An Evaluation of the Relationship Between Roots of Maxillary Anterior Teeth and Neighboring Anatomical Structures in Children: A Cone Beam Computed Tomography Study

Kamile Nur Tozar [1*], Uğur Akdağ [1], Kadir Kaplanoğlu [2]

1. Adıyaman University, Faculty of Dentistry, Pediatric dentisry, Adıyaman, Turkiye
2. Adıyaman University, Faculty of Dentistry, Department of Oral and Maxillofacial Radiology, Adıyaman, Turkey

.

***Corresponding author**: Tozar KN, Msc. PhD. Ass. Prof. Department of Pediatric Dentistry, Faculty of Dentistry, Adıyaman University, Adıyaman-Turkey.
E-mail: wapurlu@gmail.com
DOI : 10.61139/ijdor.1291639

Abstract

Background: This study aimed to evaluate the distances between the roots of maxillary incisors and the nasopalatine canal and the floor of the nasal cavity, and the buccal cortical bone thickness at the apices of the roots of these teeth by Cone Beam Computed Tomography (CBCT) in children in the permanent dentition period.
Materials and Methods: CBCT images of 49 patients aged 6-14 years were evaluated. In the sagittal plane, the distances of the apices of the maxillary central teeth with the nasopalatine canal and with the floor of the nasal cavity were evaluated. Buccal cortical bone thickness at the apex of the roots of maxillary anterior teeth was examined. These data were compared in terms of gender and whether the teeth had open or closed apices.
Results: When the mean distance of the maxillary central teeth (11,21) to the nasopalatine canal was evaluated in terms of the open/closed apex status of the teeth and gender, there was no significant relationship ($p>0.05$). Among the maxillary anterior teeth (11, 21,12, 22), the root apex of tooth 22 was the farthest from the floor of the nasal cavity and the root apex of tooth 12 was the closest. It was found that the mean buccal cortical bone thickness of maxillary anterior teeth 11 and 21 with open apex was significantly higher than those with closed apex ($p<0.05$).
Conclusions: The buccal cortical bone thickness of maxillary central teeth with closed apexes is higher than that of open apexes, which makes apical surgical applications in this region difficult.

Research Article (HRU Int J Dent Oral Res 2023; 3(2): 86-90

Keywords: Anterior maxilla, cone-beam computed tomography, nasopalatine canal, nasal floor.

Introduction

Although the anterior maxilla is considered a safe region for surgical procedures, the anatomical structures in its neighborhood may increase the risk of complications (1,2). The anterior maxilla is an area that requires careful evaluation due to the frequent occurrence of traumatic injuries such as intrusion or lateral luxation in this region, apical surgical applications, overflow filling due to faulty root canal treatment, orthodontic treatment applications, and implant placement (3).

Maxillary incisors are the teeth most frequently affected by dental trauma (4). While crown fracture is the most common traumatic dental injury in permanent dentition, intrusive luxation injury is frequently reported in deciduous dentition (5,6). In injuries such as intrusion or lateral luxation, the roots of the maxillary anterior teeth may be displaced towards the adjacent nasopalatine canal, nasal cavity, and buccal cortical bone and damage these anatomical structures (1,7).

After a dental trauma, apical periodontitis or root resorption occurs due to devitalization, which is frequently encountered in maxillary anterior teeth (8). Therefore, endodontic treatment or apical surgery may be required for traumatized teeth depending on the case (9). In unsuccessful endodontic treatments, gutta-percha or canal filling paste may overflow from the tooth apex and damage adjacent anatomical structures (10). The root lengths of the maxillary anterior teeth, the distance between the roots of these teeth and the nasopalatine canal and the base of the nasal cavity, and the thickness of the buccal cortical bone differ in each person.

It was hypothesized that maxillary lateral teeth would be closer to the nasal cavity due to their longer root length compared to central teeth.

The aim of this study was to evaluate the distances of the roots of the maxillary incisors to the nasopalatine canal and also to the floor of the nasal cavity, and the thickness of the buccal cortical bone at the apices of the roots of these teeth using Cone Beam Computed Tomography (CBCT) in children in the permanent dentition period.

