Co-Existence of Anatomical Variants and Rhinosinusitis on Multi-Sliced Computed Tomography

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ABSTRACT:

BACKGROUND:

Computed tomography (CT) is mandatory and a medicolegal requirement to evaluate rhinosinusitis and provides a road map regarding anatomical variants and endoscopic treatment of rhinosinusitis.

OBJECTIVE:

To identify coexistence between anatomical variants of nasal constituents and rhinosinusitis by using multi-sliced CT and to ascertain the value of CT as a road map prior to functioning endoscopic sinus surgery.

PATIENTS AND METHODS:

This is a cross sectional study was done on 87 patients referred for CT scan of the paranasal sinuses. The patients were clinically suspected to have sinonasal diseases. The sample of this study was consist of 52 males and 35 females. The age of patients ranged from 12 - 60 years. All patients were examined by using 64 multi-slice CT scan of paranasal sinus including axial sections and coronal reformat.

RESULTS:

76 patients were had diseased sinuses, we discovered 5 abnormalities; mucosal thickening, opacification, air fluid level, mucosal polyp and cyst. The most commonly involved sinus was the maxillary (62 patients) followed by anterior ethmoid, and the commonest abnormality was mucosal thickening. Types of variations include; nasal septal deviation(52.4%), concha bullosa(49%), enlarged ethmoidal bullae (15.9%), large Aggar nasi (15.9%), Haller cells(19.1%), bent uncinate process(11.4%), Onodi cells (11.4%), paradoxical middle turbinate(9.1%), maxillary sinus hypoplasia (7.9%), pneumatized crista galli (6.8%), and both pneumatized nasal septum and asymmetrical ethmoid roof were of (3.4%). The total number of patients having anatomical variants but not associated with sinonasal mucosal abnormalities were (17.1%), while (82.9%) of patients were associated with sinonasal abnormalities.

CONCLUSION:

The study reveals correlation between certain anatomical variations and specific sinonasal mucosal abnormalities that may interfere with the drainage of the sinus secretions and subsequent secondary infection. Another group of variants were discovered that may lead to intra-operative complications if surgery indicated.

KEY WORDS: paranasal sinuses, variation, multi-slice CT

INTRODUCTION:

The paranasal sinuses secretions are transported by cilia towards the natural ostium of each individual sinus. According to this, any congenital variation or mucosal thickening is likely to produce obstruction, stasis and recurrent infection of the sinuses [(1)].

One of the aims of functional endoscopic sinus surgery is to re-establish the normal ventilation and the sinus drainage. For this reason a good knowledge of the anatomy of paranasal sinuses, the clinical significance of anatomical variants, and the

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terminology used in functional endoscopic sinus surgery is basic to the correct interpretation of imaging studies [2].

The main purpose of this study to assess the frequency of the anatomical variations of nasal constituents and their effect on the incidence of rhinosinusitis and also to identify the value of multi-sliced computed tomography as a road map prior to functioning endoscopic sinus surgery.

PATIENTS AND METHODS:

This is a cross sectional study was done on 87 patients referred for CT scan of the paranasal sinuses in Al-Shaheed Ghazi Al-Hariri Teaching Hospital in Medical City – Baghdad, from January 2013 to June 2013 with patients clinically suspected to have sinonasal abnormalities.

The sample of this study was consist of 52 males and 35 females. The age of patients ranged from 12 - 60 years. The inclusion criteria were that all patients were complaining from symptoms related to sinonasal diseases (headache, nasal obstruction, snoring, epistaxis, nasal discharge, facial pain and postnasal drip) and those patients were not responding to medical treatment. The exclusion criteria were applied to this study were patients with no anatomical variants on CT, child age group, patients with previous surgical intervention, post-traumatic patients, and patients with extensive sinonasal disease like fungal infection or malignant tumor.

