BONY ANATOMIC VARIANTS SEEN ON SCREENING SINUS CT

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ABSTRACT

Screening sinus CT (SSCT) has emerged as the standard imaging modality in the investigation of inflammatory disease of the sinuses. Its ability to demonstrate detailed anatomy of the sino-nasal complex makes it an invaluable tool in functional endoscopic sinus surgery (FESS). In addition to exquisite demonstration of the anatomy and pathology of the sinonasal complex, anatomic variants which are identified can be predisposing factors to inflammatory sinus diseases. They are important operative considerations during the planning of FESS. The aim of this study is to document the prevalence of major anatomic variants seen on SSCT in our local population and to illustrate some of these variants as identification of these anomalies may have crucial operative implications. In view of the heterogeneous make up of our study population,an analysis of the prevalences of the variants amongst the different races is also made.

Screening sinus CT of 302 consecutive patients referred for sinonasal symptoms were studied. Anatomic variations were identified and recorded. These included pneumatized middle turbinate (concha bullosa) , paradoxical middle turbinate (PMT), Haller's cells, septal deviation and uncinate process pneumatization. Overall bony anatomic variations were seen in 216 (71.5%) patients. A total of 134 (44.4%) patients had concha bullosa, 18 (6.0%) had paradoxical middle turbinate while 24 (7.9%) patients showed the presence of Haller's cells. There was significant lower prevalence of paradoxical middle turbinate noted in the Chinese group when compared with the Non-Chinese. There were only 4 patients (1.3%) with pneumatization of the uncinate process and these were only seen in the Non-Chinese group. Comparison is made between our study population and that of other similar published studies.

INTRODUCTION

Screening sinus CT (SSCT) has proven to be an important integral preoperative diagnostic tool in the patient with inflammatory disease. The detailed anatomy demonstrated on CT is far superior to that

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of plain radiography. In terms of radiation exposure, SSCT has been shown to be well below that associated with cataract formation.[1,2] Hence SSCT has largely replaced the plain radiograph in investigation of sinusitis. Besides confirming the presence or absence of disease, SSCT also demonstrates:

1. Sinonasal anatomy and major mucociliary drainage pathways[3] crucial to the ENT surgeon performing FESS.
2. Normal variants which may predispose to sinus disease and affect the planning of FESS.[3,4,5]
3. Complications of endoscopic sinus surgery.[4,5]
4. Non-inflammatory disease of the sinuses eg tumours.[6]

The purpose of this study is to document the prevalence of major anatomic variants in the local population. Comparison is made with similar published studies.

METHODS AND MATERIALS

302 consecutive SSCT scans were reviewed over a two and half year period between March 1993 to September 1995. The study group consisted of 120 females and 182 males. Age ranged from 6 to 80 years old with a mean of 37.7 years. The racial breakdown of the study population is as follows in Table 1. Due to the small numbers of Indians, Malays and other races, we have divided the study group into the Chinese and the Non-Chinese for purposes of statistical analysis, There were a total of 88 Non-Chinese (29.1%) and 214 Chinese (70.9%).

All scans were performed at the Department of Diagnostic Imaging at Tock Seng Hospital. All cases were referred from the ENT Department for assessment of sinusitis. The age, sex and race of the patients were recorded. Scans were performed according to a protocol similar to that proposed by Babbel et al.[7] This included use of a sympathomimetic nasal spray (Ko-trin) 15 minutes before the scan, followed by nose blowing. Patients were then placed prone in the gantry with neck extended and the head resting on the chin. The gantry angle was positioned perpendicular to the hard palate and a lateral scout obtained. The absolute gantry angle is not critical as it has to be adjusted to avoid artefacts from dental amalgam.[7] 5 mm contiguous slices were then performed from the posterior sphenoid wall to the posterior wall of the maxillary sinuses. This was followed by 3mm contiguous scans from the posterior margin of the maxillary sinuses to the anterior wall of the frontal sinuses (see Fig 1). The scans were performed on a Picker 2000 CT machine. No intravenous contrast was used unless there was suspicion of a non inflammatory disease. A bone algorithm was used as part of the imaging protocol. All scans were then filmed at a window level of 250 and width of 2500.

