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Anatomical variations of nasal and paranasal sinuses among Sudanese patients undergoing CT scan evaluation at Antalya Diagnostic Center – Khartoum – Sudan, 2017

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ABSTRACT

Introduction: The anatomical variations of the paranasal sinus are common among populations. These variations are asymptomatic most of the time, yet it may be associated with some inflammatory or allergic conditions. Knowledge of these anatomic variations helps in choosing the operative techniques, reducing the surgical complication rates and explains recurrence of disease. **Objective:** The aim of this study was to investigate the incidence and type of the anatomical variations of the paranasal sinus among adult Sudanese population by using CT scan. **Patients and Method:** This is a retrospective descriptive and health facility-based study, conducted at Antalya Diagnostic Center, Khartoum, during the period from July to September 2017. Included in the study all patients referred to the center for CT scan of the sinuses (n=151). A simple random technique was used for anatomical variations; with a sample size of 76 patients. Data collection sheet was used included demographic data and the anatomical variations. Data was analyzed using SPSS version 22. **Results:** The total number of patients diagnosed with variations was 76, which constituted of 50.3% of all patients included in the study. The age of patients ranged between 16 to 65 years, with a mean age of 36.46 (±11.12SD) years. The most frequent age groups were (16 to 25) and (26 to 35) years which constituted (52.63%) of the patients. Males were 34 (44.7%) and females were 42 (55.3%), with a male to female ratio 1:1.23. Relationship between age and gender with anatomical variants was found not statistically significant. Ninety variations were detected among the study sample.

Nasal septal deviation was the commonest variation observed in (26.7%), followed by Concha bullosa in (20%), Onodi Cells in (11.1%), Agger nasi in (10%), frontal sinus hypoplasia in (10%) and other variations in (22.2%) of cases. Most of the variants were unilateral (81.6%) and were more on the left side in (46.1%) of cases. **Conclusions and recommendations:** the commonest variation was Nasal septal deviation, variations were common among the age group 16 to 35 years with slight female predominance. The study emphasizes the importance of CT scan for the detection of anatomical variations of the paranasal sinus in every patients planned for nasal or sinus surgery.

KEYWORDS Nasal, Sinuses, CT, Sudan

INTRODUCTION

The paranasal sinuses (PNSs) are air-filled, mucosa-lined spaces extensions of the nasal cavity that develop in the facial and cranial bones and communicate with the nasal airways. However, their precise function is debated and has been the subject of much theory. They possibly have a role in lightening the weight of the head, modifying inhaled air, increasing the resonance of speech, and serving as a crease zone to protect vital structures in the event of facial trauma. In lower animals, sinuses are largely lined by olfactory epithelium increasing the surface area resulting in its sharp smelling. However, in humans, olfaction is limited to a much smaller surface area, and the presence of the paranasal sinuses is probably a vestigial anachronism [(1)].
The PNSs are clinically categorized, according to the bone in which they are located, into the following four paired types: 1) the frontal sinuses; their posterior wall is located adjacent to the anterior cranial fossa. They are usually asymmetrical and occasionally absent; 2) the maxillary sinuses; its superior wall forms the floor of the orbit and its medial wall is formed by the lateral wall of the nose. Inferiorly, the maxillary sinus is related to the tooth-bearing area of the maxilla; 3) The ethmoid sinuses in the superior and lateral walls of the nose and the medial walls of the orbits and 4) The sphenoid sinus, located in the sphenoid bone where the sella turcica projects into this space.

