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Anatomic variations of para-nasal sinuses in patients undergoing CT scan: spectrum, prevalence and implications

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Abstract
Background Knowledge of the anatomic variations reduces the surgical complication rates during FESS, helps explain recurrence of disease and allows one to change the operative technique. These variations can be the etiological factor for sinusitis and spread of infection to adjacent structures. The aim of this study is to investigate variations in paranasal sinuses discovered at CT scan, explain their spectrum, and prevalence as well as clinical and surgical implications. Patients and methods This study is a retrospective cross-sectional study where about 500 Egyptian patients were included for routine MSCT of the paranasal sinuses from Banha University Hospitals during January 2019 to January 2020. In all the included patients, we gathered data regarding complete history of symptoms, findings of ENT examination and MSCT examination of the paranasal sinuses (PNS). Results The mean age of the studied patients was 29 ±14 years. About half of the patients were males (45.8%), and the other half were females (54.2%). The most frequent symptom was headache (77.4%), followed by nasal obstruction (76.0%), discharge (61.6%), blurring of vision (25.0%), and vertigo (6.0%). The most frequent variations were agar nasi reported in (86.4%), nasal septal deviation (76.2%), sphenoid sinus septation (74.2%), Maxillary sinus hyper-pneumatization (66.0%), Haller cell (65.8%) & Frontal sinus septation (60.2%). Agar nasi was significantly higher in those with sinusitis (95.3%) than those without (75.3) ($P < 0.01$). Also, haller cell was significantly higher in those with sinusitis (93.5%) than those without (31.4%) ($P < 0.001$). Conclusion MSCT on paranasal sinus plays an important role in preoperative assessment by detecting paranasal sinus variations preventing possible injuries of important structures beside detection of anatomical variant and their relation to sinusitis.
Keywords Paranasal sinus, variations, Nasal septum, concha bullosa

1.Introduction

Knowledge of the anatomic variations does reduce the surgical complication rates during FESS, helps explain recurrence of disease and allows one to change the operative technique. These variations can be the etiological factor for sinusitis and spread of infection to adjacent structures. [1]

The aim of this study is to investigate extensively variations in paranasal sinuses discovered at CT scan, explain their spectrum, and prevalence as well as clinical and surgical implications.

2.Patients and methods

This study is a retrospective cross-sectional study where about 500 Egyptian patients were included for routine MSCT of the paranasal sinuses from Banha University Hospitals during January 2019 to January 2020. In all the included patients, we gathered data regarding complete history of symptoms, findings of ENT examination and MSCT examination of the paranasal sinuses (PNS). The significant symptoms detected were headache, nasal obstruction, nasal discharge, blurring of vision & vertigo.

Inclusion Criteria:

- Clear interpretable images of paranasal sinuses; whether scan was for brain or PNS.

Exclusion Criteria:

- Patients with history of previous nasal surgery or direct nasal trauma.
- Patients below the age of fifteen years.
- Presence of general contraindications for CT such as pregnant women.

Patient protocol

Routine multi-slice CT of the paranasal sinuses was performed to look for mucosal disease of the paranasal sinuses, drainage pathways, and presence of anatomical variations and their relation to known sinus drainage pathways. A review of CT scans of the paranasal sinuses of 500 patients was done; special attention was directed toward identifying bony anatomic variants and mucosal abnormalities.

Methods

- Selection of good quality images from CT datasets in PACS (MILLENSYS Vision tools Workspace PACS Egypt Ver 4.6) in department of radiology, Benha university hospitals.
- Selected cases were to be mainly for paranasal sinuses, or brain studies where paranasal sinuses are well scanned.
- Clinical complaints are analyzed for each case.

- CT technique as done in Benha university: Scanner Toshiba Activion 16, slice thickness 3mm, slice interval 3mm, Kv 120, mA 200, no contrast, followed by sumbillimetric reconstruction in three orthogonal planes.
- Both direct coronal and axial scanning was performed. The coronal scans expanded from the anterior wall of the frontal sinus to the posterior wall of the sphenoid sinus. In the axial scans, the beam was parallel to the hard palate, and the scans extended from the hard palate to the top of the frontal sinus. Both soft tissue and bone windows were gotten. A high-resolution calculation was utilized for upgrade of the fine hard points of interest of the ostiomeatal complex.
- Image analysis: in same PACS viewer by two radiologists.
- Films were assessed in a schedule, standardized mold to safeguarded that little points of interest were not missed utilizing PACS.

