Investigation of the Relationship between Maxillary Dimensions and Labial and Palatal Maxillary Impacted Canines Using Cone Beam Computed Tomography

Ahmet Karaman
Istanbul Aydın University
Esra Genc (dtegencc@gmail.com)
Private Practise

Research Article

Keywords: Canine Impaction, Maxillary transverse width, CBCT, Skeletal dimensions

Posted Date: April 18th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-1525574/v1

Abstract

Objectives: To compare the maxillary dimensions of individuals with labial and palatal bilateral maxillary canine impaction and a control group of individuals with no impaction using CBCT.

Materials and Methods: 45 patients were included in the study with age range of 13 to 18 and consisted of 22 females and 23 males. The sample included three groups of 15 patients as the control, labial and palatal group. The measurements made on the axial and coronal planes were made on the levels of the 1st premolar and the 1st molar. Also nasal cavity and anteroposterior depth were measured.

Results: The maxillary anteroposterior depth, basal first molar width, alveolar first molar and premolar width and first molar palatal vault depth of the control group were significantly higher than labial and palatal groups ($p<0.05$).The basal first premolar width of the control group was significantly higher than palatal group ($p<0.05$). The first premolar palatal vault depth and nasal cavity width of the palatal group were significantly lower than other groups ($p<0.05$).

Conclusions: The basal and alveolar widths associated with the molars and the palatal depths were lower in the impacted group than control group. The anatomical structures in the female patients were affected by the position of impaction to a higher extent in comparison to the anatomical structures in the male patients.

Clinical Relevance: In the case of impaction of maxillary canines, the dimensions of the arch will be smaller and the maxillary base of the dental arches will be less developed.

Introduction

The ectopic eruption and impaction of the maxillary canines are frequently encountered anomalies [1]. The prevalence of maxillary canine impaction was reported to be between 1% and 5% [2]. Unilateral impacted canines are much more prevalent than bilateral impacted canines [3]. McConnell et al. and Sambataro et al. stated that 8% of impacted canine teeth are bilaterally impacted. Kuftinec et al. found that unilateral impactions were more prevalent than bilateral ones at a ratio of 5:1 [1].

Previous studies have reported a 3–6 times higher prevalence of impaction on the palatal side than the buccal side. Likewise, other studies revealed that in East Asians, maxillary canine impaction is 2–3 times more prevalent on the buccal side than the palatal side. Moreover, maxillary canine impaction is seen 2–3 times more frequently in females than males [2].

With the development of three-dimensional imaging techniques, CBCT has started to be utilized in the diagnoses and treatment planning of impacted teeth. CBCT also has several advantages, it is reliable, reduces distortion, has a low cost, and requires lower doses of radiation than BT [3].

Previous studies have reported that maxillary impacted canines are associated with maxillary transverse deficiency, and the maxilla develops asymmetrically in the case of unilateral impacted canines [4]. Only a few studies reported that there is no difference in maxillary transverse dimensions in individuals with impacted canines, and there can even be an increase. In addition to this, in cases of palatal impaction, the maxillary arch is longer, and the palatal structure is deeper in comparison to buccal impaction [5, 6].

The purpose of this study is to compare the maxillary transverse dimensions of individuals with labial and palatal bilateral maxillary canine impaction and a control group of individuals with no impaction using CBCT.

Material And Method

This retrospective study was approved by the Ethics Committee of Istanbul Aydın University (No.2022/14). The data were collected from patients who presented to the orthodontics department of the faculty of dentistry at XXX University and a private clinic.

On a significance level of 0.05 and with a power of 95%, a sample size of 15 patients per group was calculated using the G*Power 3.1 software. In this study, the sample included 45 patients, with 15 patients in each group.

Inclusion criteria: patients with age range of 13–18 years, absence of impacted teeth other than maxillary canines or third molars, patients with complete permanent dentition except deciduous maxillary canines.

Exclusion criteria: Patients with canines distally impacted towards the first premolar, odontomas/supernumerary tooth, craniofacial anomalies, multiple impacted or congenitally missing tooth.

The 45 patients consisted of 22 females and 23 males were included in the study. The mean age of the sample was 15.82 ± 1.62 years. The sample included 3 groups of 15 patients as the "no impaction group (control group)", "the group with labial bilateral impaction (labial group)", and "the group with palatal bilateral impaction (palatal group)" (Fig. 1)(Table 1).

Table 1
The evaluation of gender distribution by groups.

	Female	**Male**	
Groups	**n (%)**	**n (%)**	p
Control	8 (%36.4)	7 (%30.4)	0.915
Labial	7 (%31.8)	8 (%34.8)	
Palatinal	7 (%31.8)	8 (%34.8)	
Ki-kare test			

The CBCT images were taken with the patients standing upright, and when their Frankfurt horizontal plane was parallel to horizon plane (field of view 0.250 voxels, 90 kV and 5.0 mA for 30.8 s and 140×100 cm FOV). All DICOM images were analyzed using the Morita One Volume Viewer Manager software (Dental Imaging Company Ltd., Kyoto, Japan).

All measurements were made by the same researcher (A.K.). The measurements made on the axial and coronal planes were made on the levels of the 1st premolar and the 1st molar. Also nasal cavity and anteroposterior depth were measured. The measurements of the maxillary transverse dimensions were made on 4 levels: BMW(6), AMW (6), BPMW(4), and APMW(4). In the CBCT scans, while the 1st molar measurements were made on the anterior most coronal section showing buccal root furcation with the palatal plane in a horizontal position, the 1st premolar measurements were made on the coronal section showing the center of the root canal (Fig. 2–6).

From samples, 20 CBCT radiographs were randomly selected, and these were reexamined four weeks later. The intra-class correlation coefficients for the measurements were > 0.990.

Statistical Analyses

The IBM SPSS Statistics 22 program was used to analyze the data obtained in the study. The normality of the distributions of the parameters was checked using Kolmogorov-Smirnov and Shapiro-Wilk tests, and the parameters were found to be normally distributed. In the analyses, descriptive statistics were utilized, in addition to one-way analysis of variance(ANOVA) for the comparisons of the quantitative data between the tooth position groups, Tukey’s HSD test for identifying the source of the difference in the case that the variances were homogeneous, and Tamhane’s T2 test in the absence of variance homogeneity. Student’s t-test was used to compare the parameters between the male and female patients. The level of statistical significance was accepted as $p < 0.05$.

