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Maxillary Sinus Measurements in Different Age Groups of Human Cadavers

Mohammad A. Abd-alla BDS, MSc., Ph.D. [1]
Abdul-Jabbar J. Mahdi BDS, MSc., Ph.D. [2]

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Abstract

The maxillary air sinus is the largest air sinus among the four air paranasal sinuses, which is a cavity in the body of maxilla. It is pyramidal in shape consisting of base, apex and four sides; its base comprises the thin lateral wall of nasal cavity. This study carried out at the Institute of Forensic Medicine in Baghdad and the Forensic Medicine Unit in Tikrit Teaching Hospital during the period from January 2010 to July 2011. A randomized sample of 110 human cadavers that arranged in four different age groups and dissected to study the three dimensions of both maxillary sinuses in both sexes by using a standard flexible tape measure or vernier caliper. The mean value of the maxillary sinus length in males was (36.4 ± 4.6 mm) and in females was (33.9 ± 4.2 mm); from these results, the mean value of males was significantly greater than that of females. On the other side, the mean value of the maxillary sinus width in males was (27.4 ± 4 mm) and in females was (25.3 ± 3.9 mm); therefore, these results demonstrate that the maxillary sinuses were wider in males than females. For males, the mean value of the maxillary sinus height was (35.1 ± 3.9 mm) and for females was (30.8 ± 3.6 mm). From these findings, a higher significant difference between the mean values was found; also there was a high significant difference between the two genders because the mean value of the maxillary sinus height for males was significantly higher than that for females. According to age groups of the present study, group 1 of maxillary sinus found to be still in growing state and not reaching its full size. Group 2 showing an extensive growth in maxillary sinus length and width, especially on the right side. Group 3 might partly showing growth in maxillary sinus length and height, which indicates that at this age the maxillary sinus reaches its full height. Finally, group 4 might partly indicates that the maxillary sinus reaches its full growth if it fails to reach it in group 3. The findings of the present study disagree with that done by Parks [1] who made measurements for the maxillary sinuses on normal Korean adults using computed tomography, since these differences were may be due to ethnic variations. Also due to race differences, this study disagree with Fernandes [2] who studied the maxillary sinus in European and Zulu using computed tomography.

Introduction

The maxillary air sinus or antrum of Highmore (Greek; antron, a cave), was first described by Nathaniel Highmore in the 17th century [3]. Maxillary sinuses are two spaces that filled with air, located in

(1)Ass. Prof., Department of Anatomy, College of Medicine, Tikrit University.
(2)Ass. Prof., Department of Anatomy, College of Medicine, Tikrit University.

the maxillary bones and can be of various sizes and shapes, their walls are thin. The apex of these sinuses can extend into the zygomatic process of the maxilla or even can occupy the zygomatic bone itself [4]. Anatomically, the maxillary sinus described as a quadrangular pyramid form with an internal base that formed by the lateral wall of the nasal cavity [5]. The medial wall of the antrum is bounded by the nasal surface of the body of the maxilla and by parts of the palatine, lacrimal, ethmoid and inferior turbinate bones. The presence of these bones reduces considerably the size of the opening between the antrum and the nasal cavity during life [6]. The roof is formed by the floor of the orbit, frequently ridged by the overlying infraorbital canal. On the other side, the floor of the antrum is formed by the alveolar process, which is approximately 1.25 - 1.50 cm below the level of floor of nasal cavity, and in majority of cases radiating bony septa are present on the floor of the sinus situated at intervals between the roots of adjoining teeth and sometimes the floor is actually perforated by apices of related teeth [7]. The number of upper teeth whose roots are in direct relation to maxillary sinus is not constant because of individual differences in the size of the air space. In general, roots of the central and lateral incisor teeth are not in close proximity to the maxillary sinus, also the roots of the maxillary premolars and molars, however are consistently located below the sinus floor. The roots of the second molars are in closest proximity to the sinus floor, followed in frequency by the roots of the first molar, third molar, second premolar, first premolar and canine [8]. The floor of the maxillary sinus is related to the first, the second, the third molars and the roots of the canines that may elevate the sinus or may perforate its floor [9]. Sinus dimensions were varied extensively after extraction of maxillary posterior teeth, that why the expansion of the sinus was larger following the extraction of teeth enveloped by a superiorly curving sinus floor, with the extraction of several adjacent posterior teeth and the extraction of second molars [10]. The internal surface of the sinus can be smooth or ridged with prominent bony septa and the lateral wall contains canals or grooves for the nerves and blood vessels supplying the upper posterior teeth [11]. The adult dimensions of the maxillary sinus with an average 34×33×23 mm; and communicates with the posterior part of hiatus semilunaris in middle meatus via an aperture, the maxillary ostium that is 3-6 mm in diameter [12].

