ОРИГИНАЛЬНАЯ СТАТЬЯ

VALIDITY OF COMPUTED TOMOGRAPHY FOR ASSESSMENT NORMAL ANATOMICAL VARIANT IN NASAL CAVITY WITH CHRONIC SINUSITIS

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A variety of anatomical variants in the sinonasal region are commonly identfied through sinus CT scans. The variations are potentially linked to chronic rhinosinusitis.

Purpose. To determine the computed tomography validities of nasal cavity and paranasal sinuses in normal anatomical variant and to assess the role of CT in chronic sinusitis.

Materials and methods. A prospective study was conducted at department of radiology in Al-Hilla General Hospital from 26th July 2023 to 29th May 2024. Participants data, including age, sex, effected sinus and CT findings were evaluated. All multidetector computed tomography (MDCT) scan findings were analyzed by experience radiologist.

Results. In this study, 27 patients with chronic sinusitis were enrolled. The mean age of patients was 19.63±8.76 yrs. Among them 20 (66.7%) were male, and 10 (33.3%) were female. The commonest effected sinus was Maxillary sinus in 19 cases (70.4%). Nasal septal deviation (NSD) seen in the most of patients in 21 cases (77.8%). Concha Bullosa (CB) was visualized in 8 cases (44.4%).

Discussion. In this study, the commonest effected sinus was Maxillary sinus in 19 cases (70.4%), sphenoid sinus were 6 cases (22.2%), and ethmoid sinuses in 6 cases (22.2%). NSD seen in the most of patients in 21 cases (77.8%). Uncinate process variation and mucosal thickening of the sinuses seen in one case for each. Mucosal thickening of the sinuses was noticed in seven cases. Concha bullosa was visualized in 8 cases (44.4%). Nasal septal spur reported in 5(27.8%) cases. Inferior turbinate enlargement was visualized in 2 cases (7.4%). Pneumatization lateral sphenoid bone wings and pneumatization of anterior cliniod process of sphenoid bone were seen in one case for each. Nearly, same percent than our findings seen by Dawood mentioned several anatomic variants as NSD (71.7%), septal spur (34%), septal pneumatization (16.7%), paradoxical turbinate (19%), hypoplastic turbinate (1%), Aggernasi cells (72%), Haller cells (70.7%), Onodi cells (44.7%), elongation of ethmoid Uncinate process (69.7%), pneumatization of ethmoid process (3%), frontal sinus agenesis (hypoplasia) (11.7%), Keros classification [I=31%, II=66.7%, III=2.3%], asymmetry of ethmoidal roofs (43.3%), sphenoidal variants (78.7%), crista galli pneumatization (5.7%), hypoplasia of maxillary sinus (1.3%) and maxillary septum (25%). Also, these data similar to other studies like Kaya et al., Kubota et al., Choby et al., and Han et al. NSD in this study is common, this is similar to Kaya et al., Kaplanoglu et al., Sharma et al. and differ from Reddy et al. and Alsowey et al.

Conclusions. Maxillary sinus is the commonest effected sinus. Nasal septal deviation is the commonest anatomical variants. The mucosal thickening and Concha bullosa variants more visualize in male than female. The effected sinuses of anatomical variants distribution influences by age of patients but not by sex. CT scan more reliable to detection numerous anatomic variants of nasal cavity and PNS.

Keywords: nasal septal deviation, nasal septal spur, ethmoidal variations, septal pneumatization, concha bullosa, paranasal sinuses.

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ДОСТОВЕРНОСТЬ КОМПЬЮТЕРНОЙ ТОМОГРАФИИ ПРИ ОЦЕНКЕ НОРМАЛЬНОЙ ВАРИАНТНОЙ АНАТОМИИ НОСОВОЙ ПОЛОСТИ ПРИ ХРОНИЧЕСКОМ СИНУСИТЕ

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Цель. Различные анатомические варианты строения области околоносовых синусов обычно выявляются при помощи компьютерной томографии. Эти вариации потенциально связаны с хроническим риносинуситом.