Rhinosinusitis is the inflammation of the nasal mucosa of the paranasal sinuses is predisposed by obstruction to normal drainage causing stagnation of secretions, negative pressure and mal-aeration in the sinus, which creates an environment favorable for bacterial growth [(2)]. For example, variations in the pneumatization of ethmoid sinuses may disturb sinus ventilation. Hence, can be the etiological factor for sinusitis and spread of infection to other sinuses. Although, not all anatomic variants are accountable for development of chronic rhinosinusitis, yet knowledge of their presence and degree is paramount particularly in nasal surgery [(3, 4)].
The most common anatomical variations studied in the literature are Concha bullosa, Nasal septal deviation, Haller cells, Onodi cells, Maxillary sinus hypoplasia, Sphenoid

sinus hypoplasia and Frontal sinus hypoplasia. Evaluation of anatomic variations of the paranasal sinuses is important in patients who are undergoing CT scan evaluation for a variety of reasons. Identifying the landmarks and anatomic variations does reduce the surgical complication rates during nasal surgery especially functional endoscopic sinus surgery (FESS), helps explain recurrence of disease and allows one to choose the most appropriate surgical approach [(5)]. Among all sinuses, the ethmoid sinuses play a crucial role in FESS. The posterior ethmoids and the sphenoid sinuses could be accessed via the anterior ethmoid cells. Moreover, anterior ethmoidectomy helps improve frontal air sinus drainage thus minimizing the need to axcess the frontal sinus during surgery. The anatomic variations of nose and paranasal sinuses make the FESS procedure much more tricky. During FESS, crossing beyond the surgical field may lead to serious complications such as cerebrospinal fluid leak, meningitis, or damage to the optic nerve and blindness and massive bleeding so a detailed knowledge of the possible anatomical variations is essential [(5)].

Computer Tomography scan is a mandatory radiological investigation for patients undergoing FESS. CT scan helps identify different anatomic variations. Many centers use the three-millimeter cuts for all views – coronal, sagittal and axial to assess the different anatomical structures of the lateral nasal wall and the paranasal sinuses. The coronal views are best for the sphenoid and the ethmoid cell variants such as the onodi or sphenoethmoida cell [(6)]. The development and refinement of CT scans has allowed extensive assessment of patients' paranasal sinuses thus providing a guide map for FESS surgeons to operate. [(7)]

Materials and methods

This is a retrospective descriptive health facility-based study conducted in the period from July to September 2017 at Antalya medical center, which is one of the major private medical centers, located in Khartoum state capital of Sudan. It provides most of the needed medical services, privately and through health insurance, it has a department for diagnostic radiology. The center receives cases from Khartoum ENT hospital in addition to referred cases from all other states of Sudan. The study included all patients who attended to Antalya medical center in the study period for elective CT scan of the nose and paranasal sinus for different nasal conditions, regardless of the indication. The total number was 151 patients. By total coverage sampling technique, all the included patients were above fifteen years of age (the age paranasal sinuses are developed). Patients who had previous nasal surgical intervention or trauma and patients who had tumors in the nose and paranasal sinus were excluded from the study. CT-imaging device used was General Electric: GE 8 Slice. After the procedure, the information and data including readings of the radiologist reports were stored at the radiology department. Data collection sheets were filled, covering the Socio-demographic data and the anatomical variation. Data were coded, transferred to data master-sheet and then entered into the computer, organized and analyzed using Statistical Package for Social Sciences (SPSS) software version 22. General tabulations, including frequency and percentage distribution, were

used for the anatomical variations against socio-demographic characteristics. Categorical data were analyzed using chi squire test. P-value <0.05 was considered statistically significant.

Results:

The total number of patients included in this study was76, which constituted of 50.33% of all patients included in the study. Males were 34 (44.7%) and females were 42 (55.3%), with a male to female ratio of 0.81:1 (Table 1). The age of patients ranged between 16 to 65 years, with a mean age of 36.46(±11.12SD) years. The most frequent age groups involved were (16 to 20) and (26 to 35) years with 40 (52.63 %) patients (Table 1). Chi square test was performed to measure the relationship between age and anatomical variants; it was found not significant (P. value > 0.05). The relationship between gender and anatomical variants was also found not statistically significant (P. value > 0.05).

