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MAXILLARY TRANSVERSE DIMENSIONS IN SUBJECTS WITH IMPACTED CANINE COMPARED WITH NORMAL SUBJECTS USING CONE BEAM COMPUTED TOMOGRAPHY

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ABSTRACT

Introduction: One of the many causes of maxillary canine impaction is the mechanical obstruction by a small maxillary arch. By introducing Cone Beam Computed Tomography (CBCT) to the orthodontic field, studying such a relation became possible and accurate. **Aim:** The aim of this study was to compare the maxillary transverse dimensions between subjects with impacted maxillary canines and normal subjects using Cone Beam Computed Tomography. **Methods:** Cone-beam computed tomographic images of 60 adults were acquired. They were grouped into three groups of 20 each: buccal canine impaction, Palatal canine impaction and a control group. The width of the maxilla was measured skeletally, dentally and alveolar in each group using Dolphin software program. **Results:** the skeletal width of the maxilla was similar among study groups and control ones. It was found that there was a statistically significant difference between canine impaction groups and control group regarding the premolar width and the premolar alveolar width. As for the molar width and the molar alveolar width, there was no statistically significant difference between them. **Conclusion:** Premolar dental and alveolar widths of the maxillary arch were significantly smaller in palatal canine impaction subjects than in subjects with buccal impactions or normal subjects. Skeletal, molar dental and molar alveolar widths of maxilla had non-significant difference between canine impaction and normal subjects.

INTRODUCTION

A maxillary canine in its optimal position is essential for proper function and esthetics of the oral cavity as well as protecting and maintaining the dentition. (1) For these reasons, any abnormality in the eruption process of such tooth triggers immediate concerns to both the patient and the orthodontist.(2) The specific cause of maxillary canine impaction is still unclear. Certain theories were introduced for how it failed to erupt (3). Some found it to be more common with certain transverse relationships (4,5) Consequently, it was proposed that the smaller width of the maxillary arch might be a possible causative factor that is mechanically hindering the eruption of the upper canines Moreover, a recommendation was proposed as an early intervention to correct the width of the upper arch in cases that show signs of canine displacement in hope of preventing it (6); however, the grounds for this proposition were still ambiguous.

The introduction of Cone Beam Computed Tomography (CBCT) was of major value for both the orthodontist and the oral surgeon in dealing with these cases. Not only it helped in diagnosis of root resorption of incisors and other major complications of canine impaction, but also it made the localization and management of these cases more convenient along all therapeutic phases[7].

So this study was conducted to compare the maxillary transverse dimensions between subjects with impacted maxillary canines and normal subjects using Cone Beam Computed Tomography.

MATERIALS AND METHODS:

This retrospective study was constructed on a sample of Cone Beam Computed Tomography (CBCT) collected form the archive of Faculty of Dentistry, Suez Canal University after the approval of the Research Ethical Committee of Faculty of Dentistry, Suez Canal University (Ethical approval number 148/2018). All CBCT images were taken with the same machine; Soredex SCANORA 3D and were obtained from the archive of the Radiology department, Faculty of Dentistry, Suez Canal university.

Sample size calculation:

The sample size for this study was calculated according to Arkin [8] using the formula $n=(Z\propto)^2*(S)^2/(d^2)$ where n = Sample size, S = Standard diversion at 7.90, $Z\propto=1.96$ at significant level 95% and d= the difference between factors and equals 2. The sample size was calculated by the equation and the result was 59.93 which was rounded to 60 cases.

Sampling:

Inclusion criteria were 1. radiographic images fully showing the maxillary permanent canine and the maxillary bone from alveolus, zygomatic buttress until the lower border of the arch of the zygoma and extending posteriorly to the pterygoid plates. 2. Radiographs of patients 15-40 years of age with full permanent dentition. 3-Radiographs with unilateral or bilateral canine impactions. Exclusion criteria were radiographs with supernumerary teeth, odontoma, craniofacial anomalies, cleft palate, odontogenic tumors or cysts around impacted canines or with dental follicle 3 mm or larger. 2-Hazy radiographs or radiographs with errors that may alter landmark identification such as metal artifacts.

