ISSN Print: 2394-7489
ISSN Online: 2394-7497
IJADS 2023; 9(2): 203-209

www.oraljournal.com
Received: 08-01-2023
Accepted: 20-02-2023

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An innovative facet in gender determination of regional population: A cross sectional study

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DOI: https://doi.org/10.22271/oral.2023.v9.i2c.1729

Abstract
Background: Maxillary sinuses have reportedly survived mass disasters despite the skull and other bones being severely damaged. Forensic odontology relies heavily on radiography to identify individuals. The largest and earliest to form among the paranasal sinuses is the maxillary sinus. In order to identify skeletal remains and determine gender, sinus radiography has been performed.
AIM: To determine shape, height and width of maxillary air sinus and their possible corelation to gender determination.
Methods: Total of 52 panoramic radiographs were taken and were divided into male and female groups. the radiographs were traced for the shape of maxillary sinus and height and width were determined. Both dentate and partially dentate were included in this study. There were 8 shapes reported. The values obtained after determining the height and width were subjected to statistical analysis.
Results: The mean height of male right and left maxillary sinuses are 26.85±5.1mm and 27.82±8.3 mm respectively, and for women, 26.62 ±5.7 mm; 25.79 ±5.11mm respectively. The width of the sinuses for men are 33.14±6.7 mm; 32.67± 8.5mm respectively, and for women, 34.06±6.05 mm; 32.65±7.12 mm respectively. There are 7 shapes documented in the left side of maxillary sinus, namely, ovoid, rectangular trapezoid, cloudy, square, triangle and round. Out of which 25% is rectangular in shape, 26% are ovoid in shape, 12% shows triangular shape, 12% square shape, 7% are cloudy and round and 11% are trapezoid.
There are 8 shapes reported in the right side of the maxillary air sinus. Out of which 32% reported with ovoid shapes, 21% depicted rectangular shapes, 12% presented trapezoidal shape, 7% showed cloudy shape, 2% revealed square shape, 12% showed triangular shape, 12% presented with round shape and 2% showed pyramidal shape.
Conclusion: In this particular study, the left side of the sinus can be used to identify the gender. A correlation between gender and the shape of the maxillary air sinuses on the right and left side is attempted, however the result is non-significant. Hence, it can be concluded that morphometric analysis of maxillary sinus plays crucial role in gender determination.

Keywords: Innovative facet, determination, cross sectional

Introduction
The first paranasal sinus that develops, the maxillary sinus, is situated in the body of the maxilla, commonly referred to as the "Antrum of Highmore" [1]. It begins to form in the seventeenth week of pregnancy. By the end of the eighth year, it has grown to half its final size, and by the end of the sixteenth year, all of its diameter and volume have achieved their maximum values [2]. It might differ based on racial and sexual categories of people (Fernandes). The sinus is described as having a pyramidal shape in anatomical textbooks. It has four sides, with the lateral wall of the nose serving as the sinus' base and the zygomatic process as its apex (Standring, 2016).
The statistical parameters used in the human identification process are linked to qualitative and quantitative data aspects like species, sex, age, height, and racial group [3].

The first step in this identification process, along with the age and stature estimation techniques, frequently involves determining the gender in adult skeletons. There are various ways for determining sex [4] and the accuracy of the sex determination depends on the skeletal remains and the level of sexual dimorphism present in the population [5].

The anatomical part of the body that displays the most sexual dimorphism, with an accuracy of above 92% in the pelvis and the skull [6], favours a single necropsy of their anatomical components that can be supplemented with imaging tests. These include the defined chambers found within the maxillary bone known as the maxillary sinuses by the alveolar ridge, the wall of the nasal passageways, the orbital floor, the roots of the back teeth, and the maxillary tuberosity connected to the infratemporal and pterygomaxillary fossa [7].

Lerno classified shapes of maxillary sinus into triangular, oval, curved, rectangular and square shapes while shapes of its base were classified into triangular, leaf, scapular and renal shape [8].