Materials And Methods

One hundred-ten cadavers dissected at the Institute of Forensic Medicine in Baghdad and the Forensic Medicine Unit in Tikrit Teaching Hospital during the period from January 2010 to July 2011. These human cadavers are arranged in four groups as in table (1). The cadavers included in the present study are for those persons who brought to the forensic medicine for dissection of a cause of death that neither related to the head nor to the respiratory system. So that any case with head injury, brain tumor, maxillofacial trauma or any other related cause of death were excluded from this study; even the loss of more than a single tooth in the maxillary posterior region, since shapes and sizes of the maxillary sinuses might change especially due to that loss of teeth [13]. Cadaveric dissections for these 110 cases done by gross anatomy for the head region with inspective examination, measurements and comparison. This dissection on fresh tissue human bodies carefully and precisely done to reach the different areas related to the maxillary sinuses, which are the target of this study using Cunningham's Manual of Practical Anatomy [14]. In order to obtain fine sagittal sections demonstrating the maxillary sinuses, the head was fixed to a wood block and anchored with screws. Then very fine sagittal sections were prepared, utilizing either an orthopedic band saw or a fine manual saw that has very small teeth to produce a very thin sheet layer in dissection. By a standard flexible tape measuring or vernier caliper, the dimensions of each maxillary sinus were recorded. ANOVA test was used to evaluate the statistical significance difference in mean between more than two

groups (four age groups in each gender). The range of normal values for each measure was described by the mean ± standard deviation.

Results

Maxillary Sinus Length

The mean value of right maxillary sinus length for males was (35.6 ± 5.1mm) and was (37.3 ± 4.1mm) for the left side. On the other hand, the mean value of right maxillary sinus length for females was (33.2 ± 4.3mm) and for the left side the mean value was (34.7 ± 4.2mm). No significant side differences were seen in both genders. Regarding gender differences, both right and left maxillary sinus length were significantly higher in males when compared to that of females, as given in table (2). According to table (3), the present study revealed that the maximum length of the maxillary sinus in males found in group 3 of the left side with (39.2 ± 3.9mm) and the minimum length found in group 1 of the right side with (34.1 ± 4.6mm), while in females the maximum length of the sinus found in group 1 of the left side with (36.2 ± 4.2mm) and the minimum length found in group 2 of the right side with (31.7 ± 3.8mm). ANOVA test was applied for different age groups and revealed no significant difference for both sides and in both genders.

Maxillary Sinus Width

In the present study, the mean right maxillary sinus width for males was (28.3 ± 3.8mm) and the mean width for the left sinus was (26.5 ± 3.9mm). For females, the mean right maxillary sinus width was (24.2 ± 3.7mm) and the mean left maxillary sinus width was (26.7 ± 4.1mm). The overall side difference revealed no statistical significant difference. Males showed statistical significant side difference, while females showed higher significant side differences. Regarding gender difference, the right maxillary sinus width was significantly higher in males when compared with that of females, while the left sinus width was approximately the same in both sexes as seen in table (2).For age grouping, the maximum width of the maxillary sinus in males found in group 2 of the right side with (31.1 ± 3.7mm) and the minimum width found in group 2 of the left side with (25.4 ± 4.0mm); on the other side, in females the maximum width of the sinus found in group 2 of the left side with (28.1 ± 3.9mm) and the minimum width found in group 1 of the right side with (23.1 ± 3.3mm). In the present study, ANOVA test was applied and there was a statistical significant difference among the four age groups for right side in both sex groups; while the left side maxillary sinus width revealed significant age difference in females only, as seen in table (3).

Maxillary Sinus Height

The mean value for right maxillary sinus height in males was (33.2 ± 3.8mm), whereas left maxillary sinus height recorded a mean value of (36.7 ± 4.0mm). For females, the mean value of right maxillary sinus height was (29.7 ± 3.6mm) and for left maxillary sinus height was (32.8 ± 3.7mm). The overall side differences showed a statistically significant difference. Both males and females also demonstrated a highly significant side difference. Male cadavers recorded significantly higher mean values of maxillary sinus height of both sides when compared with that recorded in females, as shown in table (2). When cadavers grouped according to age, the maximum height of the maxillary sinus in males found in group 3 of the left side with (38.2 ± 4.1mm) and the minimum height found in group 3 of the right side with (30.7 ± 3.7mm), while in females the maximum height of the sinus found in group 4 of the left side with (35.4 ± 4.0mm) and the minimum height found in group 4 of the right side with (24.6 ± 3.1mm). In the this study, ANOVA test results revealed only high significant statistical differences in right maxillary sinus height in females among the four groups as shown in table (3).

