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Investigation of the morphometric features of bony nasolacrimal canal: a cone beam computed tomography study

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Investıgatıon of the morphometrıc features of bony nasolacrımal canal: a cone beam computed tomography study

Running head: The morphometric features of nasolacrimal canal

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Abstract

Background: The aim of this study was to investigate the diameters of the bony nasolacrimal canal by cone beam computed tomography (CBCT) in normal adult Turkish population and the effect of gender and age on the nasolacrimal canal diameter.

Materials and methods: The randomly selected 100 patients aged from 18-83 years were analyzed, a total of 200 nasolacrimal canals were examined using CBCT. The anteroposterior and transverse diameters, the sectional area of the bony nasolacrimal canal and the angle between the bony canal and the nasal floor were measured in axial, sagittal CBCT scan.

Results: The anteroposterior diameter of the bony nasolacrimal canal was 6,56±1,53 mm, and the transverse diameter was 4,34±1,03 mm. The sectional area of the bony nasolacrimal canal was 7,39±3,29 mm^2, and the angle between the bony canal and the nasal floor was 73,46±6,77°. No significant difference in the anteroposterior diameter, the transverse diameter and the sectional area of the bony nasolacrimal canal between age. The angle between the bony canal and the nasal floor was significantly greater in female.

Conclusions: This study may provide useful information of morphometric features of the bony nasolacrimal canal. The detailed anatomical knowledge of bony nasolacrimal canal morphology may help the clinicians plan the treatment options.

Key words: cone beam computed tomography, diameter, morphology, nasolacrimal canal

INTRODUCTİON

The nasolacrimal canal is bordered medially by palatine bone and the inferior turbinate in the nose and laterally by maxillary bone and it opens at the inferior meatus of the nose. The nasolacrimal canal is 12 to 18 mm long and tear fluid is drained by the nasolacrimal duct [17]. Embriyologically, the nasolacrimal canal starts forming around 5 weeks of gestation. It starts out as a linear thickening of ectoderm located in a groove between the nasal and maxillary prominences. This thickening eventually separates into a solid cord and sinks into the surrounding mesenchyme. Over time the cord canalizes forming the lacrimal sac and the beginning of the nasolacrimal canal. The nasolacrimal duct extends intranasally until it exits under the inferior turbinate [10].

The nasolacrimal canal obstruction lead to epiphora is a common ophthalmologic problem [13]. The nasolacrimal canal obstruction can be congenital or acquired. The acquired lacrimal duct obstruction was classified into primary and secondary by Bartley [2]. The etiology of secondary obstruction includes neoplasm, sarcoidosis, facial trauma, surgery, or Wegener granulomatosis [11]. Primary acquired nasolacrimal duct obstruction (PANDO) is known idiopathic, and occurs more frequently in female patients [11]. Although the exact etiology of PANDO remains unknown, some anatomical factors had been defined [8]. A substantial etiology is a smaller diameter of the nasolacrimal canal, and studies have reported gender and racial variations in dry skull studies [8]. The differences in the diameter of the bony nasolacrimal canal have been thought to relate with gender and age [18].

Although Computed tomography (CT) is one of the most available imaging method providing high-resolution images and reliable information to assess the nasolacrimal duct diameter [5]. Cone-beam computed tomography (CBCT) which is widely used in dentistry in the recent years, is preferred to CT due to low cost, high resolution, a lower dose of radiation and better image quality. CBCT allows diagnosis by providing three-dimensional data about the anatomical formations. The data acquired by CBCT presents coronal, sagittal and axial sections, decreasing the superposition of anatomical formations. These advantages help the clinician to understand the whole anatomical formation of the tissue [16].

Therefore, the aim of this study was to evaluate the diameters of the bony nasolacrimal canal by CBCT in a normal adult Turkish population and to evaluate how these diameters are affected by gender and age.

