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# Normal Anatomical Variations of Maxillary Sinus Septa using Computerized Tomography from Benghazi – Libya

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## Abstract

**Background:** *The maxillary sinus is the largest paranasal sinus and had significant inter-individual variations. CT images are used in the assessment of the maxillary sinus.*

**Aim:** *The aim of this study is to determine the prevalence, location, orientation and height of maxillary sinus septa by using CT images and to assess their relationship with gender.*

**Subjects and Methods:** *Paranasal sinuses CT images of one hundred patients were examined. The location, type, height and orientation of maxillary sinus septa were estimated.*

**Results:** *A total of 200 sinuses were evaluated in the study; the total number of septa were 52 (26%) of the maxillary sinuses, (36.5 %) were present in males and (63.5 %) in females. The primary type of these septa represented 57.7%. The mean height of sinus septum was 3.3±0.63 mm. The most location was in the anterior area (48.1%) and the most observed orientation was medio-lateral orientation (46.2%). There were no significant differences between all features of maxillary sinus septa and gender.*

**Conclusion:** *Maxillary sinus septa appear common and the morphological details particularly their location, will guide the rhinologists for drainage of secretions in maxillary sinusitis and dentists in performance of safe implant surgeries. CT could be useful in pre-surgical planning.*

**Keywords:** *Anatomical variations; Maxillary sinus septa; Computerized Tomography*

## 1. INTRODUCTION

Maxillary sinus septa are bony crests within the sinuses and are referred to as Underwood's septa, because they were first described in detailed anatomy of the maxillary sinus by Underwood in 1910.[1] Even though, Underwood published a detailed description of maxillary sinus anatomy (antrum of Highmore) and classified them into anterior (between the second premolar and first molar), middle (between the first and second molar), and posterior (distal to the third molar). [1,2] Krenmair. [3] further classified the sinus septa into primary and secondary; the primary septa occur along with the development of the maxilla, while the secondary arises as a result of irregular pneumatization of the sinus floor after tooth loss,. Several authors have studied the etiology of maxillary sinus septa. [1-3] Neivert. [2] Proposed that septa were derived from finger-like projections produced by the embryonic out-pouching of the ethmoidal infundibulum. For decades these septa were considered clinically-insignificant anatomical variations but now it's important to understand the maxillary sinus and its anatomical variations. [1,4] The presence of anatomic variations within the maxillary sinus, such as septa, may increase the risk of schneiderian membrane perforation during sinus operations and this represents the most common complication. [5, 6] As such, a detailed knowledge of the anatomy of the sinuses is critical in performing procedures such as functional endoscopic sinus surgery [7].

According to the literature, the prevalence and location of sinus septa varies. The prevalence varies from 16% to 58%. [1, 3& 8] Moreover,

position, number, and depth were extremely variable. [9]

The study was undertaken to estimate prevalence and parameters of sinus septa (heights, locations, type, and orientations) using computed tomography (CT) images and to compare the differences in the parameters of sinus septa among males and females.

## 2. Subjects and Methods

### 2.1. Study Design

Case series descriptive study was applied in this research.

### 2.2. Study Setting

The study was applied at National Cancer Center – Benghazi, Libya.

### 2.3. Duration of Study

The records of paranasal sinus CT during the period from the 1st of April 2018 to 31st August 2018 were reviewed.

### 2.4. Inclusion Criteria of Cases

Male and female patients aged 18 years and above who have done sinus CT scan that recommended by physicians for various indications were included in the study.

### 2.5. Exclusion Criteria of Cases

Any male and female patients aged less than 18 years and patients with history of previous trauma, patients with congenital abnormality or sinus pathology and patients with history of nutrition or bony diseases, as well as presence of metallic artifacts or grafted sinuses.

### 2.6. Studied Population

All paranasal sinus computerized scans conducted during the period of study were reviewed. These scans included 200 maxillary sinuses from 100 patients (33males 67females) between the ages of 18 and 76 years were examined in this study.

## 3. Equipment and Measurement

CT machine was used; its model was Fast acquisition and high-quality multi-slice CT (Philips Brilliance 6 slice CT).