Materials and Methods

Our study was approved by the Non-Interventional Ethics Committee of Adiyaman University Faculty of Medicine (Decision number: 2022/7-36, Date: 25/10/2022).

In this study, we evaluated the images of patients aged 6-14 years who were admitted to the pedodontics clinic at Adiyaman University Faculty of Dentistry between 2017 and 2021 and underwent CBCT (Planmeca Promax 3D Mid Proface, Finland) on the maxillary anterior region. CBCTs of patients with artifacts or poor image quality in the maxillary anterior region were excluded from the study. In addition, CBCTs of patients with congenital deformities or syndromes affecting the orofacial region and patients who underwent surgery in the maxillofacial region due to jaw fracture were excluded.

The sample size was calculated based on the effect size of 0.50 at a significance level of 0.80 using the G power program. With these data, it was found that it would be sufficient to include 48 patients in the study for 4 groups in total, 12 for each group. Therefore, 48 patients were included in the study.

FOV size of CBCTs: 400 micron meters, FOV diameter: 160 mm, height: 100 mm. On CBCT, the distance between the maxillary central teeth (11,21) and the nasopalatine canal in the axial plane was calculated as the shortest distance from the apex of the maxillary central tooth to the anterior wall of the nasopalatine canal (Figure 1).

The distance between the maxillary anterior teeth (11,12,21,22) and the floor of the nasal cavity was calculated by measuring the distance from the point where the line passing through the long axis of the maxillary anterior teeth in the sagittal plane in the CBCT intersects the apex of the tooth to the closest distance drawn to the lower wall of the nasal cavity floor (Figure 2).

Buccal cortical bone thickness was calculated by measuring the distance from the anterior border of the buccal cortical bone to the long axis of the teeth at the level of the apices of the maxillary anterior teeth (11,12,21,22) (Figure 3).

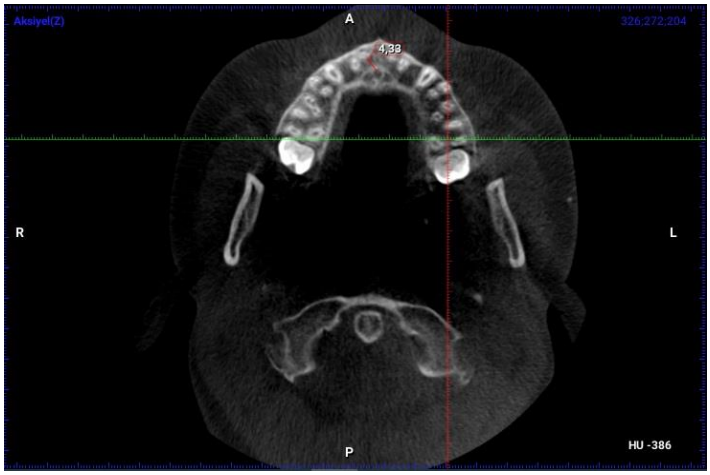

Figure 1: Measurement of the distance of the maxillary central teeth to the nasopalatine canal in the axial plane on CBCT.

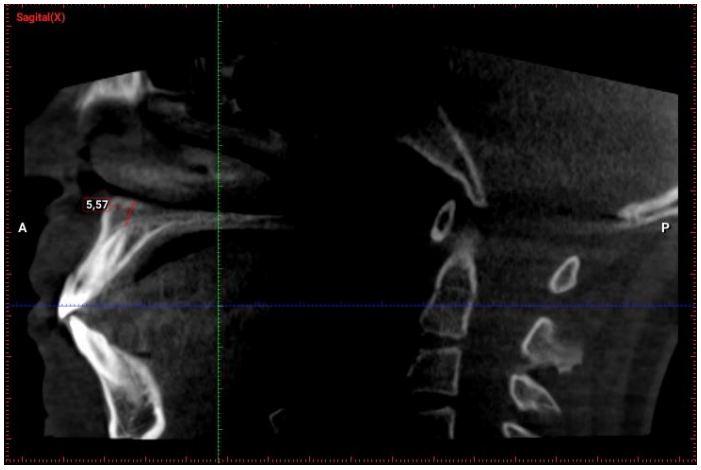

Figure 2: Measurement of the distance of the maxillary anterior teeth to the floor of the nasal cavity in the sagittal plane on CBCT.