3.Results

The mean age of the studied patients was 29 ±14 years. About half of the patients were males (45.8%), and the other half were females (54.2%)**.**

Table (1) General characteristics of the studied patients

General characteristics		
Age (years)	Mean ±SD	29 ±14
Sex	Males n (%)	229 (45.8)
	Females n (%)	271 (54.2)

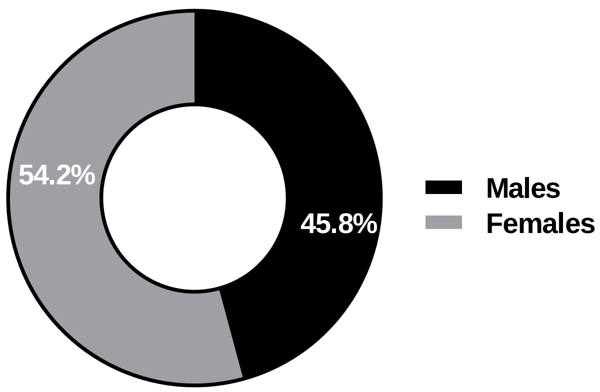

Fig 1: Gender distribution of the studied patients

- Clinical findings

The most frequent symptom was headache (77.4%), followed by nasal obstruction (76.0%), discharge (61.6%), blurring of vision (25.0%), and vertigo (6.0%)**.**

Table (2) Clinical findings in the studied patients

	n (%)
Headache	387 (77.4)
Nasal obstruction	380 (76.0)
Discharge	308 (61.6)
Blurring of vision	125 (25.0)
Vertigo	30 (6.0)

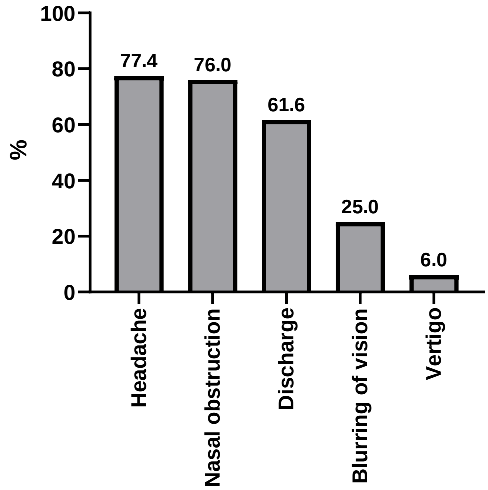

Fig 2: Clinical findings in the studied patients

- Anatomical variations

Concha bullosa **(fig.9)** was reported in about half of the patients (47%), while concha paradoxical was reported in (26%). The nasal septal deviation **(fig.9)** was reported in (76.2%), while nasal septal spur was reported in (37.8%). Olfactory fossa depth was type I **(fig 7)** in 28%, type II in 66%, and type III in 6%. Regarding frontal sinus volume, about (68.8%) showed hyper-pneumatization **(fig.8)**. Frontal sinus septation **(fig.8)** was reported in 60.2%. Maxillary sinus hyper-pneumatization was reported in (66.0%), while maxillary sinus septation was reported in 43.2%. Onodi cell **(fig.5)** was reported in 45.2%. Agar nasi **(fig.5,8)** was reported in 86.4%. Haller cell **(Fig.7)** was reported in 65.8%. The osteomeatal complex was type I in 39.8%, type II in 47.8%, and type III in 12.4%. Crista Galle pneumatization was reported in 8.4%. Regarding the sphenoid sinus, about (61.4%) showed hyper-pneumatization **(fig.6)**. Optic nerve canal dehiscence **(fig.6)** was reported in 16.2%, while carotid canal dehiscence was reported in 3.8%, and sphenoid sinus septation was reported in 74.2%. The infraorbital canal was type I **(fig.10)** in 14.4%, type II in 27.6%, and type III **(fig.9)** in 58%. About half of the patients had impacted teeth (53.4%), and 47.6% had supraorbital cells **(fig.4).**

Table (3) Anatomical variations in the studied patients

		n	%
Concha bullosa	Yes	235	47.0
Concha paradoxica	Yes	130	26.0
Nasal septal deviation	Yes	381	76.2
Nasal septal spur	Yes	189	37.8
Olfactory fossa depth	I	140	28.0
	II	330	66.0
	III	30	6.0
Frontal sinus volume	Normal	47	9.4
	Hypo	109	21.8
	Hyper	344	68.8
Frontal sinus septation	Yes	301	60.2
Maxillary sinus hyper pneumatization	Yes	330	66.0
Maxilalry sinus septation	Yes	216	43.2
Onodi cell	Yes	226	45.2
Agar nasi	Yes	432	86.4
Haller cell	Yes	329	65.8
Osteomeatal complex	I	199	39.8
	II	239	47.8
	III	62	12.4
Crista Galle pneumatization	Yes	42	8.4
Sphenoid sinus volume	Normal	143	28.6
	Hypo	50	10.0
	Hyper	307	61.4
Optic nerve canal dehiscence	Yes	81	16.2
Carotid canal dehiscence	Yes	19	3.8
Sphenoid sinus septations	Yes	371	74.2
Infraorbital canal	I	72	14.4
	II	138	27.6
	III	290	58.0
Impacted teeth	Yes	267	53.4
Supraorbital cells	Yes	238	47.6