Results

The mean AMW(6) and BPMW(4) values of the male patients were significantly higher than the female patients ($p < 0.05$)(Table 2).

Table 2
The mean values and standard deviation of measurements according to genders.

	Female	Male	
	Mean ± SD	**Mean ± SD**	**p**
Maxillary AnteroPosterior depth	26.69 ± 2.27	27.59 ± 2.69	0.235
Width of the nasal cavity	24.23 ± 1.52	24.59 ± 1.62	0.442
Width of the nostrils	23.17 ± 1.61	23.57 ± 1.22	0.361
Basal First Molar Width(6)	63.41 ± 3.57	64.65 ± 3.35	0.235
Alveolar First Molar Width (6)	54.32 ± 3.83	56.7 ± 3.62	0.038*
Basal First Premolar Width (4)	35.73 ± 2.99	38.52 ± 2.45	0.001*
Alveolar First Premolar Width(4)	45.14 ± 3.41	46 ± 3.45	0.403
Palatal vault depth(6)	22.27 ± 1.86	22.43 ± 1.73	0.763
Palatal vault depth(4)	11.8 ± 1.4	12.24 ± 1.41	0.293
Student t test			

In the intergroup comparisons, the mean MAPD, BMW(6), AMW(6), APMW(4) and PVD(6) values of control group were found significantly higher than labial and palatal groups ($p < 0.05$). The mean BPMW(4) value of control group was significantly higher than palatal group ($p < 0.05$). The mean PVD(4) and NCW values of the palatal group were significantly lower than control and labial groups ($p < 0.05$) (Table 3).

Table 3
The mean values and standard deviation of measurements and comparison between groups.

	Control (C)	Labial (L)	Palatinal (P)		Post Hoc		
	Mean ± SD	Mean ± SD	Mean ± SD	p	C-L	C-P	L-P
Maxillary AnteroPosterior depth	28.81 ± 2.67	26.73 ± 2.27	25.90 ± 1.64	0.003*	0.038*	0.003*	0.572
Width of the nasal cavity	25.35 ± 0.91	24.72 ± 1.54	23.17 ± 1.36	0.000*	0.390	0.000*	0.006*
Width of the nostrils	23.85 ± 1.14	23.47 ± 1.5	22.81 ± 1.49	0.129	0.736	0.113	0.402
Basal First Molar Width(6)	66.73 ± 3.84	63.6 ± 2.03	61.8 ± 2.4	0.000*	0.032*	0.001*	0.101
Alveolar First Molar Width(6)	59.2 ± 2.62	54.47 ± 3.31	52.93 ± 2.55	0.000*	0.000*	0.000*	0.314
Basal First Premolar Width(4)	38.8 ± 3	37.33 ± 2.44	35.33 ± 2.77	0.005*	0.319	0.004*	0.126
Alveolar First Premolar Width(4)	48.53 ± 3.46	44.67 ± 1.99	43.53 ± 2.47	0.000*	0.001*	0.000*	0.492
Palatal vault depth(6)	23.47 ± 1.92	22 ± 1.41	21.6 ± 1.45	0.007*	0.044*	0.008*	0.777
Palatal vault depth(4)	12.9 ± 1.3	12.17 ± 1.24	11 ± 1	0.000*	0.223	0.000*	0.026*

*Oneway ANOVA test *p < 0.05*

*Pos Hoc: Tukey HSD test^{+} Tamhane's T2 Test *p < 0.05*

In the female patients, the mean AMW(6) and APMW(4) values of control group were significantly higher than labial and palatal groups ($p < 0.05$). The mean NCW, BMW(6) and BPMW(4) values of palatal group were significantly lower than control group ($p < 0.05$). While the mean PVD(6) value of control group was significantly higher than labial group ($p < 0.05$), the mean PVD(4) value of palatal group was significantly lower than control and labial groups ($p < 0.05$)(Table 4).

Table 4
The evaluation of measurements according to the position of impacted maxillary canine in females and comparison between groups.

	Control (C)	Labial (L)	Palatinal (P)		Post Hoc		
Female	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**p**	**C-L**	**C-P**	**L-P**
Maxillary AnteroPosterior depth	28.00 ± 2.39	26.46 ± 1.95	25.42 ± 1.83	0.080	0.349	0.069	0.631
Width of the nasal cavity	25.15 ± 0.75	24.13 ± 2.07	23.27 ± 0.97	0.048*	0.585	0.000*	0.724
Width of the nostrils	23.69 ± 1.13	23.31 ± 1.87	22.44 ± 1.76	0.332	0.895	0.312	0.575
Basal First Molar Width(6)	66.13 ± 3.94	63.14 ± 2.12	60.57 ± 1.62	0.005*	0.130	0.003*	0.230
Alveolar First Molar Width(6)	58.25 ± 3.01	52.86 ± 2.27	51.29 ± 1.38	0.000*	0.005*	0.000*	0.383
Basal First Premolar Width(4)	37.63 ± 3.25	36.14 ± 1.95	33.14 ± 1.57	0.007*	0.478	0.005*	0.078
Alveolar First Premolar Width (4)	47.88 ± 3.91	43.57 ± 1.72	43.57 ± 2.07	0.010*	0.021*	0.021*	1.000
Palatal vault depth(6)	23.63 ± 1.77	21.14 ± 1.35	21.86 ± 1.57	0.019*	0.018*	0.105	0.681
Palatal vault depth(4)	12.74 ± 1.25	12.01 ± 1.25	10.50 ± 0.50	0.002*	0.405	0.002*	0.041*
*Oneway ANOVA test *p < 0.05*							
*Pos Hoc: Tukey HSD test^{+} Tamhane's T2 Test *p < 0.05*							

In the male patients, the mean AMW(6) and APMW(4) values of the control group were significantly higher than labial and palatal groups ($p < 0.05$). The mean BMW(6) and MAPD values of control group were significantly higher than palatal group ($p < 0.05$). The mean NCW value of palatal group was significantly lower than control and labial groups ($p < 0.05$)(Table 5).

Table 5
The evaluation of measurements according to the position of impacted maxillary canine in males and comparison between groups.

