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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 The surgical complication rates during FESS may be reduced by knowing the anatomic variances, which explains illness recurrence and allows for a modification in operating approach.
Sinusitis and the spread of infection to nearby structures may have these variances as an etiological cause. Variations in the sinuses seen on a CT scan are the focus of this study, and the researchers are interested in learning more about them.
Methods and patients: There were about 500 Egyptian patients who had regular MSCT of the paranasal sinuses from January 2019 to January 2020 who were included in this research. A thorough medical history, an ENT exam, and an MSCT of the paranasal sinuses were obtained for each participant (PNS). **Results :** The average age of the patients in the research was 29 years and 14 months. Males made up 45.8% of the patients, with females making up the remaining 50%. (54.2 percent). Nasal obstruction (76.0 percent), discharge (61.6 percent), blurring of vision (25.0 percent), and dizziness were the other common symptoms (6.0 percent). Agar nasi (86.4%), nasal septal deviation (76.2%), sphenoid sinus septation (74.2%), Maxillary sinus hyper-pneumatization (66.0%), Haller cell (65.8%) and Frontal sinus septation (65.8%) were the most common variants (60.2 percent). Patients with sinusitis had substantially more agar nasi (95.3%) than those without (75.3%) (P 0.01).
With sinusitis (93.5 percent), haller cells were substantially greater than those without (31.4%). (P 0.001). **Conclusion:** Paranasal sinus variations may be detected with MSCT, which is an essential part of preoperative evaluation. MSCT can also be used to identify anatomical abnormalities and their link to sinusitis.

Keywords: Paranasal sinus, variations, Nasal septum, concha bullosa.

1. Introduction

FESS complications are reduced when surgeons are aware of the anatomical variances, which helps explain recurrence of illness and allows for a modification in the surgical procedure.

Sinusitis and the spread of infection to nearby structures may have these variances as an etiological cause.1

Studying in-depth differences in paranasal sinuses revealed by CT scan aims to explain their scope and prevalence as well as the consequences in terms of clinical treatment. This research aims to examine.

2. Patients and methods

There were about 500 Egyptian patients who had regular MSCT of the paranasal sinuses from January 2019 to January 2020 included in this retrospective cross-sectional analysis.

A thorough medical history, an ENT exam, and an MSCT of the paranasal sinuses were obtained for each participant (PNS).

Vertigo and headache were among the most notable signs and symptoms that were found. **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

- There were roughly 500 Egyptian patients who received regular MSCT of the paranasal sinuses from January 2019 to January 2020 included in this retrospective cross-sectional investigation.
- A comprehensive medical history, an ENT exam, and an MSCT of the paranasal sinuses were collected for each participant (PNS) (PNS).
- Vertigo and headache were among thmost noteworthy indications and symptoms that were discovered.

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)

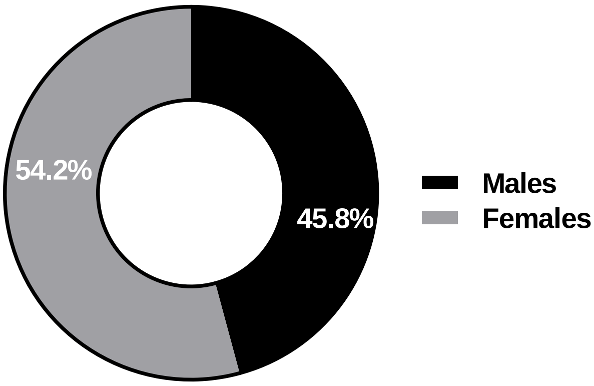

Fig. (1) Gender distribution of the studied patients

- 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)

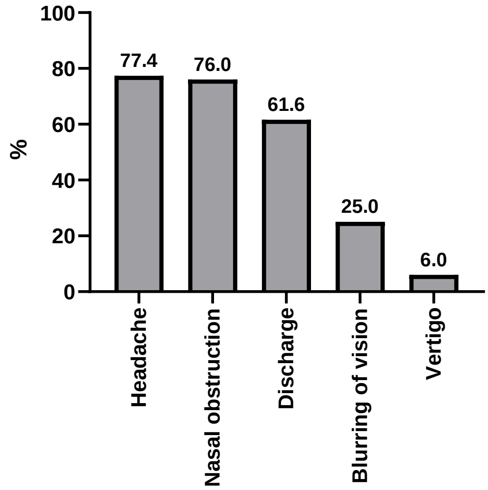

Fig. (2) Clinical findings in the studied patients

- 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
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