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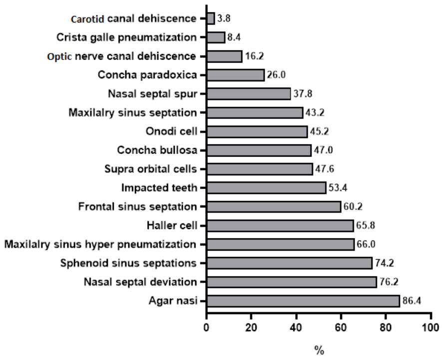

Fig 3: Anatomical variations in the studied patients

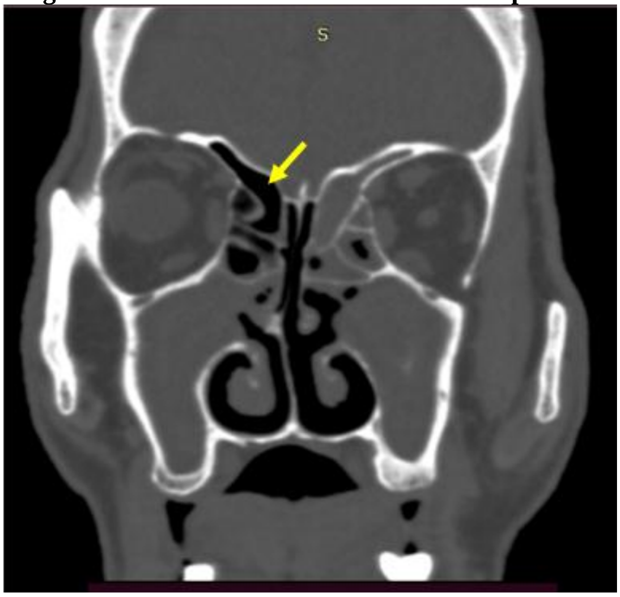

Fig 4: Supraorbital cell

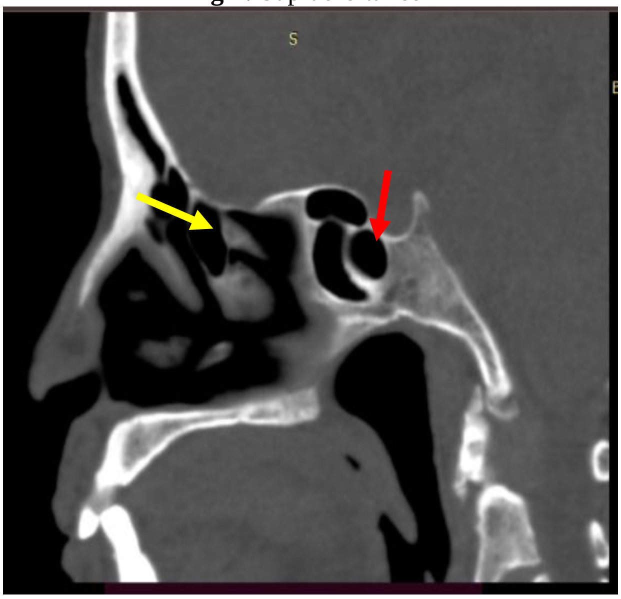

Fig 5: agar nasi (Yellow) + onodi cell (Red)

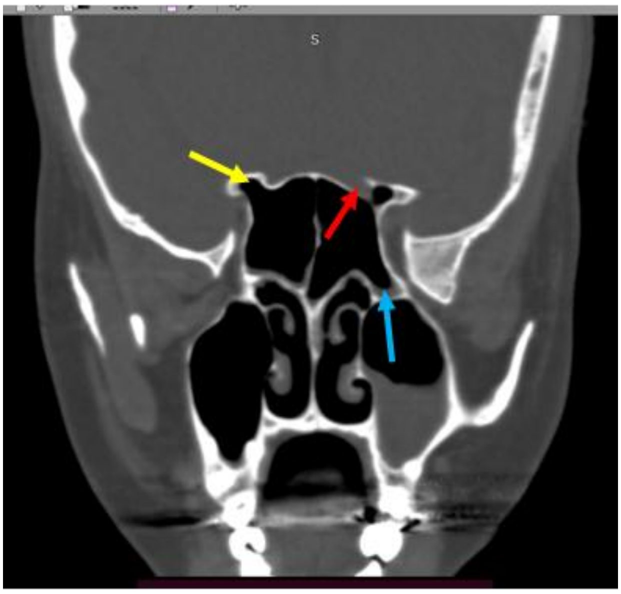

Fig 6: Pneumatized anterior clinoid process (Yellow) + optic nerve canal dehiesence (Red)+ lateral pneumatization (Blue)

