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Comparison of Maxillary Transverse Dimensions In Patients with Palatally Impacted Maxillary Canines: A Retrospective Cone Beam Computed Tomography Study

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Abstract

Aim: The aim of this retrospective study was to evaluate the maxillary transverse dimensions in individuals with palatal impacted maxillary canines relative to the control group without dental impactions using cone-beam computed tomography(CBCT).
Methods: Sixty CBCT images of the individuals were classified into two groups: 29 in the palatal impacted canine group and 31 in the control group. To determine the maxillary width at four levels, CBCT DICOM files were processed using the software OnDemand 3D to analyze maxillary transverse parameters. Basal width at molar (BWM), alveolar width at first molar (AWM), basal width at premolar (BWPM), and alveolar width at premolar (AWPM) were the four levels at which the maxillary transverse dimensions were measured. The independent T- test was utilized when comparing the impacted canine group and the control group. The level of statistical significance was set at a P-value less than 0.05 for all tests.
Results: Regarding the transverse maxillary measurement, there was no significant difference between the impacted canine group and the control group for the BWM, BWPM, and AWPM ($P \geq 0.05$). For the AWM, statistically significant differences were not found between the maxillary palatal impacted canine group and the control group ($P=0.05$).
Conclusion: No significant differences were observed between the impacted canine group and the control group in terms of maxillary transverse dimensions. Further research is needed to explore the relationship between maxillary canine impaction and maxillary transverse dimensions.

Keywords: Impacted Canine, Cone-Beam Computed Tomography, Maxilla, Transverse Dimension

Backgound

Maxillary-impacted canines are frequently observed in clinical findings in orthodontics. (1) It is the third most prevalent impacted tooth following mandibular and maxillary third molar with the prevalence ranging from 0.9% to 4.7%. (2–4) The etiology of palatally impacted canines is usually associated with two theories: growth direction(5) and the genetic theory. (6) The etiology of buccal-impacted canines seems to be related to the arch-length discrepancy. (7) Sequalae of canine impaction include infection, root resorption of impacted teeth or adjacent teeth, and formation of a dentigerous cyst. (8)

Previously, different studies have focused on the sagittal skeletal pattern of individuals with and without dental impaction and reported no significant difference between the two groups. (9–11) The transverse dimension of the maxilla is usually decreased in individuals with buccally impacted canines; however, the association between palatal maxillary impacted canines and transverse dimensions does not hold true in all cases. McConnell et al.(12) reported that palatal impacted maxillary canines are usually associated with decreased maxillary transverse dimensions. Langberg and Peck found statistically insignificant findings between transverse dimension and palatal maxillary impacted canines. (13) On the other hand, Al-Nimri and Gharaibeh found that palatal impacted maxillary canines were usually associated with increased skeletal transverse dimensions. (14) However, these studies did not match the groups to establish accurate comparisons.

Cone-beam tomography (CBCT) is recognized as the most reliable and comprehensive method for diagnosing impacted teeth. (15) It allows for three-dimensional analysis with high precision and low dosage, following the ALARA principle (as low as reasonably achievable) to reduce ionizing radiation exposure. (16,17) As far as we know, the association between impacted maxillary canine and skeletal transverse dimensions is still controversial and there have been conflicting findings in previous research due to a lack of a sufficient control group. (12–14) To address this knowledge gap, conducting a cone-beam tomographic study becomes crucial in determining whether palatally-impacted maxillary canines are indeed related to the skeletal transverse maxillary dimension. This will provide valuable insights into understanding the factors contributing to canine impaction and aid orthodontic treatment planning by allowing for more targeted interventions.

To our knowledge, no study on the Pakistani population has yet comprehensively evaluated the relation between skeletal maxillary transverse dimensions and palatally impacted maxillary canines using CBCT. Hence, this retrospective study aimed to evaluate the maxillary transverse parameters of individuals with palatally impacted canines relative to the control individuals without dental impactions using CBCT.

Methods

Ethical approval of this retrospective study was obtained from the Institutional Ethical Committee of Gandhara University [GU/2021/112], Peshawar. Sixty CBCT images of individuals were obtained from two departments of the Sardar Begum Dental Hospital and Gandhara University (i.e., Department of Orthodontics and Department of Oral and Maxillofacial Radiology). The software G*Power (version 3.1.9.7, Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) was used to calculate the sample size with an alpha level of 0.05 and a power of 80%. The effect size for the sample calculation was derived from the result of previous research (18). The study group for this research comprised 29 individuals who had at least one palatal impacted maxillary canine, while the control group consisted of 31 subjects without dental impaction, even though a minimum of 30 subjects per group was required. Individuals with unilateral or bilateral palatally impacted maxillary canines, who had not received any previous orthodontic treatment were included in this study while subjects with craniofacial malformation and anomalies, syndromes, tumors, history of trauma, or individuals with congenital absence of teeth were excluded from the study.