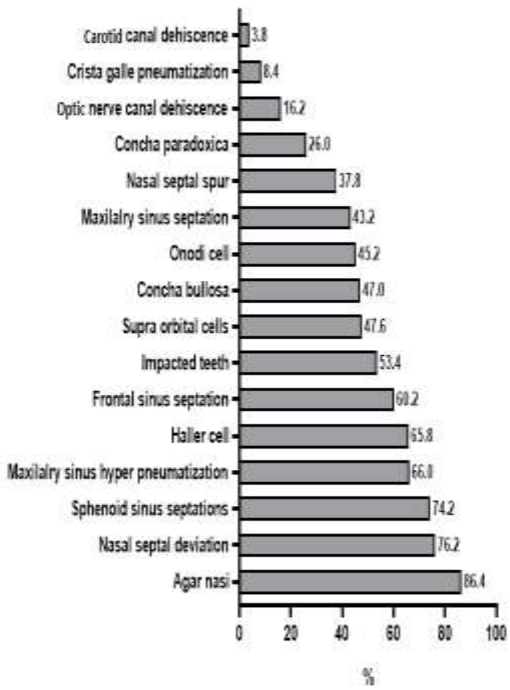

Fig. (3) Anatomical variations in the studied patients.

Fig. (4) Supraorbital cell

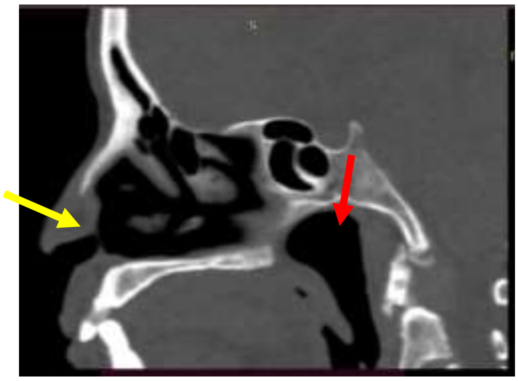

Fig. (5) agar nasi (Yellow) + onodi cell (Red)

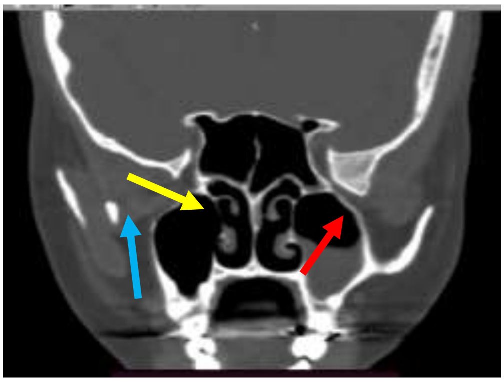

Fig. (6) Pneumatized anterior clinoid process (Yellow) + optic nerve canal dehiesence (Red)+ lateral pneumatization (Blue)

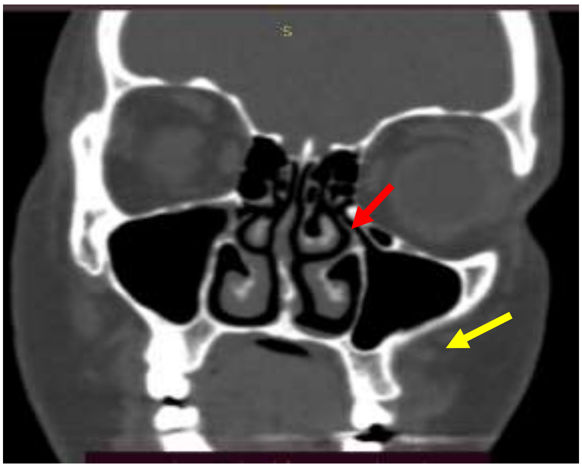

Fig. (7) Haller cell (Yellow)+ Karos type 1 (Red)