One of the most used imaging methods in forensic dentistry, panoramic radiography offers a broad picture of the craniofacial complex. The use of dental radiographs with measurements of the maxillary sinus dimensions to ascertain gender during individual human identification, however, is not well studied.

AIM

This study aims to determine the dimensions of maxillary air sinus right and left side and also its shape and their possible application in the sex determination.

Material and Methods

This research project is carried out at Department of Prosthodontics, in Navodaya dental college and hospital, Raichur. Total sample size for this study included is 52, which included 26 men and 26 women. Selected age group is 20 -50 years.

The radiographs having positional and magnification errors were excluded during selection process. The panoramic radiographs were taken with KODAK 8000 care-stream machine with exposure parameters 73kVp, 12mA, 13.9 seconds.

Inclusion criteria

1. Patients between 20 to 50 years are included
2. Both dentate and partially dentate patients are included.

Exclusion Criteria

1. Edentulous patients are excluded
2. Panoramic radiographs with positional and magnification errors are excluded
3. Any radiographic evidence of pathologies or malformations of maxillary air sinus are excluded.

Determination of shape of right and left side of sinus

The total of 52 hardcopies of panoramic radiographs are collected from department of oral medicine and radiology, Navodaya dental college, Raichur and Private practioners of Raichur and their shapes are outlined. The contour of medial wall, posterior wall, floor and an imaginary line connecting the superior points of medial and posterior walls are outlined on cephalometric tracing sheet. There are 8 types of shapes of maxillary air sinus are observed. The shapes include cloudy, rectangle, round, trapezoidal, square, ovoid and triangular.

Determination of height and width of right and left side of sinus

To measure the length and width of the maxillary air sinus, 10-mm long orthodontic wires are set near the right and left maxillary sinuses of this skull, one horizontally and one vertically. Using these wires, the measurements are noted.

Two vertical lines, parallel to the left lateral extremity of the limiting rectangle of the panoramic radiograph image, are created to the distal limits of each maxillary sinus.

Following that, lines parallel to the horizontal ones were drawn, passing over the floors of the orbits' distal limits till each sinus' mesial limits to determine their width. For the height, the centre of each horizontal line, until the floor of each maxillary sinus, is used [9].

The dimension values of the maxillary sinuses related to the analysis are fed to an Excel spreadsheet.

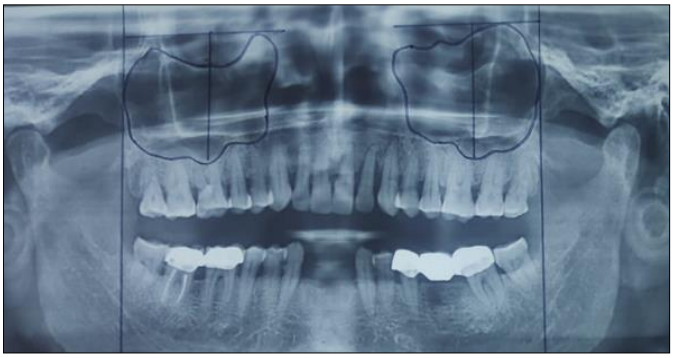


Fig 1: Measurement of width and the height of maxillary sinus in panoramic radiograph

Results

Data collected is entered into an Excel sheet and analysed using the IBM SPSS statistics 20.0 (IBM Corporation, Armonk, NY, USA). Results on continuous measurements is presented on Mean± SD. Chi Square test is used to find the association of study parameters between the groups.

