

MAXILLARY AIR SINUS- A STUDY ON SEPTAL VARIATION

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ABSTRACT

BACKGROUND

Maxillae are the largest of facial bones, jointly form whole of upper jaw and bears the sockets of upper jaw teeth. Maxillary air sinus is contained within the body of maxilla, which is roughly pyramidal in shape. The size is variable and is different on both sides. Maxillary sinus has great importance in clinical settings due to various diseases and injuries it suffers from. Maxillary sinus septae are barriers of cortical bone that arise from floor or from the walls of the sinus. The septa may partially or completely divide the sinus into two or more cavities. It may be either bony or membranous. They can be located in any region of maxillary sinus and their size also varies. Recognition of septa and its location are clinically relevant for floor elevation and sinus surgeries of maxillary sinus.

This study is conducted to examine and analyse the prevalence and morphology of maxillary sinus septa in formalin embalmed cadavers.

MATERIALS AND METHODS

For the purpose of study, 15 female and 15 male adult cadaver head specimens fixed in 40% formalin were used. Cadavers for dissection were obtained from the Department of Anatomy, Government Medical College, Kottayam. The maxillary septae were studied in detail, analysed and photographed.

RESULTS

Based on the study of 30 specimens, the degree of prevalence of sinus septa is 6% in cadaver observation method. The number of septa found in this study is 16.67% and 13.33% for male and female populations respectively in cadaver observation method.

CONCLUSION

To avoid complications during sinus lifting, a meticulous study of the sinus is necessary for identifying and locating septa.

KEYWORDS

Maxilla, Maxillary Sinus, Maxillary Septae, Maxillary Ostium.

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BACKGROUND

The maxillary sinus is a pneumatic cavity of the facial skeleton within maxillary bone and was first described by Leonardo da Vinci in 1489. They are two spaces which are filled with air, located in the maxilla and can be of various sizes and shapes. It was also referred as antrum of Highmore in honour of English Anatomist Nathaniel Highmore who in 1651 described the sinus. The maxillary sinus is largest and most constant of four paranasal sinuses,¹ whose function is believed to reduce the weight of skull, add resonance to voice, allowing enlargement of local areas of skull. Their walls are thin. It is pyramidal in shape. Average adult measurements is 36 – 45 mm in height, 38 – 45 mm

in length, 25 – 33 mm in width, mean volume is 14.25 cc (10 – 20 mL). Maxillary sinus septae are barriers of cortical bone that arise from floor or from the walls of the sinus. The septa may partially or completely divide the sinus into two or more cavities. It may be either bony or membranous. Most commonly observed are oblique bony septae. They can be located in any region of maxillary sinus and their size can vary between 2.5 and 12.7 mm. The bony maxillary sinuses septa is observed in 13% of females and 35.3% of males respectively.²

Five distinct walls such as anterior, posterior (posterolateral), inferior (floor), superior (roof of sinus) and base (medial wall) have been described for the maxillary sinus.³

The apex of the sinuses can extend into the zygomatic process and can occupy the zygomatic bone.⁴ Superior wall represents majority of floor of orbit and rest of it is being formed by orbital process of palatine bone posterior-medially, zygomatic bone anterolaterally. Groove in the roof is canal for infraorbital nerve and vessels. The floor is formed by the alveolar process of maxilla. The first, second and third molars and roots of canines can elevate the sinuses or may

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perforate their floor.⁵ Because of the close relationship with the dentition, dental diseases can cause maxillary infection, tooth extraction can result in oroantral fistula.⁶ The floor varies in its level. Anterior wall is facial surface of maxilla and facial vein and artery run on it. Medial to this is thin incisive fossa. The medial wall or base of pyramid forms lateral wall of nasal cavity. It bears maxillary hiatus, which is an irregular opening situated postero-superiorly. The maxillary hiatus was reduced to a small opening (natural ostium or principal maxillary ostium) by part of lacrimal bone anterosuperiorly, uncinated process of ethmoid from above, maxillary process of inferior turbinate from below and perpendicular plate of palatine bone posteriorly. Remaining defect is closed by mucosa from nasal cavity and maxillary sinus to form two fontanelles. The ostium varies widely in size and shape. The average is 2.4 mm, but can vary from 1-17 mm.