SOREDEXTM CRANEXTM D (Tuusula, Finland) was used to obtain the CBCT images. The CBCT settings included 10 mA of current and 90 Kv, an exposure time of 12.6 seconds, and a field of view measuring 61x78 mm. CBCT DICOM files were processed using the software OnDemand 3D to analyze maxillary transverse parameters. To ensure accurate orientation of the CBCT scans, the method proposed by Podesser et al.(19) at four levels as shown in (Fig. 1). This involved utilizing specific procedures within the software OnDemand 3D (Cybermed, Seoul, Republic of Korea) to correctly align and orientate each scan according to established guidelines.

For the analysis of the maxillary first premolar and first molar, measurements were taken on slices that displayed these teeth. Specifically, on the most anterior coronal slice, molar measurements were obtained by visualizing the buccal root furcation while ensuring that the palatal plane was horizontal in the CBCT scan (Fig. 2). To establish a reference plane for evaluating nasal floor dimensions, two points were identified at the lowest points of both right and left nasal floors. A line passing through these two landmarks served as a reference for measuring pre-molar and molar dimensions. Similar landmark placement and referencing techniques used for molar measurements were also applied to determine pre-molar dimensions on a coronal slice showing their respective root canal centers (Fig. 3). Definitions of the CBCT measurements are shown in Table 1.