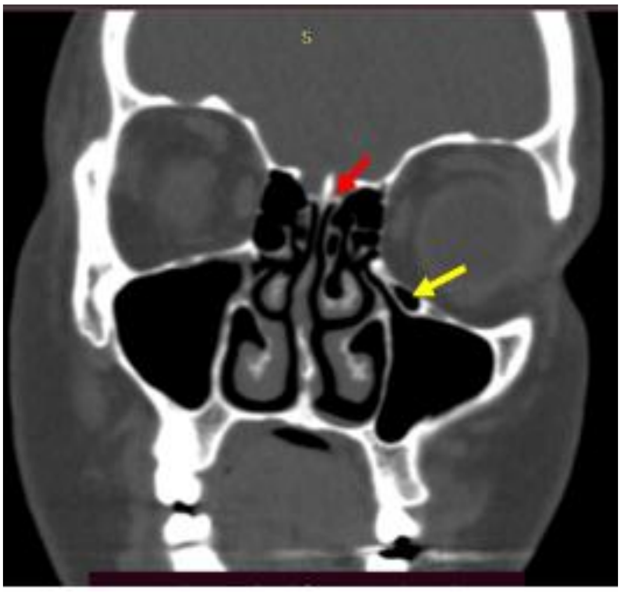

Fig 7: Haller cell (Yellow)+ Karos type 1 (Red)

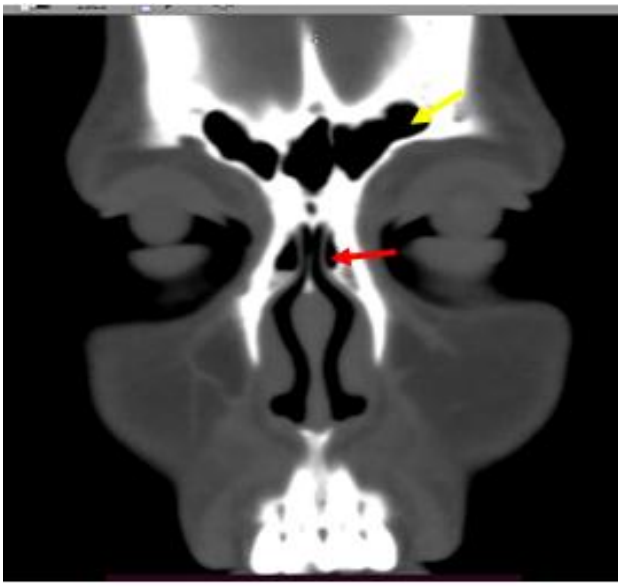

Fig 8: Frontal sinus hyperpneumatization & septation (Yellow)+ agar nasi cell(Red)

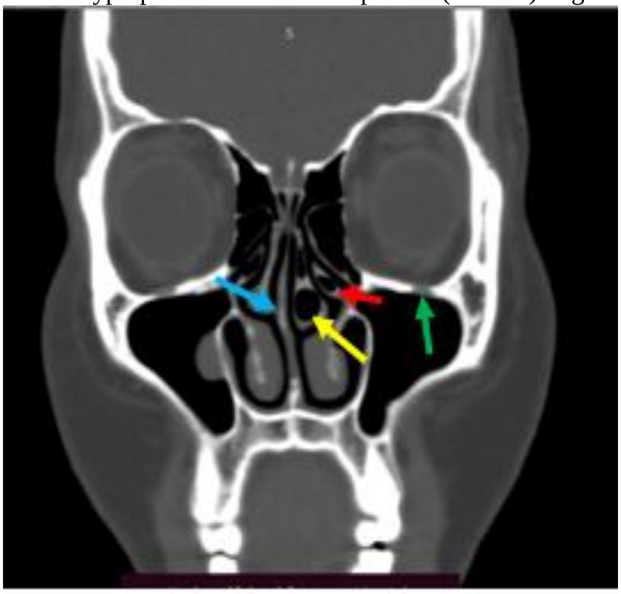

Fig 9: Lt middle choncha bullosa (Yellow)+ Lt pneumatized uncinate process (Red)+deviated nasal septum (Blue)+ infraorbital canal type 3 (Green)