Paranasal sinuses CT images with slice thickness of 2 mm of At least 2.5 mm in height of cortical bone was considered for the threshold value to identify septa [10]. Axial, coronal, sagittal and 3D images were assessed for detection of maxillary sinus septa. The axial and sagittal images were used to determine the localization of septa relative to the teeth. The location of the maxillary sinus septa was classified into 3 classes as previously described [10]. Class 1: anterior; class 2: middle; class 3: posterior. Anterior one third extended from anterior wall of the sinus to the distal aspect of the second premolar, whereas the middle one third was classified as the area from the distal aspect of the second premolar to the distal aspect of the second molar. The posterior one third extended from the distal aspect of the second molar to the posterior wall of the sinus. Sagittal images were used to determine the height of septa.[11] The type of septa was divided into two classes as described previously [8]class 1: primary (a septum located apically to the maxillary root at the dentate site); class 2: other or secondary (a septum located apically to an edentulous ridge). Orientation of the maxillary sinus septa was classified into three classes [12]: class 1: mediolateral; class 2: sagittal; class 3: transverse. The mediolateral type displayed in the buccopalatal direction in the arch connects the buccal and palatal floors. The sagittal type displayed parallel to the orientation sagittal plane. The transverse type displayed parallel to the sinus floor[12].The groups were defined according to present study variables, such as gender and the number, location, and orientation of each septum.

## 4. Data Analysis

Statistical analysis was performed with the aid of the statistical package for the social sciences (SPSS) computer program (version 23 windows). Results were expressed as mean ± standard deviation (SD) or number and (%). Comparison between two groups was performed using unpaired student t-test.

ANOVA was used for comparison of more than two groups. Categorical data was compared using Chi-square ($x^2$) test. P value <0.05 was considered significant. Figures were done by Microsoft office Excel 2007.

### 4.1. Data Collection

A record sheet was used to collect data, which included: age, gender, the presence, type, height, location and orientation of maxillary sinus septa. All of these parameters were recorded from the right and left maxillary sinuses.

### 4.2. Administrative Approval

The approval of the director of the center was taken before reviewing the records and collection of required data.

## 5. RESULTS

### 5.1. Personal characteristics

Paranasal sinuses CT images of one hundred adult patients - (33 males - 67 females) -were examined in this study as illustrated by Figure 1. The mean age of the subjects was 37.8 ± 12.6 years, with a range of 18 to 76 years.

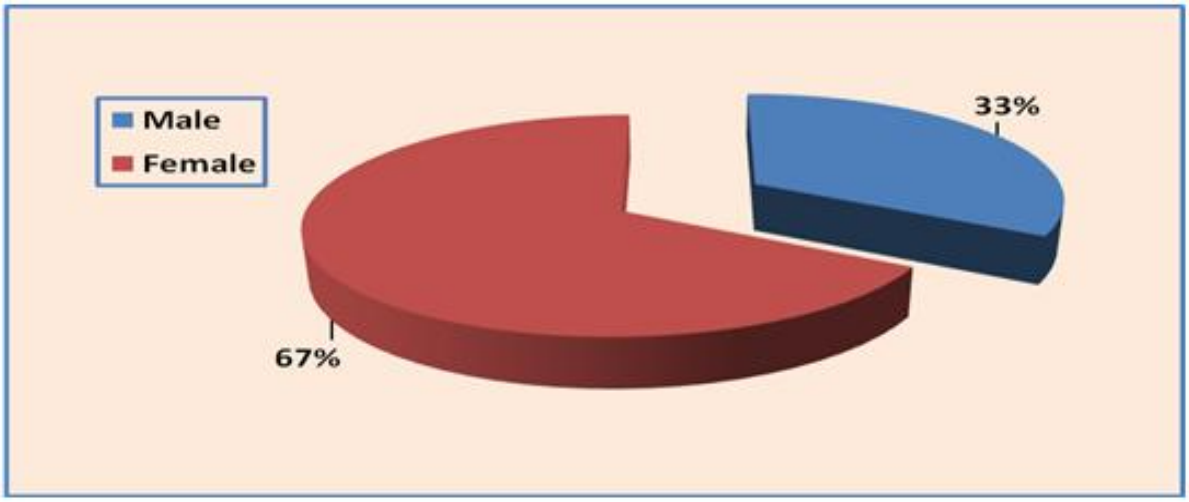


**Figure1.** *Distribution of patients according to gender*

The highest septal incidence was found in age group from 41-50, which was also the most numerous, with the lowest number of septa being seen in the >60 age groups as illustrated by Figure 2.