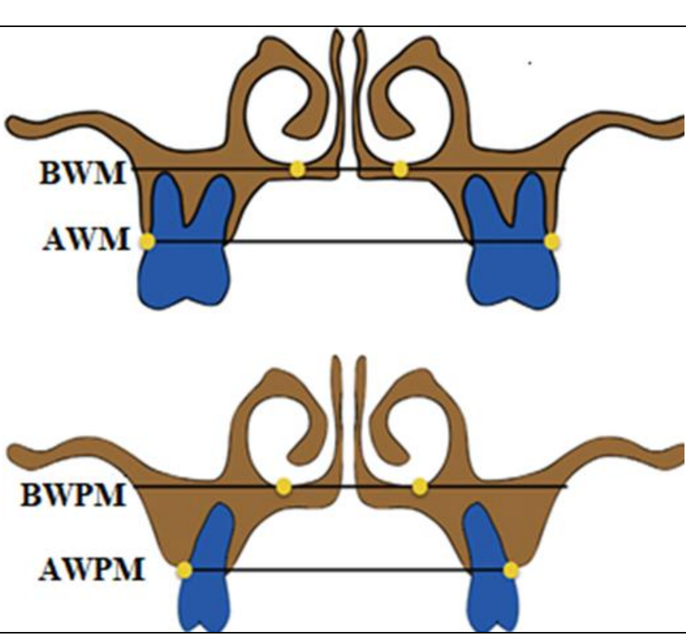

Figure 1. Maxillary transverse parameters measured at four levels

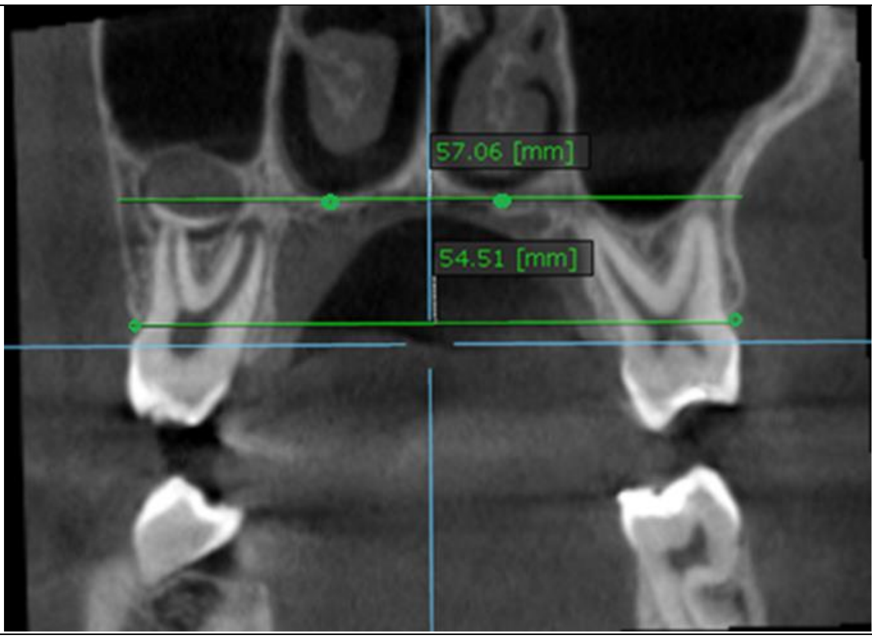

Figure 2. Maxillary transverse measurements at the level of the first molar

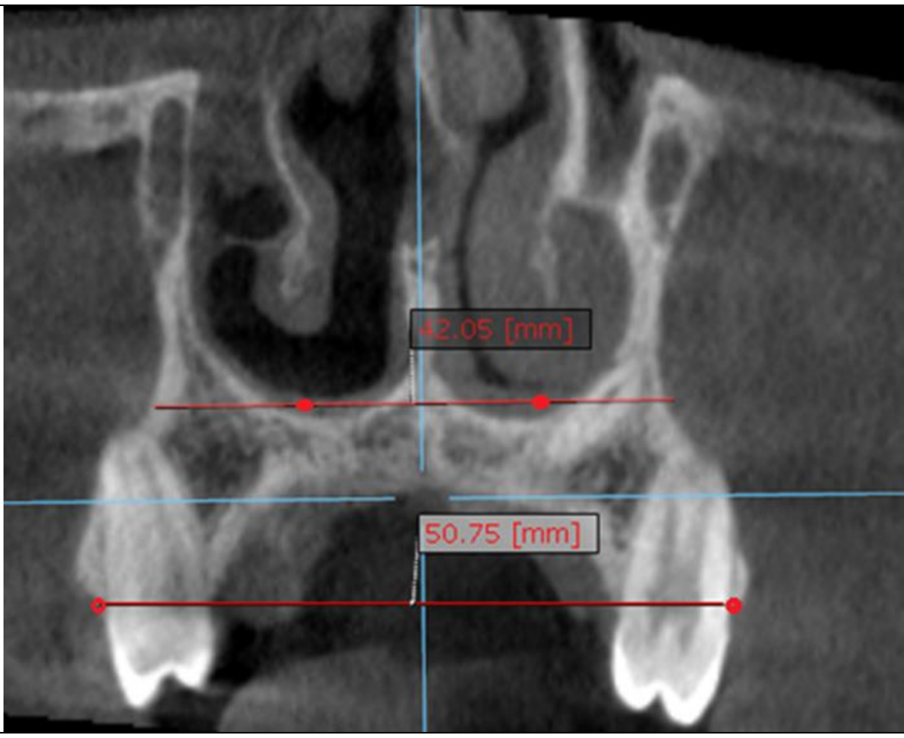

Figure 3. Maxillary transverse measurements at the level of the first premolar

Table 1. Definitions of the transverse measurements used in this study

Transversal Parameters	
BWM (Basal width at the level of the maxillary first molar)	On the coronal slice along the nasal reference plane at the level of the maxillary first molar, transverse maxillary basal width was obtained by measuring the distance in millimeters between the left and right lateral edges of the maxillary base.
AWM (Alveolar width at the level of the maxillary first molar)	Transverse maxillary alveolar width at the level of the maxillary first molar was obtained by measuring the distance in millimeters by taking the most occlusal points of the maxillary alveolar process, on the coronal slice ensuring the palatal plane is horizontal
BWPM (Basal width at the level of maxillary first premolar)	Transverse maxillary basal width at the level of the first pre-molar was obtained by measuring the distance in millimeters between the left and right lateral edges of maxillary base on the coronal slice along the nasal reference plane.
AWPM (Alveolar width at the level of maxillary first premolar)	Transverse maxillary alveolar width at the level of maxillary first premolar was obtained by measuring the distance in millimeters by taking the most occlusal points of the maxillary alveolar process on the coronal slice ensuring the palatal plane is horizontal

Statistical Analysis

SPSS software (version 24, IBM, Armonk, NY) was used for statistical analysis. The Shapiro-Wilks test was used to assess the normality of the data. The independent t-test was utilized when comparing the impacted canine group and the control group. The level of statistical significance was set at a P-value less than 0.05 for all tests.