The scans were systematically examined by a head and neck radiologist for evidence of sinus disease and reviewed for the following anatomic variants:

1. Pneumatized middle turbinate. These were further subdivided into three pattern:[8]
   a. Pneumatization of the lamellar or vertical portion.
   b. Pneumatization of the inferior or bulbous portion.
   c. Extensive pneumatization of both the lamellar as well as the inferior portions.
2. Paradoxical middle turbinate : The convexity of the middle turbinate bone is directed laterally.
3. Nasal septum deviation : These were divided into left or right deviation.
4. Haller's cells : These are ethmoidal air cells that project beyond the limits of the ethmoid complex into the floor of the orbit above the maxillary sinuses.
5. Pneumatized Uncinate Process (Uncinate bulla).

RESULTS

A total of 216 patients (71.5%) were found to have bony variants as described above (see Table 2). The most common normal bony variant was noted to be nasal septum deviation with a total of 144 patients (47.7%) showing either right (21.5%) or left (26.2%) deviation. There was also a large

proportion (44.4%) of the study population who had concha bullosa. The vertical lamella was pneumatized in 25.5% while the inferior bullous portion was peumatized in 6.3%. Extensive pneumatization of the entire middle turbinate was noted in 12.6%. Haller's cells were seen in 7.9% of our study population. Paradoxical middle turbinate were detected in 6.0%. Only 4 patients (1.3%) had uncinate process pneumatization (uncinate bulla) and these were all Non-Chinese. There was a significant lower prevalence of paradoxical middle turbinate noted in the Chinese group when compared to the Non-Chinese.

DISCUSSION

Our study of the local population showed 71.5% prevalence of major bony variants. This is higher than the 64.9% reported in a similar study by Bolger et al.[8] This is due to the inclusion of septal deviation in our study which constitutes the largest proportion of the study. A lower prevalence of 52% would be obtained if deviation of septum were omitted from the study.

CONCHA BULLOSA

This refers to middle turbinate pneumatization (see Fig 2a and 2b) and was first described by Santorini in 1739. Depending on the criteria and imaging modality utilized, the reported prevalence ranges widely from 4% to 80%.[9] The highest prevalence being found in patients with chronic sinusitis at the time of ethmoidectomy. The reported prevalence on CT is generally between 33% to 36%.[8,10,11] Our study population showed a higher prevalence of 44.4% . This is likely to be due to our biased study population which were all referred for evaluation of sinusitis. There is generally a higher prevalence of middle turbinate pneumatization in patients with chronic sinusitis.[8,9,12,15] This has been attributed to encroachment of the concha bullosa onto the ostiomeatal unit. The pneumatized concha itself may also be complicated by polyps, cysts, pyoceles or mucoceles.[9] However , this is not a view shared by all researchers. Zinreich[11] did not find any difference in the incidence of concha bullosa in patients with or without sinusitis. Extensive pneumatization of the entire middle turbinate or a "true" concha bullosa was noted in 12.6% of our patient. This is consistent with the range of 4 to 15.7% quoted by Lane and Smoker.[9] The respective prevalences of pneumatization of the vertical lamellar and inferior bulbous portions were 25.5% and 6.3% in our study. These are lower than the reported respective prevalences of 46.2% and 31.2% in a study by Bolger et al.[8]

PARADOXICAL MIDDLE TURBINATE

This is a reversal of the normal outward concavity of the middle turbinate (see fig 3). There were only 6% who demonstrated this bony variant in our study. This is a lower prevalence when compared with similar studies by Bolger et al[8] and Lloyd[12] who reported 26.1% and 17% respectively. This variation in reported figures may be due the level of the coronal sections.[12] Cases have been noted where a normal curve is seen posteriorly but with a paradoxical curve anteriorly. In our study, we have only included cases which demonstrated the curvature anteriorly, ie at the level of the ostiomeatal unit. Prevalence of this bony variant among the Chinese was 3.3% compared to 12.5% found in the Non-Chinese group. Chi square test confirmed this to be statistically significant ($p<0.05$).