The root apex openings of the maxillary anterior teeth were evaluated by CBCT and those with root apex openings of more than 1 mm were classified as open apex and those with root apex openings of less than 1 mm were classified as closed apex (Figure 4).

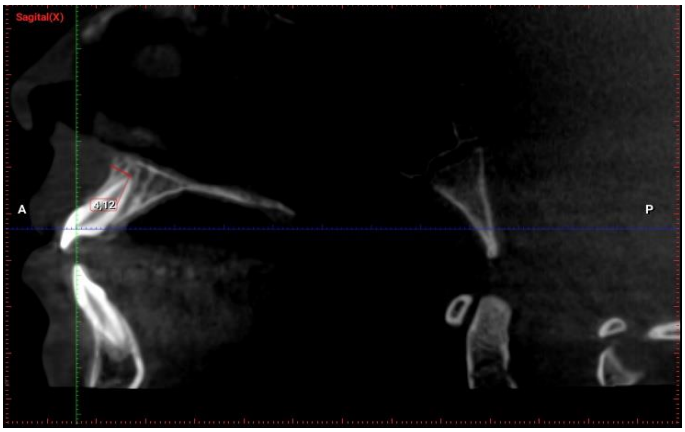

Figure 3: Measurement of the distance of the root apices of maxillary anterior teeth to the buccal cortical bone in the sagittal plane on CBCT.

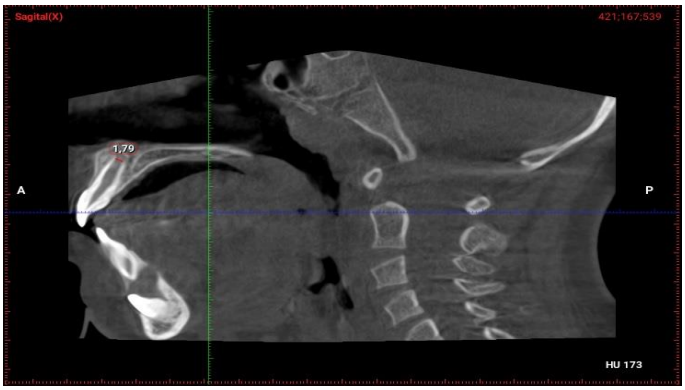

Figure 4: Evaluation of the apices of maxillary anterior teeth as open or closed in the sagittal plane on CBCT.

The mean distance between the maxillary anterior teeth and the floor of the nasal cavity and the distance between the maxillary central teeth and the nasopalatine canal were calculated and these values were compared in terms of gender and whether the teeth had open or closed apex.

Statistical Analysis

SPSS 22.0 computer program was used for data analysis. Number, mean, standard deviation, and percentage calculations were used for descriptive statistics. Student's t test, the Mann Whitney U test, one-way ANOVA, and the Kruskal Wallis test were used for comparisons within groups. Significance was evaluated as $p<0.05$.

Results

The study included 49 patients because the image quality in the maxillary anterior region was not acceptable in 16 of 65 patients who underwent CBCT. Of these 49 patients, 23 were male and 26 were female. The mean age of the patients included in the study was 12.1±1.8 years. In each of 49 patients, a total of 196 teeth, including 2 maxillary central and 2 maxillary lateral teeth, were examined. Among the maxillary anterior teeth in the examined CBCTs, 8 patients had 4 teeth with open apex and 41 patients had 4 teeth with closed apex.

The mean distances of the maxillary central teeth (11,21) to the nasopalatine canal in the examined CBCTs were calculated as 3.63 mm and 3.7 mm, respectively. There was no significant correlation in the mean distance of the maxillary central teeth (11,21) to the nasopalatine canal regarding the presence of open/closed apex and gender ($p>0.05$).