Discussion

The mean values of the maxillary sinus length in males of the dissected cadaveric cases were (36.4 ± 4.6 mm) and in females were (33.9 ± 4.2 mm); from these results, the mean value of males was significantly greater than that of females. On the other side, the mean values of the maxillary sinus width in males were (27.4 ± 4 mm) and in females were (25.3 ± 3.9 mm); therefore, these results demonstrate that the maxillary sinuses were wider in males than females. The mean values of the maxillary sinus height for males were (35.1 ± 3.9 mm) and for females were (30.8 ± 3.6 mm). From these findings, a higher significant difference between the mean values was found; also there was a high significant difference between the two genders because the mean values of the maxillary sinus height for males were significantly higher than that for females. This study disagree with Parks [(1)] study who made measurements for the maxillary sinuses of normal Korean adults resulted with mean values of maxillary sinus length, width, and height in males (40.67 ± 4.53 mm), (29.67 ± 6.18 mm), (47.88 ± 5.98 mm), and in females (38.86 ± 3.23mm), (27.18 ± 4.35 mm), (45.5 ± 4.47 mm) respectively. Since these findings were higher than that reported in the current study and this may be due to ethnic variations. Another study done by Fernandes [(2)] who studied the maxillary sinus in European and Zulu using computed tomography and he found that mean value of maxillary sinus length, width and height in European males were (40.53 mm), (25.26 mm), (37.8 mm) and in European females were (38.3 mm), (23.96 mm), (35 mm) respectively; while in Zulu the maxillary sinus length, width and height were (35.5 mm), (20.57 mm), (32 mm) for males, and (34.46 mm), (22.34 mm), (30 mm) for females respectively. The length and height of Europeans were obviously higher than that of the present findings, while the width of Europeans was lower than that recorded in the present study, which may be due to different ethnicity. On the other side, all the dimensions of Zulu sinus (except the length of female sinus) were lower than that of the present findings; moreover Zulu male sinuses were narrower than Zulu female sinuses (which disagree with the present study) and race was found to be highly significant, with European sinuses being wider than Zulu sinuses. It is noted that the two previously mentioned studies agree with the present study in that maxillary sinus measurements in males were significantly higher than that of females (except in Zulu), and this could be due to sex-specific differences in energetic intake, nutrition, body composition and genetics that explained by Teke et al [(15)]. In the present study, group 1 of maxillary sinus found with the highest value among other age groups in only one parameter, which was the length of left sinus in females. On contrary, group 1 found with the lowest value among other age groups in other two parameters; length of right sinus in males and width of right sinus in females. From these results, this study might show that the maxillary sinus of group 1 is still in growing state and not reaching its full size. Regarding group 2 of this study, it was demonstrated with the highest value among other age groups in four parameters; length of right sinus in males, width of left sinus in females and width of right sinus in both sexes. On the other side, group 2 reported with the lowest value among other age groups in five parameters; length of right sinus in females, length of left sinus in both sexes, width of left sinus in males and height of left sinus in females. According to the previous results, group 2 showing an extensive growth in maxillary sinus length and width, especially on the right side. Group 3 revealed as the highest value among other age groups in three parameters that including; length and height of left sinus in males and height of right sinus in females. On the other side, group 3 noted with the lowest value among other age groups in only one parameter that was the height of right sinus in males. Therefore, from these results, group 3 might partly showing growth in maxillary sinus length and height, which indicates that at this age the maxillary sinus reaches its full height. According to the results of the present

study, group 4 revealed with the highest value among other age groups in four parameters; length of right sinus in females, width of left sinus in males, height of right sinus in males and height of left sinus in females. Also, group 4 revealed with the lowest value among other age groups in four parameters; width of right sinus in males, width of left sinus in females, height of left sinus in males and height of right sinus in females. Due to these results, group 4 might partly indicates that the maxillary sinus reaches its full growth if it fails to reach it in the group 3.

Conclusion

The anatomical measurements of the maxillary air sinus dimensions may be of great value in support the age, gender and race or ethnic for determination of alive or dead persons.

Table (1):- Distribution of Participating Human Cadavers According to Age and Gender.

Groups	Age	Male No.	Female No.	Total No.
Group 1	20 – 29 years	16	14	30
Group 2	30 – 39 years	14	11	25
Group 3	40 – 49 years	13	12	25
Group 4	50 – 59 years	15	15	30
Total		58	52	110

Table (2):- Maxillary Sinus Measurements for Both Sexes.