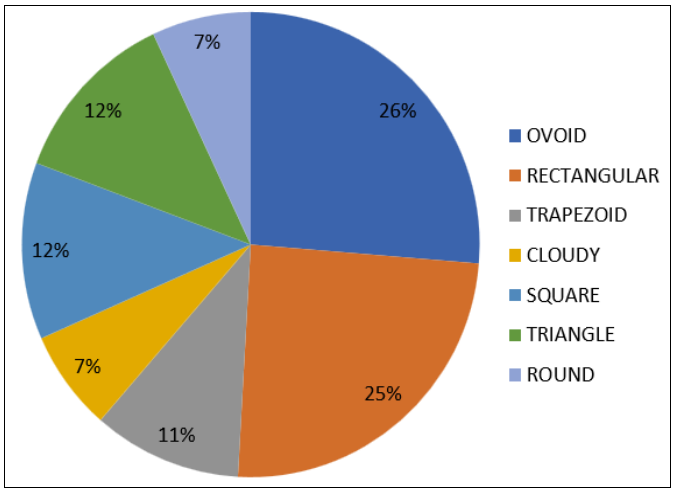


Fig 2: pie diagram of classification of maxillary antrum by shape left side

There are 7 shapes documented in the left side of maxillary sinus, namely, ovoid, rectangular trapezoid, cloudy, square, triangle and round. Out of which 25% is rectangular in shape, 26% are ovoid in shape, 12% shows triangular shape, 12% square shape, 7% are cloudy and round and 11% are trapezoid.

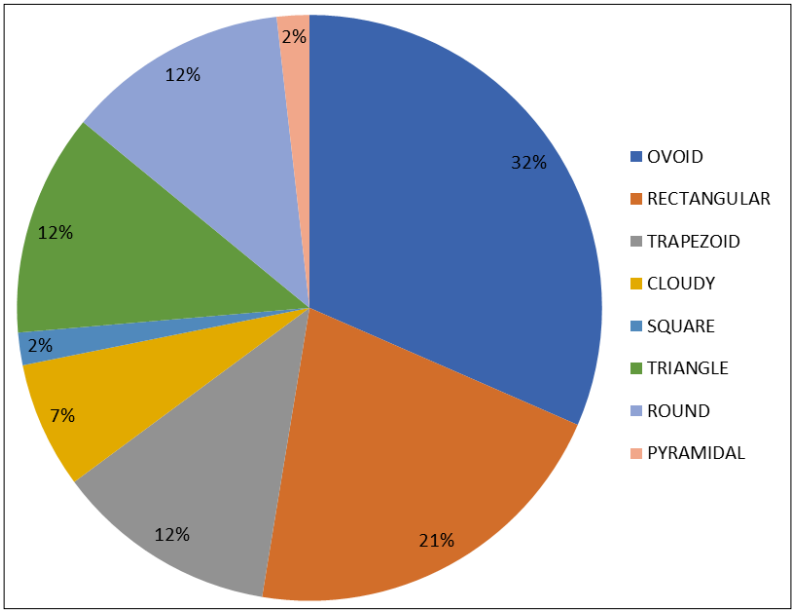
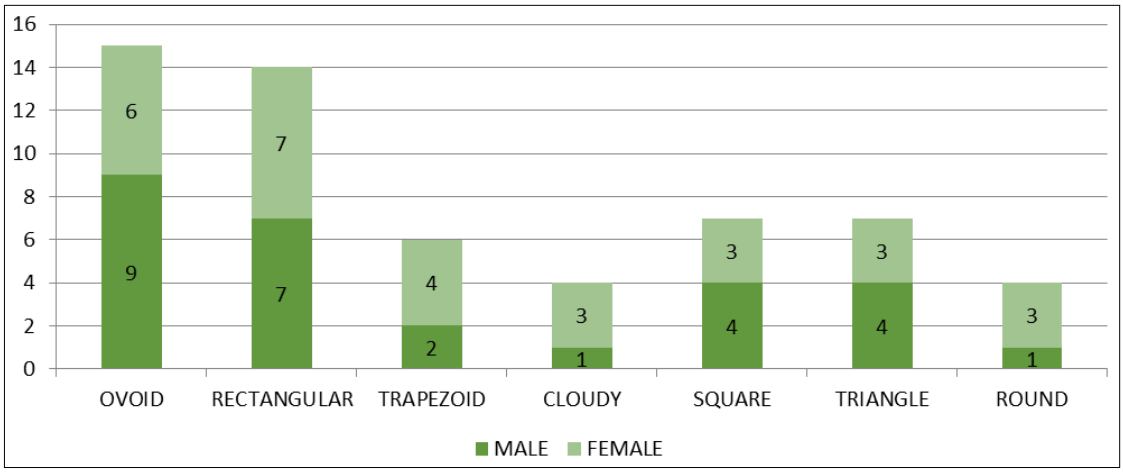