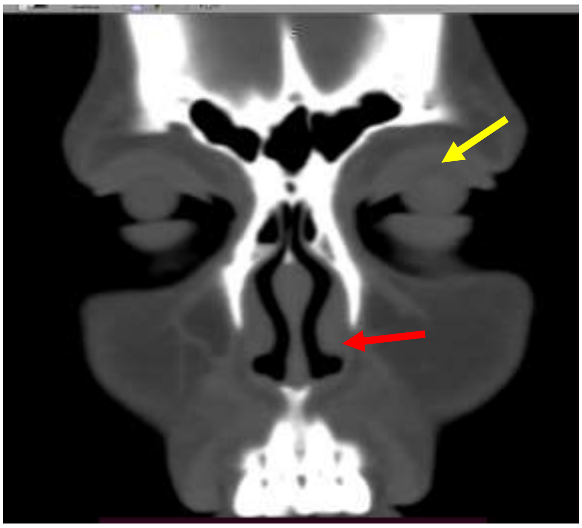

Fig. (8) Frontal sinus hyperpneumatization&septation (Yellow)+ agar nasi cell(Red)

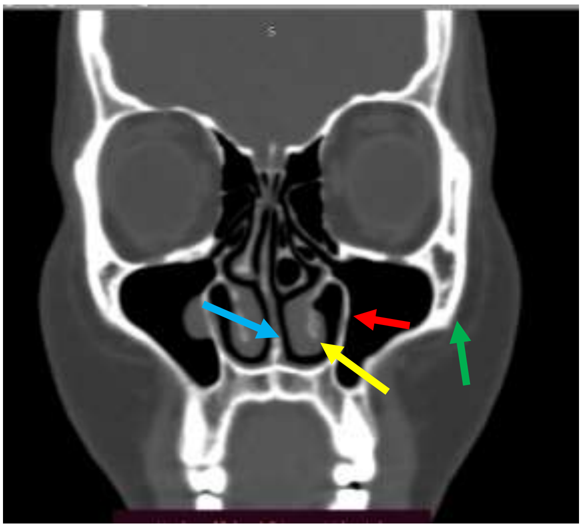

Fig. (9) Lt middle chonchabullosa (Yellow)+ Lt pneumatized uncinate process (Red)+deviated nasal septum (Blue)+ infraorbital canal type 3 (Green)

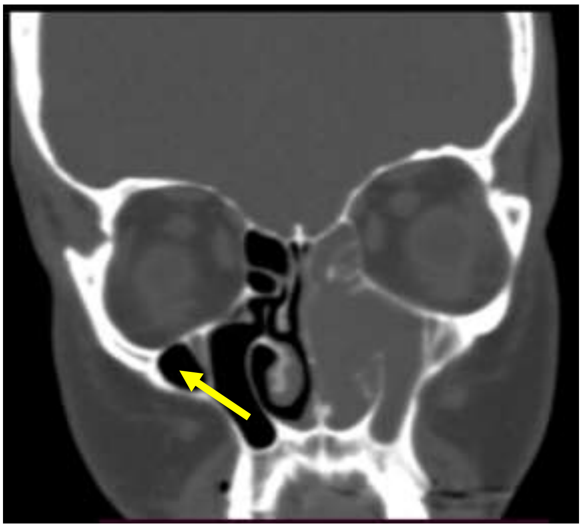

Fig. (10) Infraorbital canal type 1 (coronal)

- Anatomical variations according to gender

Females had a substantially greater rate of nasal septum deviation than men (72.1%) (P = 0.045).

Males had 42.8% more nasal septal spurs than females (33.6%), a statistically significant difference (P = 0.034).

Men were found to have a larger percentage of type I olfactory fossas (32.3%) than females (24.4%) (P = 0.021), whereas females were found to have a higher percentage of type II olfactory fossas (71.2%) than males (59.8 percent) (P = 0.021).

Men were found to be more likely to have hyper-pneumatization than women (82.5% vs. 57.2%), whereas women were more likely to have hypo-pneumatization (31% vs. 57.2%). (10.9 percent).

It was also shown that males were more likely to have frontal sinus septations (74.2%) than women (483.3%).

Males had a substantially greater rate of maxillary sinus hyper-pneumatization (72.5%) than females (60.5%) (P = 0.005).

Agar nasi was found to be substantially more prevalent in females than men (P = 0.04).

Infraorbital canals were shown to be significantly associated with gender (P 0.001), with females (19.2%) having a greater prevalence than men (8.7%) of types I and II, and males (68.8%) having a larger prevalence of type III (49.1 percent).

