The Prevalence of Anatomical Variations in Osteomeatal Unit in Patients with Chronic Rhinosinusitis

A Azila, MMed (ORL-HNS)*, M Irfan, MMed (ORL-HNS)*, Y Rohaizan, MMed (Radiology), A K Shamim, MCPS(ORL)***

*Department of Otorhinolaryngology-Head & Neck Surgery, **Department of Radiology, School of Medical Sciences, Universiti Sains Malaysia Health Campus, 16150 Kota Bharu, Kelantan, Malaysia

SUMMARY

Introduction: The complexities of the anatomy of the nose and paranasal sinuses, as well as its variations may create technical difficulties during surgery. The significance of these anatomical variations in pathogenesis of rhinosinusitis, which is the commonest disease in the region, is still unclear.

Objective: The aims of the study were to study the anatomical variations in the osteomeatal complex in chronic rhinosinusitis (CRS) patients and to compare them with the normal population. Methodology: High resolution CT scan of paranasal sinuses images of 240 individuals were reviewed comparing 120 cases of CRS and another 120 patients without CRS problem.

Results: The anatomical variations recorded were: Concha bullosa in 49 (40.8%) CRS cases and 57 (47.5%) in control cases, paradoxical middle turbinates in 14 (12.0%) CRS cases and 27 (23.0%) in control cases, pneumatized uncinate processes were found in 3 cases (3.3 %) in both CRS and control groups, Haller's cells (infraorbital ethmoid cell) in 61 (51.0%) CRS cases and 75 (62.0%) cases in the control group, there were pneumatized agger nasi cells in 100 (83.0%) CRS cases and 95(79.0%) in control subjects and deviated nasal septums in 67 (56.0%) CRS cases compared with 73 (60.8%) in controls.

Conclusion: The most common anatomical variation in the osteomeatal complex in CRS patients was pneumatized agger nasi cells and the least was pneumatized uncinate processes. However the prevalence among both groups is comparable. The detection of a single anatomical variant itself does not establish the genesis of chronic rhinosinusitis except for paradoxical middle turbinate and infraorbital ethmoid cells.

KEY WORDS:
Paranasal sinus, Anatomical variations, Chronic rhinosinusitis

INTRODUCTION

Haller's cell, pneumatization of agger nasi cell, a pneumatised and or medialized uncinate process, paradoxical middle turbinate and enlarged ethmoidal bulla [1]. However, their roles in pathogenesis of rhinosinusitis are still unclear. Theoretically, these variants could shift and compress osteomeatal complex components, determining an obstruction to the paranasal sinuses mucus drainage and further predispose to sinusitis [2]. However, this concept is still controversial and the presence of any anatomical variation does not necessarily establish aetiology for rhinosinusitis.

Variations and tomographic signs of sinonasal disease occurring on the same side reinforce the likelihood of interference with the mucus drainage process. Tonai *et al*, 1996 have analyzed tomographic studies of 75 adult patients. Comparison of anatomical variants prevalence in the symptomatic and asymptomatic groups has showed no significant difference [3]. Bolger *et al*, 1988, in their study evaluated of all the anatomical variants but found only one specific type of middle concha bullosa has the association with the clinical disease [4].

Few studies (Dutra 2002, Lusk 1996, Milczuk 1993, April 1993) have described the anatomical variants prevalence on computed tomography examinations in children with chronic or recurrent sinusitis. However, in these studies there were no control group for comparison [5-8]. Liu *et al*, 1998 have demonstrated that the greater the size of the anatomical variant, the higher the frequency of association with paranasal sinus mucosal alterations [9]. Scribano *et al*, 1993 have observed that the maxillary sinus opacification was significantly more frequent in cases where the concha bullosa determined osteomeatal complex obliteration when compared with cases of concha bullosa without osteomeatal complex obliteration [10].

There is no available published data regarding the anatomical variations of paranasal sinuses in this region of the world. It is important for us to describe these variations among our population and establish the associations if present, between the variations and the genesis of CRS.

OBJECTIVE

The objectives of this study were to identify the main anatomical variations in the osteomeatal complex in patients with and without CRS, and to determine the association between the variations in the etiology of CRS.

MATERIALS AND METHODS

This was a case control study. Patients attending Otorhinolaryngology clinic in our hospital, who were clinically diagnosed to have CRS and had undergone CT scan of the nose and paranasal sinuses were included.