The patients were examined by multislice computed tomography of the paranasal sinuses by Somatom (Definition AS) 64 slices from Siemens-Germany. A scout view was taken for the skull in order to determine the area of interest by the radiographer from the frontal sinus to the alveolar ridge, the examination was performed by using direct axial section and coronal reformat without I.V. contrast administration. The imaging protocol was; KV 120, mAs 200, slice thickness 2 mm, table increment 0.2, the pitch 0.8, window width 2000, window level 400 and scan time of about 13 seconds. The result from each examination were reviewed and following points were assessed: (1) Identification of congenital variation. (2) Identification of extent of disease: which sinuses are involved, which are spared; is the osteomeatal complex involved? Is the sphenoethmoidal recess involved? Does disease extend into orbit or cranium? (3) Identification of bone destruction.

A data collection sheet was designed for this study to collect information from each patient including symptoms, type of anatomical variation and the associated pathological abnormality that found by CT scan. Statistical analysis was done by using Microsoft excel version 2010.

RESULTS :

1- Age and gender of the patients:

In this study, the patients ages range were from 12 – 60 years with a mean of age of about 35 years. About 59.1% were males and 39.9% were females. The (20-29 years) age group was the most affected of about 33.06% (29patients). The male to female ratio was (1.4:1).

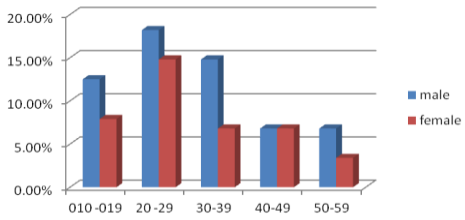


Figure 1:Shows distribution of patients according to gender and age groups.

2- Incidence of symptoms:

The most common presenting symptom was headache and occurred in 64.9% of the cases, followed by nasal obstruction which occurred in 49%.

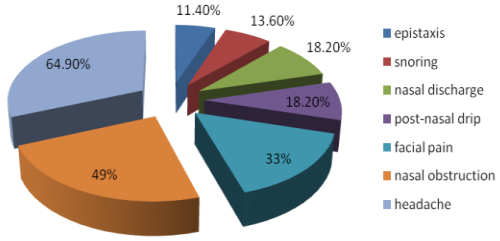


Figure 2: Shows distribution of the patients according to the presenting symptoms.

3- Distribution of the PNS abnormalities on the sinuses:

Seventy six patients were affected by rhinosinusitis (87.3%), and each patient of them had abnormalities in one or more of the sinuses. The most commonly involved sinus was the maxillary (62 patients) followed by anterior ethmoid, and the commonest abnormality was mucosal thickening (table 1).

4-Anatomical variations:

The most common type of variation was nasal septal deviation (52.4%).(table 2).

Incidence of concha bullosa was 49%, and type II was the most frequent type 21(23.9%), and cases with bilateral CB were more frequent than unilateral cases. There was 7 cases at the right side (7.9%), and 19 cases at the left side (21.6%).

The number of patients with nasal septal deviation was 46(52.4%), and the no. of cases with deviations associated with bony spur 30 (34.2%) were more frequent than simple deviation 16(18.2%).

For large Aggar nasi cells we reported 14 cases (15.9%);2 at the right (2.2%), 4 at the left (4.5%), with 8 as bilateral finding (9.1%). Haller cells were found on 17cases (19.1%); 6 at the right (6.8%), 8 at left side (9.1%), and 3 patients with bilateral finding (3.4%). For enlarged ethmoidal bulla 2 at RT. (2.2%), 8 at LT. (9.1%) and 4(4.5%) were bilateral.

Onodi cells were found in 10 cases (11.4%); 4 at the RT. (4.5%), 3 at the LT., and 3 bilaterally (3.4%).