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 gallepneumatization	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

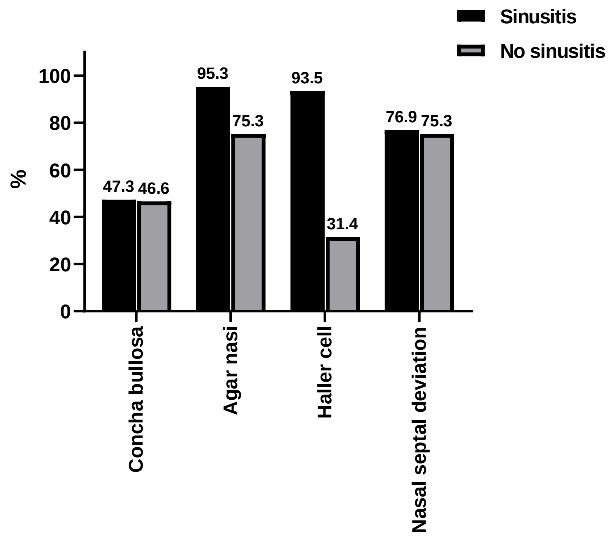

Fig. (11) Association between sinusitis and other anatomical variations

3.1. Statistical 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

The average age of the patients investigated in this research was 29 14 years.

45.8% of the patients were men, while the other 50% were women (54.2 percent).

Many research found that the average age was greater and that men were somewhat more prevalent.

In a study of 240 patients with chronic rhinosinusitis, 57.5 percent of the patients were male and 42 percent were female, according to Alsowey et al. [8]

A median age of 40.5 years separated the 20-61 year olds in the group.

Additionally, in the Yassar et al. research, 508 (59.6 percent) of the 852 MDCT patients were men and 344 (40.4%) were females, with a mean age of 40.3 years (age range, 14 to 78 years). [9]

The most common symptom in our research was a headache (77.4%), followed by nasal obstruction (76.0%), discharge (61.6%), blurred vision (25.0%), and vertigo (25.0%). (6.0 percent).

Alsowey et al. found that headache was the most prevalent clinical manifestation (52.5 percent), followed by runny nose (35 percent), postnasal discharge (33.8 percent), and nasal obstruction (33.8 percent), all of which were similar to our findings (25 percent).[8]

When compared to our findings, the Zojaji et al. research found that the most prevalent symptom among all patients was nasal blockage (100 percent).

It was followed by nasal discharge/purulence/discolored postnasal discharge (91%) cough (79%) headache and facial discomfort (73%) tooth pain (64%) and face congestion/fullness (64%) (63 percent).

On nasal cavity inspection, less prevalent complaints were tiredness (16%), hyposmia (14%), halitosis (11%), ear pain/pressure/fullness (10%), and purulence (8%). (5 percent).[10]

Concha bullosa was found in almost half of the participants in our research (47 percent), and no links were found between the occurrence of the condition and gender.

Concha bullosa and sinusitis were shown to have no statistically significant relationship (P=0.884).

They found that 32.73 percent of the participants in their research had concha bullosa, which is in line with previous studies' findings.[4]

According to Asruddin et al., Mamitha et al., Zinreich et al. and Weinberger et al., the prevalence of the disorder was 30%; 28%; 16%; and 15% in these studies.[12-15]

Higher rates of prevalence were recorded by Perez-Pinas et al. and Scribano et al., with 53.7 percent and 73% and 67% of the population respectively reporting it. [16-18]

While the incidence of concha bullosa was low in the Alsowey et al. investigation (30.6 percent).[8]

Additionally, Bolger WE et al., Perez-Pinas I et al., and Joe JK found that 4 percent to 80 percent of people had concha bullosa in their research. [5-7]

In contrast to our findings, Shpilberg et al. found that concha bullosa may elicit symptoms by intruding on the infundibulum when sufficiently big.[11]

M Kaya et al., who reported that the frequency of concha bullosa patients was determined to be 51%, observed that 67.2 percent of concha bullosa cases had sinusitis. This supports Shpilberg et al. findings.[3]

(26 percent) of our cases were reported to have concha paradoxical.

No correlations between concha paradoxica and gender were found.

Joe JK et al. also found this variance in 26% of their patients, which is in line with our findings.[7]

As compared to the prevalence of 7.9% reported by other studies like Kaygusuz et al., which was significantly lower; to the prevalence of just 3.0% seen by Bolger WE et al., which was higher; and to the prevalence of 4.3% in Kaya M et alresearch. .'s[19,3,5]

Our investigation found that nasal septal deviation was the second most prevalent alteration seen in patients (76.2 percent).

Females had a substantially greater rate of nasal septum deviation than men (72.1%) (P = 0.045).