Grouping:

Sixty Cone Beam Computed Tomography (CBCT) images were collected and divided into three equal groups (20 each); Group I as a Control group with 20 CBCT images, Group II with a Buccally displaced canine with 20 samples and Group III with Palatal displacement comprising also 20 samples with a total of 60 cases.

Determining the transverse maxillary dimensions:

For maxillary width measurements, the dimensions were based on skeletal, dental and alveolar levels.

a. Skeletal transverse maxillary dimension:

This was measured on the 3D reconstruction view. It was measured from the right to the left jugal points (Mx), which are defined as the deepest and most inferior points on the right and left jugal processes of the maxilla respectively. This can be located at intersection of the outline of the maxillary tuberosity and the zygomatic buttress on the frontal 3D reconstructed view. This was proposed by Ricketts as an accurate point to determine the skeletal width of the maxilla. Moreover, this point is not altered by any alveolar bony prominence found along the buccal bone. Saiar et al.[9] (Figure 1).

Fig. (1) Skeletal transverse maxillary dimension from the right to the left jugal points (Mx)

b. Dental transverse maxillary dimensions:

Maxillary width was measured at the dental levels of the first premolar and first molar teeth as follows: Stanaitytė and Smailienė,[10]

1- First premolar width (PMW): The coronal slice which showed the tip of the buccal and palatal cusps of both of the maxillary first premolars and their approximate long axis was selected. Then the measurement was done from the central groove point of the right to the left first premolars on this slice (Figure 2).

2- First molar width (MW): The coronal slice which showed the central pit of both of the maxillary first molars was selected. Then the measurement was done between these 2 central pits on this slice (Figure 3).

c. Alveolar transverse maxillary dimensions:

Maxillary width was measured at the alveolar levels of the first premolar and first molar teeth: Arboleda-Ariza et al.[11]

1- First premolar alveolar width (PMAW): On the coronal view, it was measured from the most occlusal points of the maxillary alveolar process at the slice showing the tip of the buccal and palatal cusps of both of the maxillary first premolars and their approximate long axis (Figure 4).

1- First molar alveolar width (MAW): On the coronal view, it was measured from the most occlusal points of the maxillary alveolar process at the slice showing the central pits of the first molars bilaterally and their respective long axis (Figure 5).

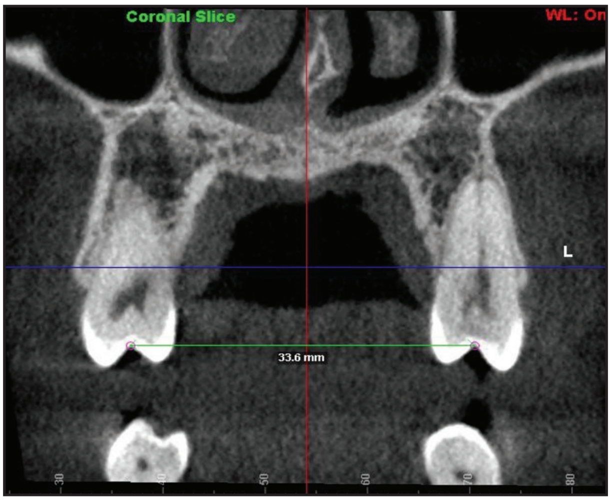

Fig. (2) First premolar width (PMW)

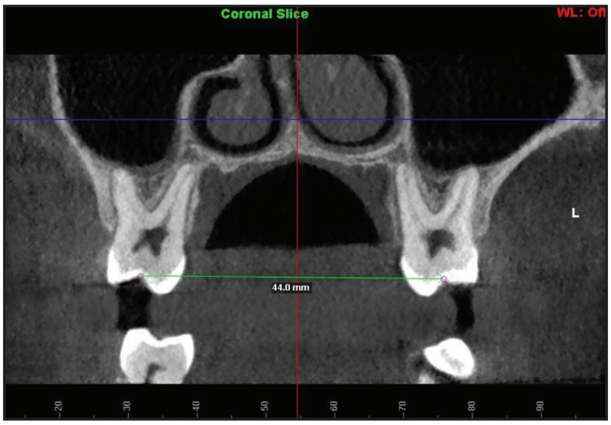

Fig. (3) First molar width (MW)