HALLER'S CELLS

These are ethmoidal air cells that grow onto the floor of orbit and may narrow the maxillary ostium and infundibulum[4,6] (see Fig 4). There were 24 patients or a prevalence of 7.9% who demonstrated this bony variant. It can be seen from Table 3 that there is a wide range of reported prevalences of Haller's cells. The reasons include different criteria used in establishing the presence of the variant. Bolger et al[8] used a broad definition of "any air cells located beneath ethmoid bulla along the maxillary sinus roof and most inferior portion of the lamina papyracea including air cells located within the ethmoid infundibulum". The technique of CT scanning, the use of different

window/level settings and variation in sample size have been implicated[8] as factors in the differing prevalences. In our study, this may be due to real differences in the prevalence of this anatomic variant in our population.

PNEUMATIZED UNCINATE PROCESS
(See Fig. 2b)

The mechanism causing this anomaly is largely unknown.[10] This is an infrequent entity with only one case noted in 230 patients (or 0.4%) by Kennedy and Zinnreich.[13] Bolger et al[8] describe a 2.5 % prevalence in his study. We had only 4 patients or 1.3% prevalence, confirming the relative infrequency of this variant. All the 4 cases were Non-Chinese with none being found in the Chinese group. Chi square test confirmed significance of this finding at $p<0.05$.

SEPTAL DEVIATION

This has been noted to occur with a prevalence of approximately 20%.[14] Our study showed a higher prevalence of 44.4% and is in closer agreement with Babbel et al[6] who reported 40% prevalence. This is likely due to the broad criteria we used for assessment. Any form of nasal septum deviation including mild deviations were included in this category. There is slight predominance of left sided deviation which is not statistically significant.

CONCLUSION

Our study shows that the local prevalence of paradoxical middle turbinate as well as Haller's cells are generally lower than that cited in other studies. The higher prevalence of pneumatized middle turbinate is probably related to the bias selection as our study consisted of symptomatic patients. There is a higher prevalence of septal deviation due to a different criteria used. There was no statistical difference in left or right deviation in this study. Only four patients or 1.3% had pneumatization of the uncinate process. This is in agreement with previous studies and confirms the relative infrequency of this variant. There were significant lower prevalences of paradoxical middle turbinate and uncinate process pneumatization among the Chinese when compared to the Non-Chinese.

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Table1 : Race distribution in the study population.

Race	Number	Proportion of study population
Indian	41	13.6%
Malay	27	8.9%
Others	20	6.6%
Chinese	214	70.9%
Total	302	100%

Table 2 : Summary of results.

Race	Pneumatized Middle Turbinate			Paradoxical Middle	Haller's	Nasal Deviation		Uncinate
	Vertical	Inferior	Extensive	Turbinate	Cells	Right	Left	Bulla
Non-Chinese	18(20.5%)	8(9.1%)	16(18.2%)	11(12.5%)	6(6.8%)	20(22.7%)	31(35.2%)	4(4.5%)
Chinese	59(27.4%)	11(5.1%)	22(10.2%)	7(3.3%)	18(8.4%)	45(20.9%)	48(22.3%)	0(0%)
Total No:	77	19	38	18	24	65	79	4
Prevalence	25.5%	6.3%	12.6%	6.0%	7.9%	21.5%	26.2%	1.3%

Table 3 : Reported prevalences of Haller's cells.

Studies	This study	Kennedy & Zinnreich	Bolger(16)
Reported Prevalence	7.9%	10%	45%