Because of the wide variety of physical characteristics and the degree of deviation, the prevalence of septal variants has been reported in the literature to be anywhere from 40% to 96.9 percent in various publications.

According to Luo et al., 40% of the population is affected.

There were 724 individuals with deviated nasal septum (DNS), the most prevalent anatomic variation of the paranasal sinuses and nasal cavity, in the research done by Yassar et al (85 percent).[9]

When it comes to chronic sinusitis, deviated nasal septum is the most common variant, accounting for 48.8% of the cases studied by Alsowey and colleagues.[8]

More recent research has been carried out by the likes of Dutra and Marchiori, Dua et al, and Onwuchekwa et al.[4].

The prevalence of nasal septal deviation was found to be 20.91 percent in Asruddin et al.12, 14.1 percent in Mamitha et al.13, and 38 percent in Aramani et al.16, with 65 percent and 74.1 percent respectively.

We found no correlation between nasal septal deviation and sinusitis in our research (P=0.684).

No statistically significant association between septal deviation and sinusitis was reported by Kaya M et al., who observed septal deviation and bony spur rates of 89.7% and 8.2%, respectively.[3]

Due to the prevalence of septal deviation, it may have a role in the development of sinusitis in conjunction with other anatomical abnormalities

On the other hand, research by Calhoun et al. found that sinusitis is linked to any degree of septal deviation.[21]

In addition, Elahi et al. reported that sinusitis was associated with spur development in the pathogenesis.[22]

Both septal deviation and concha bullosa were shown to have a statistically significant effect on the development of sinusitis by Albayrak and Guleryuz.[23]

There was a nasal septal spur described in our research (37.8 percent).

Males were more likely to have a nasal septal spur (42.8%) than females (33.6%) (P = 0.034).

However, just one example of a septal spur fused to the left nasal turbinate was documented by Regina Chinwe Onwuchekwa et al.[4]

Most of the samples had an olfactory follicle depth that ranged from 28 to 66 percent.

Men were found to have a larger percentage of type I olfactory fossas (32.3%) than females (24.4%) (P = 0.021), whereas females were found to have a higher percentage of type II olfactory fossas (71.2%) than males (59.8 percent) (P = 0.021).

There was significant hyper-pneumatization of the frontal sinus volume (68%).

Men were found to be more likely to have hyper-pneumatization than women (82.5% vs. 57.2%), whereas women were more likely to have hypo-pneumatization (31% vs. 57.2%). (10.9 percent).

3.64 percent of subjects had frontal sinus hypoplasia, while 0.91 percent had significant pneumatization, according to Regina Chinwe Onwuchekwa et al.[4]

In a research by H.D. Mohammad & Amir Daryani and in a study by Stallman in Germany, hypoplastic frontal sinus was found in 10.6 percent of patients.[26,27]

Our research found that 60.2 percent of participants had frontal sinus septation.

In men, it was 74.2 percent, but in females, it was 48.3 percent (P 0.001).

Hyper-pneumatization of the maxillary sinuses has been documented (66.0 percent).

Males made up 72.5 percent of the sample, compared to 60.5 percent of females (P = 0.005).

The presence of a maxillary sinus septum was found in 43.2% of people, although no links between maxillary sinus septum and gender could be found.

In our analysis, 45.2% of instances had an onodi cell.

Onodi cell and gender did not seem to be associated in any way.

Onodi cells were found to be present in 10–98% of samples tested.

In Kaya M et alinvestigation, .'s just 14 percent of the paranasal sides were shown to be affected.[3]

Onodi cells were found in 7.27 percent of the participants in the Regina Chinwe Onwuchekwa et al. research, which matches the prevalence seen in cadaveric investigations by Rashid et al.[4,28]

J.S. Driben et al. & S. Thanaviratananich et al. [29,30] reported prevalences of Agar nasi ranging from 39 percent to 60 percent higher than our own.

Agar nasi was found to be substantially more prevalent in females than men (P = 0.04).

Agar nasi and age groups did not seen to have any significant correlations.

Aramani et al.16 and Liu et al.31 had a very low prevalence of 1.9 percent, whereas Bolger et al.5 had a very high prevalence of 98.5 percent, according to the many authors that have reported on this variant's prevalence.

At 26 percent, this research's findings are close to those of Dua and colleagues25, Rashid and colleagues28 and Alsowey's8 study, which found a prevalence of 40 percent, 49 percent and 30.6 percent respectively.

