Distribution Patterns of Inflammatory Sinonasal Diseases

T Y Tan, M Lin, F K Cheah, D M Koh

ABSTRACT

Background/Aim of Study: There has been an increase in the demand for coronal sinus CT scan since the introduction of functional endoscopic sinus surgery; as the information provided by the scans assist the surgeon in the pre-operative plannings. Babbel and colleagues had demonstrated five distinctive patterns of recurring inflammatory sinonasal disease on CT scan. The aim of this study was to evaluate the patterns in the local population and to see if there was a difference compared to the Caucasian population.

Methods and Materials: A retrospective review of 302 scans done between March 1993 and September 1995 was carried out. All scans were carried out using a 5 mm thickness to cover the posterior sinuses and a 3 mm thickness to cover the anterior sinuses. The scans were then grouped into the various patterns and an analysis was carried out comparing the differences in the patterns between the Chinese and the non-Chinese, and between the local population and the Caucasian population in Babbel's series.

Results: There was no significant difference between the Chinese and the non-Chinese in the distribution of the various disease patterns. When compared to the Caucasian population, the local population had more sinonasal polyposis and sphenoethmoidal recess obstruction.

Conclusion: The smaller nasal passages of the Asians, particularly in the Chinese, could be the reason for the more prevalence of Type III and Type IV disease compared to the Caucasian population. The more constant and frequent exposure to allergens might also contribute to the increased prevalence of Type IV disease.

Keywords: Infundibulum, polyposis, sinusitis, uncinate, ethmoid

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INTRODUCTION

Since the introduction of functional endoscopic sinus surgery (FESS), there has been an increasing demand for coronal sinus CT scans as these provide exquisite anatomical details of the sinonasal region; information which the surgeons would find invaluable in their pre-operative plannings. The cornerstone of FESS lies in the fact that paranasal sinuses are drained by established muco-ciliary pathways. The maxillary, anterior ethmoid and frontal sinuses drain into the ipsilateral ostiomeatal unit (OMU). The components of the OMU are the middle meatus, hiatus semilunaris, ethmoid bulla, maxillary ostium and the infundibulum (Fig 1). Mucus in the spheroid sinus drains via its ostium into the sphenoethmoidal recess (SER) (Fig 2). The posterior ethmoid sinus drains first into the superior recess and subsequently into the SER. The nasopharynx receives drainage from both the OMU and the SER. Obstruction to these muco-ciliary pathways eg, by polyps or mucus plug, would lead to inflammation of their draining sinuses. The aim of FESS is to re-establish these pathways by surgically removing the obstruction.

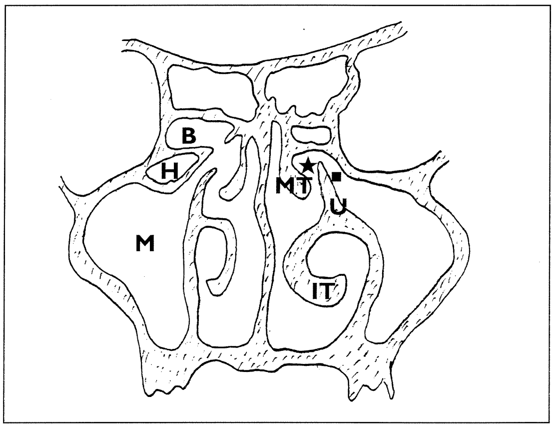

Fig 1 – Line drawing of a coronal section through the ostio-meatal unit. ★: Middle meatus, ■: Infundibulum, **B**: Ethmoid bulla, **H**: Haller's cell (normal variant), **M**: Maxillary sinus, **IT**: Inferior turbinate, **MT**: Middle turbinate, **U**: Uncinate process

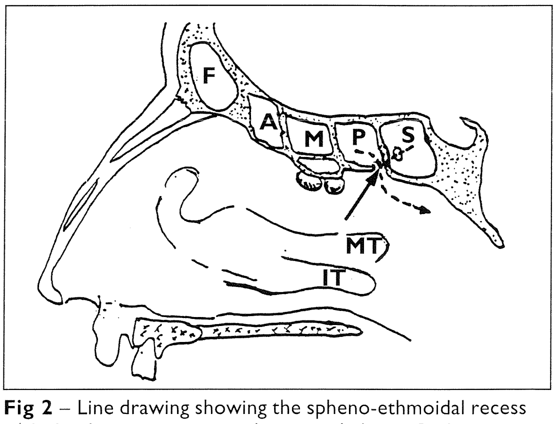

Fig 2 – Line drawing showing the spheno-ethmoidal recess with the drawing sinuses in the saggital plane. **A**: Anterior ethmoid sinus, **B**: Ethmoid bulla, **F**: Frontal sinus, **M**: Middle ethmoid sinus, **P**: Posterior ethmoid sinus, **S**: Sphenoid sinus, **MT**: Middle turbinate, **IT**: Inferior turbinate; Arrow: Spheno-ethmoidal recess; dotted arrow: Drainage pathway of the posterior ethmoid and sphenoid sinuses