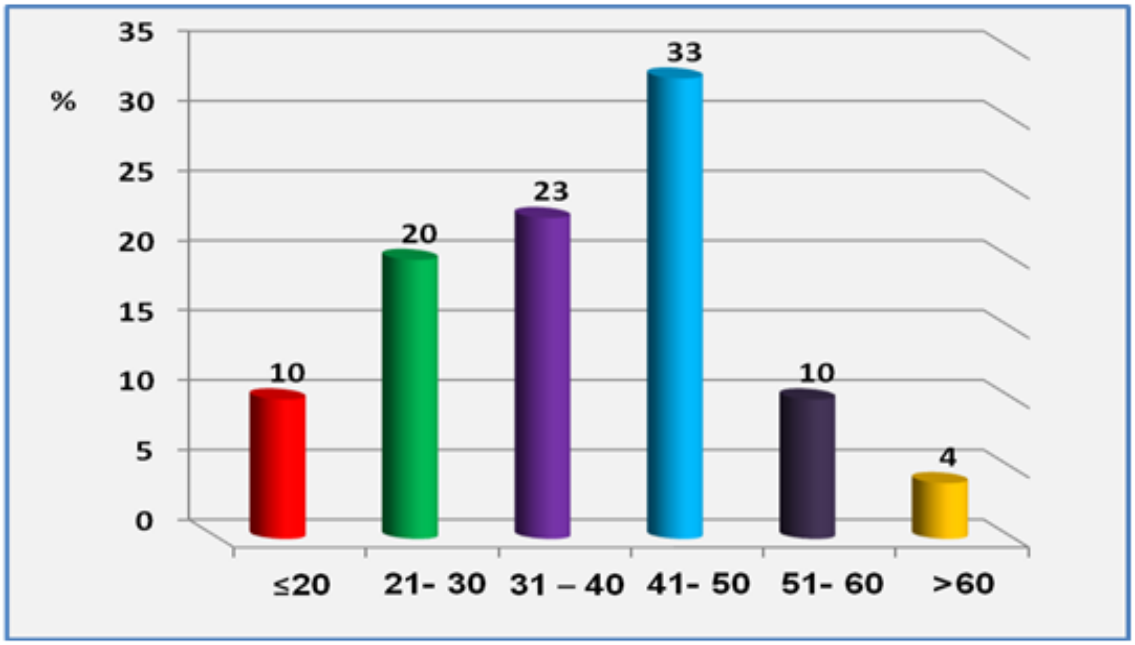


**Figure2.** *Distribution of patients according to age*

** Mean age of subjects was 37.8 ± 12.6 years*

### 5.2. Prevalence

Table1 illustrates that there was a total of 200 maxillary sinuses from 100 patients. Total number of septa recorded in 200 maxillary sinuses was 52 representing 26% of the total maxillary sinuses. Of these, 19 (36.5 %) were identified in male patients, while 33 (63.5 %) were found in female patients. Forty nine sinuses had one septum while three sinuses had two septa. Table 2 shows that thirty-two septa (61.5%) were found on the right maxillary sinus, while 20 (38.5%) were found on the left maxillary sinus. There was no significant difference between the presence of septa and gender (p=0.652) and lateralization (p=0.241).