	Control (C)	Labial (L)	Palatinal (P)		Post Hoc		
Male	**Mean ± SD**	**Mean ± SD**	**Mean ± SD**	**p**	**C-L**	**C-P**	**L-P**
Maxillary AnteroPosterior depth	29.73 ± 2.84	26.97 ± 2.64	26.33 ± 1.44	0.028*	0.086	0.029*	0.849
Width of the nasal cavity	25.57 ± 1.07	25.24 ± 0.64	23.09 ± 1.69	0.001*	0.858	0.002*	0.006*
Width of the nostrils	24.03 ± 1.21	23.60 ± 1.22	23.13 ± 1.23	0.376	0.779	0.345	0.721
Basal First Molar Width(6)	67.43 ± 3.91	64.00 ± 2.00	62.88 ± 2.53	0.017*	0.078	0.016*	0.717
Alveolar First Molar Width(6)	60.29 ± 1.70	55.88 ± 3.56	54.38 ± 2.50	0.001*	0.015*	0.001*	0.528
Basal First Premolar Width(4)	40.14 ± 2.19	38.38 ± 2.45	37.25 ± 2.05	0.065	0.300	0.053	0.582
Alveolar First Premolar Width (4)	49.29 ± 2.98	45.63 ± 1.77	43.50 ± 2.93	0.001*	0.034*	0.001*	0.255
Palatal vault depth(6)	23.29 ± 2.21	22.75 ± 1.04	21.38 ± 1.41	0.077	0.795	0.076	0.221
Palatal vault depth(4)	13.09 ± 1.42	12.31 ± 1.31	11.44 ± 1.15	0.069	0.491	0.057	0.382
*Oneway ANOVA test *p < 0.05*							
*Pos Hoc: Tukey HSD test *p < 0.05*							

Discussion

Maxillary impacted canines (MIC), which have a significant place in orthodontics and can be easily noticed clinically, have frequently been a topic of research in the literature along with the dentoalveolar and maxillofacial structures that are related to [7]. There are studies stating that there is a relationship between transverse width and impaction, as well as others reporting no such relationship [5, 8].

In our study, patients with palatal impacted canines had lower nasal cavity widths. Also, there was no significant difference between the nostril widths of the groups. Kim et al. [5] reported similar nasal cavity and nostril widths to those in groups with labial and palatal impaction, and they found no significant difference between their groups. In another study [9] as opposed to our result, there was no significant difference between nasal cavity widths of the individuals with palatal MIC and those with erupted canines. Some studies reported a close relationship between nasal cavity width and maxillary alveolar width [10]. Likewise, in a study using a unilateral MIC split-mouth design [11] the nasal cavity was wider on erupted side than the impacted side, but the difference was not statistically significant. Considering that the canine tooth germ development location, a narrow nasal cavity may lead to canine teeth developing in a more mesial position, or maybe palatal position affects the width of the nasal cavity.

In the control group in our study, molar palatal depth was significantly higher than impacted groups and the premolar palatal depth was significantly lower in palatal group than other groups. In another CBCT study [12], there were significant differences in these measurements between erupted and impacted groups, and these values were found to be distributed as control > unilateral > bilateral in descending order. In addition to this, other studies have reported that the palatal depth of individuals with impacted canines, whether buccal or palatal, is similar to that in individuals with erupted teeth [13, 14]. Kim et al. [5] determined significantly lower molar palatal depth values in their palatal impaction group, where the palate was narrower and deeper. Differently from the germ of other teeth, the maxillary canine germ develops on a much higher level [15].

In our study, the individuals in the control group who had erupted canines had higher MAPD, BMW(6), AMW(6), APMW(4) values than the individuals with labially and palatally impacted canines. As an important finding, all measurements associated with the molars showed significant differences between the control group and the groups with impaction. Verma and Dinesh [16] determined 1st molar basal alveolar and arch widths of adults with bilateral or unilateral MIC to be significantly higher than erupted group. While the 1st premolar basal alveolar width was significantly higher in control group, bilateral group had the lowest mean values in terms of 1st premolar arch width and 1st molar basal alveolar width values. While another study included CBCT images of young adults [12] did not show a significant difference among the control, unilateral and bilateral impaction groups in terms of their 1st premolar, 2nd premolar and 1st molar arch widths, the unilateral group had the lowest values in all these measurements. In a similar study [7], BMW, MAW and PMAW values were significantly higher in control group than in other groups like in our study, but there was no significant difference between the groups in terms of their PMBW values. In the groups for which they compared different combinations of unilateral/bilateral and palatal/buccal impactions, they found no significant difference in terms of molar or premolar basal or alveolar widths. According to Schindel et al. [1] while maxillary transverse deficiency is associated with unilateral impaction in patients in mixed dentition period, it is not associated with bilateral impaction.

As there are various etiological reasons related to impaction, the position of the impacted tooth is the most important variable that needs to be considered. In a study conducted with CBCT images of individuals over the age of 12 [13], BMW, AMW and APMW values were found significantly lower in both buccal and palatal impaction groups than erupted group, whereas impaction groups did not significantly differ. Similarly, some studies have reported no significant relationship between palatal impaction and premolar or molar dental or alveolar width values in CBCT examinations [17–19]. Buccal impaction, on the other hand, is frequently associated with a narrow maxilla [18]. According to Richardson [20], palatal impaction is a consequence of the failure of maxillary canine that is continuing to erupt to move from the palatal side to the buccal side. However, it was also reported that approximately 80% of individuals with palatally impacted teeth have a sufficient arch perimeter [11].

There are studies with similar methodologies to the one in our study, but these studies have used dental casts. One of these studies revealed higher levels of maxillary transverse discrepancies in individuals with MIC in a sample of patients at the ages of 10 to 25. In addition to this, interpremolar and intermolar dental arch widths of the labial MIC group were significantly lower than those in palatal MIC and erupted control groups [21]. Ghaffar et al. [22] could not find a statistically significant relationship between maxillary transverse dimensions and potential impaction in individuals in the mixed dentition period. Langberg and Peck [23] could not identify a difference in dental arch widths between palatal impaction and erupted canine groups. As a result, they emphasized that genetic factors may be more effective on palatal impaction than maxillary transverse deficiency.