Цель исследования. Определение достоверности компьютерной томографии (КТ) носовой полости и околоносовых синусов при оценке нормальной вариантной анатомии, а также оценка роли КТ в диагностике хронического синусита.

Материалы и методы. Проспективное исследование было проведено в отделении лучевой диагностики больницы Аль-Хилла с 26 июля 2023 года по 29 мая 2024 года. В исследование были включены данные пациентов, включая возраст, пол, пораженные синусы и результаты компьютерной томографии (КТ). Все данные компьютерной томографии были проанализированы экспертом – врачом-рентгенологом.

Результаты. В данное исследование было включено 27 пациентов с хроническим синуситом. Средний возраст пациентов составил 19,63±8,76 лет. Из них 20 (66,7%) были мужчинами, 10 (33,3%) – женщинами. Чаще всего поражался верхнечелюстной синус (19, 70,4%). Искривление носовой перегородки наблюдалось у большинства пациентов (21, 77,8%). Булла носовой перегородки визуализировалась в 8 (44,4%) случаях.

Обсуждение. В данном исследовании наиболее часто поражались верхнечелюстные синусы – 19 случаев (70,4%), клиновидный синус и клетки решетчатой кости – 6 случаев (22,2%). Искривление носовой перегородки было выявлено у большинства пациентов – в 21 случае (77,8%). Вариабельность крючковидного отростка и утолщение слизистой оболочки синусов наблюдались в одном случае. Утолщение слизистой оболочки синусов отмечено в 7 случаях. Буллёзная деформация носовой раковины визуализировалась в 8 случаях (44,4%), а гребень носовой перегородки – в 5 случаях (27,8%). Увеличение нижних носовых раковин определялось в 2 случаях (7,4%). Пневматизация боковых крыльев клиновидной кости и пневматизация переднего клиновидного отростка наблюдались в одном случае. Почти идентичный процент анатомических вариантов был зафиксирован в исследовании Dawood, который упомянул несколько вариаций: искривление носовой перегородки (71,7%), носовой гребень (34%), септальная пневматизация (16,7%), парадоксальная раковина (19%), гипоплазия раковины (1%), клетки валика носа (72%), клетки Галлера (70,7%), клетки Оноди (44,7%), удлинение крючковидного отростка решетчатой кости (69,7%), пневматизация решетчатого отростка (3%), агенезия (гипоплазия) лобной пазухи (11,7%), классификация глубины ольфакторной ямки по Керосу (I=31%, II=66,7 %, III=2,3 %), асимметрия верхней стенки решетчатой кости (43,3%), вариантное строение клиновидной кости (78,7%), пневматизация петушиного гребня (5,7%), гипоплазия верхнечелюстного синуса (1,3%) и гипоплазия носовой перегородки (25%). Также эти данные схожи с данными других исследований таких, как Kaya et al., Kubota et al., Choby et al. и Han et al. Искривление носовой перегородки в данном исследовании встречается часто, что совпадает с данными Kaya et al., Kaplanoglu et al., Sharma et al. и отличается от исследований Reddy et al. и Alsowey et al.

Заключение. Наиболее часто наблюдалось поражение верхнечелюстных синусов. Искривление носовой перегородки являлось наиболее распространённым анатомическим вариантом строения. Утолщение слизистой оболочки и наличие буллёзной деформации носовой раковины (Concha bullosa) чаще наблюдалось у мужчин, чем у женщин. Распределение анатомических вариантов строения синусов было связано с возрастом пациентов, но не зависело от их пола. Компьютерная томография являлась наиболее информативным методом для выявления различных анатомических вариантов строения полости носа и околоносовых синусов.

Ключевые слова: искривление носовой перегородки, гребень носовой перегородки, варианты строения решетчатой кости, пневматизация носовой перегородки, буллёзная деформация носовой раковины, околоносовые синусы.