**Table1.** *Comparison between number of maxillary sinus septa and patients' gender – Benghazi, Libya*

| **Total number of patients (100)** | | | | P-value |
|---|---|---|---|---|
| Males (33) | | Females (67) | | |
| **Total number of sinuses (200)** | | | | |
| **Total number of septa (52)** | | | | |
| **No. of septa (%)** | | **No. of septa (%)** | | |
| 19 (36.5 %) | | 33 (63.5 %) | | 0.652 |
| **No. of one septum (%)** | **No. of two septum (%)** | **No.of one septum (%)** | **No. of two septum (% )** | |
| 17 (89.5%) | 2 (10.5%) | 32 (97.0%) | 1 (3.0%) | |

**Table2.** *Comparison between number of maxillary sinuses septa and side of sinuses – Benghazi, Libya*

| **Total number of sinuses (200)** | | | | **P-value** |
|---|---|---|---|---|
| Right sinus (100) | | Left sinus (100) | | |
| **Total number of septa (52)** | | | | |
| **No. of septa (%)** | | **No. of septa (%)** | | |
| 32 (61.5%) | | 20 (38.5 %) | | 0.241 |
| **No. of one septum (%)** | **No. of two septum (%)** | **No. of one septum (%)** | **No. of two septum (%)** | |
| 30 (93.8%) | 2 (6.2%) | 19 (95%) | 1 (5%) | |

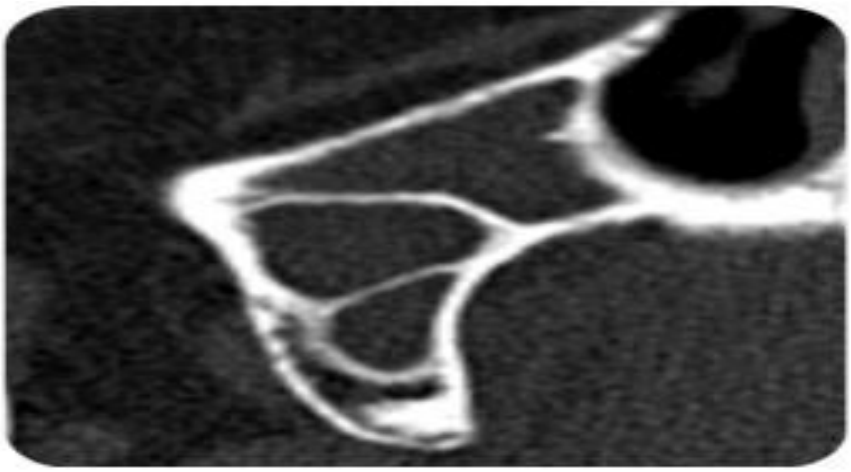

**Figure3.** *Two septa seen in right maxillary sinus in axial view*

Figure 3 demonstrates the presence of two septa in the right maxillary sinus of one patient by using the axial view.

### 5.3. Location

The analysis of the anatomic location of the septa within the sinus showed that of the 52 (26%) septa identified in this study, 25 (48.1%) were located in the anterior region, 18 (34.6%) in the middle region, and 9 (17.3%) in the posterior region. According to these results, there were no significant differences between location of septa and gender (p=0.526) (Table 3).

**Table3.** *Relationship between anatomic location of septa and patients' gender – Benghazi, Libya*

| **Patients' gender** | **Anatomic Location of septa** | | | | **P-value** |
|---|---|---|---|---|---|
| | **Anterior No (%)** | **Middle No (%)** | **Posterior No (%)** | **Total No (%)** | |
| **Males** | 9 (47.4) | 8 (42.1) | 2 (10.5) | 19 (100) | 0.526 |
| **Females** | 16 (48.5) | 10 (30,3) | 7 (21.2) | 33 (100) | |
| **Total** | 25 (48.1) | 18 (34.6) | 9 (17.3) | 52 (100) | |

### 5.4. Heights

As previously mentioned at least 2.5 mm in height of cortical bone was considered for the threshold value to identify septa as illustrated by Figure 4.

The mean height of the maxillary sinus septa was 3.3±0.63 mm (Table 4).

The mean height of septa for males was 3.44±0.73 mm and 3.22±0.56 mm for females, respectively.

There were no statistically significant differences among the height values of maxillary sinus septa, with regard to gender (p=0.362) and lateralization (p=0.241) (Table 4).

