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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: This retrospective study aimed to evaluate the maxillary transverse dimensions in individuals with palatally impacted maxillary canines relative to the control individuals without dental impactions using cone-beam computed tomography (CBCT).
Methods: The sample consisted of 60 CBCT images of individuals from two departments of Sardar Begum Dental College and Hospital, Gandhara University (i.e., Department of Orthodontics and Department of Oral and Maxillofacial Radiology). 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 OnDemand 3D software to analyze maxillary transverse parameters. Basal width at molar (BWM), alveolar width at first premolar (AWM), basal width at premolar (BWPM), and alveolar width at premolar (AWPM) were the four levels at which the maxillary transverse dimensions were measured.
Results: Regarding the transverse maxillary measurement, there was no significant difference between the impacted canine and control groups in BWM, BWPM, and AWPM ($p \geq 0.05$). For the AWM, statistically significant differences were found between the maxillary palatally impacted canine and the control groups ($P=0.05$).
Conclusion: No significant differences were observed between the impacted canine and control groups in maxillary transverse dimensions. However, a significant difference favoring the smaller dimension of the impacted canine group was observed in the alveolar width at the first premolar. Further research is needed to explore the relationship between maxillary canine impaction and maxillary transverse dimensions.

Keywords: Cone-Beam Computed Tomography, Impacted Canine, Maxilla.

Background

Impacted maxillary canines are frequent clinical findings in orthodontics (1). It is the third most prevalent impacted tooth after mandibular and maxillary third molars, 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 genetic theory (6). The etiology of buccally impacted canines seems to be related to the arch length discrepancy (7). Sequalae of canine impaction include infection, root resorption of impacted 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, reporting no significant difference between the two groups (9–11). The transverse dimension of the maxilla usually decreases in individuals with buccally impacted

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canines; however, the association between palatally impacted maxillary canines and transverse dimensions does not hold in all cases. McConnell et al. (12) reported that palatally impacted maxillary canines are usually associated with decreased maxillary transverse dimensions. Langberg and Peck found no statistically significant correlation between the transverse dimension and palatally impacted maxillary canines (13). On the other hand, Al-Nimri and Gharaibeh found that palatally 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 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). To our knowledge, the association between impacted maxillary canine and skeletal transverse dimensions is still controversial, with conflicting findings in previous research due to a lack of a proper control group (12–14). To address this knowledge gap, conducting a CBCT study becomes crucial in determining whether palatally impacted maxillary canines are related to the skeletal transverse maxillary dimension. This will provide valuable insights into 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 comprehensively evaluated the relation between skeletal maxillary transverse dimensions and palatally impacted maxillary canines using CBCT. Hence, this retrospective CBCT study aimed to evaluate the maxillary transverse parameters of individuals with palatally impacted canines relative to the control individuals without dental impactions.

Methods

Ethical approval of this retrospective study was obtained from the Institutional Ethics Committee of Gandhara University [GU/2021/112], Peshawar, Pakistan. 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 previous research (18). The study group for this research comprised 29 individuals with 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 undergone any previous orthodontic treatment were included in this study. In contrast, 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 61 × 78 mm.

CBCT DICOM files were processed using the OnDemand 3D software to analyze maxillary transverse parameters. To ensure the accurate orientation of CBCT scans, the method proposed by Podesser et al. (19) at four levels, as shown in (Fig. 1), was used. This involved specific procedures within the OnDemand 3D software (Cybermed, Seoul, Republic of Korea) to correctly align and orientate each scan according to established guidelines.

Measurements were taken on slices that displayed these teeth to analyze the maxillary first premolar and first molar. 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 the right and left nasal floors. A line passing through these two landmarks served as a reference for measuring premolar and molar dimensions. Similar landmark placement and referencing techniques used for molar measurements were also applied to determine premolar dimensions on a coronal slice showing their respective root canal centers (Fig. 3). Table 1 presents the definitions of the CBCT measurements.

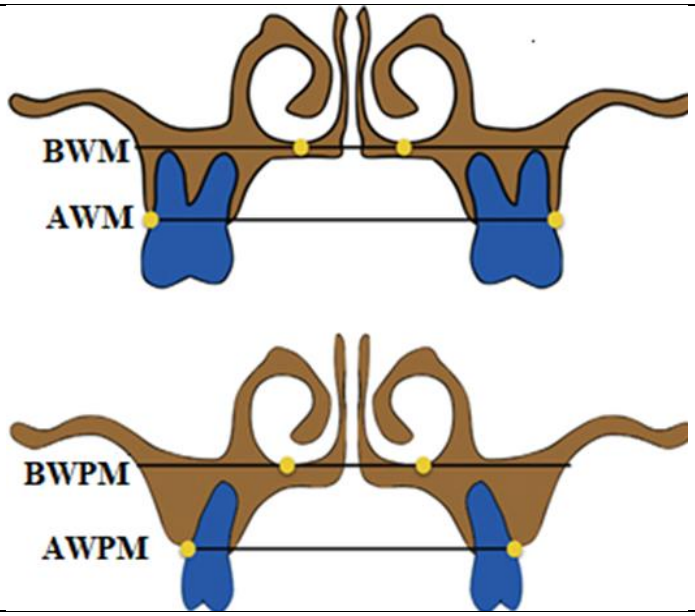


Figure 1. Maxillary transverse parameters measured at four levels.