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Anatomical variants variety of sinonasal region are commonly identified through sinus CT scans, with prevalent examples including Agger nasi cells, spheno-ethmoidal (Onodi) cells, infra-orbital ethmoidal (Haller) cells, nasal septum deviation (NSD), and Concha bullosa (CB) [1]. The most prevalent physical ailment concerning the nasal septum is NSD. The deviation may manifest as cartilaginous, osseocartilaginous, or osseous in nature [2]. The reported septal variations prevalence in literature spans from 26% to 97%, reflecting the diverse morphological characters and extents of deviations [3]. Other, few common anatomical variants of paranasal sinuses are pneumatization of the uncinate process (or an un-cinate bulla), large ethmoidal bullae, pneumatized crista galli and supraorbital cells [1].

Some anatomical variations have been identified as potentially linked to chronic rhinosinusitis, likely inducing inflammation by obstruction the drainage pathway from sinuses to nasal cavity [4]. Chronic rhinosinusitis (CRS) is character by persistent inflammation of PNS mucosa lasting at least three months. The origins of chronic sinusitis are diverse, encompassing infections, allergies, anatomical anomalies, immune system deficiencies, and mucociliary transport disorders [5].

In the contemporary era, CT of PNS has emerged as preferred investigative method for radiological detection in nasal and sinus diseases. Distinguished from plains radiography, sinus CT exhibits exceptional clarity in anatomical soft tissue and bony details, facilitating accurate diagnosis and offering a comprehensive view of sinonasal anatomy crucial for safe surgery [2]. For patients undergoing Functional Endoscopic Sinus Surgery (FESS), a CT scan has become a mandatory radiological investigation. This scanning modality aids in the identification of various anatomical variations. Many medical facilities utilize three-millimeter cuts across coronal, sagittal, and axial views to assess distinct anatomical structures of the lateral nasal wall and para-nasal sinuses. Coronal views, in particular, are well-suited for examining variants in the sphenoid and ethmoid cells, such as the Onodi or spheno-ethmoidal cell. The continual advancement and refinement of CT scan have empowered a comprehensive evaluation of patients' para-nasal sinuses, providing FESS surgeons with an invaluable guide map for their surgical procedures [6].

CT scan is useful in diagnosing chronic sinusitis. A distinctive finding involves the presence of sclerotic thickened of bone (hyperostosis) within walls, indicative of a prolonged muco-periosteal reaction. In some cases, intrasinus calcification may also be observed. It is important to note that the identification of opacification does not effectively differentiate chronic sinusitis from an acute sinus infection [7].

Aims of the study are to determine the CT validities of nasal cavity in normal anatomical variant and to assess the CT roles in chronic sinusitis of nasal cavity.

Patients and Methods.

Study design.

A cross-sectional study conducted at Department of Radiology in Al-Hilla General Hospital from 26th July 2023 to 29th May 2024. Sample consist of 27 cases with Paranasal sinuses CT scan.

Data collection.

Participants data, including age, sex, effected sinus, CT findings (Normal finding, NSD, Nasal septal spur, Ethmoidal variations, Septal pneumatization, CB, Agger nasi cells, Onodi cells, Haller cells, Uncinate process variation, Maxillary sinus affection, Sphenoidal variants, Keros classification, Ethmoidal roof asymmetry, mucosal thickening of the sinuses and inferior turbinate enlargement). All CT scan findings were analyzed by experience radiologist.

Inclusion criteria.

1. All age groups and both sex
2. Chronic rhinosinusitis
3. Symptoms (obstruction, discharge, headache)

Exclusion criteria.

1. Pregnancy
2. Loss of follow-up
3. Previous PNS surgery
4. Nasal polypsis
5. Tumors
6. Traumas
7. Facial Anomalies
8. Massive opacification (distortion the normal anatomy)

CT scan.

Multidetector computed tomography (MDCT) scan (Philips Brilliance 64 CT scanner, multidetector CT scanner, Germany, serial number 10 416) was used. The protocols were: coronal and sagittal reconstructions.