Babbel and colleagues[1] described five distinctive patterns of recurring inflammatory sinonasal disease demonstrated on coronal sinus computed tomography (CSCT). Type I pattern was due to obstruction of the infundibulum leading to ipsilateral maxillary sinusitis. Type II or the OMU pattern was due to obstruction of the OMU, resulting in inflammatory changes within the ipsilateral maxillary, anterior ethmoidal and frontal sinuses. Obstruction to the SER gave the Type III pattern which involved the ipsilateral spheroid and/or posterior ethmoid sinuses. In Type IV pattern or sinonasal polyposis, polypoidal soft tissue densities were noted throughout the nasal cavities and sinuses in association with variable diffuse sinus opacification. Type V disease was also known as sporadic or unclassifiable disease, which included retention cysts, mucoceles, mild muco-periosteal thickenings without co-existent OMU or SER obstruction and CT scans showing post-operative changes. Those scans which showed no evidence of any disease were termed Normal (Type N).

The purpose of this study was to determine if there was any difference in the distribution of the various patterns between the Caucasian population in Babbel's series and our Asian population. At the same time, an attempt was made to see if there was any distinctive difference in pattern distribution between the Chinese and the non-Chinese in our study population.

Table I – Distribution of the various disease patterns of the study population with comparative results from Babbel's series

Types of disease seen on CT	Type I (%)	Type II (%)	Type III (%)	Type IV (%)	Type V (%)	Type N (%)
Study population	35 (11.6)	74 (24.5)	58 (19.2)	68 (22.5)	84 (27.8)	34 (11.3)
Babbel's series	129 (26)	126 (25)	32 (6)	49 (10)	121 (24)	133 (27)
p-value	<0.0001	NS	<0.0001	<0.0001	NS	

Footnotes: Type N denotes normal scans.
The statistical test used is the exact probability test.
NS denotes statistically non-significant.

Table II – Distribution of the various disease patterns between non-Chinese and Chinese

	Type I (%)	Type II (%)	Type III (%)	Type IV (%)	Type V (%)	Type N (%)
Non-Chinese	8 (17.1)	25 (28.4)	19 (21.6)	21 (23.9)	30 (34.1)	5 (5.7)
Chinese	27 (12.6)	49 (22.8)	39 (18.1)	47 (25.1)	54 (25.1)	29 (13.5)
Chi-square test	0.4743	0.3786	0.583	0.8894	0.1056	

Table III – Distribution of the various disease patterns between males and females

	Type I (%)	Type II (%)	Type III (%)	Type IV (%)	Type V (%)	Type N (%)
Males	19 (10.4)	46 (25.3)	33 (18.1)	49 (26.9)	53 (29.1)	12 (6.6)
Females	16 (13.3)	27 (22.5)	24 (20.0)	19 (15.8)	31 (25.8)	22 (18.3)
Chi-square test	0.4165	0.6274	0.6431	0.028	0.5811	

METHODS AND MATERIALS

Three hundred and eight consecutive CSCT scans done in our department between March 1993 and September 1995 were reviewed retrospectively. Six cases were found to be tumours and were excluded from the study, resulting in a study population of 302. All scans were performed on a Picker 2000 CT machine. All patients were given a standard preparation protocol prior to the scanning. This included at least two weeks of antihistamine and antibiotics treatment followed by the use of a sympathomimetic nasal spray 15 mins before the scanning. The patients were also advised to blow their noses vigorously after the nasal spray. The preparation protocol was to ensure that at the time of scanning, most of the changes that could be treated medically would have resolved and those that were left needed surgical intervention. All the patients were scanned in the prone position and the gantry was angled perpendicular to the hard palate. Five millimetres contiguous slices were obtained from the posterior spheroid wall to the posterior wall of the maxillary sinuses followed by 3 mm contiguous scan to the anterior aspect of the frontal sinuses. The images were filmed at a window width of 2500 HU and window level at 250 HU. Individual patient's scans were scrutinised and grouped into the various disease patterns. The age, sex and race of the patients were also noted.