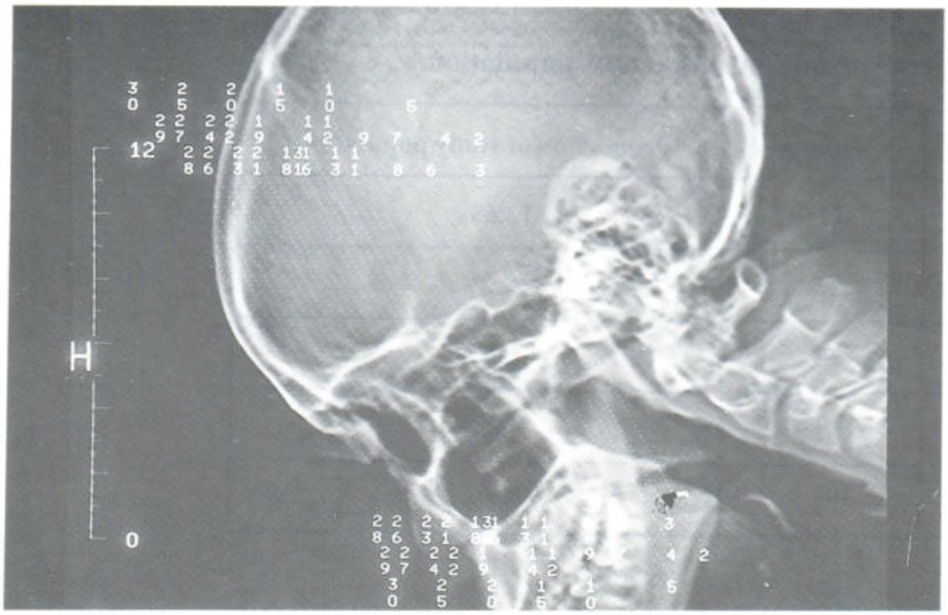

Fig. 1 Lateral scout image of patient undergoing screening sinus CT .

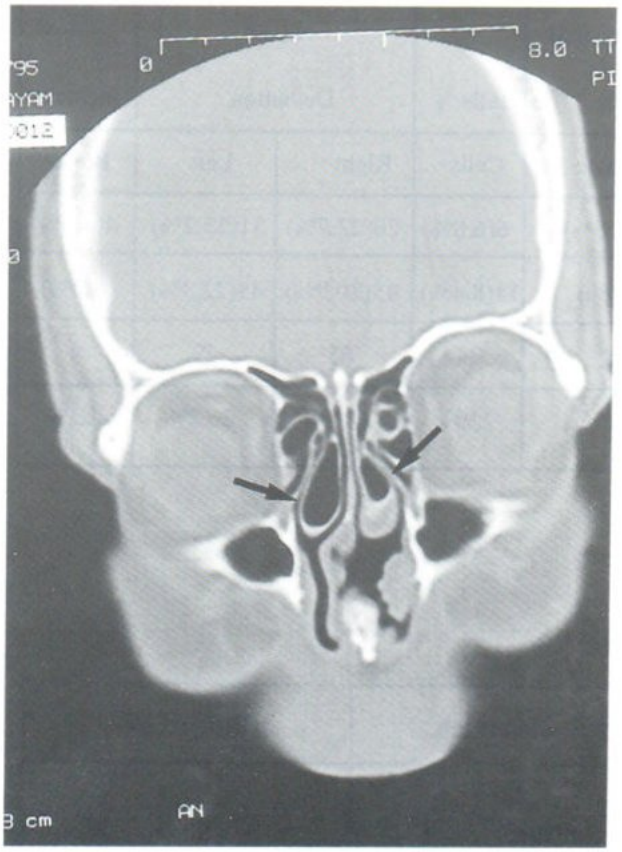

Fig. 2a Extensive pneumatization of the middle turbinates - the " true concha bullosa ".