Nasal and paranasal sinus variations on CT scan were found in 76 patients (50.3%) of the study population. Ninety (90) variations were detected. These variations, in order of frequency, were nasal septal deviation in 24 (26.7%), Concha bullosa in 18 (20%), Onodi Cells in 10 (11.1%), Agger nasi in 9 (10%), frontal sinus hypoplasia in 9 (10%), Haller cell in 7 (7.8%), sphenoid sinus sepetated in 7 (7.8%), maxillary sinus hypoplasia in 3 (3.3%) and sphenoid sinus hypoplasia in 3 (3.3%) of cases. (Figure 1, Table 1)

The side of variants were unilateral in 62 (81.6%) of the cases; on the left side in 35 (46.1%) and on the right side in 27 (35.5%) of the cases. The variants were bilateral in 28 (36.8%) of cases. (Table 2)

Nasal septal deviation (26.7%) was commonest among the variations, in 13 males and 11 females and mostly in the age group 16-35 years. (Table 1) It is mostly common on the left side in 16 cases (Table 2).

Concha bullosa (20%) from the total variations, in ten females and eight males, and mostly among the age group 26-35 years (Table 1). It was on the left side in six, in the right side in five and it was bilateral in seven cases, and was mostly on the middle in 15 cases (Table 2). Onodi Cells with (11.1%) of the variations in the sample, with seven females and three males, and the most frequent age group was 26-35 years (Table 1). It was bilateral in four cases, and in three patients on each side (Table 2). Agger nasi were found in (10%) of the patients, in six females and three males, mostly in the age group 26-35 years. (Table 1) It was on the left side in one, on the right side in three and was bilateral in five cases (Table 2). Frontal sinus hypoplasia were found also in (10%) of the variations, in six males and three females, mostly in the age group 26-35 years (Table 1). It was on the left side in two, on the right side in five and was bilateral in two cases (Table 2). Haller cell were found in (7.8%) of the variations, in four males and three females, also mostly in the age group 26-35 (Table 1). It was on the left side in one, on the right side in four and was bilateral in two

cases (Table 2). Sphenoid sinus sepetated were found in (7.8%), in three males and four females, mostly in the age group 36-45 (Table 1). It was on the left side in two and bilateral in five cases (Table 2). Maxillary sinus hypoplasia was found in (3.3%), which was found only among females (Table 1). It was on the left side in two and onthe right side in one case (Table 2). Sphenoid sinus hypoplasia were found in (3.3%) of cases, in two females and only one male (Table 1) It was on the left side in two and on the right side in one case (Table 2).