The sequences were:

• Coronal (anterior wall (frontal sinus) to posterior wall (sphenoid sinus)).

• Axial (parallel to palate (hard) and to frontal sinus).

Parameters: slice thickness (0.6 mm), table incrimination (3 mm), 130 KV and 150 mA/sec, scan time (0.5 sec), window widths (1300: 2000), window levels (–80: –200), rotation time (0.5 sec) and FOV (240 mm).

Ethical considerations.

The study approved by The Medical Ethical Board of College of Medicine, Babylon University (5053 in 26-07-2023).

Statistical analysis.

Statistical package for social science (SPSS version 24.0, Chicago, US, IBM Inc.) was used. Data were described in the form of number and percentage for qualitative data and (mean, and SD) calculation for quantitative data. Monte Carlo test was used to detect the relationship between continuous variables. A one-sided P-value of 0.05 or less was considered statistically significant.

Results.

Patients results.

In this study, 27 patients with chronic sinusitis were enrolled. The mean age of patients was 19.63±8.76 yrs ranged from 5 yrs to 36 yrs (median =18 yrs). The common reported age group was (16-25 yrs) in 10 (37.1%). In relation to sex, 20 (66.7%) were male, and 10 (33.3%) were female. (Table №1).

Results according normal anatomical variant in nasal cavity.

Regarding the effected sinus, the commonest was Maxillary sinus in 19 cases (70.4%). Those with sphenoid sinus were 6 cases (22.2%). One patient had frontal and one case had solitary hypo- plastic frontal sinusitis. In addition, ethmoid sinuses effected in 6 cases (22.2%) of cases accompanied with other major sinuses. Normal anatomical variant of nasal cavity seen in four cases (14.8%). Nasal septal deviation seen in the most of patients in 21 cases (77.8%). Uncinate process variation and mucosal thickening of the sinuses seen as oligo sign in one case for each. However, mucosal thickening of the sinuses was noticed in seven cases (35.2%) accompanied with other findings. Concha bullosa was visualized in 8 cases (44.4%). Nasal septal spur reported in 5 cases (27.8%). Inferior turbinate enlargement was visualized in 2 cases (7.4%). Pneumatization lateral sphenoid bone wings and pneumatization of anterior cliniod process of sphenoid bone were seen in one case for each (Fig. 1-4), (Table №2).

Results according anatomical variant in nasal cavity in relation to age.

Table №3 listed the results according effected sinuses of anatomical variant in nasal cavity in relation to age. Those aged ≤20 yrs were eight Maxillary, five Sphenoid, one Frontal, one Solitary hypo-plastic frontal and two Ethmoid. Those aged >20 yrs were eleven Maxillary, one Sphenoid and four Ethmoid. These findings presented with a high statistical difference (Monte Carlo= 4.06, P=0.029).

Table №4 listed the results according CT scan findings of anatomical variant in nasal cavity in relation to age. Those aged ≤20 yrs were two Normal, twelve Nasal septal deviation, four Mucosal thickening of the sinuses, four Concha bullosa, three Nasal septal spur and one Inferior turbinate enlargement. Those aged >20 yrs were two Normal, nine Nasal septal deviation, one Uncinate process variation, four Mucosal thickening of the sinuses, four Concha bullosa, two Nasal septal spur, one Inferior turbinate enlargement and two Pneumatization of sphenoid. These findings presented with no significant difference (Monte Carlo= 0.136, P=0.462).

Results according anatomical variant in

Table №1. Patients results regarding age and sex (n=27).