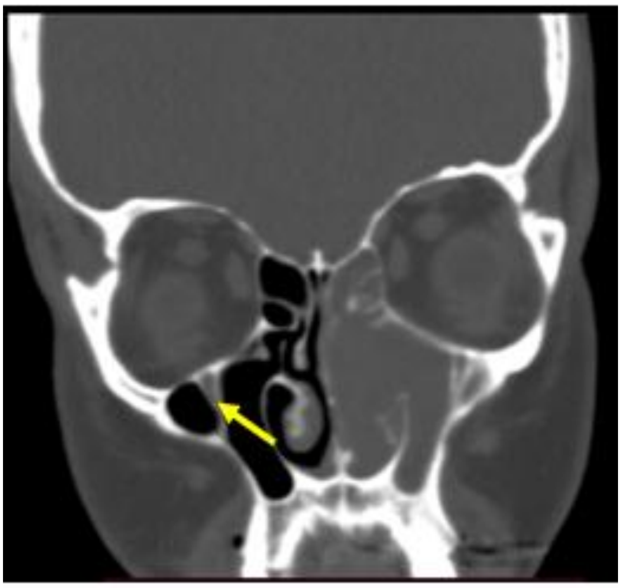

Fig 10: Infraorbital canal type 1 (coronal)

- Anatomical variations according to gender

Nasal septum deviation was significantly higher in females (79.7%) than males (72.1%) (P = 0.045). In contrast, nasal septal spur was significantly higher in males (42.8%) than females (33.6%) (P = 0.034).

Olfactory fossa depth showed a significant association with gender (P = 0.021); type I was higher in males (32.3%) than females (24.4%), and type II was higher in females (71.2%) than males (59.8%) (P = 0.021).

Frontal sinus volume showed a significant association with gender (P < 0.001); hyper-pneumatization was higher in males (82.5%) than females (57.2%), while hypo-pneumatization was higher in females (31%) than males (10.9%). Also, frontal sinus septations was significantly higher in males (74.2%) than females (48.3%) (P < 0.001).

Maxillary sinus hyper-pneumatization was significantly higher in males (72.5%) than females (60.5%) (P = 0.005). Agar nasi was significantly higher in females (89.3%) than males (83%) (P = 0.04). A significant association was reported between infraorbital canal and gender (P < 0.001); type I and II were higher in females (19.2% and 31.7%, respectively) than males (8.7% and 22.7%, respectively), while type III was higher in males (68.8%) than females (49.1%).

No significant associations were reported between all other parameters and gender

Table (4) Anatomical variations according to gender in the studied patients

		Males		Females		
		N	**%**	**N**	**%**	**P-value**
Concha bullosa	Yes	106	46.3	129	47.6	0.769
Concha paradoxica	Yes	60	26.2	70	25.8	0.925
Nasal septal deviation	Yes	165	72.1	216	79.7	0.045*
Nasal septal spur	Yes	98	42.8	91	33.6	0.034*
Olfactory fossa depth	I	74	32.3	66	24.4	0.021*
	II	137	59.8	193	71.2	
	III	18	7.9	12	4.4	
Frontal sinus volume	Normal	15	6.6	32	11.8	<0.001*
	Hypo	25	10.9	84	31.0	
	Hyper	189	82.5	155	57.2	
Frontal sinus septation	Yes	170	74.2	131	48.3	<0.001*
MS hyper pneumatization	Yes	166	72.5	164	60.5	0.005*
MS septation	Yes	106	46.3	110	40.6	0.2
Onodi cell	Yes	96	41.9	130	48.0	0.176
Agar nasi	Yes	190	83.0	242	89.3	0.04*
Haller cell	Yes	157	68.6	172	63.5	0.232
Osteomeatal complex	I	93	40.6	106	39.1	0.655
	II	105	45.9	134	49.4	

	III	31	13.5	31	11.4	
Crista galle pneumatization	Yes	23	10.0	19	7.0	0.223
SS volume	Normal	72	31.4	71	26.2	0.08
	Hypo	28	12.2	22	8.1	
	Hyper	129	56.30%	178	65.7	
Optic nerve canal dehiscence	Yes	45	19.7	36	13.3	0.054
Carotid canal dehiscence	Yes	8	3.5	11	4.1	0.742
SS septations	Yes	163	71.2	208	76.8	0.156
Infra orbital canal	I	20	8.7	52	19.2	<0.001*
	II	52	22.7	86	31.7	
	III	157	68.6	133	49.1	
Impacted teeth	Yes	112	48.9	155	57.2	0.064
Supra orbital cells	Yes	119	52.0	119	43.9	0.072

Chi-square test was used MS: Maxillary sins SS: Sphenoid sinus

- Association between sinusitis and other anatomical variations

Agar nasi was significantly higher in those with sinusitis (95.3%) than those without (75.3) (P < 0.01). Also, haller cell was significantly higher in those with sinusitis (93.5%) than those without (31.4%) (P < 0.001).