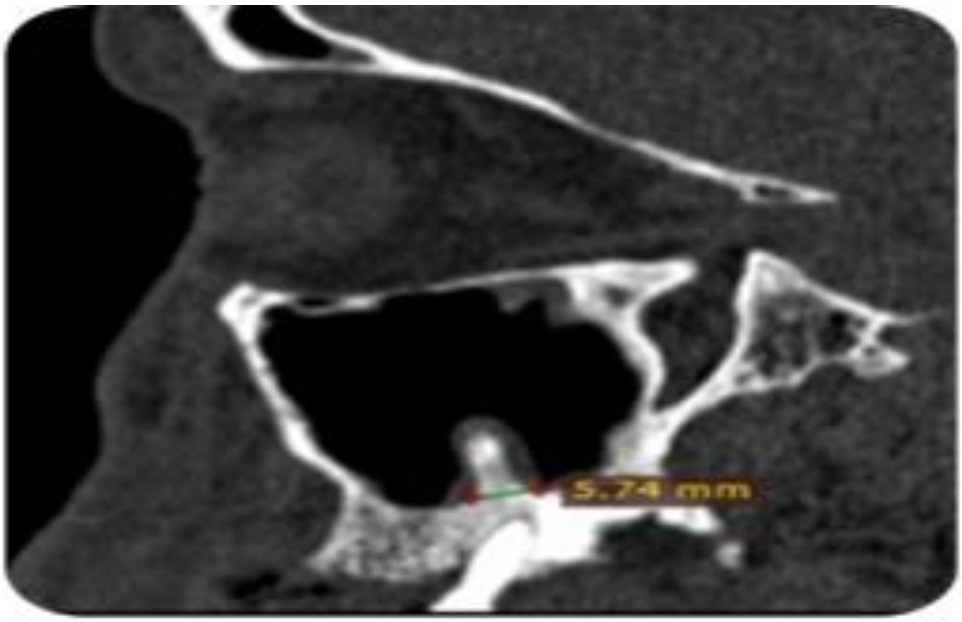


**Figure4.** *Height of maxillary sinus septa in sagittal view measured in mm*

**Table4.** *Comparison between heights of maxillary sinuses and patients' gender - Benghazi, Libya*

| Height of maxillary sinuses measured in mm | Male | Female | P- value |
|---|---|---|---|
| Min | 2.6 | 2.5 | 0.362 |
| Max | 5.7 | 4.7 | |
| Mean height ± standard deviation | 3.44 ± 0.73 | 3.22 ± 0.56 | |

*Mean height of all maxillary sinuses = 3.3±0.63 mm*

### 5.5. Orientation

In this study, mediolateral septa (24) and sagittal septa (23) had the highest frequency (46.2%, 44.2%respectively) while the transverse septa had the lowest frequency (5, 9.6%). In males, 7 (36.8%) of maxillary sinus septa were observed in a mediolateral type orientation, one septa (5.3%) were observed with transverse type orientation, and 11 septa (57.9%) were observed in a sagittal type. Regarding orientation in females; 17 (51.1%) maxillary sinus septa were observed with mediolateral type orientation, 4 (12.1%) septa were observed with transverse type orientation, and 12 (36.4%) septa were observed with sagittal type orientation. Accordingly, there was no significant difference between orientation of septa and gender (p=0.299), (Table 5).

### 5.6. Type

The prevalence of primary septa was 30 (57.7%), while the prevalence of secondary septa was 22 (42.3%). However, there was no significant difference between type of septa and gender (p=0.299), (Table 5).