Those with sinusitis had considerably greater levels of agar nasi (95.3%) than those without (75.3%), indicating that agar nasi and sinusitis are linked in some way.

Ethmoidal cells extended to this area at a rate of 72 percent in Kaya M et alinvestigation. .'s[3]

According to their findings, a higher incidence of sinusitis was linked to the presence of agger nasi cells, and this was related to a blockage in the drainage of the frontal recess.

Agger nasi was previously shown to be a cause of frontal sinusitis in earlier surgical and imaging research by I. Perez-Pinas et al. and Messerklinger W et al. [6,32]

A wide variety of agger nasi cell frequencies were observed in these experiments, ranging from 10% to 100%.

A Haller cell was found in 65.8% of the cases.

For the Haller cell, age had a significant effect (P 0.001) and was highest in the 30-year-old demographic (71%).

Haller cell and gender did not seem to be linked in any way.

In Regina Chinwe Onwuchekwa's investigation, Haller's cells were found in 20.91 percent of the samples.4

Similar results were found by Asruddin et al.[4] (28%), Perez-pinas et al.[6] (20%), Dua et al.25 (16%), and Asowey et al.[8] (11.2%).

Lower prevalence rates of 1.9% and 1% were found by Aramani et al.16 and Liu et al.[31].

According to our research, haller cell prevalence was substantially greater in individuals with sinusitis (93.5 percent) than those without (31.4 percent) (P 0.001), indicating a link between the two conditions.

It has been shown that this polymorphism has a broad range of prevalence (2.7 percent – 45 percent) and is relevant in the etiology of maxillary sinusitis [6,33.7,32]

Haller's cell was linked to maxillary chronic sinusitis by Davis et al. as well.[2]

Different descriptions of Haller cells may be a factor in the broad variation in prevalence.

A research by Kaya M et al. found that 25 percent of the paranasal sides were found to have Haller cells, which coexisted with inflammatory alterations on the same side in 82.3 percent of the cases.[3]

Type I, II, and III osteomeatal complexes were found in 39.8%, 47.8%, and 12.4% of patients, respectively.

The kind of osteomeatal complex and gender were not shown to be associated in any way.

According to Azila and coworkers, blockage and stagnation of secretions may lead to infection in the ostio-palatal complex, which can be caused by either structural abnormalities or hypertrophied mucosa.[34]

They predicted that the inflammatory process would be reversed when the blocked drainage channel is reopened.

A total of 8.4% of the population had Crista Galle pneumatization.

Females were shown to be unaffected by Crista Galle's pneumatization in any way.

In Regina Chinwe Onwuchekwa et alstudy, .'s this variation was found in nine out of eighteen patients (8.18%).[4]

While Basic et al. found 2.4 percent pneumatization of the crista galli in 212 individuals utilizing CT images.[35]

Also, in five cases, Som et al. discovered pneumatized crista galli (2.4 percent).

There were 36 patients with hyper-pneumatization of the sphenoid sinus.

Gender was not shown to be a major factor in sphenoid sinus hyper-pneumatization.

Carotid and optic nerve canal dehiscence were both detected in 3.8 percent of patients.

Gender was not shown to be a major factor in optic nerve canal dehiscence.

Bone dehiscence above the optic nerve was detected in 24% of the cases studied by DeLano et al.[38]

While 74.2 percent of patients had sphenoid sinus septation.

Gender was not shown to be a major factor in sphenoid sinus septation.

In 14.4% of cases, the infraorbital canal was type I, in 27.6%, type II, and in 58 percent of cases, type III.

Infraorbital canals were shown to be significantly associated with gender (P 0.001), with females (19.2%) having a greater prevalence than men (8.7%) of types I and II, and males (68.8%) having a larger prevalence of type III (49.1 percent).

Patients with supraorbital cells accounted for 47.6 percent of the total sample size.

Gender had no major influence on the results.

Other studies show that just 5.4 percent of people have the condition.[37]

When it comes to impacted tooth cases, nearly half of the patients experienced the problem (53.4 percent).

Gender had no major influence on the results.

5. Conclusion

In addition to identifying anatomical variations and their connection to sinusitis, MSCT on the paranasal sinus serves an essential role in preoperative evaluation by detecting paranasal sinus variants that avoid potential damage to vital tissues.