Evolution is a gradual process in which man attained erect posture, whereby the principal or main ostium came to be located at a higher level. Consequently, drainage is no longer due to gravity. Maxillary sinusitis is therefore the demerited gift of erect posture.

Aims and Objectives

1. To examine the number, morphology, location of maxillary sinus septa on right and left sides.
2. To analyse the prevalence of maxillary sinus septa in male and female cadaver.

MATERIALS AND METHODS

For the present study, 30 cadaver heads (60 maxillary sinuses) of adult population were obtained from Department of Anatomy, Medical College, Kottayam. The study was done for a period of six months- November 2016 - April 2017. The maxillary septae were studied in detail and measurements were taken, analysed, tabulated and photographed. It was compared with the previous studies in literature.

The specimens were stored in 10% neutral formalin for 1 - 6 months. Among them 15 heads were of male and 15 heads were female of South India. All examinations were done in a standardised manner with due respect to the cadaver. The head was separated from the rest of the body for ease of handling by dissecting out at the prevertebral region and by ligating the great vessels and tubular structures at the root of neck. The head was sectioned parasagittally with an electric band saw to expose the nasal cavity. The location of maxillary sinus ostium was noted in relation to hiatus semilunaris with a sliding Vernier calliper by keeping the head in Frankfurt's plane and the distance between maxillary sinus ostium and nasal floor was measured. The superior concha, middle concha and inferior concha with corresponding meatuses were observed in the lateral wall. Scissors were used to remove middle concha and a curved slit was identified in the middle meatus (Hiatus Semilunaris) and ostium of the maxillary sinus.

Bone forming the medial wall of the sinus was removed to see the intact layer of mucous membrane inside the sinus. With a bone cutter, the part of the rim of the orbit forming

the roof of the sinus is dissected. Interior of the sinus was illuminated with light source for direct observation of the sinus. Sinus was inspected for the presence of septa from the medial aspect.

The height of the septa was measured as distance from the sinus floor taking the more inferior point of the two possible sides of the septum. To identify a real septum in contrast to a bottom lath of the sinus floor after a loss of teeth, a minimum level of 2.5 mm was set as critical value. Data was documented. Maximum callipers' inferior dimension (height) and maximum posteroanterior measurements (length) were taken. Probe and forceps were used to remove bony and cartilaginous part of nasal septum and the remaining mucosa that lines the other side of nasal septum. The measurements were taken and tabulated. Chi-square test was done to analyse the difference in prevalence between left and right sides. The difference among male and female was also noted.

Inclusion Criteria

Adult Male and Female cadavers were included in this study for direct observation and measurements of maxillary sinuses.

Exclusion Criteria

Injury or chronic diseases including tumours in maxilla or maxillary sinus as well.

RESULTS AND OBSERVATIONS

The prevalence of septa found in the present study is 16.67% and 13.33% for male and female population respectively as shown in Table 1 and Figure 1. There was no significant difference for the degree of prevalence of maxillary sinus septa in male and female on the right side, Table 2. The prevalence of septa in left maxillary sinus was more in male compared to female. Refer Table 3. It was observed that the septa are of two types, bony and membranous. Out of the 9 cases, 5 are complete bony septa and 3 are incomplete. The complete bony septa are obliquely placed in 2 cases (Figure 2 and Figure 3) and transversely placed in (Table 4 and Figure 4). The oblique septa was found towards anterior part of sinus dividing the cavity into small anterosuperior part and large posteroinferior part. It was also observed that bony and membranous septum was found in the same specimen, one above the other in one case on the right side (Figure 5). The upper one was bony and lower one was membranous and the membranous septa were incomplete. The incomplete bony septa in one of the specimens showed three incomplete bony ridges towards the floor of the sinus dividing the space into a number of recesses (Figure 6). The maxillary sinus and septae are covered by thickened mucoperiosteum and opens through the maxillary hiatus (Figure 7) into the middle meatus of the nose at the hiatus semilunaris.