RESULTS

There were 302 cases in the study population. 39.7% were females and 60.3% were males. The age ranged from 6 to 80 years with a mean of 37.7 years. Chinese made up 71.2% of the study population, whereas Malays made up 8.9%, Indians made up 13.5% and Others made up 6.6%. 'Others' comprised a heterogenous group of Caucasians, Arabians, Pakistanis, Sikhs and Jews. For the purpose of statistical comparison, the Malays, Indians and Others were grouped together as non-Chinese. Table I shows the distribution of the various patterns of inflammatory sinonasal disease of the study population with comparative figures from Babbel's series. Using exact probability test, we found that there were significantly more (at $p<0.0001$) Type III and Type IV disease in our study population than that in Babbel's series, while Type I disease was proportionately less here.

The distribution of the various disease patterns between Chinese and non-Chinese, and between males and females are shown in Table II and Table III respectively. Chi-square test showed no significant difference between Chinese and non-Chinese with regard to the various disease pattern. There is however, significantly more males having Type IV disease than females (at $p< 0.05$), using the same probability test.

The total number of the various disease patterns added up to be more than 302 because some patients had more than one disease pattern, for example, some had a combination of Type I and Type III diseases while others had Type II and Type III diseases.

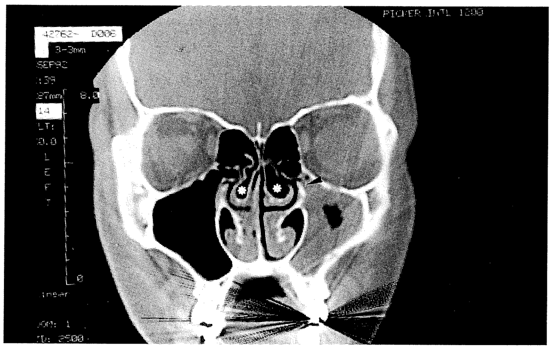

Fig 3 – The infundibulum of the left maxillary sinus is obstructed by mucosal thickening (arrowhead), leading to left maxillary sinusitis. Patient has bilateral Concha Bullosa (*). These are normal variants.

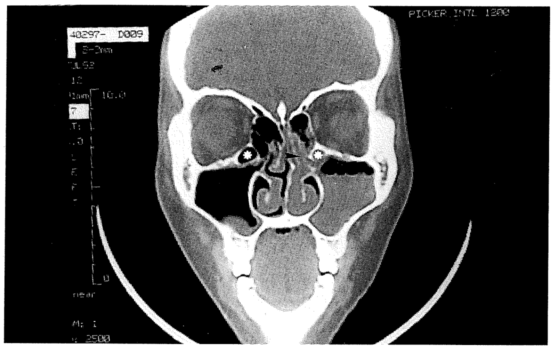

Fig 4 – There is obstruction in the left OMU (arrowhead) resulting in inflammatory changes in the left maxillary and the left anterior ethmoid sinuses. Type I disease is present on the right side. Bilateral Haller's cells (*) are noted. These can sometimes contribute to the narrowing of the respective infundibulum if they are large.

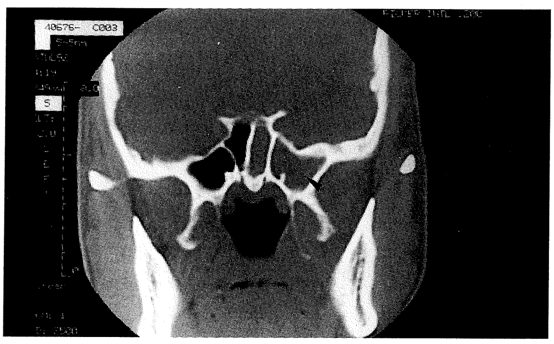

Fig 5 – There is complete opacification of the left sphenoid sinus and the pneumatised left Pterygoid plate (arrowhead).

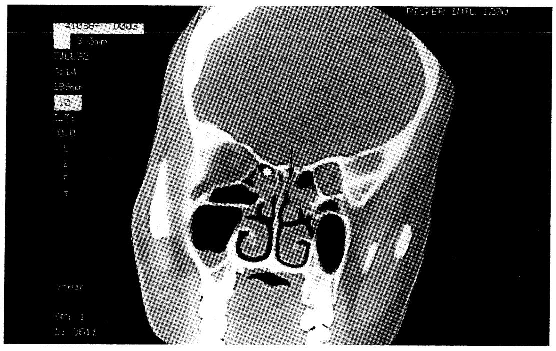

Fig 6 – Obstruction to the left SER (arrow) and left superior meatus (arrowhead) has resulted in the changes seen in Fig 5. The right superior meatus is obstructed with resultant inflammation of the right posterior ethmoid sinus (*). Type I disease is present on the right side.