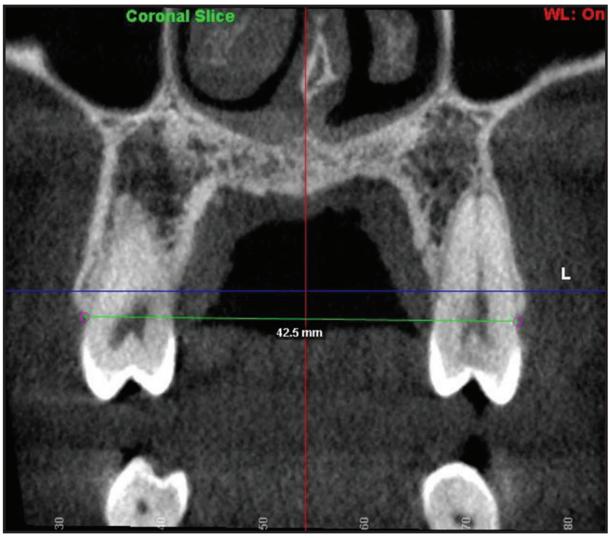

Fig. (4) First premolar alveolar width (PMAW)

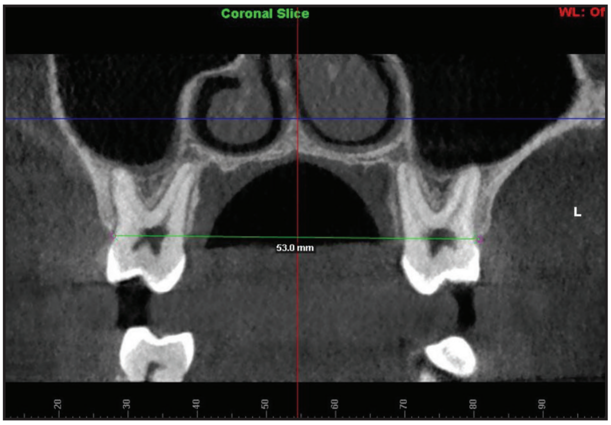

Fig. (5) First molar alveolar width (MAW)

Statistical analysis of the data

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp) Qualitative data were described using number and percent. The Kolmogorov- Smirnov test was used to verify the normality of distribution Quantitative data were described using range (minimum and maximum), mean, standard deviation and median. Significance of the obtained results was judged at the 5% level of confidence. Chi-Square test was used for categorical variables, to compare between different groups, F-test (ANOVA) was used to normally distribute quantitative variables, to compare between more than two groups.

RESULTS

There was no statistically significant difference between maxillary width in skeletal width (P-value = 0.432), molar width (P-value = 0.382) and molar alveolar width (P-value = 0.724) within each group.

Table (1) *Descriptive statistics and results for comparison between transverse maxillary measurements (mm) in the three groups*

	Control (n=20)	Buccal displacement (n=20)	Palatal displacement (n=20)	P
Mx-Mx				
Mean ± SD.	63.63 ± 4.60	62.76 ± 7.41	62.04 ± 3.38	**0.432**
PMW				
Mean ± SD.	37.27 ± 2.93	35.64 ± 1.41	35.55 ± 1.92	**0.025***
Sig. bet. grps.	P_1=0.055, P_2=0.041*, P_3=0.992			
PMAW				
Mean ± SD.	45.41 ± 3.13	43.08 ± 1.25	43.34 ± 2.48	**0.006***
Sig. bet. grps.	P_1=0.009*, P_2=0.023*, P_3=0.940			
MW				
Mean ± SD.	47.30 ± 3.49	47.94 ± 5.60	46.16 ± 2.52	**0.382**
MAW				
Mean ± SD.	**56.58 ± 4.02**	**57.70 ± 7.35**	**56.60 ± 2.25**	**0.724**