Septa	Male		Female		Total	
	N	%	N	%	N	%
0	25	83.33	26	86.67	51	85
1	5	16.67	4	13.33	9	15
Total	30	100	30	100	60	100

Table 1. Prevalence of Septa in Maxillary Sinus

$\chi^2 = 0.131$, $df = 1$, $p = 0.718$



Figure 1. Shows Oblique Bony Maxillary Sinus Septa

Septa	Male		Female		Total	
	N	%	N	%	N	%
0	12	80	12	80	24	80
1	3	20	3	20	6	20
Total	15	100	15	100	30	100

Table 2. Prevalence of Septa in Right Maxillary Sinus

$\chi^2 = 0.000$, $df = 1$, $p = 1.0000$

Septa	Male		Female		Total	
	N	%	N	%	N	%
0	13	86.7	14	93.3	27	90
1	2	13.3	1	6.7	3	10
Total	15	100	15	100	30	100

Table 3. Prevalence of Septa in Left Maxillary Sinus

$\chi^2 = 0.370$, $df = 1$, $p = 0.543$

	Bony		Membranous	
	Complete	Incomplete	Complete	Incomplete
Number of Cases	5	3	0	1
Percentage of Cases	16.66	10	0	3.33

Table 4. Different Types of Septae- Number and Percentage



Figure 4. Shows Maxillary Sinus Septum (MSS)

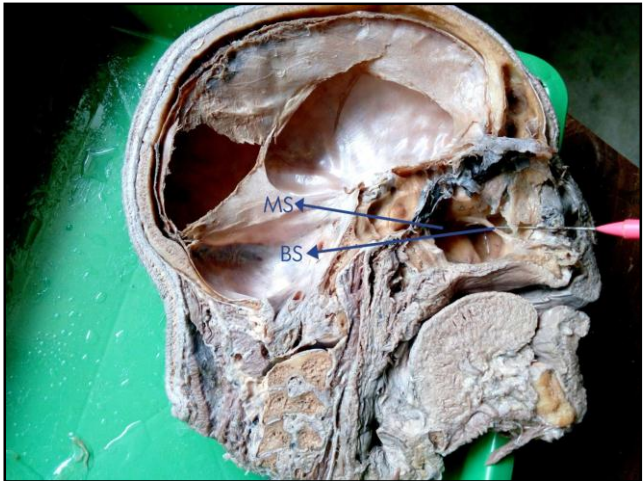


Figure 2. Shows an Oblique Bony Sinus Septa (BS) in the Anterior Part of Left Maxillary Sinus (MS)

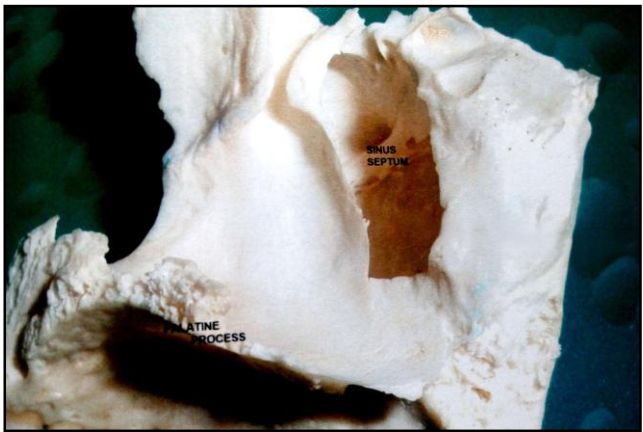


Figure 3. Shows Oblique Bony Sinus Septa on Right Side

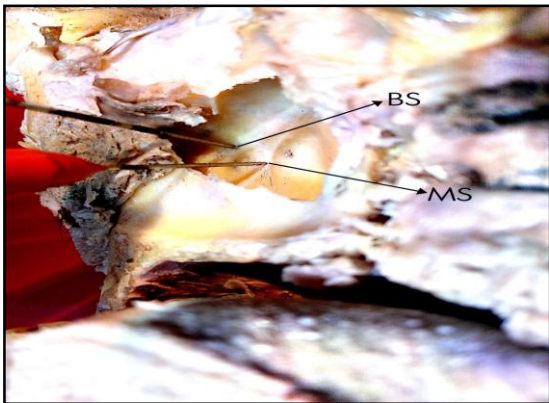


Figure 5. Shows Bony Septa (BS) and Membranous Septa (MB)