Table 1: **Incidence and distribution of the mucosal abnormalities of the sinuses.**

		Mucosal thickening No. (%)	Opacification No. (%)	Air-fluid level No. (%)	Retention cyst No. (%)	Polyp or soft tissue mass No. (%)
Maxillary	RT	15 (17.1%)	4 (4.5%)	5 (5.7%)	6 (6.8%)	2 (2.8%)
	LT	12 (13.6%)	7 (7.9%)	5 (5.7%)	8 (9.1%)	7 (7.9%)
	BIL	14 (15.9%)	0 (0.0%)	1 (1.4%)	1 (1.4%)	0 (0.0%)
	total	41 (46.74%)	11 (12.54%)	11 (12.54%)	15 (17.1%)	9 (10.26%)
Anterior ethmoid		22 (25%)	12 (13.68%)	5 (5.7%)	0 (0.0%)	0 (0.0%)
Posterior ethmoid		14 (15.9%)	12 (13.68%)	5 (5.7%)	0 (0.0%)	0 (0.0%)
Frontal		16(18.2%)	11 (12.54%)	6 (6.8%)	5 (5.7%)	4 (4.5%)
Sphenoid		12 (13.68%)	9 (10.26%)	7 (7.98%)	7 (7.98%)	6 (6.8%)

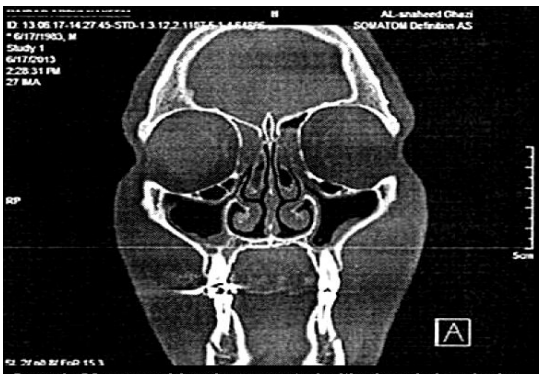
Table 2: The incidence and distribution of each anatomical variation.

Variant			Right No. (%)	Left No. (%)	Bilateral No. (%)	Total No. (%)
Concha bullosa	Type I		3 (3.42%)	2 (2.28%)	6(6.84%)	11 (12.54%)
	Type II		2 (2.28%)	13 (14.82%)	6(6.84%)	21 (23.94%)
	Type III		2 (2.28%)	4 (4.56%)	5 (5.7%)	11 (12.54%)
	Total		7 (7.98%)	19 (21.66%)	17 (19.38%)	43 (49.02%)
Nasal septal deviation	Simple		8 (9.12%)	8 (9.12%)	-	16 (18.24%)
	With bone spur		18 (20.28%)	12 (13.68%)	-	30 (34.2%)
	Total		26 (29.64%)	20 (22.8%)	-	46 (52.44%)
Aggar nasi cells			2 (2.28%)	4 (4.56%)	8 (9.12%)	14 (15.95%)
Haller cells			6 (6.84%)	8 (9.12%)	3 (3.4%)	17 (19.12%)
Onodi cells			4 (4.56%)	3 (3.42%)	3 (3.42%)	10 (11.4%)
Ethmoidal bulla			2 (2.28%)	8 (9.12%)	4 (4.56%)	14 (15.95%)
Paradoxical middle turbinate			1 (1.14%)	2 (2.28%)	5 (5.7%)	8 (9.1%)
Maxillary sinus hypoplasia		Type I	1 (1.14%)	-	2 (2.28%)	3 (3.42%)
		Type II	-	1 (1.14%)	3 (3.42%)	4 (4.56%)
		Total	1 (1.14%)	1 (1.14%)	5 (5.7%)	7 (7.78%)
Uncinate process variation		Bent	3 (3.42%)	-	7 (7.78%)	10 (11.4%)
		Pneumatized	-	-	4 (4.56%)	4 (4.56%)
		Atelectatic	-	1 (1.14%)	2 (2.28%)	3 (3.42%)
		Total	3 (3.42%)	1 (1.14%)	15 (17.1%)	19 (21.66%)
Pneumatized crista galli			-	-	-	6 (6.84%)
Pneumatized nasal septum			-	-	-	3 (3.42%)
Asymmetry of ethmoidal roof			-	-	-	3 (3.42%)