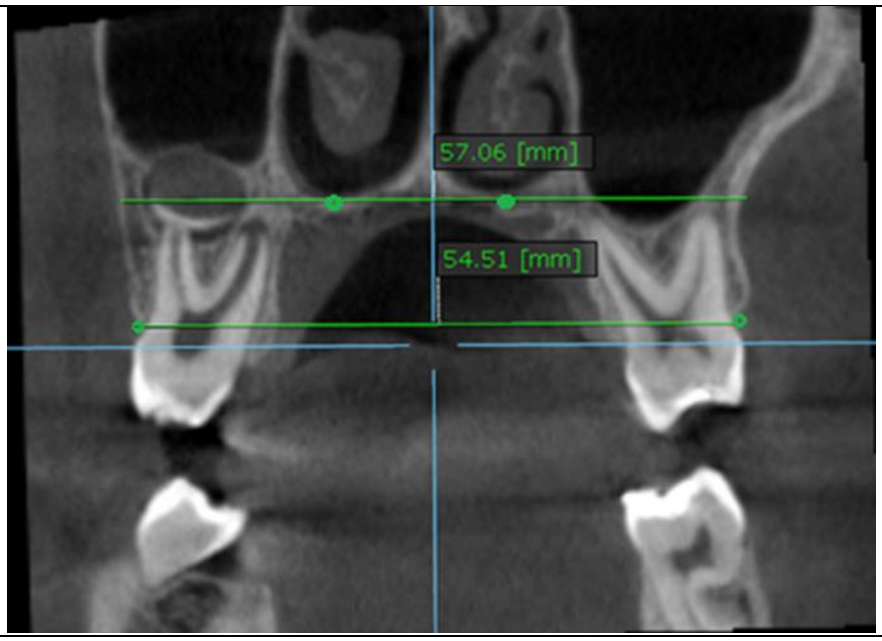


Figure 2. Maxillary transverse measurements at the level of the first molar.

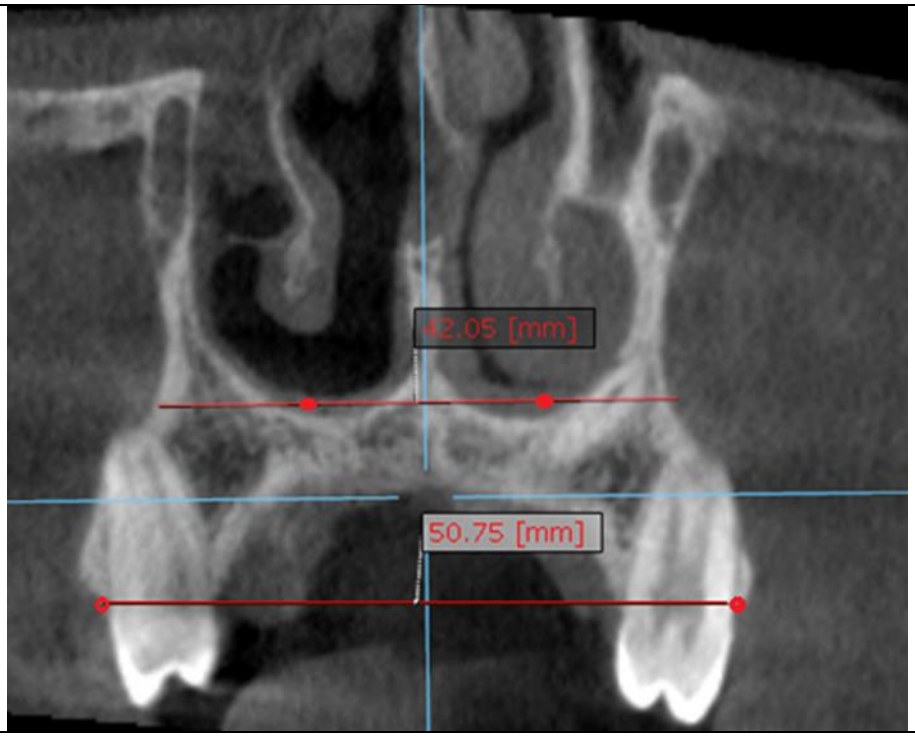


Figure 3. Maxillary transverse measurements at the level of the first premolar.

Table 1. Definitions of maxillary transverse measurements

Transversal Parameter	
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 mm) 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 mm) 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 premolar was obtained by measuring the distance (in mm) between the left and right lateral edges of the 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 mm) 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-Wilk test was used to assess the normality of the data. The independent t-test was used to compare the impacted canine and control groups. The level of statistical significance was set at $P<0.05$ for all tests.