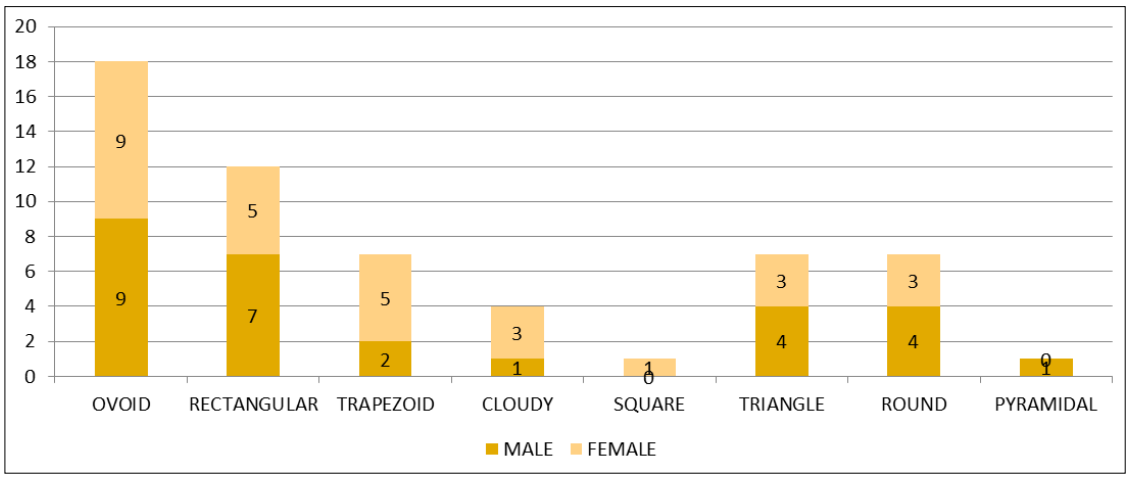
Fig 3: Pie diagram of classification of maxillary antrum by shape right side

There are 8 shapes reported in the right side of the maxillary air sinus. Out of which 32% reported with ovoid shapes, 21% depicted rectangular shapes, 12% presented trapezoidal shape, 7% showed cloudy shape, 2% revealed square shape, 12% showed triangular shape, 12% presented with round shape and 2% showed pyramidal shape.



Graph 1: Association of gender and shape (Left side of maxillary sinus} $\chi^2 = 3.536$, p value =. 739

Ovoid shape of maxillary air sinus is predominantly found in the left side for the males and least appearance of cloudy and round shape is noticed in the left side of maxillary sinus
Females have shown equal distribution of cloudy, square, triangle and round shape in the left side of the maxillary air sinus. This shows that there is dimorphism in the shape of the sinus among the genders {graph -1}.