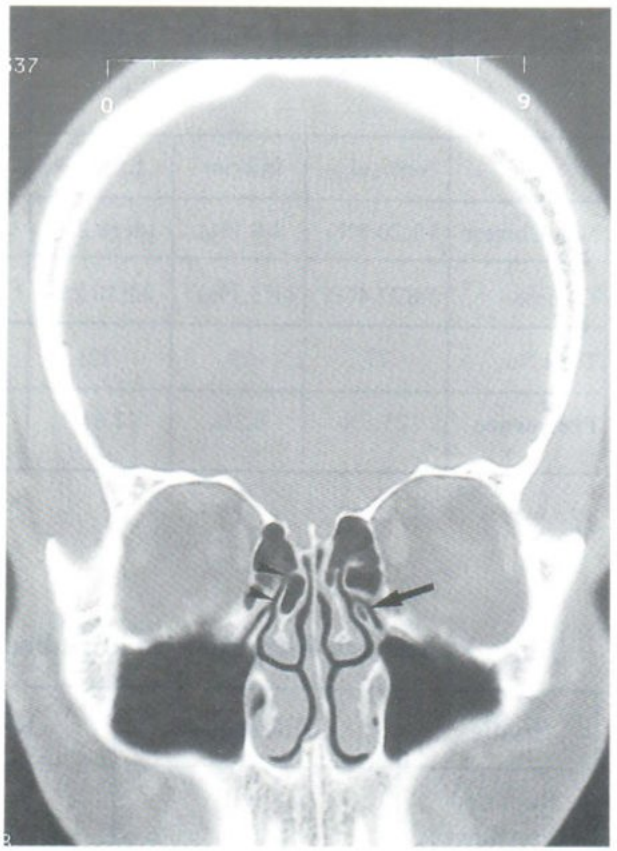

Fig. 2b Pneumatization of the vertical lamella of the right middle turbinate (arrow-heads). Pmeumatization of the left uncinate process (arrows) is seen as well.

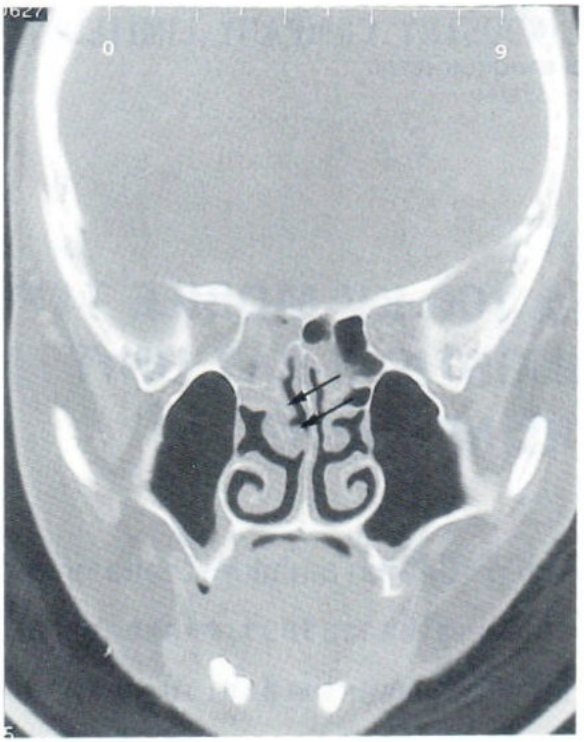

Fig. 3 Paradoxical middle turbinate seen on the right side (arrows). Disease of the sphenoid and ethmoidal sinuses are noted.

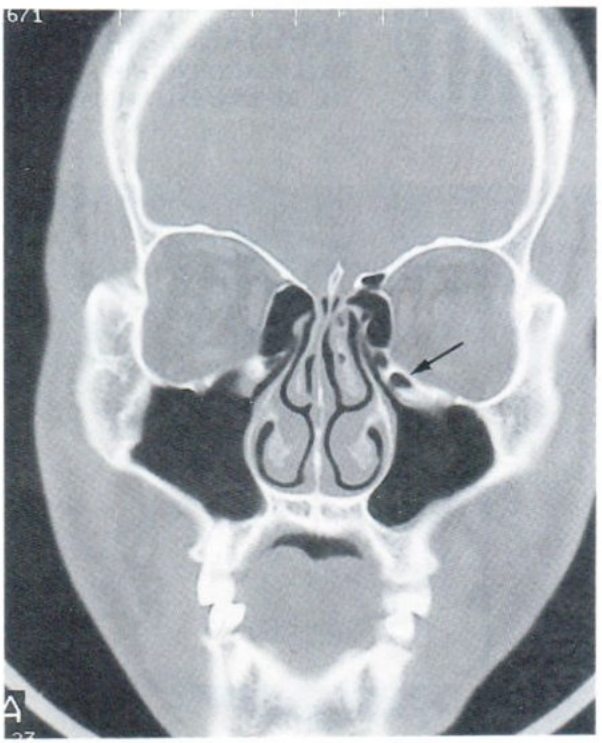

Fig. 4 Haller's cells demonstrated on the left side (arrows).

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