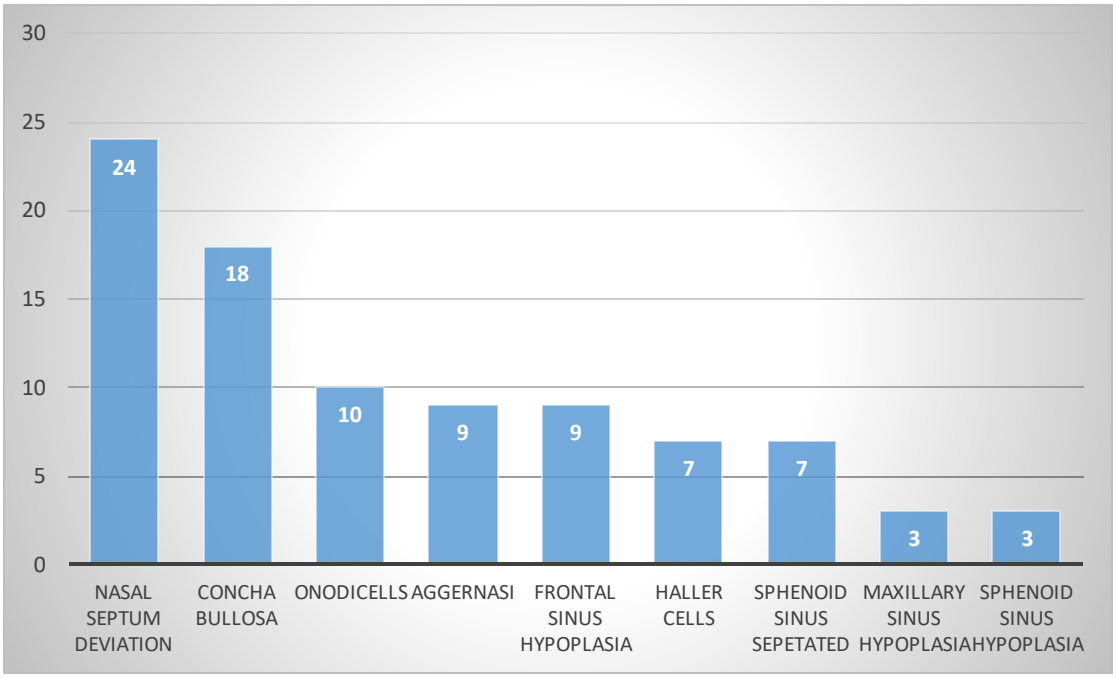

Figure 1: Type and frequency of nasal and paranasal sinuses variations among the study group

Table 1: Distribution of Anatomical variations among the age groups and gender of the study group

Variation	Gender	Age groups in years					Total
		16-25	26-35	36-45	46-55	56-65	
Nasal Septum Deviation	Male	2	4	2	3	2	13
	Female	4	2	2	0	3	11
	Total	6	6	4	3	5	24
Concha bullosa	Male	1	2	3	2	0	8
	Female	2	3	1	2	2	10
	Total	3	5	4	4	2	18
OnodiCells	Male	0	2	1	0	0	3
	Female	2	2	2	1	0	7
	Total	2	4	3	1	0	10
AggerNasi	Male	1	1	0	0	1	3
	Female	1	2	1	1	1	6
	Total	2	3	1	1	2	9
Frontal sinus hypoplasia	Male	3	1	0	1	1	6
	Female	2	1	0	0	0	3
	Total	5	2	0	1	1	9
Haller Cells	Male	1	2	1	0	0	4
	Female	1	1	1	0	0	3
	Total	2	3	2	0	0	7
Sphenoid sinus sepetated	Male	0	0	1	2	0	3
	Female	1	0	2	0	1	4
	Total	1	0	3	2	1	7
Maxillary Sinus Hypoplasia	Male	0	0	0	0	0	0
	Female	0	1	1	0	1	3
	Total	0	1	1	0	1	3
Sphenoid Sinus Hypoplasia	Male	1	0	0	0	0	1
	Female	0	0	1	1	0	2
	Total	1	0	1	1	0	3
Total	Male	9	12	8	8	4	41
	Female	13	12	11	5	8	49
	Total	22	24	19	13	12	90

Table 2: Side of Anatomical variations among the study group

Variation (n=90)	Side			Total
	Left	Right	Bilateral	
Nasal Septum Deviation	16	5	3	24 (26.75)
Concha bullosa	6	5	7	18 (20%)
Onodi Cells	3	3	4	10 (11.1%)
Agger Nasi	1	3	5	9 (10%)
Frontal sinus hypoplasia	2	5	2	9 (10%)
Haller Cells	1	4	2	7 (7.8%)
Sphenoid Sinus Sepetated	2	0	5	7 (7.8%)
Maxillary Sinus Hypoplasia	2	1	0	3 (3.3%)
Sphenoid Sinus Hypoplasia	2	1	0	3 (3.35)
Total	**35**	**27**	**28**	**90 (100%)**

Discussion

The superiority of computed tomography (CT) scan compared with conventional radiography has unquestionable importance for the evaluation of anatomy and pathology (8). Nowadays, both radiologists and otolaryngologists depend on CT scan as the radiological modality of choice for the evaluation of the nose and paranasal sinuses (9). CT scan has the ability to detect fine bone architecture of the nasal cavity and paranasal sinuses, the mucosa, and the air, thus making it a preferred tool for imaging (10). It is essential to perform CT scan of the paranasal sinuses before attempting sinonasal surgery, to avoid potential complications resulting from unrecognized important anatomical landmarks and significant anatomic variations (11). In the advanced era of endoscopic sinus and skull base surgery, a thorough knowledge of the precise anatomy and common anatomic variation of the nose and paranasal sinuses and the relation with the neighboring structures constitute an integral part of the total diagnostic and therapeutic management of patients with sinonasal disease (12,13). As such, a detailed preoperative checklist evaluation of the sinonasal CT scan enhances the safety and efficacy of the nose and paranasal sinus surgery (14).