Graph 2: Association of gender and shape (Right side of maxillary sinus) χ^2=4.889, p value =. 674

Males and females have shown equal distribution of ovoid shape in right side of maxillary air sinus. The least appearance of pyramidal shape in right side of maxillary air sinus in males whereas least appearance of square shape in females {Graph -2}

Table 1: Mean and SD of Height and Width of Right and Left side of Maxillary sinus gender basis

Gender	Height of left side of maxillary sinus		Width of left side of maxillary sinus		Height of right side of maxillary sinus		Width of right side of maxillary sinus	
	Mean	Std	Mean	Std	Mean	Std	Mean	Std
Female	25.79	5.11	32.65	7.12	26.62	5.7	34.06	6.05
Male	27.82	8.3	32.67	8.5	26.85	5.1	33.14	6.7

The data obtained by means of descriptive analysis showed that the width of maxillary sinus for female right and left sides are 34.06mm and 32.65mm respectively, whereas for males right and left sinus width are 33.14mm and 32.67mm. For the height of maxillary sinus for female right and left sides are 26.62mm and 25.79mm respectively, whereas for males right and left height are 26.85mmand 27.82mm {table 1}.

Shapes of Maxillary Sinus

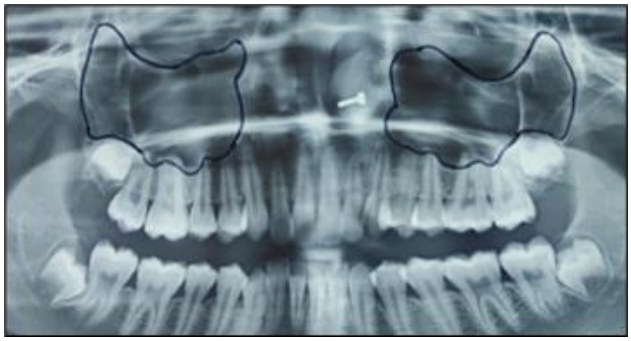


Fig 4: Cloudy shape of maxillary sinus

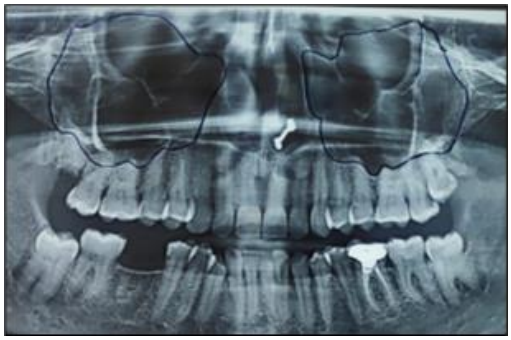


Fig 5: Square shape of maxillary sinus

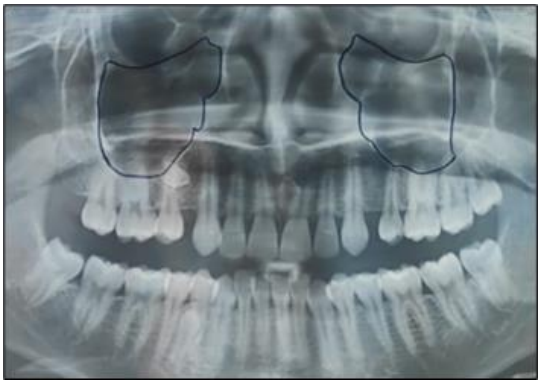


Fig 6: Triangle shape of maxillary sinus

Fig 7: Ovoid shape of maxillary sinus

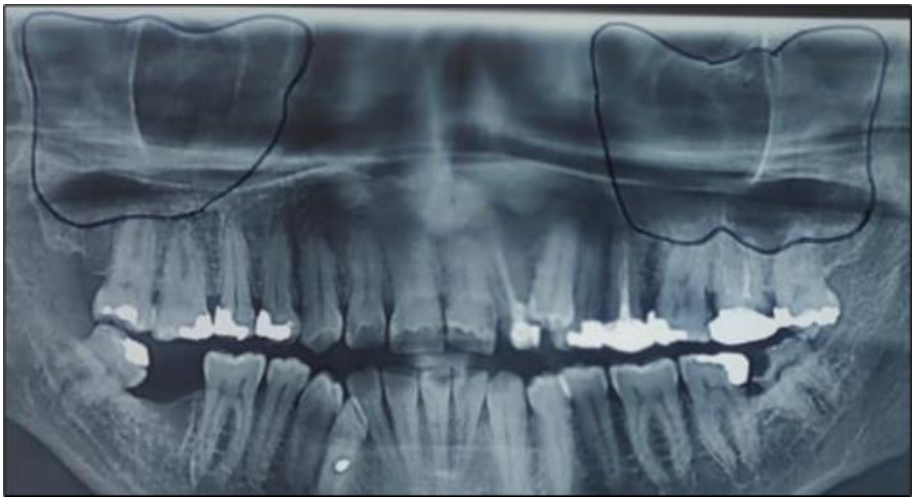


Fig 8: Trapezoid shape of maxillary sinus

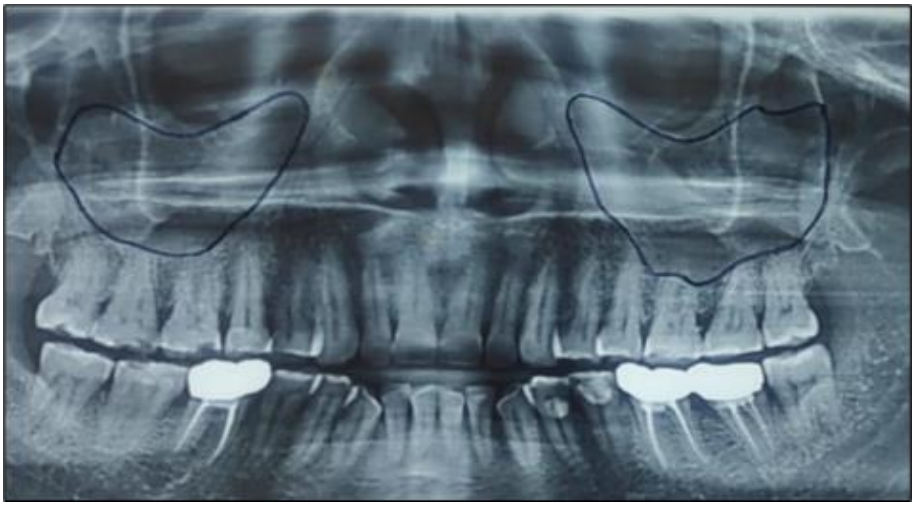


Fig 9: Round Shape of maxillary Sinus Right side

Fig 10: Rectangle shape of maxillary sinus Left side