Results

The CBCT scans of 60 subjects were assessed for transverse maxillary dimension. The mean ages of the palatal impacted canine group and control group (without impacted canine) were 17.4 ± 3.9 and 21±8 years, respectively. A Shapiro-Wilk test was performed to evaluate the normal distribution of the data . The sex distribution and intergroup age comparability of the selected sample are shown in Table 2. A comparison of mean basal and alveolar bone widths in the molar and premolar region are shown in Table 3.

Regarding the maxillary transverse measurement, there were no significant differences found between the impacted canine group and the control group for the BWM, BWPM, and AWPM measurements. However, for the AWM measurements, statistically significant differences were observed between the impacted maxillary palatal canine group and the control group (without impacted canine).

The mean values for basal width at the maxillary first molar were found to be smaller in the palatally impacted maxillary canine group compared to the control group. The difference between the basal width of the two groups at the maxillary first molar level was approximately 1±3 mm. The palatally impacted maxillary canine group had an average maxillary first molar basal width of 61.07±3 mm, while it was around 62.0±4 mm in the control group. However, this difference was statistically insignificant (P=0.362). When measuring the alveolar width at the maxillary first molar, there were statistically significant differences of 1.7 mm between the control group (56.2 mm) and the palatally impacted maxillary canine group (54.5 mm) and P=0.05. The measurements for the first-premolar basal width (BWPM) and first-premolar alveolar width (AWPM) were smaller in the palatally impacted maxillary canine group than the control group but there was a statistically insignificant difference between the two groups respectively as shown in Table 3.

Table 2. Sex distribution and intergroup age comparability

	Gender distribution			**Age**
Group	**Male**	**Female**	**Total**	**Mean (SD)**
Cases	14	15	29	17.4 ± 3.9 yrs.
Control	19	12	31	21 ± 8 yrs.

Table 3. Intergroup comparisons of the maxillary transverse width measurements in millimeters

Transverse parameters	**Cases (Palatal impacted canine group) n=29**		**Control (Without impacted canine group) n=31**		**P-value**
	Mean	SD	Mean	SD	
BWM	61.07	3.17	62.00	4.45	0.362
AWM	54.56	2.7	56.22	3.6	0.05
BWPM	37.42	3.01	38.2	2.8	0.261
AWPM	42.66 mm	3.2	44.0	3.3	0.133

BWM=basal width molar; ***AWM=alveolar width at first molar; ****BWPM=basal width at premolar; and *** AWPM=alveolar width at premolar

Test of significance: Independent t-test

Discussion

Impacted maxillary canine is a common dental problem that dental professionals frequently encounter in their practice. It has been reported to have a prevalence ranging from 0.9% to 4.7%. (2-4) For effective treatment planning and intervention, timely diagnosis of impacted maxillary canines is crucial. Early diagnosis allows for timely identification of an impacted maxillary canine during childhood or adolescence when preventive and interceptive treatments such as maxillary expansion and early removal of deciduous first molars and canines are most effective. Failure to address impacted maxillary canines in a timely manner may lead to various complications including cyst formation, root resorption, and development of malocclusion. (8)

This study aimed to utilize CBCT as a method to measure the transverse dimension of a palatal impacted maxillary canine and compare it to control subjects without impacted teeth using CBCT. The mean age of the individuals with impacted maxillary palatal canine was 17.4 years. It is important to note that growth of transverse dimensions of the dental arch are typically established about the age of 12, and thus, the age difference between the two groups did not affect our results.

Regarding the transverse parameters of the individuals in the impacted palatal canine group at the level of first molar (BWM) and premolar (BWPM and AWPM) were smaller compared to the individuals without dental impaction. However, our findings were not statistically significant but similar results were found in an older study done by McConnell et al.(12) They evaluated 57 study models with impacted canines and found that maxillary transverse parameters were significantly smaller in the palatally displaced canine group than in the control group. However, it is worth noting that Al-Nimri and Gharaibeh reported a wider maxillary arch on the impacted side. (14) The cause of this disagreement could be attributed to differences in the evaluation method for the transverse measurements, sex dimorphism, and ethnic differences. In our sample, the majority of the population was of Asian origin and exhibited smaller maxillary deficiency. This contradiction could be supported by the study of Peck et al., as they reported a higher frequency of maxillary underdevelopment in Asians as compared to Europeans and North Africans.