No significant associations were reported between sinusitis and concha bullosa (P = 0.884) or nasal septal deviation (P = 0.684).

Table (6) Association between sinusitis and other anatomical variations

		Sinusitis (n = 223)	No sinusitis (n = 277)	P-value
Concha bullosa	n (%)	131 (47.3)	104 (46.6)	0.884
Agar nasi	n (%)	264 (95.3)	168 (75.3)	<0.001*
Haller cell	n (%)	259 (93.5)	70 (31.4)	<0.001*
Nasal septal deviation	n (%)	213 (76.9)	168 (75.3)	0.684

Chi-square test was used * Significant

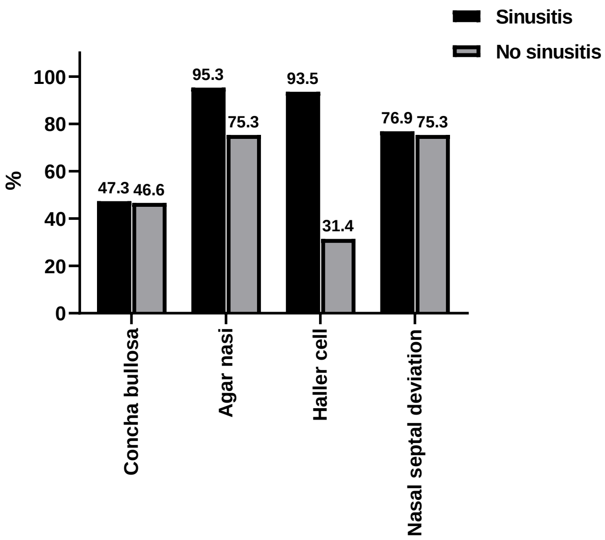

Fig 11: Association between sinusitis and other anatomical variations

3.1Statistical methods

Data management and statistical analysis were done using SPSS version 28. (IBM, Armonk, New York, United States). Numerical data were summarized as means and standard deviations. Categorical data were summarized as numbers and percentages. Anatomical variations were compared according to gender, age groups, and occurrence of sinusitis using the Chi-square test. All statistical tests were two-sided. P values less than 0.05 were considered significant.

4.Discussion

In the present study the mean age of the studied patients was 29 ±14 years. About half of the patients were males (45.8%), and the other half were females (54.2%). The mean age was slightly higher in many studies with also slightly male dominance. In Alsowey et al. study which included 240 patients with chronic rhinosinusitis (57.5%) were males and (42.5%) were females.[8] Their ages ranged from 20 to 61 years, with the mean age of 40.5 years. Also in Yassar et al. study, out of total 852 patients evaluated on MDCT, 508 (59.6%) were males and 344 were females (40.4%) with a mean age of 40.3 years (age range, 14 to 78 years).[9]

The most frequent symptom in our study was headache (77.4%), followed by nasal obstruction (76.0%), discharge (61.6%), blurring of vision (25.0%), and vertigo (6.0%). Similar to our results, Alsowey et al. recorded headache as the most common clinical presentation (52.5%) followed by runny nose (35%), postnasal discharge (33.8%), and nasal obstruction (25%).[8] In contrast to our results, the most common presenting symptom in Zojaji et al. study was nasal obstruction (100%) which was present in all patients in this study group. It was followed by nasal discharge/purulence/discolored postnasal discharge (91%), cough (79%), headache and facial pain (73%), dental pain (64%), and facial congestion/fullness (63%). Less common symptoms were fatigue (16%), hyposmia (14%), halitosis (11%), ear pain/pressure/fullness (10%), and purulence on nasal cavity examination (5%).[10]

Concha bullosa was reported in our study in (47%) with no significant associations reported between concha bullosa and gender. No significant association was reported between sinusitis and concha bullosa (P=0.884).

Regina Chinwe Onwuchekwa et al. in their study stated that prevalence of concha bullosa was 32.73% which is within the range reported by other study.[4] Asruddin et al., Mamitha et al., Zinreich et al. and Weinberger et al. reported prevalence of 30%, 28%, 16% and 15% respectively.[12-15] Higher prevalence was reported by Aramani et al., Perez-Pinas et al. and Scribano et al. who got 53.7%, 73% and 67% respectively.[16-18] While in Alsowey et al. study incidence of concha bullosa was (30.6%).[8] Also, Bolger WE et al., Perez‑Pinas I et al. & Joe JK in different studies showed the prevalence of concha bullosa was 4%–80%.[5-7]

Unlike our results, Shpilberg et al. reported that concha bullosa can, when sufficiently large, produce signs and symptoms by encroaching upon the infundibulum.[11] Supporting Shpilberg et al. results, M Kaya et al. who reported that the frequencies of concha bullosa cases were found to be 51% revealed that there was sinusitis in 67.2% of concha bullosa cases.[3]

Concha paradoxical was reported in (26%) of our cases. No significant associations were reported between concha paradoxica and gender.