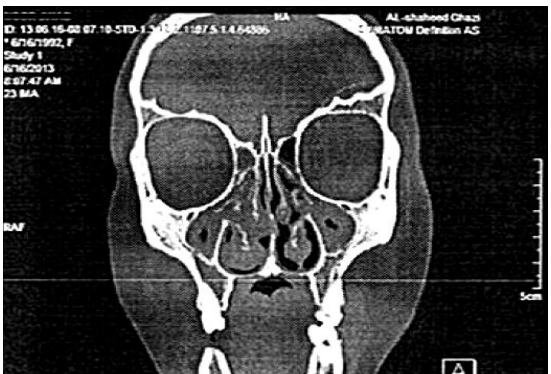
Pneumatized crista galli in 6 cases (6.8%). Pneumatized nasal septum in 3 patients (3.4%). Paradoxical middle turbinate were found in 8 cases (9.1%); 1 at the RT. (1.14%), 2 at the left (2.28%) and 5 cases with bilateral finding (5.7%).
Maxillary sinus hypoplasia were found in 7 patients (7.9%); with 5 of them as bilateral finding (5.7%), with 4 patients with type 2 (4.5%), and 3 with type 1(3.4%), and type 3 not identified at this study.
Uncinate process variation were found in 19 patients(21.66%), with 3 at the right(3.4%), 1 patient at the left (1.14%), and 15 patients were with bilateral finding(17.1%).

Table 3: Correlation of anatomical variants with different types of associated mucosal abnormalities.

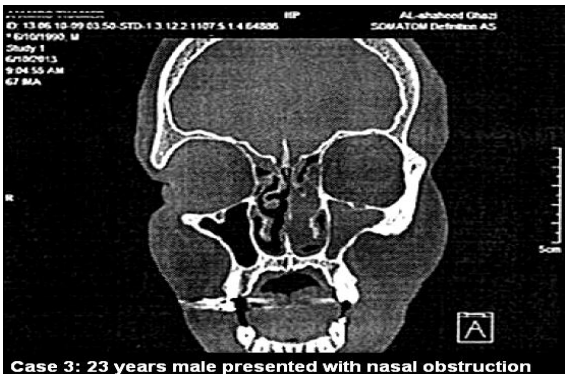
	Normal No. (%)	Mucosal thickening No. (%)	Opacification No. (%)	Air-fluid level No. (%)	Retention cyst No. (%)	Polyp No. (%)	Multiple combined findings No. (%)	Total No. (%)
Septal deviation	5 (23.8%)	5 (23.8%)	2 (9.52%)	2 (9.52%)	2 (9.52%)	2 (9.52%)	3 (14.2%)	21 (100%)
Concha bullosa	2 (16.6%)	3 (24.9%)	1 (8.33%)	2 (16.6%)	1 (8.33%)	1 (8.33%)	2 (16.6%)	12 (100%)
Pneumatized Uncinate process	2 (33.2%)	1 (16.66%)	-	1 (16.66%)	1 (16.66%)	-	1 (16.66%)	6 (100%)
Maxillary sinus hypoplasia	1 (20%)	1 (20%)	2 (40%)	-	-	-	1 (20%)	5 (100%)
Paradoxical middle turbinate	1 (25%	1 (25%)	1 (25%)	-	-	-	1 (25%)	4 (100%)
Large agar nasi cells	-	1 (33.33%)	1 (33.33%)	-	-	-	1 (33.33%)	3 (100%)
Haller cells	1 (50%)	1 (50%)	-	-	-	-	-	2 (100%)
Large bulla ethmoidalis	1 (50%)	1 (50%)	-	-	-	-	-	2 (100%)
Combined variants	2 (6.24%)	8 (24.9%)	2 (6.24%)	4 (12.4%)	2 (6.24%)	2 (6.24%)	12 (37.4%)	32 (100%)