Our results also showed a statistically significant decrease in molar alveolar width in the study group. These results were in concordance with Arriola-Guillen et al.(20) and Cacciatore. (21) In both studies they examined CBCT images of individuals with an impacted canine; and, they concluded that transverse parameters of the maxillary arch were less than the control group. Another study by Ariza et al.(18) showed similar results, and it has been found that individuals with impacted maxillary canines tend to have smaller dimensions at the level of the first molar and premolar when compared with subjects without impaction. Stanaityte et al.(22) reported that maxillary canine impaction is not related to palatal width. However, these findings contradict the results of our present study. The reason for the conflict could be the method of transverse measurement as they evaluated the patient's dental cast.

Diagnosing the transverse deficiency of the individual with impacted canine would guide the orthodontist to perform the interceptive procedures (i.e., maxillary expansion). This is especially important because transverse maxillary deficiency is defined at an early age between 8 and 10 years and the maxillary canines usually erupt at mean ages of 10.5 years in girls and 11.5 years in boys with individual variation. (13) Maxillary expansion could be performed to correct the transverse deficiency and decrease the chance of canine impaction when necessary. (18)

Results of this study showed no statistically significant results between the palatal impacted maxillary canine and skeletal transverse dimension using CBCT. However, the findings were not statistically significant although skeletal transverse dimensions were smaller in the impacted canine group as compared to the controls, which are consistent with the previous reported studies. (21,22) According to our findings, the null hypothesis was accepted, since there is a statistically insignificant difference in the maxillary transverse dimension between the two groups.

We must conduct further longitudinal studies to determine whether the reduced maxillary transverse parameter is the potential cause of canine impaction. The etiology of palatal-canine impaction is generally based on two theories: the genetic theory and the growth direction theory. This study expands the understanding of the impact of the maxillary basal width constriction on dental health.

The major limitation of this study was the sample size as there was no sub-stratification between unilateral and bilateral impacted canines, due to the scarcity of bilateral impacted canines in our records. To address this issue, a large sample size with sub-stratification is recommended with more focus on the unilateral and bilateral impacted canine as well as emphasis on comparisons between males and females. It is important to highlight that despite the sub-stratification of the sample, our study still provides meaningful insights into the relationship between palatal-impacted canines and various factors.

Conclusion

According to our findings, the control group without the impacted canine group had wider maxillary transverse parameters when compared to the palatal impacted canine. It is important to note that there was no statistically significant difference between the control group and the palatally impacted maxillary canine group. This suggests that there may be a slight tendency towards wider transverse parameters in individuals without impacted canines, and this difference cannot be considered as a definitive factor contributing to canine impaction. Further studies are required to elucidate the potential causes of palatal canine impaction.