As in our study, Joe JK et al. recorded this variation in 26% of there cases.[7] While the prevalence was much lesser in other studies as Kaygusuz et al. who reported a prevalence of 7.9%, Kaya M et al. with 4.3% and Bolger WE et al. who noticed this variation in only 3% in his study.[19,3,5]

Nasal septal deviation was the second most common variations detected in patients in our study, reported in (76.2%). Nasal septum deviation was significantly higher in females (79.7%) than males (72.1%) (P = 0.045). The reported prevalence of septal variations in the literature ranges between 40% and 96.9% due to varying morphological features and the extent of deviation. Luo et al. reported a prevalence of 40%.[20] While in Yassar et al. study, deviated nasal septum (DNS) was the most common anatomic variant of the paranasal sinuses and nasal cavity seen in 724 patients (85%).[9] Also, in Alsowey et al. study, deviated nasal septum was the most frequent variation in patients with chronic or recurrent sinusitis, and it was detected in 48.8% of cases.[8] Other studies done by Regina Chinwe Onwuchekwa et al.[4], Dutra and Marchiori,[23] Dua et al.,[25] Asruddin et al.,[12] Mamitha et al.[13] and Aramani et al.[16] revealed prevalence of nasal septal deviation of 20.91%, 14.1%, 44% and 38% who got 65% and 74.1% respectively.

In our study there was no significant association reported between nasal septal deviation and sinusitis (P= 0.684). Similar to our results, Kaya M et al. who observed septal deviation and bony spur at the rates of 89.7% and 8.2%, respectively, found no statistically significant relationship between septal deviation and sinusitis.[3] Because septal deviation is a very common variation, thus it can have a role in the development of sinusitis in association with other anatomic variations.

On the other hand, studies by Calhoun et al. revealed septal deviation to be directly related to sinusitis regardless of the degree of deviation.[21] Moreover, Elahi et al. mentioned that spur formation also took place in the etiology of sinusitis.[22]

Albayrak and Guleryuz reported a statistically significant relationship between septal deviation and concha bullosa, which together had a role in the development of sinusitis.[23]

In our study, nasal septal spur was reported in (37.8%). nasal septal spur was significantly higher in males (42.8%) than females (33.6%) (P = 0.034). While Regina Chinwe Onwuchekwa et al. reported only one case of septal spur with fusion to the left nasal turbinate.[4]

Olfactory fossa depth was type I in 28%, type II in 66%, and type III in 6%. Olfactory fossa depth showed a significant association with gender (P = 0.021); type I was higher in males (32.3%) than females (24.4%), and type II was higher in females (71.2%) than males (59.8%) (P = 0.021).

Regarding frontal sinus volume, about (68.8%) showed hyper-pneumatization. Frontal sinus volume showed a significant association with gender (P < 0.001); hyper-pneumatization was higher in males (82.5%) than females (57.2%), while hypo-pneumatization was higher in females (31%) than males (10.9%). Regina Chinwe Onwuchekwa et al. noticed hypoplasia of the frontal sinus was in 3.64% of the participants and extensive pneumatisation in 0.91%.[4] Hypoplastic frontal sinus was detected in 10.6% of patients in a study by H.D. Mohammad & Amir Daryani and in 8.4% of patients in the study by Stallman in Germany.[26,27]

Frontal sinus septation was reported in 60.2% in our study. It was significantly higher in males (74.2%) than females (48.3%) (P < 0.001).

Maxillary sinus hyper-pneumatization was reported in (66.0%). It was significantly higher in males (72.5%) than females (60.5%) (P = 0.005).

While maxillary sinus septation was reported in 43.2% with no significant associations were reported between maxillary sinus septation and gender.

Onodi cell was reported in 45.2% of cases in our study. No significant associations were reported between onodi cell and gender.

The prevalence of Onodi cells was reported to be 10%–98% in the literature. In Kaya M et al. study, it was recorded in lower cases than ours showing 14% of the paranasal sides.[3] While the prevalence of onodi cells in Regina Chinwe Onwuchekwa et al. study was 7.27% which is similar to the prevalence recorded by Rashid et al. on cadaveric studies.[4,28] Higher prevalences and near to our results ranging from 39% to 60% had been recorded by J.S. Driben et al. & S. Thanaviratananich et al.[29,30]

Agar nasi was reported in 86.4%%. Agar nasi was significantly higher in females (89.3%) than males (83%) (P = 0.04). No significant associations were reported between Agar nasi and age groups. The reported prevalence of this variant by various authors differs, Aramani et al.[16] and Liu et al.[31] had very low prevalence of 1.9%, while Bolger et al.[5] had very high prevalence of 98.5%. In Regina Chinwe Onwuchekwa[4] study they got a prevalence of 26% which is comparable to that of Dua et al.[25], Rashid et al.[28] & Alsowey et al.[8] who got prevalences of 40%, 49% & 30.6% respectively.