When the mean distances of the maxillary anterior teeth (11,21,12,22) to the nasal fossa were evaluated, it was observed that the distance of the base of the nasal cavity with tooth number 22 was the greatest and the distance with tooth number 12 was the least. The distances of the maxillary central teeth (11,21) to the floor of the nasal cavity were similar ($p=0.01$) (Table 1). There was no significant difference in the mean distance of the maxillary anterior teeth (11,21,12,22) to the floor of the nasal cavity when evaluated in terms of gender and open/closed apex status of the teeth ($p>0.05$).

Among the maxillary anterior teeth, the buccal cortical bone thickness was the highest in tooth number 12 and the lowest in tooth number 21 ($p=0.03$) (Table 2). When the mean buccal cortical bone thickness of maxillary anterior teeth was evaluated in terms of gender, no significant difference was found ($p>0.05$).

It was found that the mean buccal cortical bone thickness of maxillary anterior teeth 11 and 21 with open apex was significantly thicker than those with closed apex ($p<0.05$) (Table 3).

Table 1: Evaluation of the mean distance of maxillary anterior teeth from the floor of the nasal cavity

Tooth no	Average distance to the nasal cavity	p
11	5.53 mm	0.01*
21	5.62 mm	
12	4.19 mm	
22	7.52 mm	

** One-way ANOVA test, * significance at 0.05 level

Table 2: Evaluation of mean buccal cortical bone thickness of maxillary anterior teeth

Tooth no	Mean buccal bone thickness	p
11	3.83 mm	0.03*
21	3.55 mm	
12	4.19 mm	
22	3.99 mm	

*One-way ANOVA test. **Significance at 0.05 level

Table 3: Evaluation of the mean buccal cortical bone thickness of maxillary anterior teeth according to whether the teeth have an open or closed apex

Tooth no	Open apex	Closed apex	p
11	4.49 mm	3.7 mm	0.049*
21	4.21 mm	3.42 mm	0.035*
12	3.63 mm	4.31 mm	0.151
22	3.54 mm	4.07 mm	0.227

*One-way ANOVA test. **Significance at 0.05 level

Discussion

In maxillary anterior teeth, the relationship of these teeth with the nasopalatine canal and the floor of the nasal fossa and the thickness of the buccal cortical bone gain importance due to the frequent occurrence of traumatic dental injuries such as intrusion or lateral luxation, overflow filling during faulty root canal treatment, and apical surgery/implantation in this region (3).

The distance between the maxillary central tooth apices and the nasopalatine canal is needed due to complications such as paresthesia and bleeding occurring in this region (11). Gönül et al. calculated this distance as 2.56 ± 0.80 and found no significant difference between genders (11). In a study, it was reported that the distance between the apices of the maxillary central teeth and the nasopalatine canal varies between 4.01 and 5.00 mm and this distance increases with age (12). In the present study, the mean distance of the maxillary central teeth to the nasopalatine canal ranged between 3.63 and 3.7 mm, but no significant difference was found in terms of gender and open/closed apex.

Due to the flexibility of the alveolar bone, traumatic injuries such as intrusion and extrusion are common in the primary dentition, while the incidence of intrusion decreases during the permanent dentition (9). In the case presented by Thor, the maxillary deciduous central tooth was displaced towards the nasal cavity due to intrusion in a 3-year-old child. Martin stated in a case report that the maxillary permanent lateral tooth intruded into the nasal cavity as a result of trauma. In addition to these, many other studies have reported displacement of maxillary permanent incisors into the nasal cavity as a result of traumatic injury (13-16).

In their study, Ducommun et al. measured the shortest distance between the base of the nasal cavity and the apices of the maxillary central teeth and the lateral teeth as 8.54 mm and 9.49 mm, respectively (17).

In the present study, the shortest distance between the base of the nasal cavity and the apices of the maxillary central teeth was 5.53 mm, while the shortest distance to the lateral teeth was 4.19 mm. The difference in these values may be due to the variation in the selected population. In the present study, it was observed that the distance between the base of the nasal cavity and tooth number 22 was the greatest, while the distance between tooth number 12 was the least. In line with the present data, it should be taken into consideration that perforation in the nasal cavity may occur in cases of intrusion occurring in tooth number 12 due to its anatomical proximity.