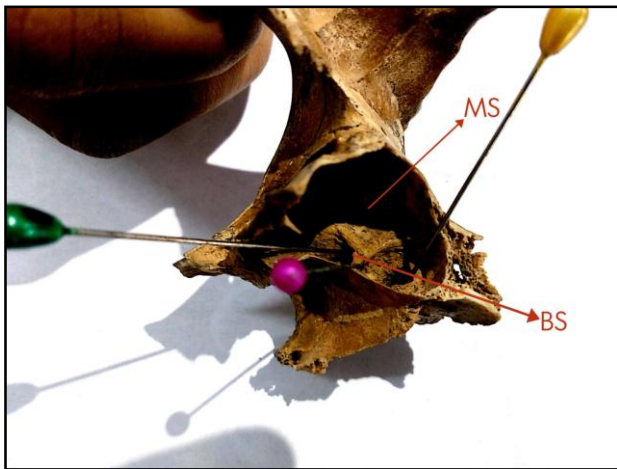


Figure 6. Shows Bony Septa (BS) arising from the Floor of the Maxillary Sinus (MS)

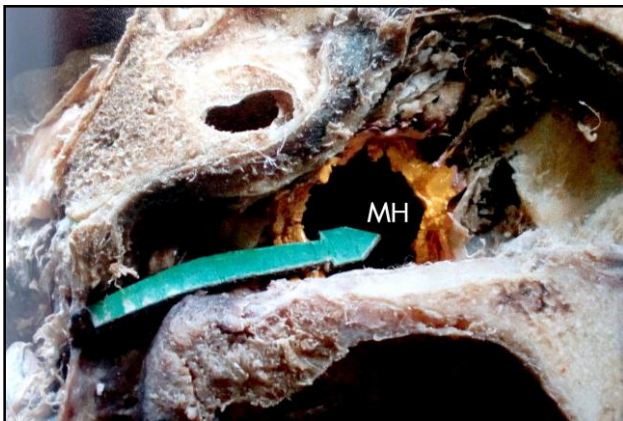


Figure 7. Showing Maxillary Hiatus (MH)

DISCUSSION

In the present study, the presence of sinus septa was identified in the area of maxillary sinus. The research has selected samples with a lower age limit of 18 yrs. By setting lower age of 18 it could avoid the chances of missing out fully developed maxillary sinuses, as it has been reported that the maxillary sinus may achieve its full adult size only by the period of late teens. The age group of more than 65 yrs. were excluded in view of getting samples with normal sinus configuration and to limit the possibility of errors.

Embryological Basis- Although maxillary sinus is first to develop, it does not reach full adulthood until after the eruption of permanent teeth. Paranasal sinuses appear as diverticula from the nasal cavity. Maxillary sinus appears before birth. Maxilla is derived from the maxillary process of first arch. It is ossified in a sheet of mesenchyme appearing in the canine fossa at the sixth week of intrauterine life. Maxillary sinuses appear at the end of second embryonic month. At 12 weeks, turbinate structures have appeared intranasally and palatal fusion has occurred.

The sinus septa are walls of cortical bone within maxillary sinus, may originate during development of maxilla and tooth growth in which case they are known as primary septa or they may be acquired structures resulting from the pneumatization of maxillary sinus after tooth loss, in which case they are called secondary septa. They can be bony or

membranous. The reported prevalence of sinus septa varies from 16% - 58%.⁷ The present study showed prevalence of 16.67% in males and 13.33% in females and bony septa were 8 in number (26.66%) and membranous septa was found in one case (3.33%). The complete bony septa divide the sinus cavity into two compartments reducing the size of the sinus and cause stagnation of secretions predisposing to chronic sinusitis. Septa were first described by Arthur S. Underwood, Anatomist, Kings College, London. The classical theory of sinus septa was introduced by Underwood, later followed by Kim et al. Maxillary sinus can be divided into three regions relating to the Zones of distinct tooth eruption, anterior, middle and posterior. Anterior between second premolar and first molar, middle between first and second molar and posterior distal to third molar. The origin of septa is dental and is due to persistence of the intervening partition when the rest of bony floor sinks down between the dental roots during tooth eruption leading to location of septa between the roots of two adjacent teeth. Two types of septa were described. Primary associated with development of maxilla and secondary due to irregular pneumatization of sinus floor following tooth loss. Secondary septa develop more in the area above last molar teeth, because of earlier extraction of molar teeth than premolar teeth. Research in Korean population with an objective to determine the prevalence, size, location and morphology of maxillary sinus septa in the atrophic/edentulous and non-atrophic/dentate maxillary sinus has reported that the prevalence of one or more septa was between 26.5% - 31.76%. The location of sinus septa also varies according to literature. In the present study of one case shows an oblique septa with three radiating ridges with two recesses into which the roots of premolar and molar tooth were found to be projecting into the floor, which can lead on to impaction and difficulty in extraction of tooth. The location of the septa found in the present study were mostly in the anterior part of the sinus. Maestre-Ferrin et al divided the sinus floor into the anterior area corresponding to premolar area, middle area corresponding to area between superior and first molar and posterior area corresponding to area of the second molar. The sinus division by Maestre-Ferrin et al was accomplished by drawing two straight lines perpendicular to the floor of the sinus equidistant from anterior and posterior walls of the sinus. Thus they obtained anterior, middle and posterior regions. Many authors, Velasquez et al have classified the septa according to location. It is considered primary septa if located superior to maxillary tooth and secondary if located superior to an edentulous ridge. The prevalence of septa can be calculated based on either the number of sinuses, which have septa or on the number of patients who have septa. The cadaver examination has revealed a prevalence of 5% of septa based on the number of sinuses, but based on the number of persons it is found to be 10% (Laura Maestra-Ferrin et al). The present study has found a prevalence of 16.67% for male and 13.33% for female population. A higher prevalence of septa found in men⁸ coincide with the present study, in which the prevalence was more in male. It was reported a higher