In our study we reported that agar nasi was significantly higher in those with sinusitis (95.3%) than those without (75.3) (P < 0.01), denoting that there is significant relation between presence of agar nasi and sinusitis. As in Kaya M et al. study, the rate of the ethmoidal cells extending to this region was 72%.[3] They revealed that agger nasi cells were associated with high rate of sinusitis, which was attributed to the drainage of frontal recess. In previous surgical and imaging studies done by I. Perez-Pinas et al. & Messerklinger W et al., agger nasi had been shown to be in the etiology of frontal sinusitis.[6,32] In these studies, the frequency of agger nasi cells varied in a broad range from 10% to 100%.

Haller cell was reported in 65.8%. Haller cell showed a significant association with age groups (P < 0.001); it was higher in the age group ≤ 30 years (71%) than other age groups. No significant associations were reported between Haller cell and gender. The prevalence of Haller's cells in Regina Chinwe Onwuchekwa study was 20.91%.[4] Similar findings were observed by Asruddin et al.[4] 28%, Perez-pinas et al.[6] 20%, Dua et al.[25] 16% & Alsowey et al.[8] 11.2%. Aramani et al.[16] and Liu et al.[31] recorded lower prevalence of 1.9% and 1% respectively.

We found a relation between presence of haller cell and sinusitis as haller cell was significantly higher in our study in those with sinusitis (93.5%) than those without (31.4%) (P < 0.001). Perez‑Pinas et al. and Stammberger and Wolf showed that this variation had a wide range of prevalence (2.7%–45%) and important in the etiology of maxillary sinusitis.[6,33] Also, Davis et al., associated Haller's cell to maxillary chronic sinusitis.[2] The reason for the wide range of prevalence may be the presence of different definitions of the Haller cells in the literature. In Kaya M et al. study, Haller cells were recorded in 25% of the paranasal sides, coexisted with inflammatory changes at the same side at the rate of 82.3%, having a significant effect on the prevalence of sinusitis.[3]

The osteomeatal complex was type I in 39.8%, type II in 47.8%, and type III in 12.4%. No significant associations were reported between osteomeatal complex type and gender. Azila et al. propose that stenosis of the ostiomeatal complex, resulting from either anatomical variations or hypertrophied mucosa, can cause obstruction and stagnation of secretions that may then become infected.[34] They stated that, when the obstructed drainage pathway reopens, reversal of the inflammatory process will result.

Crista Galle pneumatization was reported in 8.4%. No significant associations were reported between all Crista Galle pneumatization and gender. This prevalence is in keeping with finding by Regina Chinwe Onwuchekwa et al. who noticed this variant in 9 (8.18%) cases.[4] While Basic et al. using CT scans in a series of 212 patients noted pneumatisation of the crista galli in 2.4%.[35] Also Som et al. found pneumatized crista galli in five patients (2.4%).[36]

Regarding the sphenoid sinus, about (61.4%) showed hyper-pneumatization. No significant associations were reported between sphenoid sinus hyper-pneumatization and gender.

Optic nerve canal dehiscence was reported in 16.2%, while carotid canal dehiscence was reported in 3.8%. No significant associations were reported between optic nerve canal dehiscence and gender. DeLano et al. reported that bone dehiscence over the optic nerve was found in 24% of cases.[38]

While sphenoid sinus septation was reported in 74.2%. No significant associations were reported between sphenoid sinus septation and gender.

The infraorbital canal was type I in 14.4%, type II in 27.6%, and type III in 58%. A significant association was reported between infraorbital canal and gender ($P < 0.001$); type I and II were higher in females (19.2% and 31.7%, respectively) than males (8.7% and 22.7%, respectively), while type III was higher in males (68.8%) than females (49.1%).

About half of the patients 47.6% had supraorbital cells. No significant associations were reported with gender. On the other hand, Zhang et al., reported a prevalence of 5.4%.[37]

Also, about half of the patients had impacted teeth (53.4%). No significant associations were reported with gender.

5.Conclusion

From our study we concluded that MSCT on paranasal sinus plays an important role in preoperative assessment by detecting paranasal sinus variations preventing possible injuries of important structures beside detection of anatomical variant and their relation to sinusitis.

6.References

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