References

1. Ericson S, Kurol J. Radiographic examination of ectopically erupting maxillary canines. Am J Orthod

Dentofacial Orthop. 1987;91(6):483–92. doi: 10.1016/0889-5406(87)90005-9. PMID: 3473928
2. Mossey PA, Campbell HM, Luffingham JK. The palatal canine and the adjacent lateral incisor: a study of a west of Scotland population. Br J Orthod. 1994;21(2):169–74. doi: 10.1179/bjo.21.2.169. PMID: 8043565
3. Sajnani AK, King NM. Prevalence and characteristics of impacted maxillary canines in Southern Chinese children and adolescents. J Investig Clin Dent. 2014;5(1):38–44. doi: 10.1111/jicd.12027. PMID: 23355390
4. Fardi A, Kondylidou-Sidira A, Bachour Z, Parisis N, Tsirlis A. Incidence of impacted and supernumerary teeth-a radiographic study in a North Greek population. Med Oral Patol Oral Cir Bucal. 2011;16(1):56-61. doi: 10.4317/medoral.16.e56. PMID: 20711166
5. Becker A. In defense of the guidance theory of palatal canine displacement. Angle Orthod. 1995;65(2):95–8. doi: 10.1043/0003-3219(1995)065<0095:PCDGTO>2.0.CO;2. PMID: 7785811
6. Neela PK, Atteeri A, Mamillapalli PK, Sesham VM, Keesara S, Chandra J, et al. Genetics of Dentofacial and Orthodontic Abnormalities. Glob Med Genet. 2020;7(4):95–100. doi: 10.1055/s-0040-1722303. PMID: 33693441
7. Rimes RJ, Mitchell CN, Willmot DR. Maxillary incisor root resorption in relation to the ectopic canine: a review of 26 patients. Eur J Orthod. 1997;19(1):79–84. doi: 10.1093/ejo/19.1.79. PMID: 9071048
8. Manne R, Gandikota C, Juvvadi SR, Rama HRM, Anche S. Impacted canines: Etiology, diagnosis, and orthodontic management. J Pharm Bioallied Sci. 2012;4(2):34–8. doi: 10.4103/0975-7406.100216. PMID: 23066259
9. Sacerdoti R, Baccetti T. Dentoskeletal features associated with unilateral or bilateral palatal displacement of maxillary canines. Angle Orthod. 2004;74(6):725–32. doi: 10.1043/0003-3219(2004)074<0725:DFAWUO>2.0.CO;2. PMID: 15673132
10. Yan B, Sun Z, Fields H, Wang L, Luo L. Etiologic factors for buccal and palatal maxillary canine impaction: a perspective based on cone-beam computed tomography analyses. Am J Orthod Dentofacial Orthop. 2013;143(4):527–34. doi: 10.1016/j.ajodo.2012.11.021. PMID: 23561415
11. Mercuri E, Cassetta M, Cavallini C, Vicari D, Leonardi R, Barbato E. Skeletal features in patient affected by maxillary canine impaction. Med Oral Patol Oral Cir Bucal. 2013;18(4):e597–602. doi: 10.4317/medoral.18746. PMID: 23722128
12. McConnell TL, Hoffman DL, Forbes DP, Janzen EK, Weintraub NH. Maxillary canine impaction in patients with transverse maxillary deficiency. ASDC J Dent Child. 1996;63(3):190–5. PMID: 8853823
13. Langberg BJ, Peck S. Adequacy of maxillary dental arch width in patients with palatally displaced canines. Am J Orthod Dentofacial Orthop. 2000;118(2):220–3. doi: 10.1067/mod.2000.104819. PMID: 10935964
14. Al-Nimri K, Gharaibeh T. Space conditions and dental and occlusal features in patients with palatally impacted maxillary canines: an aetiological study. Eur J Orthod. 2005;27(5):461–5. doi: 10.1093/ejo/cji022. PMID: 15961570
15. Kapila SD, Nervina JM. CBCT in orthodontics: assessment of treatment outcomes and indications for its use. Dentomaxillofac Radiol. 2015;44(1):14-20. doi: 10.1259/dmfr.20140282. PMID: 25358833
16. American Dental Association Council on Scientific Affairs. The use of cone-beam computed tomography in dentistry: an advisory statement from the American Dental Association Council on Scientific Affairs. J Am Dent Assoc. 2012 ;143(8):899–902. doi: 10.14219/jada.archive.2012.0295. PMID: 22855905
17. American Academy of Oral and Maxillofacial Radiology. Clinical recommendations regarding use of cone beam computed tomography in orthodontics. [corrected]. Position statement by the American Academy of Oral and Maxillofacial Radiology. Oral Surg Oral Med Oral Pathol Oral Radiol. 2013;116(2):238–57. doi: 10.1016/j.oooo.2013.06.002. PMID: 23849378
18. Arboleda-Ariza N, Schilling J, Arriola-Guillén LE, Ruíz-Mora GA, Rodríguez-Cárdenas YA, Aliaga-Del Castillo A. Maxillary transverse dimensions in subjects with and without impacted canines: A comparative cone-beam computed tomography study. Am J Orthod Dentofacial Orthop. 2018 ;154(4):495–503. doi: 10.1016/j.ajodo.2017.12.017. PMID: 30268260
19. Podesser B, Williams S, Bantleon HP, Imhof H. Quantitation of transverse maxillary dimensions using computed tomography: a methodological and reproducibility study. Eur J Orthod. 2004;26(2):209–15. doi: 10.1093/ejo/26.2.209. PMID: 15130045
20. D´ Oleo-Aracena MF, Arriola-Guillén LE, Rodríguez-Cárdenas YA, Ruíz-Mora GA. Skeletal and dentoalveolar bilateral dimensions in unilateral palatally impacted canine using cone beam computed tomography. Prog Orthod. 2017;18(1):7. doi: 10.1186/s40510-017-0160-6. PMID: 28164257
21. Cacciatore G, Poletti L, Sforza C. Early diagnosed impacted maxillary canines and the morphology of the maxilla: a three-dimensional study. Prog Orthod. 2018;19(1):20. doi: 10.1186/s40510-018-0220-6. PMID: 30009340
22. Stanaitytė R, Smailienė D. Tooth Size Discrepancies and Dental Arch Width In Patients With Palatally And Labially Impacted Maxillary Canines. Sveikatos mokslai. 2014 22;24(2):69–74. doi:10.5200/sm-hs.2014.027