Discussion

The maxillary sinuses became the focus for this investigation because they exhibit characteristics that imply, they can be utilised to identify human remains [10], aiding, for example, in sex determination. Although anatomical portions overlap [11] on panoramic radiographs, which are two-dimensional images, they nonetheless provide visualisation of all teeth, the maxilla, the jaws, and several facial bones in a single exposure [12]. As a result, they are frequently utilised in a variety of dental specialties [13]; this inspired us to utilise them in our work.

The maxillary sinus is the anatomical structure that might be challenging to assess when its radiography image is viewed by a less experienced specialist [14].

When the skeleton is incomplete, the width and height of the maxillary sinuses can be utilised in conjunction with other bones to establish the gender [15]. Maxillary sinuses are known to exhibit morphological differences between sexes, and this could be seen in the current investigation.

In the present study with panoramic radiographs, that used manual technique to obtain the measurements, the mean height of male right and left maxillary sinuses are 26.85±5.1mm and 27.82±8.3 mm respectively, and for women, 26.62 ±5.7 mm; 25.79 ±5.11mm respectively. The width of the sinuses for men are 33.14±6.7 mm; 32.67± 8.5mm respectively, and for women, 34.06±6.05 mm; 32.65±7.12 mm respectively.

Thus, it is possible to infer that subjects with maxillary sinuses higher than 36 mm and wider than 41mm are male, whereas when they are less than 32mm high and less than 40mm wide, it is likely that the subject is female.