**Table5.** *Relationship between orientation, type of maxillary sinuses septa and patients' gender - Benghazi, Libya*

| Gender | Orientation | | | | Type | | |
|---|---|---|---|---|---|---|---|
| | Medio-lateral No (%) | Transverse No (%) | Sagittal No (%) | Total No (%) | 1ry No (%) | 2ndry No (%) | Total No(%) |
| Male | 7 (36.8%) | 1 (5.3%) | 11(57.9%) | 19(100%) | 12(63.2%) | 7(36.8%) | 19 (100%) |
| Female | 17(51.5%) | 4 (12.1%) | 12 (36.4%) | 33 (100%) | 18(54.5%) | 15(45.5%) | 33(100%) |
| Total | 24(46.2%) | 5(9.6%) | 23(44.2%) | 52(100.0%) | 30(57.7%) | 22(42.3%) | 52(100.0%) |

*p =0.299*

As previously mentioned maxillary sinuses septa are classified into: mediolateral, sagittal and transverse orientation as illustrated by Figure 5.

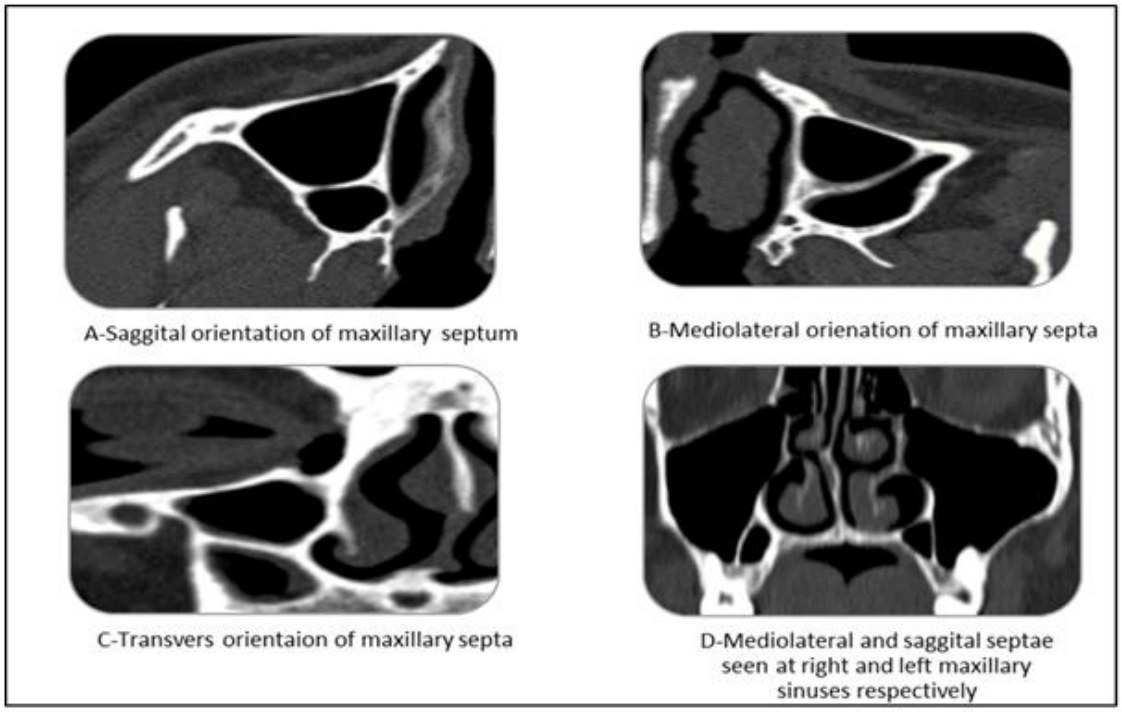


**Figure5.** *Orientations of sinus septa, A & B axial images and C & D coronal images*

## 6. DISCUSSION

In this study, the prevalence of maxillary sinus septa was 26 %; of these, three sinuses had doubled septa. None of the sinuses examined had 3 septa. The incidence of septa from this study was lower than the estimated prevalence of antral septa among Canadians by Donal,[9] where 50% of cadaveric models had septa. Similarly, Ella,[13] in France reported 38.6% prevalence, Maryam,[14] in Leuven, Belgium, with prevalence of 47%; and among Italians by Gabriele, [15] who reported a prevalence of 40% in a cadaveric study of the maxillary sinus septa.

However, the results of this study compared favorably with the works of Krenmair,[16] in Austria, and Kim,[8] in Seoul, Korea, where the prevalence of maxillary sinus septa were 26.8% and 22.6%, respectively.