prevalence of septa in totally edentulous or atrophic areas than in partially edentulous or non-atrophic ones with statistically significant differences. Another study reported atrophic or edentulous maxillary segments contain secondary septa. The sinus lift operation consist of the preparation of a top hinge window in the lateral maxillary sinus wall. The septum was developed from the finger-like projection produced by the embryologic outpouching of the ethmoid infundibulum of which adjacent walls did not resorb.⁹ Septa can be classified into primary and secondary.¹⁰ The presence of septa located at the inner surface of the maxillary sinus increase the risk of sinus membrane perforation during a sinus elevation for dental implantation surgery.¹¹ This is insinuated inward and upward together with the Schneiderian membrane to a horizontal position forming new sinus floor. The space between the old and new floor is filled with graft material. Another author stated cutting the septa with a chisel and remove with haemostatic forceps, so graft placed without interruption or modify lateral window design to avoid fracture of the septa. If septa are high make two windows one on each side or make a W-shaped window if septa is low. During endoscopic surgery in the maxillary sinus via transnasal approaches, septa may obstruct visibility making a transoral route preferable. In cases where infraorbital nerve was seen in sagittal oriented maxillary sinus septa, accidental injury during sinus or facial procedures may lead to infraorbital nerve palsy. In a study rare anatomical variant in the form of a bony septum crossing the upper part of maxillary sinus, any surgical attempt to break down would result in infraorbital nerve palsy with permanent paraesthesia in maxillary region; nerve is also liable to injury in facial trauma.¹² Radiologists and dentists should be aware of these anatomical variations in maxillary sinus. Rare anatomical variations like the presence of bony trabecula containing the middle superior alveolar nerve in the centre of maxillary antrum should also be kept in mind by radiologists and anaesthesiologists, because complete anaesthesia cannot be achieved by targeting the nerve just in the infraorbital foramen as some of the fibres escape through this bony trabecula. According to one study existence of septa is more than 2.5 mm. Single septum is more common than multiple septa. Septa can be either bony or membranous, oblique or transverse. Another classification into primary or secondary. Septa vary in number, thickness and length and may influence the dental implants and sinus augmentation procedures. Septa can be either bony or membranous, oblique or transverse. Another classification into primary or secondary. Septa vary in number, thickness and length and may influence the dental implants and sinus augmentation procedures.

The size of septa usually increase from lateral to medial segment. Current study has not made any analysis of prevalence of septa based on edentulous or non-edentate status of the persons. There is a wide range of anatomical variations in incidence, location and height of the maxillary septa. Therefore, all surgical procedures in and around the

maxillary sinus should be preceded by adequate radiographical examination and its efficient assessment. The morphological details of maxillary sinus septa like location and anatomical planes will guide dentists in performance of safe implant surgeries.¹³

CONCLUSION

Recognition of prevalence and distribution of maxillary sinus septa is important in order to avoid complications during sinus lift procedures. Advanced knowledge of sinus anatomy and related structures increase the chance of a successful surgery and reduce complications. Knowledge of maxillary sinus ostium is essential for ENT surgeons for drainage of secretions in maxillary sinusitis.

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