MATERIALS AND METHODS

In this retrospective study in which were randomly selected 100 patients aged from 18-83 years were analyzed, a total of 200 nasolacrimal canals were examined using CBCT. The study was carried out in Department of Dentomaxillofacial Radiology of Altınbas University of Faculty of Dentistry. The informed consent form was routinely received from all patients before radiographic examinations. Patients with clinical or radiologic evidence of orbital or paranasal sinus pathology or prior nasolacrimal and sinus surgery were excluded and the images only included in the axial view of the nasolacrimal canal level of the scaning protocol were used.

All CBCT examinations were acquired with NewTom Vgi evo (CeflaGroup, Verona, Italy). During the exposure, the patients were standing and the patient head was positioned to be the sagittal and vertical planes are perpendicular to the floor and the orbitomeatal plane was parallel to the floor and kept stable with special headband and chin support to prevent patient movement, and the device has made a single rotation of 360º around the patient's head in each beam.

All measurements were made by the specialist of dentomaxillofacial radiology (O.O). The anteroposterior and transverse diameters and the sectional area of the bony nasolacrimal canal at the level of the infraorbital margin were measured in the axial CBCT scan image on NNT Viewer (CeflaGroup, Verona, Italy) software program. The first that showed the central portion of the inferior orbital rim was chosen (Fig 1). The area of the nasolacrimal duct at the measured point was determined using the equation for area of an ellipse.

Also on the sagittal CBCT scan, a line connecting the most proximal portion of the bony nasolacrimal canal to the distal end of the bony nasolacrimal canal was drawn and the angle between this line and the line parallel to the nasal floor was measured. (Fig 2).
The findings were analyzed statistically and the effect of gender and age on the nasolacrimal canal diameter were investigated.

Stastical analysis

For the statistical analyses, the IBM SPSS Statistics 22 (IBM SPSS, Turkey) program was used while assessing the findings of the study. The normal distribution of the parameters was evaluated by Shapiro Wilks test. The Oneway Anova test was used for comparison of the parameters of normal distribution in comparison of quantitative data as well as descriptive statistical methods (mean, standard deviation [SD], and frequency). The Tukey HDS test was used to determine the difference between groups of normal distribution. Student's t-test was used to compare normal distribution parameters between two groups. Values of <0.05 were considered as significant statistically ($P<0.05$).

RESULTS

There were 100 patients (58% female, 42% male) and age ranged from 18 to 83 years with a mean of 41.62±16.02 years. There was no significant difference between males and females in all age groups.

The anteroposterior diameter of the bony nasolacrimal canal was 6.56±1.53 mm (mean ± standard deviation), and the transverse diameter was 4.34±1.03 mm. The sectional area of the bony nasolacrimal canal was 7.39±3.29 mm^2, and the angle between the bony canal and the nasal floor was 73.46±6.77° (Table 1).

The angle between the bony canal and the nasal floor was significantly greater in female patients (74.66±6.62) than in male patients (71.8±6.66) ($p<0.003$). No statistically significant difference was found in the other parameters between gender (Table 2).

All parametres except the anteroposterior diameter were significantly affected by age in the correlation test ($p<0.05$) (Table 3). When the subjects were divided 5 age groups, no statistically significant difference was found in the anteroposterior diameter, the transverse diameter and the sectional area of the bony nasolacrimal canal. However, the angle between the bony canal and the nasal floor was affected significantly in age goups (Table 4).

The angle between the bony canal and the nasal floor was significantly higher in female subjects under the age of 30 ($p<0.05$). No statistically significant difference was found in other parameters between gender. The age significantly affected the anteroposterior diameter ($P=0.004$), the transverse diameter ($P=0.017$) and the sectional area of the bony nasolacrimal canal ($P=.007$) in female patients. All parametres were not significantly affected in subjects between 30-39 years, 40-49 years and over age of the 60 (Fig 3).