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Corresponding Author: Irfan Mohamad, Department of Otorhinolaryngology-Head & Neck Surgery, School of Medical Sciences, Universiti Sains Malaysia Health Sciences, 16150 Kota Bharu, Kelantan, Malaysia Email: irfan@kb.usm.my

Table I: Bony anatomical variations among CRS and normal population

	CRS(n/120)	Normal (n/120)	Total (n/240)	P value
Concha Bullosa	49	57	106	>0.05
Paradoxical middle turbinate	14	27	41	<0.05
Pneumatized uncinate process	3	3	6	>0.05
Infraorbital ethmoid cell	61	75	136	<0.05
Pneumatized Agger Nasi Cell	100	95	195	>0.05
Deviated nasal septum	67	73	140	>0.05

*Pearson Chi Square test significant at P <0.05

The control group was taken from patients who had undergone CT scan of the nose and paranasal sinuses for any other reason than rhinosinusitis problem (example in motor vehicle accident case). These patients also must not have had any symptom of rhinosinusitis.

These CT images (high resolution CT 1.25 mm thickness CT machine W450) were reconstructed from the initial CT scan images in order to get better view of the paranasal sinuses region using the dedicated workstation. Both the initial images and the reconstructed images were then reviewed by two investigators, each one from ENT and Radiology department, who was blinded to the clinical information. The data were analyzed using Statistical Package for the Social Sciences, SPSS with dichotomous independent sample for two proportion test (using Pearson Chi Square test).

RESULTS

A total of 240 films were reviewed (120 with CRS and 120 for control) within a period of two years between 1st January 2006 and 31st December 2007. Based on gender distribution, male and female patients were not equally distributed. Thirty eight percent were males in CRS group whereby 41% in control group. More than 90% of CRS group and 80% of control group patients were Malays.

DISCUSSION

The role of anatomical variants in the CRS pathogenesis can be evaluated by comparison between anatomical variants prevalence in populations with and without sinonasal problems.

Many studies have been done on the prevalence of anatomical variants and its relation with CRS, however most of the studies done were among the American and European population.

There were only a few variations particularly at the osteomeatal complex are that had been evaluated and recorded. We had observed the prevalence of almost all the possible anatomical structures whose variations could possibly influence in the drainage pathways of anterior group of sinuses. This had included the concha bullosa, paradoxical middle turbinate, pneumatized uncinate process, infraorbital ethmoid cell (Haller's cell), pneumatized agar nasi cell and deviated nasal septum. Interestingly, we found that the incidences of these variations are very common among our population even though no proper prevalence study has been done before in Malaysia. There were very limited studies done among Asian population concerning these variations.

Concha Bullosa

The reported incidence of concha bullosa in the literature shows a wide discrepancy. Lam WW *et al*, 1996, noted the incidence of concha bullosa in CRS was 47% [11]. In our study we found that the incidence was 40.8%. This discrepancy in the incidence of concha bullosa not only occurs among the CRS patients but also in the normal population. This maybe due to genetic difference among different races, and perhaps the definition for pneumatization may vary among different investigators. The reported prevalence of concha bullosa could vary according to differing opinions regarding significant degrees of pneumatization. It is difficult to decide when it should be said that the concha bullosa is small and non-significant, or vice versa. We therefore choose to report aeration of any degree.

Clark *et al*, 1989 had found concha bullosa in 33% of patients with symptoms of sinusitis and 11% in the control group ($p< 0.001$) [12]. While Bolger *et al*, 1991 found no statistical difference in the incidence of true concha bullosa and concha bullosa involving the vertical part only between patients undergoing scanning for sinus or non-sinus complaints, whereas pneumatization of the bulbous part of the concha bullosa was noted in 35.3% of patients with sinusitis or rhinitis as compared with 13.9% in the control group ($p=0.042$) [13].

However, Yousem *et al*, 1991 did not find a higher risk of sinusitis in the presence of concha bullosa. It was therefore postulated that most of the concha bullosa are small and cause no significant narrowing or obstruction [14]. In our study we concluded that the presence of this common variation alone (49 in CRS and 57 in controls) is not a risk for development of chronic rhinosinusitis. The size of the concha bullosa is another important factor to be considered besides the presence of mucosal contact in the nasal mucosa itself and association of this variation with other variant which occur simultaneously.