In our study, all measurements were higher in male patients in comparison to the females, and this difference was significant only in molar alveolar widths and premolar basal maxillary widths. According to the assessments of the positions of impaction, the anatomical structures of female patients were affected by the position of impaction to a higher extent in comparison to the males. In both sexes, while there was no significant difference between three groups in terms of their nostril widths, the molar and premolar alveolar widths were higher in the control group, and the molar basal width in the palatal group was significantly lower than that in the control group. A difference was observed in the premolar palatal depths among the female patients between the labial and palatal groups, while the male patients in these two groups had different nasal cavity widths. For both sexes, regardless of the position of the impacted teeth, the only parameter differing from the control group was the alveolar width.

Refaat and El-Desouky [24] reported that female patients with palatal MIC had a deeper palatal structure than those with buccal MIC. According to the researchers, the strength of the relationship between impacted canine position and palatal depth was much higher in the female patients than the male patients. Moreover, they reported that in the male patients, the intermolar width and arch length values were higher than those in the female patients in the palatal impaction and erupted groups, and the palatal depth, maxillary width and nasal cavity width values were higher than those in the female patients in the buccal impaction group. Verma and Dinesh [16] reported that female molar and premolar basal alveolar widths were lower than male ones, and this may be an etiological factor of impaction. Ruiz-Mora et al. [25] examined post-traction buccal and palatal impacted canines and revealed that the degree of changes in the palatal, buccal and distal maxillary alveolar bone measurements was higher in female patients in comparison to male patients. In another study conducted for investigating CBCT images in adult MIC cases [7], sex was identified as the only variable that affected all transverse measurements, and the transverse measurement values of female patients were lower than those of male patients. Many studies carried out about dental casts [22, 26] have shown higher measurements in male patients than female patients in MIC cases, especially for measurements made in the anterior region. It may be considered that this situation indicates a higher basal alveolar width value in males, and therefore, a lower probability of impaction [25]. In their split-mouth study involving CBCT analyses, Tadinada et al. [27] did not find a difference between sexes in terms of the arch perimeter, buccopalatal width or alveolar height measurements in unilateral palatal impaction cases.

Conclusions

- The basal and alveolar widths associated with the molars and the palatal depths were lower in the impacted group than the control group. All parameters except nostril width had significantly lower values in the palatal impaction group than the control group.
- The parameters that showed differences between the labial and palatal impaction groups were nasal cavity width and premolar palatal depth.
- The anatomical structures in the female patients were affected by the position of impaction to a higher extent in comparison to the anatomical structures in the male patients.
- The differences between the labial and palatal impaction groups were in premolar palatal depth in the female patients and nasal cavity width in the male patients.

Declarations

Author Contributions

A.K.: conceived the ideas and methodology, led the writing and editing and final approval of manuscript.

E.G.: led the writing and editing and final approval of manuscript.

Funding

This study was self-funded by the authors.

Ethics Approval and Consent to Participate

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent

was obtained from all participants included in the study.

Conflict of Interests

The authors declare no competing interests.

References

1. Schindel RH, Duffy SL (2007) Maxillary transverse discrepancies and potentially impacted maxillary canines in mixed-dentition patients. Angle Orthod. 77:430–5.
2. Kim Y, Hyun HK, Jang KT (2017) Morphological relationship analysis of impacted maxillary canines and the adjacent teeth on 3-dimensional reconstructed CT images. Angle Orthod. 87:590–597.
3. Dağsuyu İM, Okşayan R, Kahraman F et al. (2017) The Relationship between Dental Follicle Width and Maxillary Impacted Canines' Descriptive and Resorptive Features Using Cone-Beam Computed Tomography. Biomed Res Int. 2017:2938691.
4. Arriola-Guillén LE, Rodríguez-Cárdenas YA, Aliaga-Del Castillo A et al. (2020) Inter-premolar width changes related to the orthodontic traction of maxillary impacted canines in adolescents and young adults: A retrospective CBCT study. International orthodontics. 18:480–489.
5. Kim Y, Hyun HK, Jang KT (2012) Interrelationship between the position of impacted maxillary canines and the morphology of the maxilla.Am J Orthod Dentofac Orthop. 141:556–62.
6. Okasha O, Abdallah E, Yousry T (2019) Morphological features of dentition associated with unilateral palatally impacted canine using cone beam computed tomograpahy: an etiological study. Egyptian Orthodontic Journal. 55:53–65.
7. Arboleda-Ariza N, Schilling J, Arriola-Guillén LE et al. (2018) Maxillary transverse dimensions in subjects with and without impacted canines: A comparative cone-beam computed tomography study. Am J Orthod Dentofacial Orthop.154:495–503.
8. Al-Nimri K, Gharaibeh T (2005) Space conditions and dental and occlusal features in patients with palatally impacted maxillary canines: an aetiological study.Eur J Orthod. 27:461–465.
9. Saiar M, Rebellato J, Sheats RD (2006) Palatal displacement of canines and maxillary skeletal width. Am J Orthod Dentofacial Orthop. 129:511–519.
10. Basciftci FA, Mutlu N, Kahraman AI et al. (2002) Does the timing and method of rapid maxillary expansion have an effect on the changes in nasal dimensions? Angle Orthod. 72:118–123.
11. D Oleo-Aracena MF, Arriola-Guillén LE, Rodríguez-Cárdenas YA et al. (2017) Skeletal and dentoalveolar bilateral dimensions in unilateral palatally impacted canine using cone beam computed tomography. Prog Orthod. 18:1–7.
12. Mohammed OF, Mahmood AD (2018) Investigating the correlation between palatal depth and width measurements in impacted maxillary canine patients by using cone beam computed tomography. JODR. 5:32–39.
13. Elmarhoumy S (2021) Cone-Beam Computed Tomography Evaluation of the Relationship between Maxillary Transverse Dimensions and Impacted Maxillary Canines. Egyptian Dental Journal. 67:1767–1775.
14. Cacciatore G, Poletti L, Sforza C (2018) Early diagnosed impacted maxillary canines and the morphology of the maxilla: a three-dimensional study. Prog Orthod. 19:1–20.