Buccal cortical bone thickness is important for implant placement, periodontal surgery, and evaluation of bone perforation of the lesion in teeth with apical periodontitis (18). In addition, buccal cortical bone can be damaged in traumatic dental injuries such as lateral luxation (19). In a literature review, it was observed that a small number of maxillary anterior teeth had a buccal cortical bone thickness of more than 1 mm (20). In addition, the thickness of the buccal cortical bone increases from anterior to posterior in the dental arch and from coronal to apical along the root surface of the tooth (20). Koç et al. reported no significant relationship between buccal cortical bone thickness of maxillary anterior teeth and age and gender (21). In addition, in this study, the average buccal cortical bone thickness was the highest around the right canine with 1.91 mm and the lowest around the right lateral with 0.35 mm. Yıldız reported that the buccal cortical bone thickness between the maxillary lateral and canine teeth was greater than the bone thickness between the maxillary central and lateral teeth. In the present study, the average buccal cortical bone thickness of the maxillary anterior tooth number 12 was more than the other teeth, while the average buccal cortical bone thickness of the tooth number 21 was less than the other teeth.

It was reported that the buccal cortical bone thickness in the apical part of the maxillary anterior teeth was greater in males than in females (22).

In the present study, there was no significant difference when the buccal cortical bone thickness of maxillary anterior teeth was evaluated in terms of gender.

There exists no study in which the relationship of maxillary anterior teeth with the anatomical structures in this region was compared with the apex opening status and buccal cortical bone thickness of these teeth. In the present study, buccal cortical bone thickness was higher in maxillary central teeth with open apex than in teeth with closed apex. In line with these data, in cases requiring apical surgery in teeth with an open apex, the fact that the bone thickness is higher than in teeth with a closed apex should be taken into consideration during the operation.

This retrospective study has some limitations. The present study was conducted in a small population. Further studies in large populations are needed to obtain more precise data.

Conclusions

The buccal cortical bone thickness of maxillary central teeth with closed apexes is higher than that of open apexes, which makes apical surgical applications in this region difficult.