DISCUSSION

Although the certain etiology of PANDO is still unclear, many situations such as smoking, maxillofacial trauma and history of dacryocystitis [23]. Also one of the defined etiologic factor is relatively smaller diameter of the nasolacrimal canal. Small changes in the bony nasolacrimal canal diameter may lead to the obstruction by influencing tear flow [11,12].

The normal diameter of the bony nasolacrimal canal has evaluated by several studies. Janssen et al. [11] evaluated the normal bony nasolacrimal canal diameter in 100 subjects without pathology of nasolacrimal duct and the mean transverse diameter was 3.5 mm in axial CT images. The transverse diameter was approximately 4.6 and 4.8 mm in the studies of Duke-Elder and Steinkogler, respectively [6,19]. The anteroposterior diameter was approximately 6.8 and 4 to 8 mm in the studies of Steinkogler and Cowen and Hurwitz, respectively [4,19]. The transverse and anteroposterior diameter were 4.5 and 6.5 mm, respectively in the study of Lee et al. [12] and 5.6 and 5.0 mm in the study of Shigeta et al. [18]. In our study the anteroposterior diameter of the bony nasolacrimal canal was 6.56 mm, and the transverse diameter was 4.34 mm. These differences could be explained by different measurement methods, different patient ages and possibly racial differences.

In some recent studies, gender differences in nasolacrimal canal dimension were reported so it has suggested that PANDO is more frequently in female patients, could be explained by this anatomical difference [11,18]. The mean nasolacrimal canal diameter in subjects with normal was 12.3±2.5 mm in male and 10.8±2.5 mm in female in the study of Ramey et al. [15]. Bulbul et al. [3] compared the anatomical differences of bony nasolacrimal canal diameter between PANDO and non-PANDO patients and detected no significant gender differences in measured measurements. In our study, the mean of anteroposterior diameter was 6.39±1.54 mm in female and 6.79±1.49 mm in male, the mean of transverse diameter was 4.3±1.03 mm in female and 4.41±1.04 mm in male, and there was no significant gender difference.

Takahashi et al. [20] reported shorter transverse diameter in female than in male, on the contrary, no significant gender difference in anteroposterior diameter. Shigeta et al. [18] reported smaller sectional area, anteroposterior and transverse diameter of bony nasolacrimal canal in female patients than in male patients. Furthermore, they reported the smaller bony canal diameter as a cause of greater prevalence of obstruction in female. Lee et al. [12] evaluated the diameters, angles, and sectional area of bony nasolacrimal canal in patients without PANDO and they reported no significant gender differences in diameter, which is similar to our results. Also the angle between the bony canal and the nasal floor was significantly greater in female patients (74.66±6.62) than in male patients (71.8±6.66) in our study.

McCormick and Sloan [14] investigated the gender and racial differences in nasolacrimal canal diameter so they concluded that the narrower canals were observed in female and no racial differences.

The effect of age on results of anatomical studies correlated the nasolacrimal canal morphology with age and observed that there was an increasing trend in diameter and sectional area of nasolacrimal canal with age, however no statistical significance was found [4,18,23]. Similarly, Groessl et al. [9] reported an association between the diameter of the nasolacrimal canal and age. Lee et al. [12] investigated the diameters, angles, and sectional area of bony nasolacrimal canal in patients without pathology of nasolacrimal duct and found that these parameters have increasing trend after 5 years of age.

Janssen et al. [11] and Shigeta et al. [18] reported that the the mean angle between the bony canal and the nasal floor was 22.5° and 78.3°, respectively. In our study, the mean angle between the bony canal and the nasal floor was 73.46°. These differences could be explained by different methods and patient ages and possibly racial differences.

In another study Ela et al. [7] investigated the bony nasolacrimal canal morphology and dimension in children retrospectively. They concluded the positive correlation between the anteroposterior diameter, transverse diameter, sectional area and age. However, they reported that no significant association between gender and parametres.