	Male		Female		Both Sexes	
	Range	Mean±SD	Range	Mean±SD	Range	Mean± SD
Right maxillary sinus length (mm)	(27.2 – 41.3)	35.6±5.1	(22.1 – 40.2)	33.2±4.3	(22.1 – 41.3)	34.4±4.7
Left maxillary sinus length (mm)	(28.4 – 47.5)	37.3±4.1	(27.1 – 43.6)	34.7±4.2	(27.1 – 47.5)	36.0±4.1
Right - left maxillary sinus length (mm)	(27.2 – 47.5)	36.4±4.6	(22.1 – 43.6)	33.9±4.2	(22.1 – 47.5)	35.2±4.4
Right maxillary sinus width (mm)	(18.1 – 34.2)	28.3±3.8	(14.5 – 33.7)	24.2±3.7	(14.5 – 34.2)	26.2±3.8
Left maxillary sinus width (mm)	(20.5 – 38.3)	26.5±3.9	(19.7 – 30.7)	26.7±4.1	(19.7 – 38.3)	26.5±4.0
Right - left maxillary sinus width (mm)	(18.1 – 38.3)	27.4±4.0	(14.5 – 33.7)	25.3±3.9	(14.5 – 38.3)	26.3±3.9
Right maxillary sinus height (mm)	(22.6 – 40.2)	33.2±3.8	(18.2 – 37.8)	29.7±3.6	(18.2 – 40.2)	31.3±3.7
Left maxillary sinus height (mm)	(21.4 – 47.5)	36.7±4.0	(23.1 – 42.7)	32.8±3.7	(21.4 – 47.5)	34.7±3.8
Right - left maxillary sinus height (mm)	(21.4 – 47.5)	35.1±3.9	(18.2 – 42.7)	30.8±3.6	(21.4 – 47.5)	33.0±3.7

* SD= Standard Deviation

Table(3):- Age Difference of Maxillary Sinus Measurements for Both Sexes.

		Group 1		Group 2		Group 3		Group 4	
		Range	Mean±SD	Range	Mean±SD	Range	Mean±SD	Range	Mean±SD
Male	Right maxillary sinus length (mm)	(29.4 – 40.5)	34.1±4.6	(32.1 – 39.7)	37.2±4.8	(27.2 – 41.0)	35.7±5.3	(30.4 – 41.3)	35.4±5.7
	Left maxillary sinus length (mm)	(28.4 – 45.4)	38.2±3.8	(28.8 – 44.6)	35.3±4.3	(30.3 – 47.5)	39.2±3.9	(29.1 – 46.5)	36.5±4.4
	Right maxillary sinus width (mm)	(18.1 – 33.6)	28.6±4.1	(19.4 – 34.2)	31.1±3.7	(21.1 – 33.7)	27.4±4.2	(20.2 – 31.9)	26.1±3.2
	Left maxillary sinus width (mm)	(22.4 – 37.1)	26.9±3.7	(20.8 – 35.6)	25.4±4.0	(20.5 – 38.0)	26.1±3.8	(21.6 – 38.3)	27.6±4.1
	Right maxillary sinus height (mm)	(24.1 – 38.4)	34.1±4.0	(23.0 – 40.1)	33.3±3.8	(22.8 – 39.6)	30.7±3.7	(22.6 – 40.2)	34.7±3.7
	Left maxillary sinus height (mm)	(21.8 – 44.8)	37.4±3.9	(21.4 – 46.1)	36.5±4.2	(23.1 – 45.4)	38.2±4.1	(24.6 – 47.5)	34.7±3.8
Female	Right maxillary sinus length (mm)	(22.1 – 40.2)	32.1±4.0	(22.6 – 37.5)	31.7±3.8	(24.2 – 38.6)	33.4±5.7	(23.2 – 39.1)	35.6±3.7
	Left maxillary sinus length (mm)	(28.2 – 43.6)	36.2±4.2	(27.7 – 41.2)	33.6±4.3	(27.1 – 40.9)	35.4±3.9	(29.4 – 42.0)	33.6±4.4
	Right maxillary sinus width (mm)	(16.1 – 33.7)	23.1±3.3	(15.3 – 31.7)	26.1±4.0	(15.2 – 32.0)	24.4±4.0	(14.5 – 29.4)	23.2±3.5
	Left maxillary sinus width (mm)	(21.2 – 30.6)	27.3±4.1	(19.7 – 29.7)	28.1±3.9	(22.2 – 28.8)	26.7±4.2	(20.8 – 30.7)	24.7±4.2
	Right maxillary sinus height (mm)	(19.1 – 37.8)	30.2±3.8	(20.2 – 36.1)	31.5±4.0	(21.3 – 35.5)	32.5±3.5	(18.2 – 35.6)	24.6±3.1
	Left maxillary sinus height (mm)	(23.1 – 40.0)	31.8±3.6	(25.6 – 42.7)	30.7±3.7	(24.5 – 39.1)	33.3±3.5	(26.2 – 38.8)	35.4±4.0

* SD= Standard Deviation

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