References

[1] NR.Ankle, RR.Havaldar&S. Soni.Variations in Intranasal Anatomical Parameters and Its Association with Rhinosinusitis-a One Year Hospital based Observational Study. Madridge J Case Rep Stud.vol.4(1),pp.163-166,2019.

[2] W.E. Davis, J. Templer, D.S. Parsons. Anatomy of the paranasal sinuses OtolaryngolClin North.vol.29,pp57-91,1996.

[3] M.Kaya, F. Çankal, M.Gumusok, N.Apaydin&I.Tekdemir. Role of anatomic variations of paranasal sinuses on the prevalence of sinusitis: Computed tomography findings of 350 patients.Niger J Clin Pract.vol.20,pp.1481-8,2017.

[4] Regina ChinweOnwuchekwa&NengiAlazigha. Computed tomography anatomy of the paranasal sinuses and anatomical variants of clinical relevants in Nigerian adults. Egyptian Journal of Ear, Nose, Throat and Allied Sciences.vol.18,pp. 31-38,2017.

[5] WE.Bolger, WW Jr.Woodruff, J.Morehead&DS.Parsons.Maxillary sinus hypoplasia: Classification and description of associated uncinate process hypoplasia. Otolaryngol Head Neck .vol.65,pp.103:759,1990.

[6] I.PerezPinas, J.Sabate, A.Carmona, CJ.CatalinaHarrera&J.JimenezCastellanos. Anatomical variations in the human paranasal sinus region studies .vol.17,pp.197:221,2000.

[7] JK.Joe, SY.Ho&E. Yanagisawa .Documentation of variations in sinonasal anatomy by intraoperative nasal endoscopy. Laryngoscope.vol. 35,pp.110:229,2000.

[8] A. M.Alsowey , G.Abdulmonaem, A.Elsammak, &Y. Fouad .Diagnostic Performance of Multidetector Computed Tomography (MDCT) in Diagnosis of Sinus Variations. Polish journal of radiology.vol.82,pp.713–725,2017.

[9] YassarShiekh, Abdul HaseebWani, AamirJaved Khan & Mohammad IqbalBhat.Anatomical Variations of Paranasal Sinuses - A MDCT Based Study. IAIM.vol.6(3),pp.300- 306,2019.

[10] Zojaji, Ramin, M.Mirzadeh, &s.Naghibi . Comparative Evaluation of Preoperative CT Scan and Intraoperative Endoscopic Sinus Surgery Findings in Patients with Chronic Rhinosinusitis. Iranian Journal of Radiology.vol.5,pp.77-82,2008.

[11] KA.Shpilberg, SC.Daniel&AH.Doshi.CT of anatomic variants of the paranasal sinuses and nasal cavity: Poor correlation with radiologically significant rhinosinusitis but importance in surgical planning. Am J Roentgenol.vol.204(6),pp.1255–60,2015.

[12] S.P.S.Asruddin, R.K. Yadav, Yadav& J. Singh .Low dose CT in chronic sinusitis. Indian J Otolaryngol.vol.52,pp.17-22,2000.

[13] H. Mamitha, N.M. Shamasunder, M.B. Bharathi & L.C. Prasanna. Variations of osteomeatal complex and its applied anatomy: a CT scan study. Indian J Sci Technol.vol.3,pp.904-907,2010.

[14] SJ.Zinreich, S.Albayaram, ML Benson &PJ.Oliverio. The osteomeatal complex and functional endoscopic surgery. In: Som PM, Curtin HD, editors. *Head and neck surgery*. St Louis: Mosby Inc.vol.15,pp.149–73,2003.

[15] D.G. Weinberger, V.K. Anand, M. Al-Rawi, H.I. Cheng & A.V. Messina. Surgical anatomy and variations of the onodi cell. Am J Rhinol.vol.10,pp. 365-370,1996.

[16] A. Aramani, R.N. Karadi& S. Kumar. Anatomical variation in osteaometal complex. J ClinDiagn Res.vol.8,pp. 01-04,2014.

[17] I. Perez-Pinas, J. Sabate, A. Carmona, C.J. Catalina Herrera & J. Jimenez-Castellanos.Anatomical variations in the human paranasal sinus region studied by CT. J Anat.vol.197,pp.221-227,2000.

[18] E. Scribano, G. Ascenti, F. Casio, S. Racchiusa & I. Salamone Computerized tomography in the evaluation of anatomic variations of the osteomeatal complex. Radio Med (Torino).vol. 86, pp.195-199,1993.