Variables		No. of patient	%
Age (years)	5-15	9	33.3
	16-25	10	37.1
	26-35	7	25.9
	≥36	1	3.7
Gender	Male	17	62.9
	Female	10	37.1

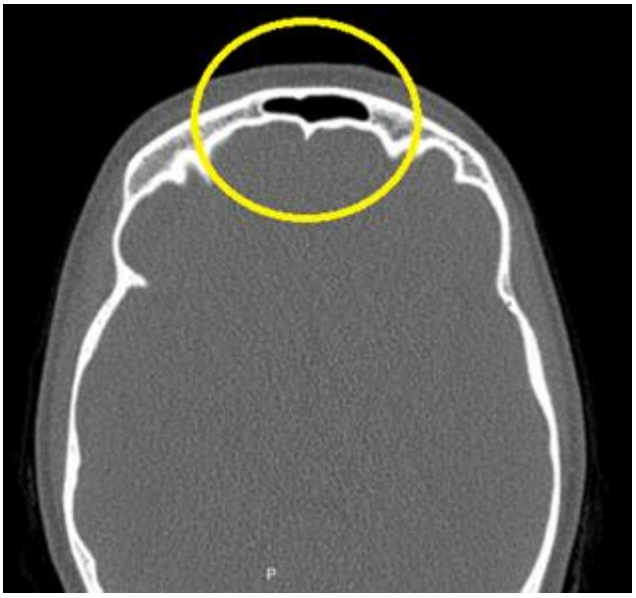

Fig. 1 a (Рис. 1 а)

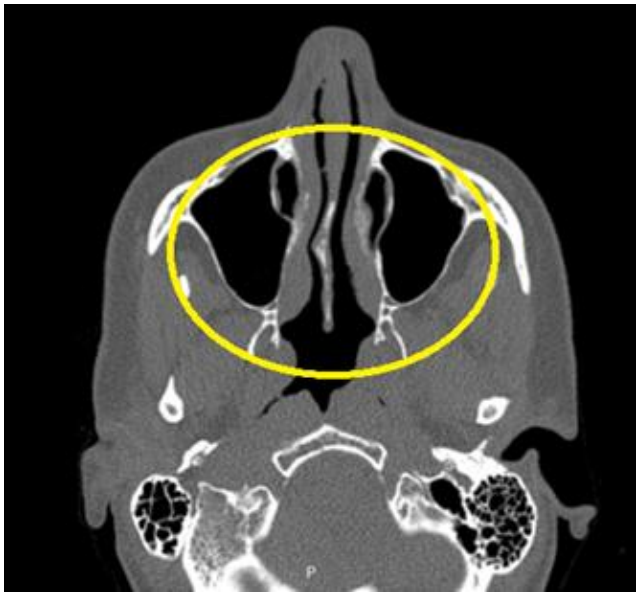

Fig. 1 b (Рис. 1 б)

Fig. 1. CT, facial skeleton, axial slices, bone window.

Patient, 14-years-old girl with solitary hypo-plastic frontal sinus (a, yellow circle), NSD and nasal septal spur (b, yellow circle).

Рис. 1. КТ, лицевой скелет, аксиальные срезы, режим костной плотности.

Пациентка, 14 лет, с гипоплазией единичного лобного синуса (а, желтая окружность), искривлением и гребнем носовой перегородки (б, желтая окружность).

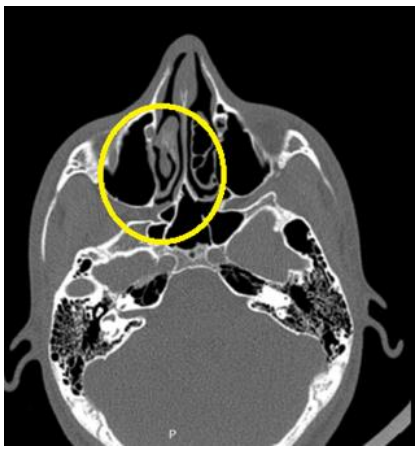

Fig. 2 a (Рис. 2 а)