Our results were essentially in agreement with the report of Velasquez-Plata,[17] from the University of Detroit, Michigan, USA, who found 24% prevalence of antral septa on CT scan analysis of maxillary sinuses, and Won-Jin, [18]who reported a prevalence of 24.6%, among Koreans in Jeonju.

However, our results were higher than the septal prevalence reported by Ulm, [6] (18.3%), from the University of Vienna, Austria, and Krenmair, [3] (14.3%), from the University of Vienna, Austria, while Amusa, [19] who worked on south-western Nigerians at the Obafemi Awolowo University Teaching Hospital, recorded no antral septa in 24 dried human skulls.

Septa incidence in relation to age, shows that the highest rate was found in age group from 41-50, which was also the most numerous, with the lowest number of septa being seen in the >60 age groups.

The average septal height was found to be 3.3 mm, The height of septa from this study was lower than the reported by other researchers who reported mean heights of 5.9±3 mm, 5.5 mm and 4.9 mm, respectively [18] (Velásquez-Plata et al.[17]; Malec et al.[20]; Maestre- Ferrin et al.[21] The height of the septa may have an influence on sinus lift procedures used in maxillary bone compromised patients before dental implant treatment.[22]

Sinus septa can be divided into primary septa and secondary septa; the primary septa located apically to the maxillary root at the dentate site, whereas the secondary septa located apically to the edentulous ridge. 30 of these septa were primary (57.7%) and 22 septa were secondary (42.3%).

The location of septa observed in the present study demonstrated a greater prevalence in the anterior region (48.1%), followed by the middle region (34.6%) and the posterior region (17.3%).

This result agrees with the result of previous study.[1, 3, 6, 15, 19] Krennmair et al.[3] reported the greatest prevalence in the anterior region, at 70-75%, In a study by Shahidi et al, [23] septa were present in the anterior, middle, and posterior segments of the sinuses in (58.9, 21.1, and 20%) of the cases respectively.

However, (Koymen et al. [24]; Kim et al. [8]; Velásquez-Plata et al (17]), reported a conflicting result, with the greatest prevalence in the middle region. Kim et al.[8] Reported prevalence's of 25.4% in the anterior region, 50.8% in the middle region, and 23.7% in the posterior region. Such a discrepancy between the results might be attributed to individual differences and minor differences in dividing the sinuses into anterior, middle, and posterior segments.[25].The prevalence of septa in the right sinus

Was higher than in the left sinus, at 61.5% (32) in the right, compared to 38.5% (20) in left. Velasquez- Plata et al.[17]reported 72 septa in 312 sinuses, and found 39 in the left sinus and 36 in the right sinus. In our investigation, mediolateral orientation of septa was most common (46.4%) followed by sagittal orientation of septa (44.2%).

Koymen et al reported similar findings to our research. [24] He reported that all of the septa identified (46.4%) was oriented mediolateral.

Also, previous studies observed mediolateral orientation of septa while transverse oriented septa were identified less frequent. [26] Consequently, detection of septa orientation is very important prior to maxillary sinus surgery.

Therefore, the presence/ absence and the location of septa need to be diagnosed using CT. Only then can a precise surgical plan be decided upon, and perioperative complications prevented.

Detailed knowledge about location, morphology and height of antral septa is clinically relevant to reduce the rate of complications when maxillary sinus surgery, i.e. sinus floor elevation, is carried out.[16]

## 7. Conclusion

Based on the results of the present study, 26 % of the maxillary sinuses had septa. In order to avoid intra operative problems during sinus lift procedures, it is necessary to accurately evaluate the sinus; preferably with the use of CT. Knowledge of location of maxillary sinus ostium is mandatory for the rhinologists for drainage of secretions in maxillary sinusitis. The morphological details of maxillary sinus septa, particularly their location and anatomical planes, will guide dentists in performance of safe implant surgeries.

## Recommendations

Further studies using larger population size to enable us to generalize the findings for the Libyan population to compare the accuracy of CT findings with cone-beam computed tomography for the same patients.

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