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Anatomical Variations of Nasal Structures in Chronic Rhinosinusitis as Detected by Computed Tomography Scan

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ABSTRACT

Background: There is a wide range of anatomical variations affecting the nose, paranasal sinuses (PNS) best diagnosed by Computed Tomography (CT). These variations may cause impairment of mucociliary drainage of the PNS resulting in sinusitis. **Objectives**: In this paper, the aim is to study the relationship of the anatomical variations of the lateral nasal wall, nasal septum and paranasal sinuses with the occurrence of chronic rhinosinusitis. **Methods**: The study included two groups of patients, the first has chronic rhinosinusitis while the second was without chronic rhinosinusitis. Anatomical variations of nose and paranasal sinuses which are nasal septal variations, concha bullosa, agger nasi cells, haller cells, paradoxical middle turbinatesand uncinate process variations were detected in both groups to investigate the relation between the anatomical variations and chronic rhinosinusitis. **Results**: A case control study was done which showed that there a significant statistical relation between nasal septal deviation and chronic rhinosinusitis.
Conclusion: There was a significant relation between nasal septal deviation and chronic rhinosinusitis.
Key words: Anatomical variations, Chronic rhinosinusitis, CT scan.

INTRODUCTION

There is a wide range of anatomical variations affecting the nose, paranasal sinuses (PNS) best diagnosed by Computed Tomography (CT), which is a non-invasive imaging modality with high image resolution and reconstruction capability. These variations may cause impairment of mucociliary drainage of the PNS resulting in sinusitis [(1) (2)]. Many anatomical variations have been studied and the relation between them and sinusitis is not clear till now [(3)]. Some studies showed statistically significant association between common anatomical variations and the presence of sinusitis [(4)]. While in other studies, no statistically significant relationship was found [(5)]. With the increased use of endoscopy for the treatment of paranasal sinus diseases surgically, attention is now focused on the analysis of the lateral nasal wall and paranasal sinus anatomy [(6)]. Chronic adult rhinosinusitis is rhinosinusitis lasting more than 12 weeks and the diagnosis is confirmed by the presence of major and minor clinical factors [(7)].

CT imaging has become a widely accepted tool for assessment of the PNS. It gives detailed anatomy of the lateral nasal wall; and considered necessary to endoscopic sinus surgery (ESS). A pneumatized middle turbinate, also called concha bullosa is the most commonly detected anatomical variation of the lateral nasal wall**.** CT of the paranasal sinuses offers the gold standard in terms of imaging that shows the extension of inflammatory disease and the fine detailed anatomy and its variants [(8)].The severity of chronic sinusitis on CT scan is scored according to Lund-Mackay scoring system (Radiologic grading of sinus systems proposed by Lund and Mackay) as: 0= no abnormality, 1= partial opacification and 2= total opacification. The sinus groups include the maxillary, frontal, sphenoidal, anterior ethmoidal and posterior ethmoidal sinuses. Osteomeatal complex is scored as: 0 (not obstructed) and 2 (obstructed). Thus a total score is from 0 to 24 [(9)]. Despite the fact that concha bullosa of the middle turbinate is usually asymptomatic, it has been involved in cases of inflammatory sinus disease and nasal obstruction [(10)]. Few studies have examined the role of anatomical variations of osteomeatal complex such as concha bullosa, septal deviation, uncinate process variations, Agger nasi cells, Haller cells and paradoxically curved middle turbinate in the development of traditional chronic rhinosinusitis [(11)]. Theoretically these variants can shift and compress osteomeatal complex components, causing an obstruction to the mucus drainage of the paranasal sinuses and further predispose to sinusitis [(3)].

PATIENTS AND METHODS

This case control study included 88 cases as recommended by statistician which were collected from January 2017 to June 2017 from Al Demerdash hospital and divided into two groups:

1. The first group was the study group including patients who had chronic rhinosinusitis as

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detected by CT of paranasal sinuses (44 patients of different ages and sexes).

2. The second group was control group including patients who had symptoms of chronic rhinosinusitis and underwent paranasal CT scan and no chronic rhinosinusitis was detected (44 patients of different ages and sexes).

The study was undertaken after an ethical approval was granted by Ain Shams University Hospital Ethics Committees. Informed consent was received from all participants prior to enrollment in the study.

The severity of chronic sinusitis (in the case group) on CT scan was scored according to Lund-Mackay scoring system (Radiologic grading of sinus systems proposed by Lund and Mackay) as: 0= no abnormality, 1= partial opacification and 2= total opacification. The sinus groups include the maxillary, frontal, sphenoidal, anterior ethmoidal and posterior ethmoidal sinuses. Osteomeatal complex was scored as: 0 (not obstructed) and 2 (obstructed). Thus a total score is from 0 to 24.

Inclusion criteria

Patients who had one or more of the following symptoms: facial pain, facial fullness, nasal obstruction, nasal discharge, hyposmia or anosmia, headache, fever, fatigue, dental pain, cough and ear pain or fullness more than 12 weeks who had suspected chronic rhinosinusitis.