In the literature, there are a few studies using CBCT to investigate the nasolacrimal canal diameter and system [1,21,22]. Altun et al. [1] evaluated retrospectively the morphometric changes in the nasolacrimal canal using CBCT in patients with unilateral cleft lip/palate. They concluded that the nasolacrimal canal diameter at the affected side of unilateral cleft lip/palate was narrower than the unaffected side. Wilhelm et al. [22] and Tschopp et al. [21] evaluated the usefulness and safety of CBCT dacryocystography in detecting lesions and determining treatment methods in patients with epiphora so concluded that CBCT dacryocystography is a reliable and time efficient method to assess the nasolacrimal canal system in patients with epiphora.

CONCLUSIONS

In conclusion, this study may provide useful information of morphometric features of the bony nasolacrimal canal. The detailed anatomical knowledge of bone nasolacrimal canal morphology may help the clinicians plan the treatment options.

Conflict of interest: The author declare that she has no conflict of interest.

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Table 1. The mean anatomical diameters of bony nasolacrimal canal

		Anteroposterior diameter (mm)	Transverse diameter(mm)	Sectional area (m^2)	Angle Degree
Side	n	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD
Right	100	6.51 ± 1.61	4.25 ± 1.04	7.22 ± 3.46	72.81 ± 7.29
Left	100	6.61 ± 1.44	4.43 ± 1.02	7.55 ± 3.11	74.11 ± 6.16
Total	200	6.56 ± 1.53	4.34 ± 1.03	7.39 ± 3.29	73.46 ± 6.77

Table 2. The mean anatomical diameters of bony nasolacrimal canal by gender

	Female	Male	P
	Mean ± SD	Mean ± SD	
Anteroposterior diameter (mm)	6.39 ± 1,54	6.79 ± 1.49	0.071
Transverse diameter (mm)	4.3 ± 1,03	4.41 ± 1.04	0.456
Sectional area (m^2)	7.13 ± 3,25	7.74 ± 3.33	0.201
Angle (degree)	74.66 ± 6.62	71.8 ± 6.66	0.003*

Student t test; * p<0.05

Table 3. Correlation between age and parametres

	Age	
	R	p
Anteroposterior diameter (mm)	–0.131	0.064
Transverse diameter (mm)	–0.181	0.010*
Sectional area (m^2)	–0.172	0.015*
Angle (degree)	–0.303	0.000*

Pearson Correlation Analysis; *p<0.05

Table 4.Mean values of bony nasolacrimal canal by teh age groups.

	Age					p
	<30	30-39	40-49	50-59	≥60	
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	
Anteroposterior (mm)	6.87 ± 1.84	6.48 ± 1.3	6.41 ± 1.38	6.47 ± 1.55	6.32 ± 1.21	0.454
Transverse (mm)	4.54 ± 1.01	4.33 ± 1	4.61 ± 1.18	4.03 ± 1.1	4.18 ± 0.8	0.082
Sectional area (m^2)	8.14 ± 3.84	7.24 ± 2.83	7.6 ± 3.07	6.82 ± 3.6	6.72 ± 2.2	0.212
Angle (degree)	76.13 ± 7.39	74.76 ± 4.96	71.36 ± 8.15	70.76 ± 5.32	71.61 ± 6.2	0.000*