As per the results obtained from this study, left side of maxillary sinus is higher in males than females and also have wider maxillary sinus of the left side in males when compared to females.

This study reveals that height of the right side of sinus in males and females does not have significant difference. Right side of maxillary sinus is higher and wider than the left side in females.

The current study shown that both the height and the breadth of both sinuses are significant for the distinction between sexes, which is consistent with the findings of Uthman *et al*., who noted that the height of the left sinus was the best variable to discriminate between sexes [16].

In support of the current study, Teke *et al*. also discovered that male maxillary sinuses have larger mean heights than female ones [17].

The width, depth, height, and volume of the maxillary sinuses in the Masri *et al*. study were all larger in the male samples than the female ones [18]. These results are consistent with

those of Kawari *et al*., who discovered that men have broader sinuses [19].

In alignment with the findings of the current study, Jasim & Al-Taei, who also used a dentulous group as a sample, obtained the following mean values for the width and height of the right and left maxillary sinuses and reported that male maxillary sinuses are wider, deeper, and higher, as well as having more volume than the female ones [20].

In contrast to panoramic radiographs, which only produce two-dimensional images, CT scan studies produce three-dimensional ones. However, there was general agreement that males have larger maxillary sinuses than females. This study's additional pertinent discovery is that, if there is at least one maxillary sinus, it is still possible to identify a person's sex even if their skull is shattered. In consensus with this study, the data obtained with the attempt made to corelate the shape of sinuses {right and left side} to determine gender is non-significant. Hence it can infer that the shape does not aid in the gender prediction and although height and width of the sinus contribute significantly in determination of gender.

Within the limitation of this study, the variations between the studies could be attributed to the use of various measuring techniques, areas or reference points, sample sizes, inclusion criteria, or types of analyses.

Additionally, this study was conducted in a location with a range of physical characteristics, including body stature, ancestry, body type, environmental factors, sinus pneumatization in different age and sex groups, and the presence or lack of teeth. The application of CBCT is not considered for this study owing to its cost and affordability by the subjects.

Evidence of relation between maxillary air sinus and malocclusion: There have been wider maximum maxillary sinus dimensions observed in people with skeletal Class II malocclusion Therefore, the maxillary sinus dimensions are bigger in Class I–II patients and narrower in Class III patients [21].

Prosthodontic Significance

In the maxillary posterior region, the extraction of posterior teeth causes sinus pneumatization, which lowers the height of the bone tissue and makes prosthetic rehabilitation challenging, sometimes necessitating further adjunctive operations. By layering osteoid that is inferior to it and osteoclastic degradation of the sinus' cortical walls, pneumatization takes place. Due to the wider socket in the molar region, it is frequently observed after maxillary molar extraction. The maxillary sinuses can expand as a result of tooth loss, joining the sinus floor to the crest of the remaining alveolar ridge. Rather than sinus depth, this expansion is connected to sinus height and length. The prosthetic rehabilitation is made possible by adjunctive operations including direct and indirect sinus lifts and augmentation procedures.

Conclusion

Since men have higher mean values of height and width, for both sinuses, than women, the dimensions of the maxillary sinuses in panoramic radiography images, such as height and width, can be used to detect sex in adults. In this particular study, the left side of the sinus can be used to identify the gender. A correlation between gender and the shape of the maxillary air sinuses on the right and left side is attempted, however the result is non-significant. it can be concluded that morphometric analysis of maxillary sinus plays crucial role in gender determination.

Acknowledgement
Not available

Author's Contribution
Not available

Conflict of Interest
Not available

Financial Support
Not available

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How to Cite This Article
Dr. Nidawani P, Dr. Singh S, Dr. Sai S, Dr. Sufiya S, Dr. Galagali G. Acellular dermal matrix in the treatment of multiple mandibular gingival recessions. International Journal of Applied Dental Sciences 2023; 9(2): 203-209