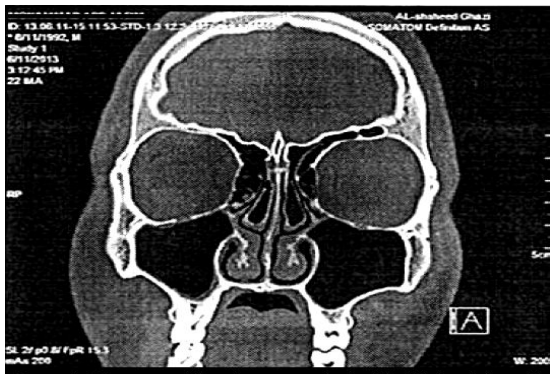
Case 1: 30 years old male presented with chronic headache. coronal CT scan showed bilateral haller cells, bilateral concha bullosa, pneumatized crita galli, and bilateral maxillary sinus mucosal thickening.



Case 2: 21 years old female presented with facial pain, coronal CT scan showed bilateral maxillary sinus hypoplasia type II



Case 3: 23 years male presented with nasal obstruction and coronal CT scan showed paradoxical middle turbinate with opacification of contralateral maxillary sinus and nasal cavity.



Case 4: 26 years old male presented with bilateral type II concha bullosa without evident mucosal abnormality

DISCUSSION :

Variations in paranasal sinus anatomy as shown by multislice computed tomography scans are of potential importance because it may induce risk during surgery or predispose for certain pathological conditions. Thus, in general we can divide these variations by their effect into two groups: variation which cause mechanical obstruction or limitation of the normal drainage pathways leading to sinonasal diseases manifested by different types of mucosal abnormalities, or recurrence; the other group of variants which not predispose to sinonasal diseases but are important to be noted prior to surgery to avoid operative morbidity and complication.

Age and gender:

In the current study, the mean age was 35 years, and male: female ratio (1.4:1), in agreement with Roozbahany et al study [3], which showed the mean age was 34 years.

Symptoms:

we found that the most common presenting symptoms was headache (64.9%), followed by nasal obstruction by 49%, in contrast to Stammberger study [4] who found that the nasal obstruction to be the most common presenting symptoms (82%), while the headache of about (48%) of the patients of their study, this is because in our society the nasal obstruction is not frequently awared about until headache present.

Types of mucosal abnormalities:

We reported 5 sinonasal mucosal abnormalities; mucosal thickening, opacification, air-fluid level, retention cyst and polyp. These abnormalities were found in (87.3%) of patients. The maxillary sinus

was the commonest sinus involved (81.5%) of patients with diseased sinuses, followed by anterior ethmoid this could be belonged to that most of variants were located near the middle meatus and affecting the drainage by the osteomeatal complex. This agree with Lloyd et al study[5], who found abnormalities in 88% of their patients, and the commonest sinus involved was maxillary sinus in 83%.

Anatomical variants:

Nasal septal deviation was found in (52.4%) of the patients, where 29.6% of them deviated to the right and 22.8% deviated to the left, which is approached to Talaiepour et al study[6] with a reported frequency of (63%), where 28% of them deviated to the right and 31.5% deviated to the left of the studied cases.

We reported about (9.1%) with paradoxical middle turbinate where most of our cases were bilaterally found (5.7% from 9.1%), while Roozbahany et al study [3] with (4.6%).

There was (49%) of patients with concha bullosa, while Stallman et al study[7] reported (35%) only, this could be explained by the Stallman's definition for concha bullosa to be present when more than 50% of the vertical height(measured from superior to inferior in coronal plane) of the middle turbinate.

We reported the incidence of Agger nasi cells of (15.9%), which differs from Kantraci et al. [8] finding of 47%, this could be belong to the large sample size of their study.

Haller cells were found in this study in (19.1%), which disagree with Sarna et al study [9] with a reported incidence of (10%), this could be due to the high resolution of the multi-detectors computed tomography used by our study compared with the direct coronal examination.

Onodi cells were with incidence of (11.4%), which almost agree with Stammberger et al. study [10], where the reported Onodi cells was (8%).