[19] A.Kaygusuz, M.Haksever,D.Akduman, S.Aslan & SayarZ,Sinonasal.Anatomical variations: Their relationship with chronic rhinosinusitis and effect on the severity of disease – a computerized tomography assisted anatomicalandclinical study. Indian J Otolaryngol Head Neck .vol.66(3),pp.260–66,2014.

[20] X.Luo, C.Liang&K.Xu. Influence of nasal septal deviation on incidence of bilateral sinusitis. Lin Chung Er Bi Yan HouTou Jing WaiKeZa Zhi.vol.26(17),pp.777–80,2012.

[21] KH.Calhoun, GA.Waggenspack, CB.Simpson, JA.Hokanson&BJ.Bailey. CT evaluation of the paranasal sinuses in symptomatic and asymptomatic populations. Otolaryngol Head Neck.vol. 3,pp.104:480,1991.

[22] MM.Elahi, S.Frenkiel&N.Fageeh.Paraseptal structural changes and chronic sinus disease in relation to the deviated septum. J Otolaryngo.vol.l,pp.230:236,1997.
[23] E.Albayrak&G.Guleryuz.The relationship between concha bullosa, septal deviation and sinus pathologies. J Contemporary .vol. 3,pp.182-186 ,2013.
[24] D.L. Dutra & E. Marchiori. Helical CT of the paranasal sinuses in children; evaluation of inflammatory sinus disease Radiol Bras.vol.35, pp. 161-169,2002.
[25] K. Dua, H. Chopra, A.S. Khurana, M. Munjal.C T scan variations in chronic sinusitis. Indian J Radiol Image.vol.15, pp. 315-320,2015.
[26] H.D. Mohammad & Amir Daryani Evaluation of anatomic variants of paranasal sinuses. Internet J Otorhinolaryngol.vol.1, pp. 1-5,2007.
[27] J.S. Stallman & J.N. Lobo, P.M. Som The incidence of concha bullosa and its relationship to nasal septal deviation and paranasal sinus disease. AJNR Am J Neuroradiol.vol.25, pp. 1613-1618,2004.
[28] A. Rashid, B. Deep, A. Wameedh, A. Yahya& S. Sukhpal.Clinically significant anatomical variants of the paranasal sinuses. Oman Med J.vol.29, pp. 110-113,2014.
[29] J.S. Driben, W.E. Bolger & H.A. Robles .The re-liability of computerized tomographic detection of the Onodi (sphenoethmoid) cell Am J Rhinol.vol.12,pp. 24,1998.
[30] S. Thanaviratananich, K. Chaisiwamongkol& S. Kraitkrakul.The prevalence of an Onodi cell in adult Thai cadavers. Ear Nose Throat .vol. 82, pp. 200-204,2003.
[31] X. Liu, G. Zhan & G. Xu.Anatomical variations of osteomeatal complex and correlation with chronic sinusitis: CT evaluation ZhonghuaEr Bi yanHouKeZa Zhi.vol.34, pp.143-146,1999.
[32] W.MesserklingerOn the drainage of the normal frontal sinus of man. ACTA Otolaryngol.vol.63,pp.176-81,1967.
[33] H.Stammberger&G.Wolf.Headaches and sinus disease: The endoscopic approach. Ann OtolRhinol Laryngol.vol.134,pp.2-23,1988.
[34] A.Azila, M.Irfan, Y .Rohaizan&AK.ShamimThe prevalence of anatomical variations in osteomeatal unit in patients with chronic rhinosinusitis. Med J Malaysia.vol.66,pp.191–9,2011.
[35] N. Basic, V. Basic & T. Jukic Computed tomographic imaging to determine the frequency of anatomical variations in pneumatization of the ethmoid bone. Eur Arch Otorhinolaryngol.vol.256,pp.69-71,1999.
[36] P.M. Som, E.E. Park, T.P. Naidich& W. Lawso n. Crista gallipneumatization is an extension of the adjacent frontal sinuses AJNR Am J Neuroradiol.vol.30, pp. 31-33,2009.
[37] L. Zhang, D. Han & W. Ge.Computed tomographic and endoscopic analysis of supraorbital ethmoid cells. Otolaryngol Head Neck .vol. 137, pp. 562-568,2007.
[38] DeLano, Mark Fun, FY Zinreich&Simion. Optic nerve relationship to the posterior paranasal sinuses. CT Anatomic study. AJNR. American journal of neuroradiology.vol.17,pp.669-75,1996.