Those patients underwent CT of paranasal sinuses after taking full history and doing general and local examination and the patients who their results of CT scan were chronic rhinosinusitis put in the study group and those with no chronic rhinosinusitis on CT scan were put in control group.

Exclusion criteria

Patients having previous sinonasal surgery, facial trauma, sinonasal neoplasm with altered normal nasal anatomy were excluded.

- CT scan of the nose and paranasal sinuses was multi slices with coronal and axial cuts.
- CT machine was Brigtht speed GE made in China and TOSHIBA made in Japan.
- The results of CT scan of all patients was interpreted by a radiologist and otorhinolaryngologist for detecting any of the following anatomical variations:

1. Concha bullosa.
2. Uncinate variations.
3. Nasal septal variations.
4. Haller cells.
5. Paradoxical middle turbinates.
6. Agger nasi cells.

The study was done after approval of ethical board of Ain Shams university and an informed written consent was taken from each participant in the study.

Statistical analysis

Then data were analyzed using Stata® version 14.2 (StataCorp LLC, College Station, TX, USA).

Normality of numerical data distribution was examined using the Shapiro-Wilk test. Non-Normally distributed numerical data were presented as median and interquartile and intergroup differences were compared using the Wilcoxon rank sum test (for two-group comparison) or the Kruskal-Wallis test (for comparison of multiple group). The Jonckheere-Terpstra trend test was used for comparison of multiple ordered groups. The Conover post hoc test was used for pair-wise comparisons following the Kruskal-Wallis test or the Jonckheere-Terpstra test if needed with application of the Bonferroni correction for multiple comparisons[(12)] .

Categorical data were presented as ratio or number, percentage and differences were compared using Fisher's exact test (for nominal data) or the chi-squared test for trend (for ordinal data). **P-value <0.05** was considered statistically significant[(12)].

RESULTS

Table 1. Demographic characteristics of study and controls

Variable	Study (n=44)	Control (n=44)	p-value
Gender (M/F)	22/22	18/26	0.521¶
Age (years)	34 (22 – 45)	28 (22 – 37)	0.117§

Data are ratio or median (interquartile range).

¶Fisher's exact test.

§Wilcoxon rank sum test.

Table 1 shows the distribution of age and gender in CRS cases and control groups and there are no statistically significant differences regarding age and gender between the two groups.

Table 2. Prevalence of individual paranasal sinus group involvement on CT scan and the Lund-Mackay score in study group

Variable	n (%) or median (IQR)
Involved paranasal sinus group on CT scan	
Maxillary	40 (90.9%)
Frontal	29 (65.9%)
Ethmoidal	40 (90.9%)
Sphenoidal	21 (47.7%)
Number of involved paranasal sinus groups on CT scan	
One	3 (6.8%)
Two	12 (27.3%)
Three	13 (29.5%)
Four	16 (36.4%)
Lund-Mackay score	15.5 (10 – 20.5)

IQR = interquartile range; n = number.

Table 2 shows the Prevalence of individual paranasal sinus group involvement on CT scan and the Lund-Mackay score in study group as: maxillary and ethmoidal sinuses were involved in sinusitis more than frontal and sphenoidal sinuses respectively. It also shows that four groups of sinuses (pansinusitis) were involved in sinusitis more than three groups of sinuses, two groups of sinuses and one group of sinuses respectively.

Table 3. Prevalence of individual anatomical variations in study and controls

Variable	study (n=44)	Control (n=44)	p-value¶
Septal deviation	32 (72.7%)	21 (47.7%)	**.029**
Septal spur	11 (25.0%)	8 (18.2%)	.605
Septal pneumatization	6 (13.6%)	11 (25.0%)	.280
Concha bullosa	15 (34.1%)	24 (54.5%)	.085
Agger nasi	9 (20.5%)	16 (36.4%)	.155
Haller's cells	6 (13.6%)	10 (22.7%)	.408
Paradoxical middle turbinate	1 (2.3%)	3 (6.8%)	.616
Uncinate process pneumatization	0 (0.0%)	4 (9.1%)	.116
Uncinate process attachment			.180
To lamina papyracea	13 (29.5%)	8 (18.2%)	
To posterior wall of agger nasi	1 (2.3%)	5 (11.4%)	
To middle turbinate-cribriform plate junction	8 (18.2%)	14 (31.8%)	
To skull base	6 (13.6%)	6 (13.6%)	
To middle turbinate	16 (36.4%)	11 (25.0%)	

Data are number (%) , ¶Fisher's exact test.

Table 3 shows the prevalence of anatomical variations of nose and paranasal sinuses as: among all anatomical variations of nose and paranasal sinuses only the relation between nasal septal deviation and chronic rhinosinusitis was statistically significant.

Table 4. Correlation matrix showing the correlations among the Lund-Mackay score, number of involved paranasal sinus groups on CT scan and number of anatomical variations

	Lund-Mackay Score		**Number of involved paranasal sinus groups**		**Number of anatomical variations**	
Variable	**Spearman rho**	**p-value**	**Spearman rho**	**p-value**	**Spearman rho**	**p-value**
Lund-Mackay Score	-	-	.813**	<.001	-.325*	.031
Number of involved paranasal sinus groups	.813**	<.001	-	-	-.401*	.007
Number of anatomical variations	-.325*	.031	-.401*	.007	-	-

*Statistically significant at the p <.05 level , **Statistically significant at the p <.001 level.