We reported enlarged ethmoidal bulla in (15.9%), while Roozbahany [3]reported 10.8% of their study.

Maxillary sinus hypoplasia was found in (7.9%) of our sample, while Bolger et al. [11] reported 10.4%, this could be explained by the large number of patients of their study (more than 200 patients), compared to (87 patients in our study), also their sample was from general population (including patients not with anatomical variation), while our sample from population specifically having anatomical variations.

From overall patients were surveyed, we found 32 of them have multiple variations for each patients and we put them in the category of (combined variations), 30 patients of them have mucosal abnormalities (93.75%) of this category. We tried to find the relationship with anatomical variation (one or more), and to see if there were associated mucosal abnormalities, so if the variant was in a location which could affect the drainage of that sinus, then we could consider it as a possible cause for sinusitis, in contrast to a variant in an anatomical location while the mucosal abnormality in the contralateral side or in a non-related location so we considered this variant not possible to cause sinusitis, so we put it in the category of (no effect or no finding).

The patients with multiple mucosal abnormalities we put them as (multiple findings), because each patient could have multiple sinonasal abnormalities from sinusitis. From 21 patients with nasal septal deviation, only (23.8%) of them have no associated sinonasal disease, and (76.2%) were associated with sinusitis and the most common mucosal abnormality was mucosal thickening in (23.8%) followed by multiple abnormalities in (14.2%), and (9.5%) for each of the remainder abnormalities, this agree with Talaiepour et al.[6] as they found nasal septal deviation has an important role in causing sinusitis by forcing nasal turbinates laterally resulting in narrowing of the middle meatus and ultimately blocking drainage of the ipsilateral maxillary, anterior ethmoid and frontal sinuses. While 12 patients with only concha bullosa, (83.3%) of them were with associated diseased sinuses, and the most frequent abnormality was mucosal thickening in (24.9%), followed by air-fluid level and multiple abnormalities in (16.6%) for each, and (16.6%) of them with no associated abnormality. These finding were consistent with finding of Lloyd [5] of association of concha bullosa with sinusitis in 85%.

Majority of the patients of pneumatized uncinate process (66.4%) were associated with sinonasal disease of the middle meatus and (33.2%) of them revealed no associated findings, and remaining patients presented with mucosal abnormalities.

Most of maxillary sinus hypoplasia (80%) were associated with rhinosinusitis, and sinus opacification was the frequent mucosal abnormality (50%); this correlate well with Milczuk et al. [12] who consider that maxillary sinus hypoplasia as a predisposing factor for sinusitis because of lateralization of the uncinate process and narrow ethmoid infundibulum.

Regarding large Aggar nasi cell, we found all patients associated with frontal sinusitis because of narrowing of the frontonasal recess, and (66.7%) of patients were with mucosal thickening and opacification, while the remainder with multiple signs of sinusitis.

Haller cells were reported in our study with only 50% of the patients associated with maxillary sinusitis exclusively, because this variant narrow the maxillary drainage, where the only reported abnormality was mucosal thickening. Regarding large bulla ethmoidalis, about half the patients was with no signs of sinusitis, while the other half was with chronic sinusitis, reflected by mucosal thickening only.

Finally, 82.9% of overall patients enrolled in the study were associated with sinonasal diseases, of them; mucosal thickening was the commonest abnormality (25.1%), followed by multiple sinonasal abnormalities (23.9%), and the least abnormality was polyp (5.7%).

CONCLUSION:

By using multislice computed tomography we found correlation between existence of certain anatomical variations of paranasal sinuses and specific inflammatory sinonasal mucosal abnormalities, which may lead to defect in the drainage of the sinus secretions and secondary infection. Also there was another group of variants which may lead to intraoperative complications. The most common variations were nasal septal deviation and concha bullosa, both of them are coexist with the highest incidence with diseased sinuses. The most common mucosal abnormality was mucosal thickening, where the maxillary sinus was the commonest involved sinus.

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