Acknowledgements
None
Conflicts of Interest statement
None

References

1. AlAli F, Atieh MA, Hannawi H, Jamal M, Harbi NA, Alsabeeha NHM, Shah M. Anterior Maxillary Labial Bone Thickness on Cone Beam Computed Tomography. Int Dent J. 2023;73(2):219-27.
2. Taschieri S, Weinstein T, Rosano G, Del Fabbro M. Morphological features of the maxillary incisors roots and relationship with neighbouring anatomical structures: possible implications in endodontic surgery. Int J Oral Maxillofac Surg. 2012;41(5):616-23.
3. Todi A, Singh MK, Kayal S, Das G, Chakraborty A. Assessment of insertion force for the placement of cortical implants in various anatomic sites in dried human skulls. J Indian Soc Periodontol. 2022;26(6):544-51.
4. Schatz JP, Ostini E, Hakeberg M, Kiliaridis S. Large overjet as a risk factor of traumatic dental injuries: a prospective longitudinal study. Prog Orthod. 2020;21(1):41.
5. Andersson L, Petti S, Day P, Kenny K, Glendor U, Andreasen JO. Classification, Epidemiology and Etiology. In: Andreasen JO, Andreasen FM, Andersson L, editors. Textbook and color atlas of traumatic injuries to the teeth. 5th ed. Hoboken: John Wiley & Sons Ltd; 2019;252–94.
6. Tewari N, Bansal K, Mathur VP. Dental Trauma in Children: A Quick Overview on Management. Indian J Pediatr. 2019 Nov;86(11):1043-1047.
7. Jain NV, Gharatkar AA, Parekh BA, Musani SI, Shah UD. Three-Dimensional Analysis of the Anatomical Characteristics and Dimensions of the Nasopalatine Canal Using Cone Beam Computed Tomography. J Maxillofac Oral Surg. 2017;16(2):197-204.
8. Hermann NV, Lauridsen E, Ahrensburg SS, Gerds TA, Andreasen JO. Periodontal healing complications following extrusive and lateral luxation in the permanent dentition: a longitudinal cohort study. Dent Traumatol. 2012;28(5):394-402.
9. Andersson L, Andreasen JO, Day P, Heithersay G, Trope M, Diangelis AJ, Kenny DJ, Sigurdsson A, Bourguignon C, Flores MT, Hicks ML, Lenzi AR, Malmgren B, Moule AJ, Tsukiboshi M, International Association of Dental Traumatology. International Association of Dental Traumatology guidelines for the management of traumatic dental injuries: 2. Avulsion of permanent teeth. Dent Traumatol. 2012;28(2):88-96.
10. Jonaityte EM, Bilvinaite G, Drukteinis S, Torres A. Accuracy of Dynamic Navigation for Non-Surgical Endodontic Treatment: A Systematic Review. J Clin Med. 2022;11(12):3441.
11. Gönül Y, Bucak A, Atalay Y, Beker-Acay M, Çalişkan A, Sakarya G, Soysal N, Cimbar M, Özbek M. MDCT evaluation of nasopalatine canal morphometry and variations: An analysis of 100 patients. Diagn Interv Imaging. 2016;97(11):1165-72.
12. Chatriyanuyoke P, Lu CI, Suzuki Y, Lozada JL, Rungcharassaeng K, Kan JY, Goodacre CJ. Nasopalatine canal position relative to the maxillary central incisors: a cone beam computed tomography assessment. J Oral Implantol. 2012;38(6):713-7.
13. Antunes AA, Santos TS, Carvalho de Melo AU, Ribiero CF, Goncalves SR, de Mello Rode S. Tooth embedded in lower lip following dentoalveolar trauma: case report and literature review. Gen Dent. 2012;60(6):544-7.
14. Costa VP, Barbosa MV, Goettems ML, Torriani MA, Castagno CD, Baldissera EF, Torriani DD. Primary incisor intruded through the nasal cavity: a case report. Gen Dent. 2016;64(3):64-7.
15. Yonezawa H, Yanamoto S, Hoshino T, Yamada S, Fujiwara T, Umeda M. Management of maxillary alveolar bone fracture and severely intruded maxillary central incisor: report of a case. Dent Traumatol. 2013;29(5):416-9.
16. Noleto JW, de Abreu NMR, Dos Santos Vicente KM, da Silva AVNA, Seixas DR, de Figueiredo LS. Intrusive luxation of permanent upper central incisor into the nasal cavity: A case report. Dent Traumatol. 2022;38(2):160-4.
17. Ducommun J, Bornstein MM, Wong MCM, von Arx T. Distances of root apices to adjacent anatomical structures in the anterior maxilla: an analysis using cone beam computed tomography. Clin Oral Investig. 2019;23(5):2253-63.
18. de Souza FN, de Siqueira Gomes C, Rodrigues AR, Tiossi R, de Gouvêa CV, de Almeida CC. Partially Edentulous Arches: A 5-Year Survey of Patients Treated at the Fluminense Federal University Removable Prosthodontics Clinics in Brazil. J Prosthodont. 2015;24(6):447-51.
19. Gurunathan D, Murugan M, Somasundaram S. Management and Sequelae of Intruded Anterior Primary Teeth: A Systematic Review. Int J Clin Pediatr Dent. 2016;9(3):240-50.
20. Tsigarida A, Toscano J, de Brito Bezerra B, Geminiani A, Barmak AB, Caton J, Papaspyridakos P, Chochlidakis K. Buccal bone thickness of maxillary anterior teeth: A systematic review and meta-analysis. J Clin Periodontol. 2020;47(11):1326-43.
21. Koç A, Kavut İ, Uğur M. Assessment of Buccal Bone Thickness in The Anterior Maxilla: A Cone Beam Computed Tomography Study. Cumhuriyet Dent J. 2019;22(1):102-7.
22. Yildiz, FN. Maksiller anterior bölgede bukkal kortikal kemik kalınlığının ve bukkal andırkatın alveoler kret boyutları ile ilişkisinin konik ışınlı bilgisayarlı tomografi ile değerlendirilmesi. Gazi Üniversitesi; 2018.