Paradoxical Middle Turbinate

In this variation, the convexity of the middle turbinate is on the lateral side. We found that the incidence of this variation was 14 cases among the CRS and 27 in controls. The major consequence of these anatomic variations is narrowing of the middle meatus which can lead to obstruction of infundibular drainage. However the degree of convexity of the middle turbinate is the most important factor to cause the

obstruction which will lead to rhinosinusitis. Paradoxical middle turbinate is known to abut against lateral wall and the middle meatus as compared to a normal shaped middle turbinate. It has formed the basis for contact point theory resulting into disturbance with mucocilliary clearance which further leads to development of CRS and nasal polyps.

Pneumatization of the Uncinate Process
Pneumatization of the uncinate process is also referred as uncinate bulla, refers to an aeration of air cells into the uncinate process. The uncinate process projects from the ethmoid bone to the ethmoid process of the inferior nasal concha. The pneumatization of this structure is a very rare entity. According to a study done by Kennedy *et al*, 1998, they found the incidence of this variation (uncinate process pneumatization) was 0.4% [15]. While Bolger *et al,* 1991 reviewed 202 CT scans for anatomic variation and they detected pneumatization of uncinate process in 2.5% [13].

In our study, interestingly we found 6 (3.3%) patients with pneumatized uncinate process, equally distributed among CRS patients and controls. Pneumatized uncinate process shall logically cause significant functional blockage of the osteomeatal complex. However the severity of the degree of medialization of the uncinate process (causing mucosal contact with middle turbinate or covering up the osteum of maxillary sinus) and the presence of some other anatomical variation such as Haller's cell maybe an important associating factor that may increase pathogenic effect leading to CRS rather then the presence of this variation alone.

Infraorbital Ethmoid Cell (Haller's cell)
Haller's cells are the ethmoidal cells that develop into the medial floor of orbit adjacent to and above the maxillary sinus ostium, and which if enlarged can constrict the posterior aspect of the ethmoidal infundibulum and superior medial portion of maxillary sinus osteum. Kennedy *et al*, 1998 have reported that 10% of patients evaluated by coronal CT scan have this anomaly [15].

However our prevalence was higher which showed 56.6%. It has implicated as a possible etiologic factor in CRS due to their negative influence on maxillary sinus ventilation by narrowing the infundibulum and ostium depending upon its degree of pneumatization and size.

Agger Nasi Cell
Agger nasi cells are the most anterior ethmoid air cells that are located anterior, lateral and inferior to frontal recess. The reported prevalence of agger nasi cell varies widely among investigator. In anatomic dissection, Messerklinger *et al* (1967) encountered the agger nasi cell in 10-15% of specimens [16]. Davis *et al*, 1934 noted this cell in 65% of specimens [17].

A definitive diagnosis of the presence of the disease in the agger nasi can only be made by CT scan. Coronal views clearly demonstrating the anatomic relationship of the agger nasi to the level of the frontal sinus and frontal recess. From our study we found the incidence of this variation is 81.2%. However there is no statistical association between the presence of this variation and pathogenesis of the chronic rhinosinusitis. This maybe due to the size of the cell itself in which it is not big enough to cause sinusitis by obstruction of the frontal sinuses drainage pathway.

Recognition of this relationship on CT and during surgery is essential to the diagnosis and treatment of recurrent chronic frontal sinusitis and its unusual pneumatization causing narrowing of frontal recess can furtherobstruct mucocilliary clearance from the frontal sinus.

Other anatomical variation
Other than that we also evaluated the incidence of deviation of nasal septum. We found that among our cases 53.3% incidence of this deviation. And most of the deviation was to the right.

This deviation may compress the middle concha with consequential infundibulum obstruction. However there was no statistical significant in between this variation with CRS pathogenesis. Perhaps this was due to the severity of the deviation which was not prominent to cause the obstruction.

CONCLUSION

The most common anatomical variation in osteomeatal complex in chronic rhinosinusitis patients in our study are pneumatized agger nasi cells (83%), followed by Haller's cell which were present in 51%, DNS (50%), right concha bullosa (36.7%), left concha bullosa (25.8%), paradoxical middle turbinates (12%) and pneumatized uncinate processes (3.3%). However the detection of a single anatomical variant itself does not establish the genesis of chronic rhinosinusitis except for paradoxical middle turbinate and infraorbital ethmoid cell.

This study has the limitation of being predominantly of a single race and having a relatively small number of patients as compared to other series. Despite evaluation regarding the presence or absence of the anatomical variants at OMC, we should also evaluate the size, severity and type of variations (for example grading if any) as well.

CT scan, as a major tool in the study even though has good bony resolution but does not possess similar property for soft tissue. Mucosal contact or other soft tissue abnormality is unable to be comment despite its crucial role in the pathogenesis of CRS.

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