15. Peck S, Peck L, Kataja M (1994) The palatally displaced canine as a dental anomaly of genetic origin. Angle Orthod. 64:249–256.
16. Verma P, Saravana Dinesh SP (2021) Maxillary transverse dimensions in subjects with and without impacted canines in South Indian population: a comparative cone-beam computed tomography study. Orthodontic Waves. 80:9–16.
17. Hong W, Radfar R, Chung C (2015) Relationship between the maxillary transverse dimension and palatally displaced canines: a cone beam computed tomographic study. Angle Orthod. 85: 440–5.
18. Yan B, Sun Z, Fields H et al. (2013) Etiologic factors for buccal and palatal maxillary canine impaction: a perspective based on cone-beam computed tomography analyses. Am J Orthod Dentofacial Orthop. 143:527–534.
19. Gull M, Mushtaq M, Maqbool S (2018) Palatal displacement of maxillary canines and maxillary transverse dimensions.Annals of International Medical and Dental Research. 4:9–13.
20. Richardson G, Russell KA (2000) A review of impacted permanent maxillary cuspids–diagnosis and prevention. J Can Dent Assoc. 66:497–501.
21. Vitria EE, Tofani I, Bachtiar EW et al. (2016) Association of maxillary transverse discrepancies and impacted maxillary canines in patients 10–25 years old. Journal of International Dental and Medical Research. 9:322–328.
22. Ghaffar F, Sukhia RH, Fida M (2019) Association between maxillary transverse discrepancy and occurrence of potentially impacted maxillary canines in mixed dentition patients. Int Orthod. 17:554–561.
23. Langberg BJ, Peck S (2000) Adequacy of maxillary dental arch width in patients with palatally displaced canines. Am J Orthod. 118:220–223.
24. Refaat W, El-Desouky G (2017) Cone beam computed tomography assessment of the relation between sex and morphology of maxilla in patients with impacted maxillary canine. Egyptian Dental J. 63:157–67.
25. Ruíz-Mora GA, Arriola-Guillén LE, Rodríguez-Cárdenas YA et al. (2021) Changes in alveolar bone morphology after traction of buccally vs palatally unilateral maxillary impacted canines: A cone-beam computed tomography study.Am J Orthod Dentofacial Orthop. 159:258–270.
26. Venkat Rao G, Kiran G (2016) Sex Determination by means of Inter-Canine and Inter-Molar Width-A Study in Telangana population. Asian Pacific Journal of Health Sciences. 3:171–175.
27. Tadinada A, Mahdian M, Vishwanath M et al. (2015) Evaluation of alveolar bone dimensions in unilateral palatally impacted canine: a cone-beam computed tomographic analyses. Eur J Orthod. 37:596–602.

Figures

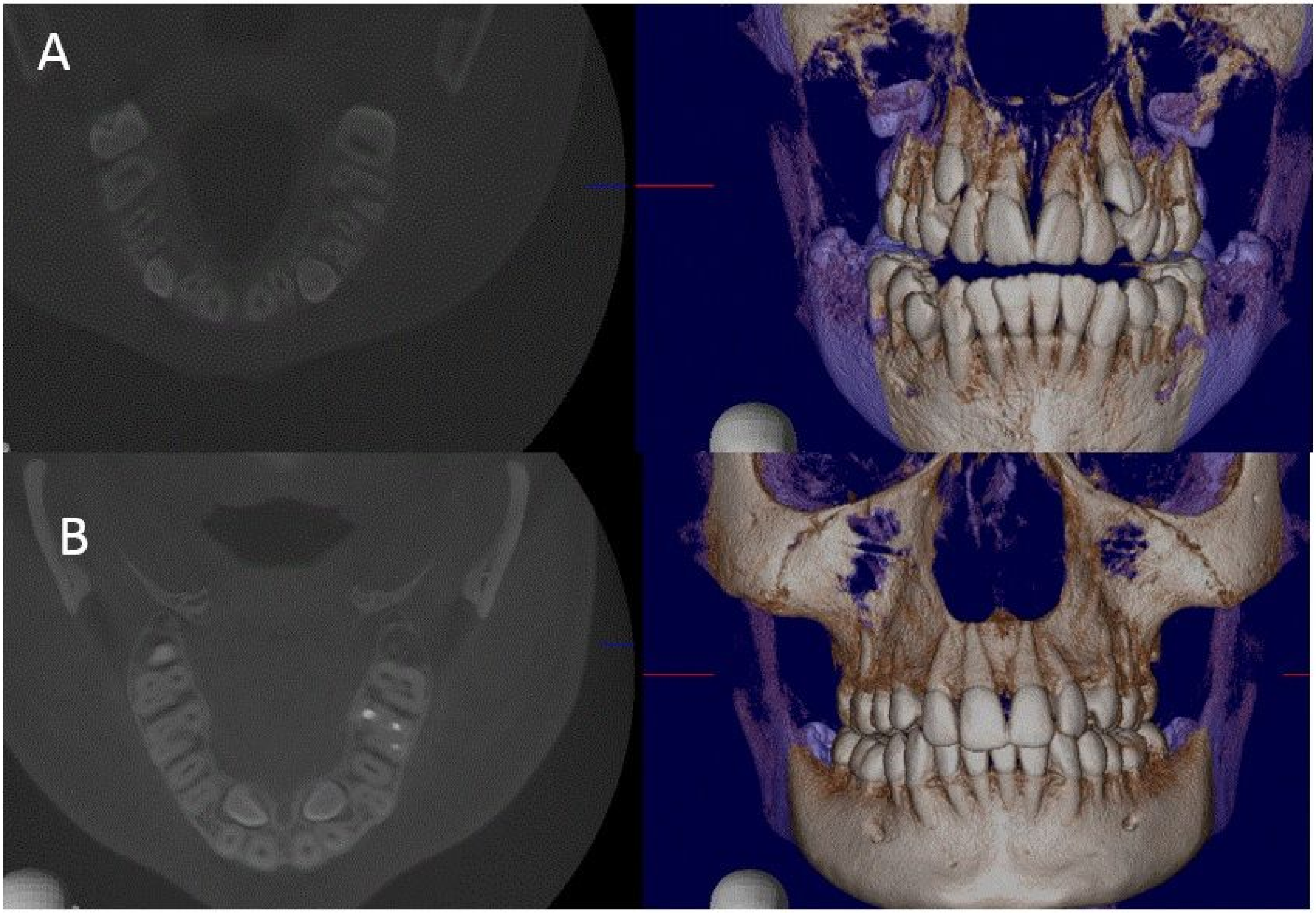

Figure 1

The CBCT images of maxillary bilateral labial and palatal canine impactions.