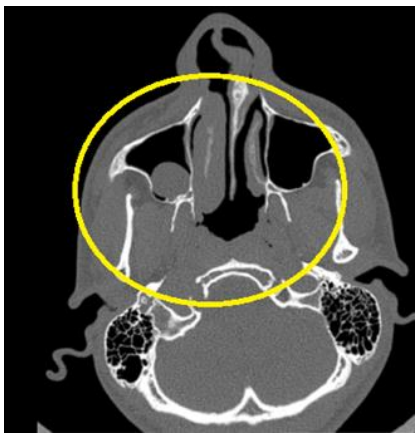

Fig. 2 b (Рис. 2 б)

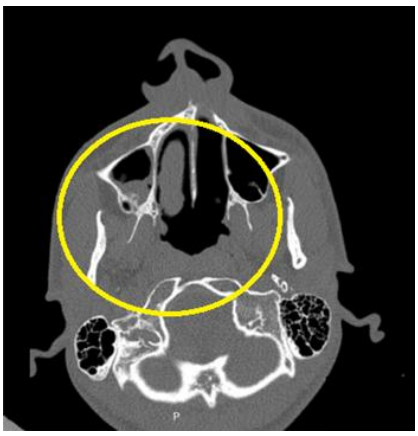

Fig. 2 c (Рис. 2 в)

Fig. 2. CT, facial skeleton, axial slices, bone window.

Patient, 9-years-old boy with inferior turbinate enlargement (a and c, yellow circle) and nasal septal deviation (b, yellow circle).

Рис. 2. КТ, лицевой скелет, аксиальные срезы, режим костной плотности.

Пациент, 9 лет, с гипертрофией нижней носовой раковины (а и в, желтая окружность) и искривлением носовой перегородки (б, желтая окружность).

nasal cavity in relation to sex.

Table №5 listed the results according effected sinuses of anatomical variant in nasal cavity in relation to sex. Males were five Maxillary, four Sphenoid, one Solitary hypo-plastic frontal and four Ethmoid. Females were fourteen Maxillary, two Sphenoid, one frontal and two Ethmoid. These findings presented with no statistical difference (Monte Carlo= 2.43, P=0.112).

Table №6 listed the results according CT scan findings of anatomical variant in nasal cavity in relation to sex. Males were one Normal, eight Nasal septal deviation, six Mucosal thickening of the sinuses, four Concha bullosa, two Nasal septal spur, one Pneumatization of sphenoid and one Inferior turbinate enlargement. Females were three Normal, thirteen Nasal septal deviation, one Uncinate process variation, two Mucosal thickening of the sinuses, four

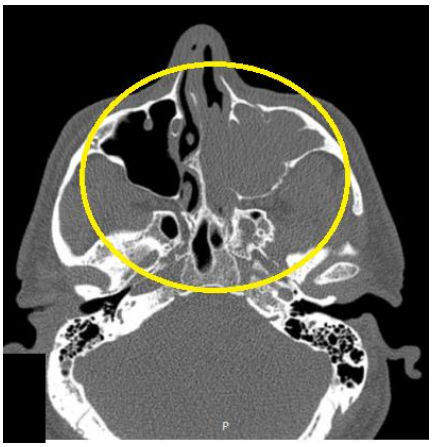

Fig. 3 (Рис. 3)

Fig. 3. CT, facial skeleton, axial slices, bone window.

Patient, 15-years-old boy with NSD and CB of maxillary and ethmoid sinuses.

Рис. 3. КТ, лицевой скелет, аксиальные срезы, режим костной плотности.

Пациент, 15 лет, с искривлением носовой перегородки и буллой носовой раковины верхнечелюстного синуса и решетчатой кости.

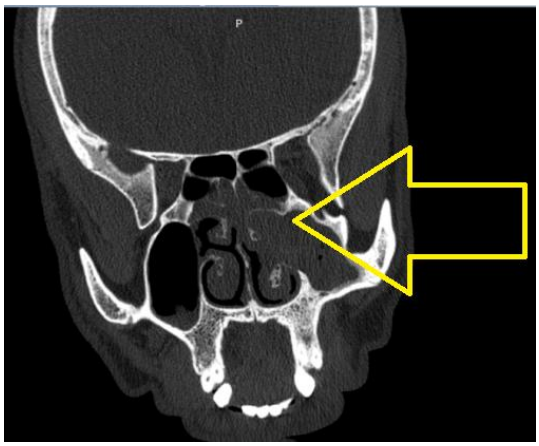

Fig. 4 (Рис. 4)

Fig. 4. CT, facial skeleton, axial slices, bone window.