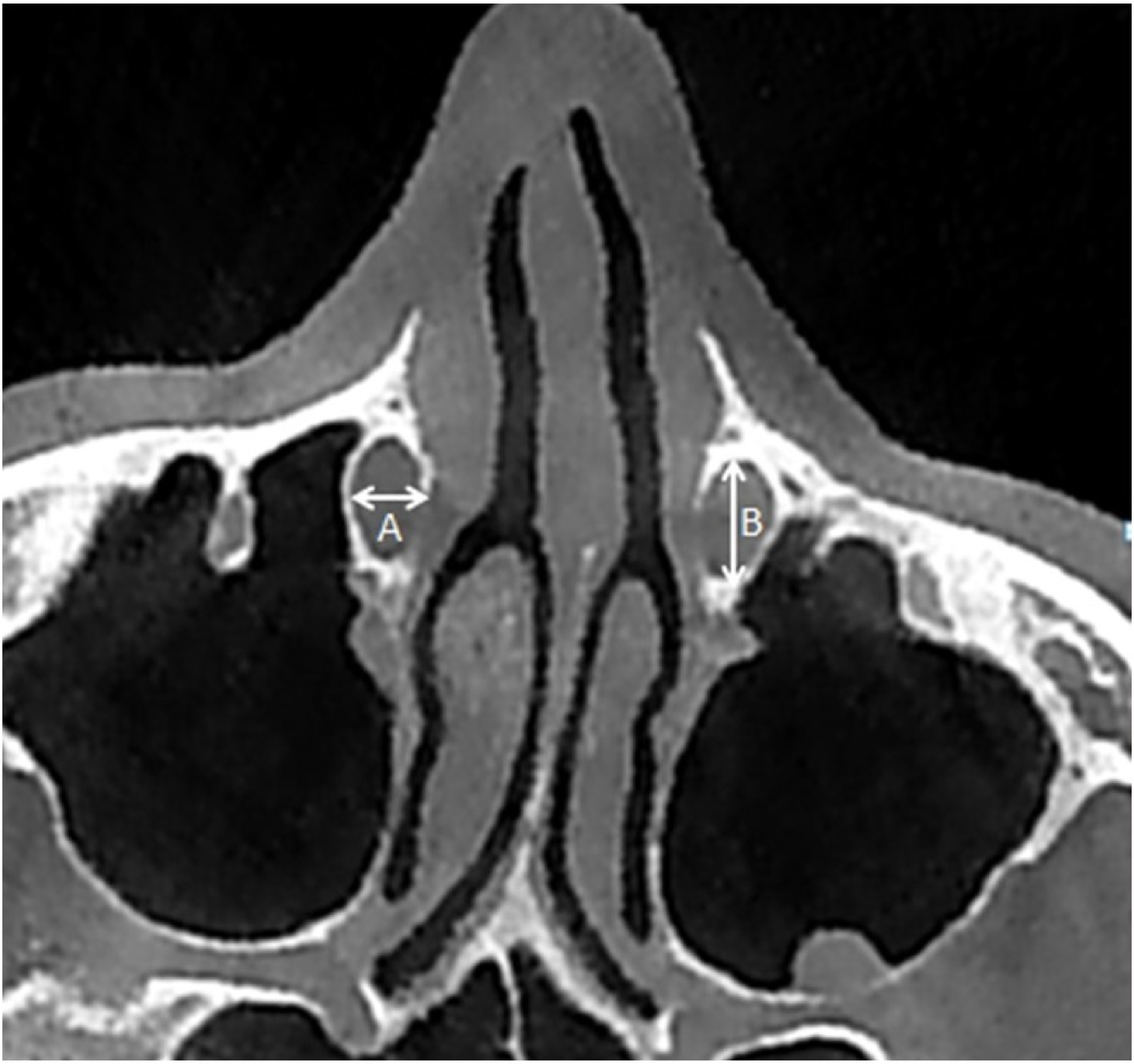
Oneway ANOVA test ; *p<0.05

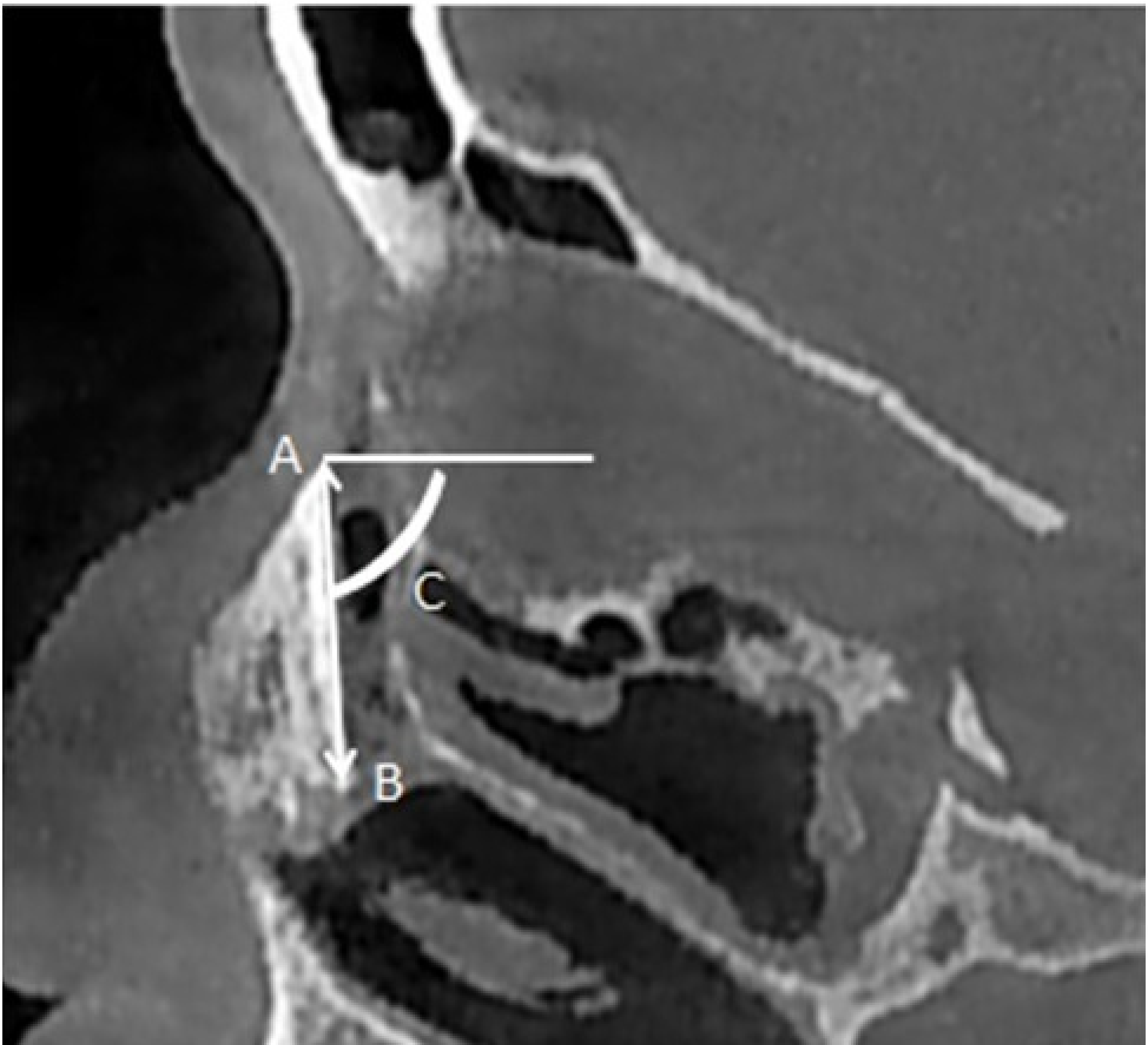
FIGURES

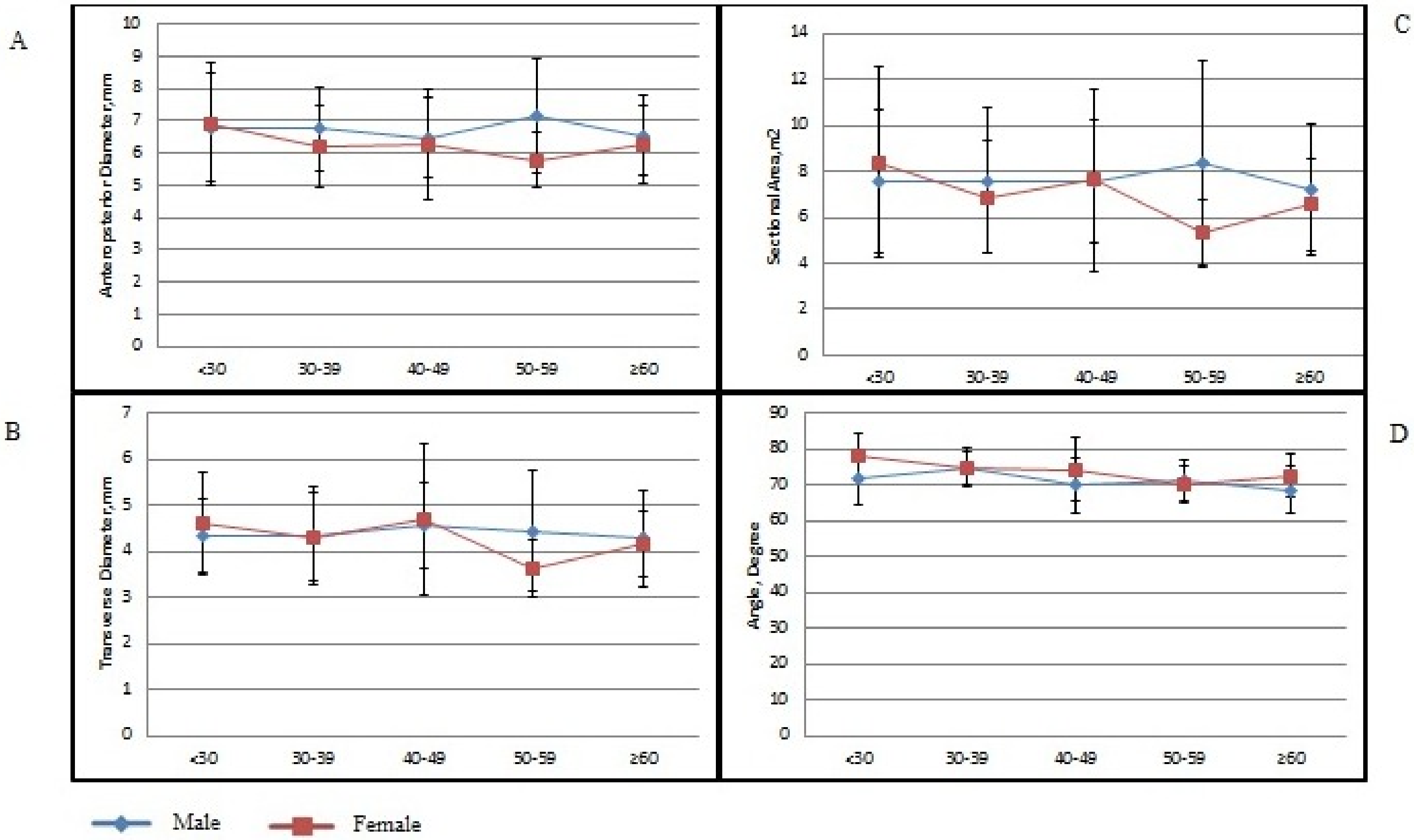
Figure 1. The anteroposterior (arrow B) and the transverse diameter (arrow A) at the level of the infraorbital margin in the axial CBCT scan.

Figure 2. Line connecting the most proximal part of the bony nasolacrimal canal (point A) to the distal end of the bony nasolacrimal canal (point B), the angle between this line and the line parallel to the nasal floor (C) in the sagittal CBCT scan.

Figure 3. The age distribution of the bony nasolacrimal canal measurements. The anteroposterior diameter (A), transverse diameter (B), sectional area canal (C), and angle (D).


A
B


A
B
C


A
B
C
D
Anteroposterior Diameter,mm
Transverse Diameter,mm
Sectional Area,m2
Angle, Degree
<30
30-39
40-49
50-59
≥60
Male
Female