A) Labial impaction, B) Palatal impaction

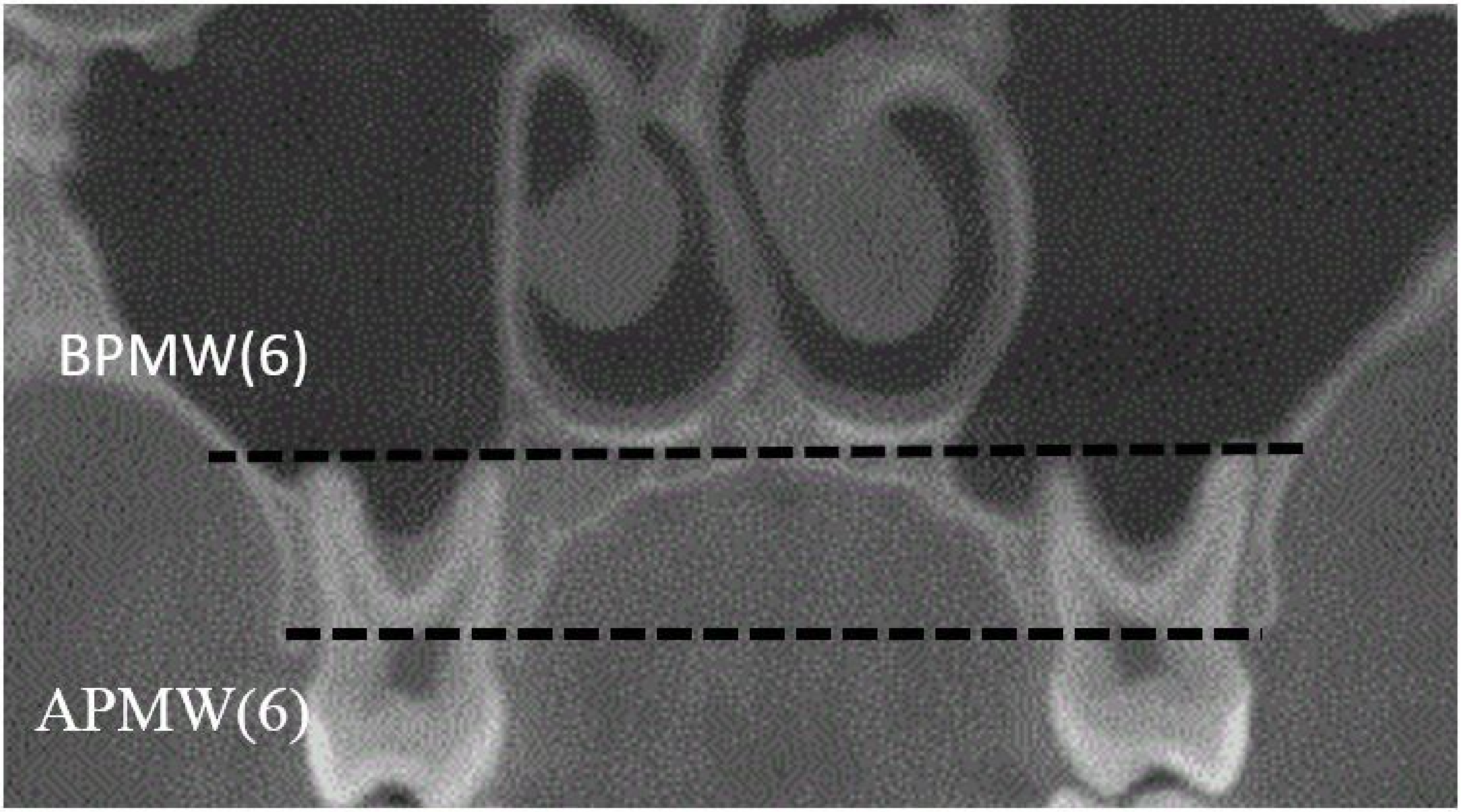

Figure 2

The alveolar and basal width measurements on the level of maxillary first molar tooth.

Basal First Molar Width (BMW 6): measured based on a line drawn from the outer edges of the right and left sides of the maxillary base along the reference plane on the nasal base level. Alveolar First Molar Width (AMW 6): measured on the first molar coronal section between the most occlusal points of the maxillary alveolar process.