Patient, 6-years-old child with pneumatization of lateral sphenoid bone wings (yellow arrow) and NSD.

Рис. 4. КТ, лицевой скелет, аксиальные срезы, режим костной плотности.

Пациент, 6 лет, с пневматизацией латеральных крыльев клиновидной кости (желтая стрелка) и искривлением носовой перегородки.

Table №2. Anatomical variant in nasal cavity (n=27).

Variables		No. of patient	%
Effected sinus	Maxillary	19	70.4
	Sphenoid	6	22.2
	Frontal	1	3.7
	Solitary hypo plastic frontal	1	3.7
CT findings	Normal	4	14.8
	Nasal septal deviation	21	77.8
	Uncinate process variation	1	3.7
	Mucosal thickening of the sinuses	1	3.7
Additional findings*	Concha bullosa	8	44.4
	Mucosal thickening of the sinuses	7	35.2
	Nasal septal spur	5	27.8
	Inferior turbinate enlargement	2	7.4
	Pneumatization lateral sphenoid bone wings	1	3.7
	Pneumatization of anterior cliniod process of sphenoid bone	1	3.7

Table №3. Effected sinuses according to age.

Sinus / Age	Maxillary	Sphenoid	Frontal	Solitary hypo-plastic frontal	Ethmoid
	No.				
≤20 yrs	8	5	1	1	2
>20 yrs	11	1	0	0	4
Total	19	6	1	1	6

Monte Carlo= 4.06, df=3, P=0.029

Table №4. CT scan findings according to age.

Sinus / Age	Normal	Nasal septal deviation	Uncinate process variation	Mucosal thickening of the sinuses	Concha bullosa	Nasal septal spur	Inferior turbinate enlargement	Pneumatization of sphenoid
	No.							
≤20 yrs	2	12	0	4	4	3	1	0
>20 yrs	2	9	1	4	4	2	1	2
Total	4	21	1	8	8	5	2	2

Monte Carlo= 0.136, df=2, P=0.462

Table №5. Effected sinuses according to sex.

Sinus / Age	Maxillary	Sphenoid	Frontal	Solitary hypo-plastic frontal	Ethmoid
	No.				
Male	5	4	0	1	4
Female	14	2	1	0	2
Total	19	6	1	1	6

Monte Carlo= 2.43, df=3, P=0.112

Table №6. CT scan findings according to sex.

Sinus / Age	Normal	Nasal septal deviation	Uncinate process variation	Mucosal thickening of the sinuses	Concha bullosa	Nasal septal spur	Inferior turbinate enlargement	Pneumatization of sphenoid
	No.							
Male	1	8	0	6	4	2	1	1
Female	3	13	1	2	4	3	1	1
Total	4	21	1	8	8	5	2	2

Monte Carlo= 0.865, df=3, P=0.277

Concha bullosa, three Nasal septal spur, one Inferior turbinate enlargement and one Pneumatization of sphenoid. These findings presented with no significant difference (Monte Carlo=0.865, P=0.0277).

Discussion.

In this study, the commonest effected sinus was Maxillary sinus in 19 cases (70.4%), sphenoid sinus were 6 cases (22.2%), and ethmoid sinuses in 6 cases (22.2%). Nasal septal deviation (NSD) seen in the most of patients in 21 cases (77.8%). Uncinate process variation and mucosal thickening of the sinuses seen in one case for each. Mucosal thickening of the sinuses was noticed in seven cases. Concha bullosa was visualized in 8 cases (44.4%). Nasal septal spur reported in 5 cases (27.8%). Inferior turbinate enlargement was visualized in 2 cases (7.4%). Pneumatization lateral sphenoid bone wings and pneumatization of anterior cliniod process of sphenoid bone were seen in one case for each.