Results

The CBCT scans of 60 subjects were assessed for transverse maxillary dimension. The mean ages of the palatally impacted canine and control groups (without impacted canine) were 17.4±3.9 and 21±8 years, respectively. Shapiro-Wilk test was used to evaluate the normal distribution of the data ($p\geq0.05$). Table 2 shows the comparison of the sex distribution and ages of the selected sample. Table 3 presents a comparison of mean basal and alveolar bone widths in the molar and premolar regions.

Regarding the maxillary transverse measurement, no significant differences were noted between the impacted canine and control groups in BWM, BWPM, and AWPM measurements. However, for the AWM measurements, statistically significant differences were observed between the palatally impacted maxillary canine and control groups (without impacted canine).

The mean values for basal width at the maxillary first molar were 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 not statistically significant (P=0.362). When measuring the alveolar width at the maxillary first molar, a statistically significant difference of 1.7 mm was noted between the control (56.2 mm) and the palatally impacted maxillary canine (54.5 mm) groups (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, with a statistically insignificant difference between the two groups, as shown in Table 3.

Discussion

Impacted maxillary canine is a common dental problem that dental professionals frequently encounter, with a prevalence ranging from 0.9% to 4.7% (2–4). For effective treatment planning and intervention, the 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 measures such as maxillary expansion and early removal of deciduous first molars and canines are most effective. Failure to address impacted maxillary canines in time may lead to various complications, including cyst formation, root resorption, and development of malocclusion (8).

This study used CBCT to measure the transverse dimension of palatally impacted maxillary canines compared to control subjects without impacted teeth. The mean age of the individuals with palatally impacted maxillary canines was 17.4 years. It is important to note that growth and transverse dimensions of the dental arch are typically established before the age of 13; thus, the age difference between the two groups did not affect our results.

Table 2. Demographic characteristics

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

Table 3. Maxillary transverse dimensions (mm)

Transverse parameters	Case Palatally impacted canine (n=29)		Control Without impacted canine (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	3.2	44.0	3.3	0.133

**BWM=basal width at fisrt molar; ***AWM=alveolar width at first molar; ****BWPM=basal width at fisrt premolar;
***** AWPM=alveolar width at first premolar
Independent t-test; *p<0.05

The transverse parameters of the individuals in the impacted palatal canine group at the level of the first molar (BWM) and premolar (BWPM and AWPM) were smaller compared to the individuals without dental impaction. However, our findings were not statistically significant. However, similar results were found in a previous study 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). 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 a study by Langberg and Peck(13) reported a higher frequency of maxillary underdevelopment in Asians compared to Europeans and North Africans.

Our results showed a statistically significant decrease in molar alveolar width in the study group. These results coincide with Oleo-Aracena et al. (20) and Cacciatore et al (21). Both studies examined CBCT images of individuals with an impacted canine, concluding that transverse parameters of the maxillary arch were less than those of the control group. Another study by Arboleda-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 compared to subjects without impaction. Stanaitytė and Smailienė (22) reported that maxillary canine impaction is not related to the palatal width. However, these findings contradict the results of the present study. The discrepancy could be the method used for transverse measurement as they evaluated the patient's dental cast.

Diagnosing the transverse deficiency of the individual with impacted canine would guide the orthodontist in performing 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 variations (13). The maxillary expansion could be performed to correct the transverse deficiency and decrease the chance of canine impaction when necessary (18).

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

Further longitudinal studies are necessary to determine whether the reduced maxillary transverse parameter is the potential cause of canine impaction. The etiology of the 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, focusing more on the unilateral and bilateral impacted canine and 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 palatally impacted canines and various factors.

Conclusion

This study evaluated the relationship between the palatally impacted canines and maxillary transverse parameters. According to our findings, the control group without the impacted canine group had wider maxillary transverse parameters than the group with palatally impacted canine. It is important to note that there was no statistically significant difference between the control and the palatally impacted maxillary canine groups, suggesting that there might 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.

Conflicts of interest: None to declare.

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.
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.

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.
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):e56-61. doi: 10.4317/medoral.16.e56.
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.
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.
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.
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.
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.
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.
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.
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: 8853829.
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.
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.
15. Kapila SD, Nervina JM. CBCT in orthodontics: assessment of treatment outcomes and indications for its use. Dentomaxillofac Radiol. 2015;44(1):20140282. doi: 10.1259/dmfr.20140282.
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.
17. American Academy of Oral and Maxillofacial Radiology. Clinical recommendations regarding use of cone beam computed tomography in orthodontics. 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.
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.
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.
20. 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.
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.
22. Stanaitytė R, Smailienė D. Tooth size discrepancies and dental arch width in patients with palatally and labially impacted maxillary canines. Sveikatos Mokslai. 2014;24(2):69-74. doi: 10.5200/sm-hs.2014.027.