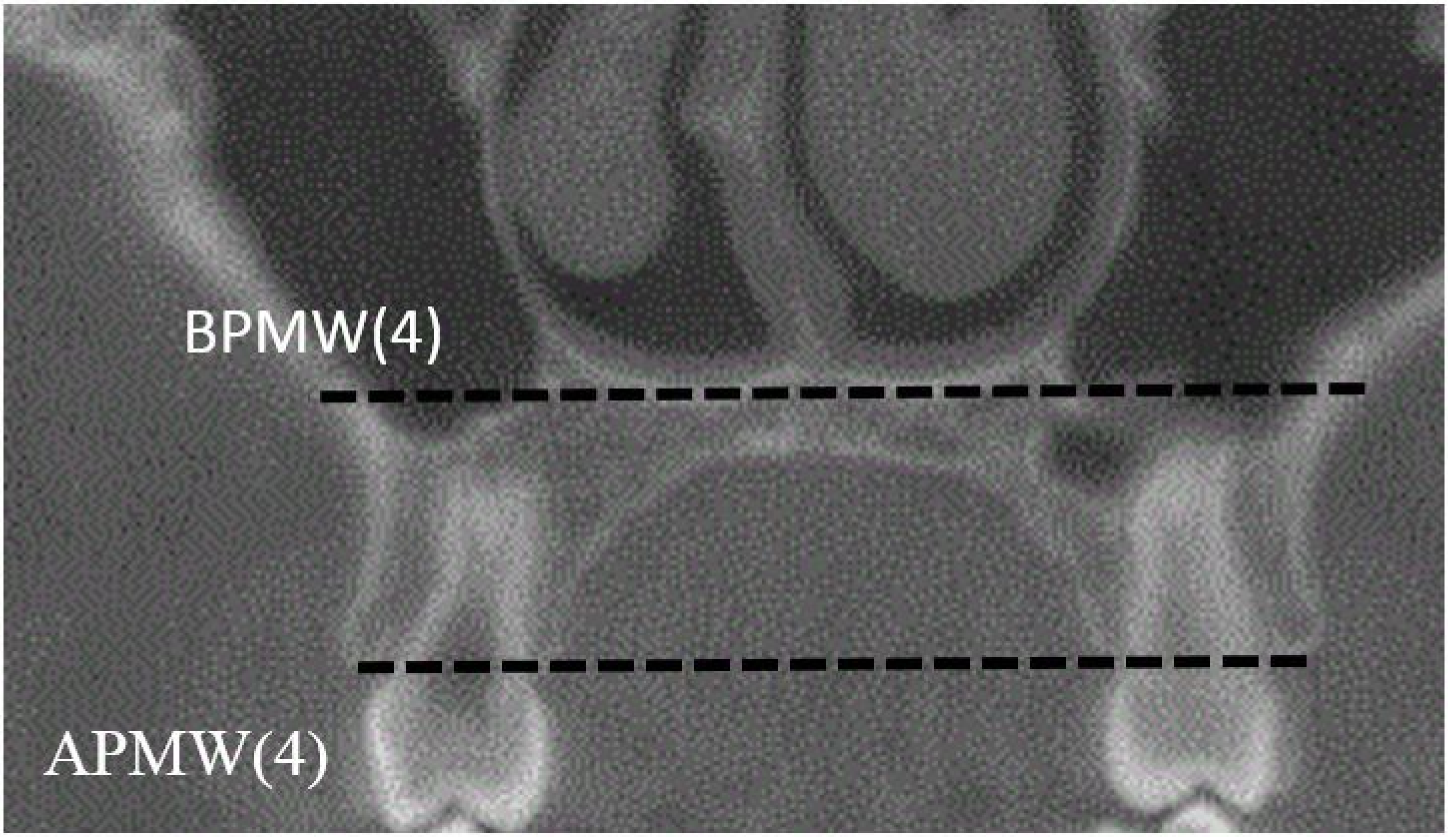

Figure 3

The alveolar and basal width measurements on the level of maxillary first premolar tooth.

Basal First Premolar Width (BPMW 4): measured based on a line drawn from the outer edges of the right and left sides of the maxillary base along the reference plane on the nasal base level. Alveolar First Premolar Width (APMW 4): measured on the first premolar coronal section between the most occlusal points of the maxillary alveolar process.

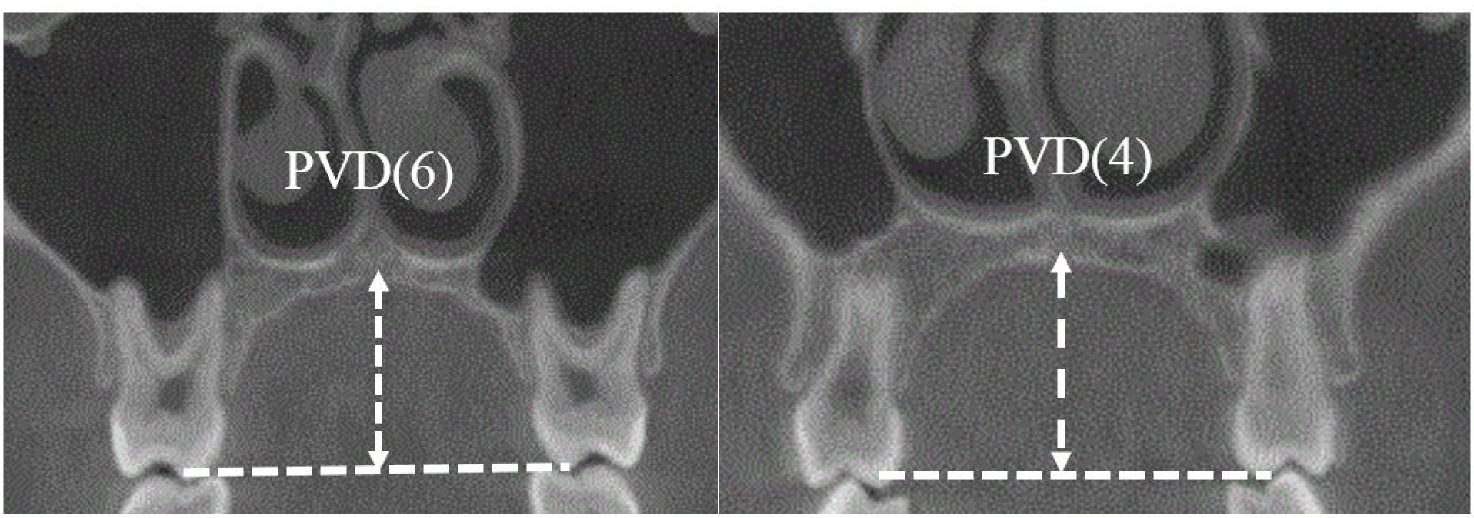

Figure 4

The palatal vault depth measurements on the level of maxillary first molar and premolar levels.

PVD (6) and PVD (4): the palatal vault depth vault was defined as the distance from contact line of the right and left first molars and premolars between mesiopalatal cusp tips to palatal vault.