Nasal and Paranasal sinus variations on CT scan found in half of patients representing the study population.

The most frequent age group was 16 to 35 years. This finding is near to the results obtained by Kumar (15), who found variations in almost (45%) of the case. Concerning gender, this study showed slight female predominance, which is similar to

the results of Aramani (16). Most of the variants were unilateral and more on the left side, this finding was also similar to the results of Kumar (15)

The commonest nasal and paranasal sinus variations on CT scan found were nasal septal deviation, Concha bullosa in, Onodi Cells in, Agger nasi, these findings are almost typical to those obtained by Vincent and Gendeh (17). The most common variation among the 76-patient enrolled in this study was nasal septal deviation in near one third of the cases (31.6%). This finding is lower than that found by Baradaranfar who found it in 45% in his study done in Malaysia (17).

The second variation was Concha bullosa (23.7%) with an incidence lower to Arslan (18) who found it in 30% of cases and higher than studies done by Dua (19) and Mamatha (20) whom findings were 16% and 15% respectively, but much lower than Pérez-Piñas (21) who found it in 73% of cases. In our study, we classified concha bullosa by their locations. We found that the most common pneumatized concha was the middle one, among 20% of patients, and the least common was the superior one (1.3%). These difference could probably be explained by their large sample size (19).

Onodi Cells were found in (13.2%) of the sample, which is lower than the result found by (22) who found it among 37.8% of his sample, but agrees with a study done by Arslan (18) who found that onodi cells in 12% of cases.

Agger nasi were found in (11.8%) of the patients, which is lower than Kumar (15), who reported that it was 27%, and Vincent who found it in 36% of his cases (17).

Haller cell was identified among (11.8%) which is greater than found in a study by conducted by Perez (21) although he had a sample size of one hundred patients of whom only 3% had haller cells, but less than Dua and Mamatha (17.5%) of their study samples (19), (20) . The difference and frequency of these variations might probably be explained by genetic factors due to hereditary differences (21) besides differences among the different racial groups (23).

Maxillary sinus hypoplasia has been reported as being very uncommon and mainly noticed on the coronal cuts of the CT scan. In our study we found hypoplasia of frontal, maxillary and sphenoid sinuses in 11.8%, 3.9 and 3.9% of patients respectively, which is slightly less than the findings by Bolger who reported prevalence of unilateral maxillary sinus hypoplasia to be 10.4% (24), while Kantarci reported 7% in his study of 512 patients (25).

In this study Aplasia of frontal, maxillary or sphenoid sinuses were not found. This is in agreement with a study done by Binal C et al who looked into 384 patients and found unilateral agenesis in 0.26%, unilateral sphenoid sinus hypoplasia in 0.26% and bilateral sphenoid sinus hypoplasia in 0.26%. Bilateral sphenoid sinus agenesis was not seen (26), but a study done by Salah D. the frequency of bilateral absence of the frontal sinus was 11.7% (27).

The differences observed between our findings and other results could be explained by the variations in the sample size used besides ethnic, geographic and inherited differences; as found by Badia (23).

Conclusion:

This study concluded that the anatomical variations of the nose and paranasal sinuses are frequent, and the commonest variation was Nasal septal deviation followed by Concha bullosa, variations were common among the age groups 16-25 and 26 to 35, but there was slight female predominance, also most variations were found more unilateral than bilateral. The results of this study are consistent with many studies done worldwide.

Recommendations

The study emphasizes the importance of CT scan for the detection of anatomical variations of the paranasal sinus in every patient planned for nasal or sinus surgery. Otolaryngologists, dentists, radiologist and anatomist should be aware about the anatomical variations of the paranasal sinuses. Further studies are needed in Sudan including large sample size and new method technique.

Limitations of the Study

Funding

Conflict of Interests

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