*P: P value for comparing between the studied groups. P_1: P value for comparing between Control and Buccal displacement. P_2: P value for comparing between Control and Palatal displacement. P_3: P value for comparing between Buccal displacement and Palatal displacement. *: Statistically significant at $P \leq 0.05$*

There was a statistically significant difference between maxillary width at premolar width (P-value = 0.025*) and premolar alveolar width (P-value = 0.006*). Palatal impaction group had less premolar and premolar alveolar width than the buccal impaction and the control groups.

DISCUSSION

Maxillary canine impaction has been increasingly recognized in orthodontic patients. Its various complications, lengthy and traumatic treatment and surgical exposure pushed many authors to find out the exact causes of it. However, canine impaction is a multi- factorial problem. Of the many correlating factors is the width of the maxillary arch, suggested as a local mechanical obstruction in the path of the erupting maxillary canine[5]. However, the correlation between impacted maxillary canine and transverse maxillary dimensions had conflicting evidence supporting them; some authors reported smaller maxillary width [4,5,11,12] while others found no correlation between them [13,14,15].

Regarding the skeletal measure of the width of the maxilla (Mx- Mx), there was non-significant difference among all groups. **D' Oleo-Aracena et al**.[12], and **Gull et al.**[14] obtained similar results. However, this was not in agreement with Arboleda-Ariza et al.[11]. This may be due to the different reference points the latter researchers used; they took the measurements on the lowest point on the nasal floor on the premolar and molar sagittal cuts, which might represent a nasal measurement rather than a skeletal maxillary one. The results of this investigation might suggest that the problem has little skeletal origin.

Concerning the premolar width of the maxilla (PMW), the result of the current study revealed a significant difference between control group and palatal impaction group. At the same time, there was no significant difference between buccal and control groups. This was in agreement with **Liu et al.**[4]. Their findings confirm the results of this study. They concluded that there is no correlation between maxillary premolar width and the impacted canine. However; **Mucedero et al**.[16] found no correlation when studying buccal impacted canine cases. Mucedero et al.[17] in another research on the palatally impacted canines found that there was decrease in the width dimensions in the palatal group, which could be due to different race. They took a sample from Indian ethnicity.

The results of the PMW were also not in agreement with Gull et al.[14] who also used a different race, White origins.

Considering the premolar alveolar width of the maxilla (PMAW), both buccal and palatal impaction groups had a statistically significant difference with the control group. Yet, there was no significant difference between buccal and palatal groups. This was in agreement with and **Arboleda-Ariza et al**.[11], **D' Oleo-Aracena et al**.[12]. Nevertheless, the results of this study were not in agreement with **Saiar et al**.[9]. This may be due to the different landmarks they used or the dissimilar methodology, obtaining the measurements through occluso-grams.

Cacciatore et al.[18], on the other hand, used a different methodology. They used a prediction method (sectoral classification) to predict canine impaction from the panoramic radiograph at a mean age of 9.1±1.1 years. Their results were not in agreement with this study, regarding the molar width of the maxilla (MW). The prediction method might have included a variation in the results as its accuracy is less compared to the use of CBCT.

Arboleda-Ariza et al.[11] found non-significant difference among all groups when measuring molar alveolar width of the maxilla (MAW). This was not in agreement with this study, which might be due to different ethnicity. They tested Peruvian (Hispanic) subjects while in this study an Egyptian sample was selected for testing.

CONCLUSIONS

From the results of the current study, the following was concluded:

1. Premolar width of the maxillary arch is significantly smaller in palatal canine impaction subjects than in subjects with buccal impactions or normal subjects.
2. Premolar alveolar width of the maxillary arch is significantly smaller in subjects with both buccal and palatal impactions than control group.
3. Skeletal width of maxilla had non-significant difference between canine impaction and normal subjects.
4. Molar width and molar alveolar width were similar in impacted canine cases and normal ones.

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