu vertikalnu udaljenost takođe imao prvi
molar distalno (3,50 mm), a najmanju drugi molar mezijalno (1,64 mm) (Slika 8).

DISKUSIJA

Zahvaljujući savremenom radiološkom sustavu za snimanje, CBCT-u, koji je dizajniran posebno za upotrebu u maksilofa
cijalnoj regiji, moguće je pravovremeno dobiti informacije od
začaja za endodontsku, hiruršku ili endodontsko-hiruršku
terapiju [12, 13, 14].

CBCT prevazilazi mnoga ograničenja konvencionalne ra
diografije stvaranjem neiskrivljenje, trodimenzionalne slike
područja koje se ispituje i omogućava vizualizaciju snimaka po
slojevima i presek u sve tri dimenzije [15].

Rezultati ove studije su pokazali da je najveću prosečnu
verticalnu udaljenost apska od mandibularnog kanala imao
distalni koren prvog molara (4,88 mm). Najmanju prosečnu
verticalnu udaljenost imao je distalni koren drugog molara (2,76
mm), koji je gracilniji u odnosu na mezijalni i blago distalno
usmeren, a njegov blizak odnos sa mandibularnim kanalom
može se pripisati putanju kanala i njegovom položaju u mandi-
buli. Do delimično sličnih rezultata merenjem na CBCT snimcima u stis
populacije, ustanovili da je najmanju prosečnu udaljenost od
mandibularnog kanala bila kraća u ženskoj populaciji [18, 24].

Sato i saradnici su vršili istraživanje na CBCT snimci-
ma zaključili da je najveću prosečnu udaljenost imao mezijalni
koren prvog molara (6,18 mm), a najmanju distalni koren dru-
gog molara (3,42 mm) [17].

Prosečna vrednost za mezijalni koren prvog molara u našem
istraživanju bila je 4,86 mm.

Aksoy je sa saradnicima merenjem najkraće udaljenosti od
mandibularnog kanala takođe ustanovio da su korenovi drugog
molara znacajno bliži mandibularnom kanalu u odnosu sa ko-
renove prvih molara, prvih i drugih premolara [18].

Denio i saradnici su u svojim podacima, u kojoj su proučavali
anatomske odnose mandibularnog kanala i bocnih zuba se-
ciranjem 22 mandibule, zaključili da najmanju udaljenost od
mandibularnog kanala pokazuju drugi mandibularni premolar
i drugi mandibularni molar [19].

Kosumar i saradnici su merenjem na CBCT snimcima usta-
novili da je najveću prosečnu udaljenost od mandibularnog
kana ima mezijalni koren prvog molara, a najjaču distalni
koren drugog molara, bilo da se radi o osobama sa normalnim
skeletnim odnosom vilica ili skeletno otvorenim zagrijzem [20].

Izuzimajući treći molar, Pucilo je sa saradnicima u sistemati-
skom pregledu zaključio da je distalni koren drugog molara

najблиži mandibularnom kanalu, što se podudara sa rezultatima
ova studije [21].

Četiri puta veća mogućnost nastanja

prilikom intervencija u bočnoj regiji mandibule može doći do
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terapije i adekvatno urađene odontometrije, prethodno infor-
mište o odnosu zuba i mandibularnog kanala.

ZAKLJUČAK

Merenja u okviru ovog istraživanja i statistički podaci pokazuju
 da najmanju vertikalnu udaljenost od mandibularnog kanala
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