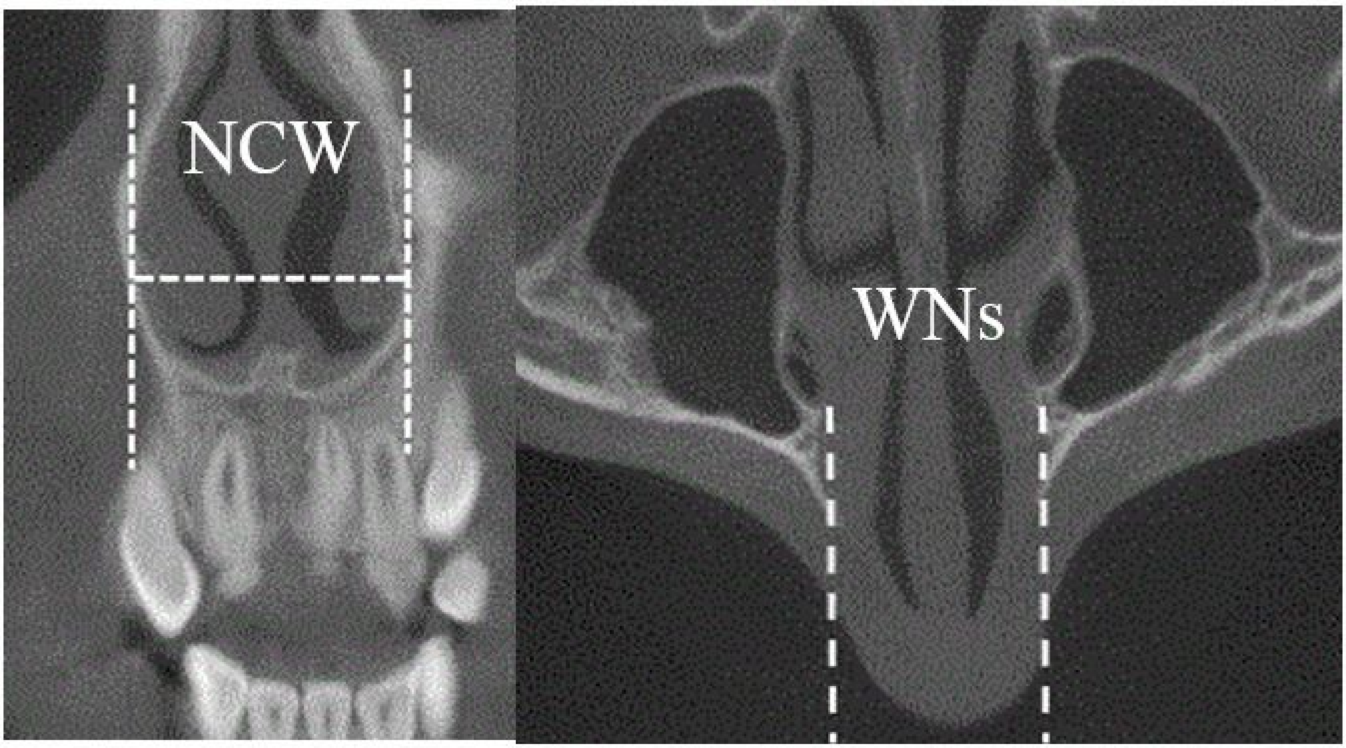

Figure 5

The nasal cavity and the nostril width measurements.

Nasal Cavity Width (NCW): measured at the broadest part of the lower third of the nasal cavity on the coronal plane from the point closest to the maxilla. Width of the Nostrils (WNs): measured from the broadest part on the horizontal plane.

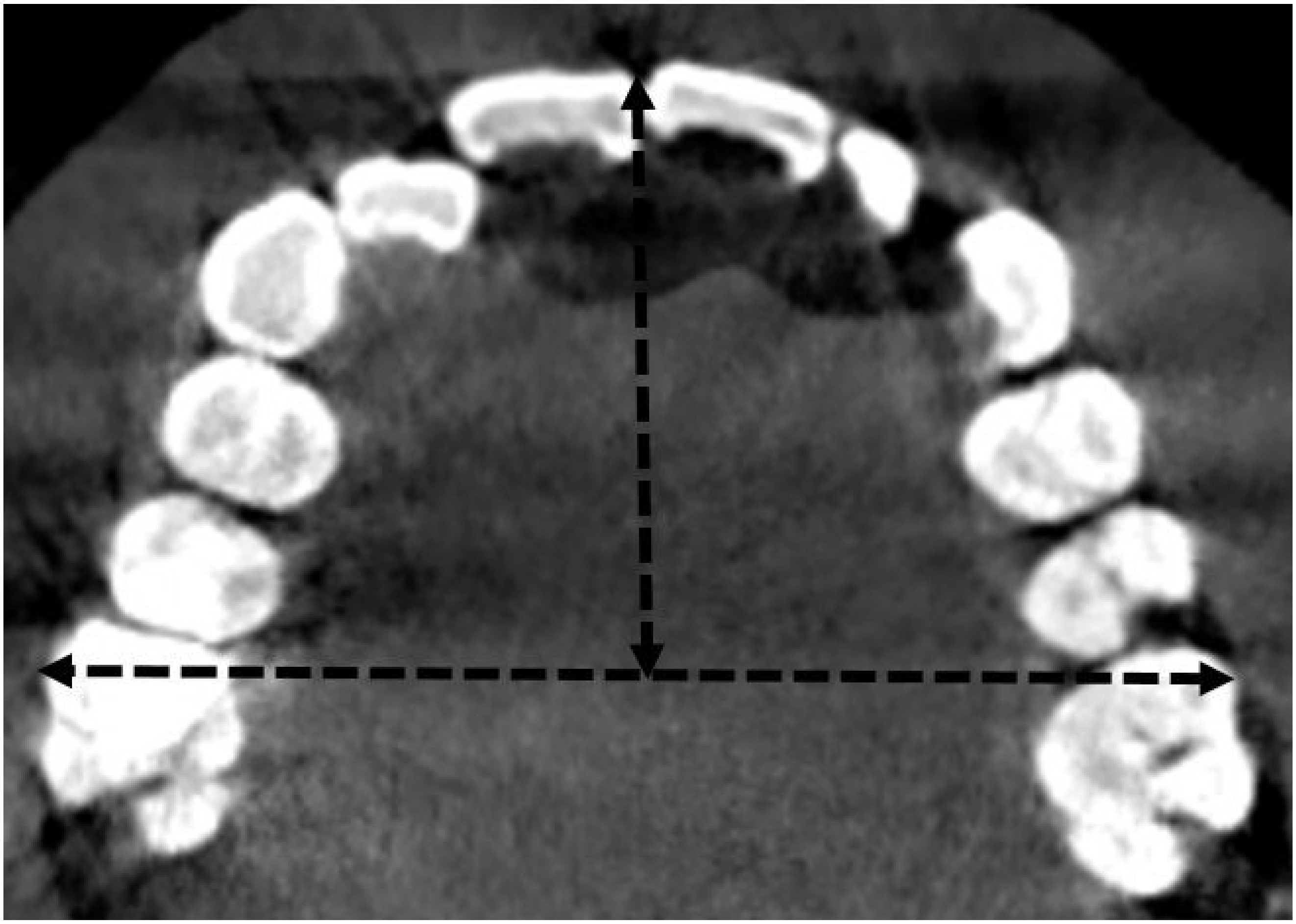

Figure 6

The maxillary anteroposterior depth measurement.

Maxillary AnteroPosterior Depth (MAPD): measured from the averaged points of the distance between the averaged incisory points of the central incisor teeth and the mesiobuccal cusp tips of first molars.