Nearly, same percent than our findings seen by Dawood mentioned several anatomic variants as NSD (71.7%), septal spur (34%), septal pneumatization (16.7%), paradoxical turbinate (19%), hypoplastic turbinate (1%), Aggernasi cells (72%), Haller cells (70.7%), Onodi cells (44.7%), elongation of ethmoid Uncinate process (69.7%), pneumatization of ethmoid process (3%), frontal sinus agenesis (hypoplasia) (11.7%), Keros classification [I=31%, II=66.7%, III=2.3%], asymmetry of ethmoidal roofs (43.3%), sphenoidal variants (78.7%), crista galli pneumatization (5.7%%), hypoplasia of maxillary sinus (1.3%) and maxillary septum (25%) [8]. Also, these data similar to other studies like Kaya et al., and Choby et al. [9, 10].

In review of literature, the prevalence of spur and pneumatization is 18% [9]. Dawood reported that the prevalence of concha bullosa is 81.7%, while we saw in 44.4% of cases [8]. It is most frequently anatomic variants with incidence more than 70% [11]. The differences report because of influence by aeration degrees, lower rates suggesting that only large turbinates may have been take into consideration, and in addition to radiologist experiences [9].

Race, geography, socio-economic, hereditary disparities and differing of data acquisition sensitivity, and discrepant definitions for in the diagnostic of anatomic variants might be a reasons for these variation in percentage with other authors. The results according effected sinuses in relation to age showed that age of patients could effected anatomical variant appearance with a high statistical difference (P=0.029), whereas sex of patients didn't respect (P=0.112). The same reported by Dawood study, the number of anatomic variants in relation to sex didn't influences [8]. Dawood concluded anatomic variants of the para-nasal sinuses were common and the most frequent one located in nasal septum, ethmoid and sphenoid sinuses [8].

In 2021 a large blinded retrospective study published by El-Din et al. included 879 patients subjected to MDCT imaging for nasal cavity and para-nasal sinuses regions [12]. Patients aged 34.5±10.7 yrs (18-79 yrs). The Concha bullosa found 488 cases (55.5%), with no sex variation (p=0.912). The ethmoid was the most predominant type followed by the maxillary and the lowest prevalence for frontal then sphenoid.

The prevalence in our study of CB is less than the studies conducted by Papadopoulou et al. [13]. In contrast, it is lower records by Anbiaee et al. and Al-Rawi et al. [14, 15]. This difference in prevalence may be due to wide ranges of numbers of CT scans and the different types of the used CT scans in whole studies.

In Saudi German Hospitals Group in Saudi Arabia, a large study conducted by Madani and colleagues [16]. They enrolled 681 patients, 420 males (61.7%) and 261 females (38.3%) underwent CT scan of nasal cavity and Paranasal sinuses. Mean age was 44.7±14.3 yrs. NSD was present in 75.2%, while normal septum was composed of 24.8%. NSD was more frequent in men than women with a significant (P<0.001).

Pneumatization is rare variants occurring at the bony parts of the nasal septums because of air extension from sphenoid sinuses or crista galli. It has low prevalence rates and few clinical evidence. Only, we had two cases, while Madani et al. recorded high rates as 23.6% [16].

The advances of techniques CT scans in detection of anatomic variants in nasal cavity and para-nasal sinuses are raising in last years, since it is wide-spreading and make these variations more apparent [17, 18].

Conclusions.

Nasal septal deviation is the commonest anatomical variants. The mucosal thickening and Concha bullosa variants more visualize in male than female. The effected sinuses of anatomical variants distribution influences by age of patients but not by sex. CT scan more reliable to detection numerous anatomic variants of nasal cavity and para-nasal sinuses.

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