Table 4 shows the correlations among the Lund-Mackay score, number of involved paranasal sinus groups on CT scan and number of anatomical variations as: there is a strong correlation between the Lund-Mackay score and the number of involved paranasal sinuses **(rho=0.813, p-value** less than **0.001)**. There is weak negative correlation between Lund-Mackay score and the number of anatomical variations **(rho= -0.325, p-value = 0.031)**.

There is moderate negative correlation between the number of anatomical variations and the number of involved paranasal sinuses **(rho= -0.401, p-value= 0.0007)**.

DISCUSSION

In our study the prevalence of **septal deviation** was **32 (72.7%)** in study group and **21 (47.7%)** in control group which is statistically significant. These results agree with those found by ***Kılıckesmez*** [13] and with ***Shoib*** [14] which suggest that the relation between the nasal septal deviation and chronic rhinosinusitis may be that: Secretions accumulates in the sinus as a result of narrowing of the osteomeatal complex and thus infections ensues in the retained secretions and causes chronic rhinosinusitis. Mucociliary activity decreases following the nasal flow rate increase and mucosal dryness in relation with the nasal septal deviation and consequently, chronic rhinosinusitis develops.

Deviation of the posterior nasal septum causes chronic rhinosinusitis by creating pressure and air flow changes within the maxillary sinuses.

In our study prevalence of **septal spur** was **11 (25.0%)** in study group and **8 (18.2%)** in control group. The difference is statistically non significant. This conclusion agrees that found by ***Kılıckesmez*** [13] and ***katya*** [15].In our study prevalence of **septal pneumatization** was **6 (13.6%)** in study group and **11 (25.0%)** in control group and the difference is statistically non significant. This conclusion agrees with that found by ***Kılıckesmez*** [13] and with ***khajavi*** [16]. In our study prevalence of **concha bullosa** was **15 (34.1%)** in study group and **24 (54.5%)** in control group show insignificant differences and this result is similar to that obtained by ***Azila***[3] and with ***Kaygusuz*** [17]. ***Fadda***[18] found that the prevalence of concha bullosa was **69 (49.3%)** patients with chronic paranasal sinusitis which was statistically significant. This result disagrees with our results. This end result could be due to the use of one group of patients who had sinusitis without using anther control group to for the comparison between the results of both groups.

In our study prevalence of **Agger nasi** cells was **9 (20.5%)** in study group and **16 (36.4%)** in control group (statistical significant difference) and this conclusion concur those observed by ***Azila***[3] and with ***Kaygusuz*** [17]. Exclude ***Fadda***[18] Found that the prevalence of Agger nasi cells was **34 (24.3%)** patients with chronic paranasal sinusitis which was statistically significant which exclude with our results probably because this study included one group of patients who had sinusitis without taking another control group to compare the results with it.

In our study prevalence of **Haller cells** was **6 (13.6%)** in study group and **10 (22.7%)** in control group which (statistically non significant difference) which agree that found by ***Kılıckesmez*** [12] and with ***katya*** [14]**.** ***Fadda***[18] prevalence of Haller cells was **32 (22.8%)** patients with chronic paranasal sinusitis which was statistically difference which is disagree with our result probably because this study included one group of patients who had sinusitis without taking another control group to compare the results with it. In our study prevalence of **paradoxical middle turbinate** was **1 (2.3%)** in study group and **3 (6.8%)** in control group which is statistically non significant difference is agree with ***Kılıckesmez*** [13] and with ***katya*** [15]**.**

In our study prevalence of **uncinate process pneumatization** was **0 (0.0%)** in study group and **4 (9.1%)** in control group which is statistically non significant which agree with ***Kaygusuz*** [17] and with ***Azila***[3]. ***Elsayed***[19] prevalence of uncinate process pneumatization was **6%** in Sporadic unclassified sinusitis patients which was statistically significant which disagree with our result probably because this study included one group of patients had sinusitis and divided it into subgroups without taking another control group to compare the results with it.

In our study prevalence of **uncinate process attachment** was to lamina papyracea **13 (29.5%)** in study group and **8 (18.2%)** in control group, to posterior wall of agger nasi was **1 (2.3%)** in study group and **5 (11.4%)** in control group, to middle turbinate-cribriform plate junction was **8 (18.2%)** in study group and **14 (31.8%)** in control group, to skull base was **6 (13.6%)** in study group and **6 (13.6%)** in control group, to middle turbinate was **16 (36.4%)** in study group and **11 (25.0%)** in control group which is show non significant. This result agrees with that found by ***khajavi*** [16]**.**

STUDY LIMITATIONS

In this study the relation between unilateral sinus diseases like fungal sinusitis and anatomical variations was not considered . Another limitation of this study is that it did not detect the relation between each anatomical variation with sinusitis like the relation between septal deviation and maxillary sinusitis.

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