DISCUSSION

Coronal CT scan of the sinuses gives exquisite anatomical and pathological detail of the sinonasal region and displays them in the same anatomical plane that the surgeon would see during endoscopy. This has become a pre-requisite investigation for patients prior to FESS. Babbel and collegues[1] showed five patterns of disease in their series of 500 cases. The obstructive patterns were Type I to Type III. In Type I disease, the obstruction was in the maxillary infundibulum, resulting in maxillary sinusitis (Fig 3). Type II disease was due to obstruction to the drainage site of frontal, maxillary and anterior ethmoid sinuses, ie. the OMU (Fig 4). Obstruction to the SER (Fig 5) causing inflammation in the ipsilateral spheroid and posterior ethmoidal sinuses (Fig 6) was classified as Type III disease.

Type IV disease or sinonasal polyposis was characterised by presence of polyps within the nasal cavity and paranasal sinuses. Characteristic CT findings were polypoidal masses in the nasal vault, bilateral widening of the infundibulum (Fig 7), convexity of the ethmoid sinus walls and attennuation of the bony nasal septum and ethmoid trabeculae.

Type V disease comprised inflammatory diseases not attributed to obstruction to the OMU or SER or to sinonasal polyposis. Post-surgical changes are also included in this group (Fig 8).

We reviewed 302 cases of coronal sinus CT done over two and a half years and as our population comprises mainly Asians, we have compared the various disease patterns with that of the Caucasian population in Babbel's series. Our population had significantly less Type I disease and significantly more Type III and Type IV diseases than the population in Babbel's series. Type II and Type V diseases showed no significant difference.

Sinonasal polyposis (Type IV) made up 22.5% of our cases compared to the 10% in Babbel's series. In order to try and explain this difference, we had to look into the etiology and pathogenesis of sinonasal polyposis. Sinonasal polyposis had been strongly considered to be a manifestation of allergy in the 1930s but the theory was challenged in the 1970s. Keith et al[2] found that seasonal allergy exposure did not result in an increase in sinonasal polyposis in their study whilst others[3,4] suggested that exposure to allergens had a role in the pathogenesis. Asthma and aspirin intolerance are known associations[5] and sinonasal polyposis is a recognised complication of cystic fibrosis[6]. Braun[7] found that a history of vasomotor rhinitis preceded the polyposis by a mean interval of eight years. Most authors now agree that the etiology of sinonasal polyposis is multifactoral and that allergy only plays a contributory role[8,9].

Gray[10] believed that Bernouilli phenomenon had a part to play in the production of polyps. Bernouilli's theorem postulated that gas passing through a constricted area would create a negative pressure. Gray contended that the lowered pressure

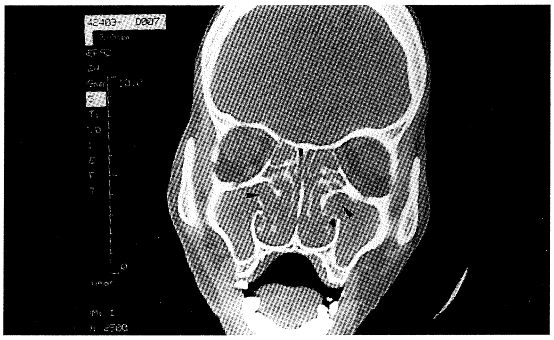

Fig 7 – The nasal cavity on both sides are blocked by polyps. Both infundibulum are widened (arrowheads). There is total opacification of the maxillary and anterior ethmoid sinus on both sides. This patient had complete bilateral opacification of the frontal sinus, posterior ethmoidal sinus and the sphenoid sinus (not shown).

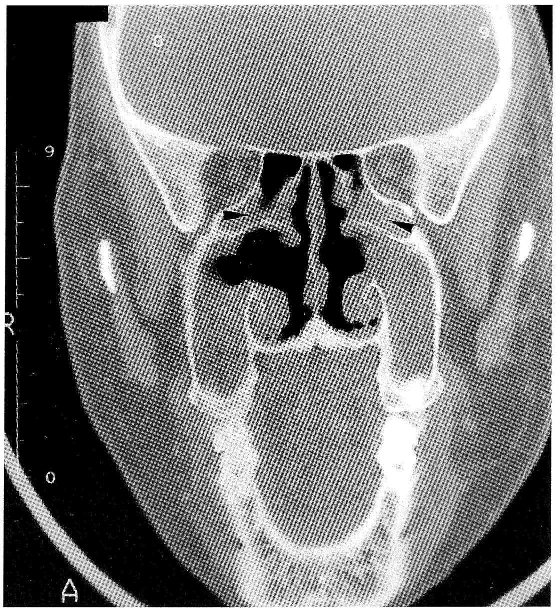

Fig 8 – Previous bilateral uncinectomy and middle turbinectomy had been done in this patient. Mucosal thickenings are still seen in both maxillary sinuses and both superior meati (arrowheads).

then reduced extravascular fluid pressure in the surrounding tissues, leading to increased formation of tissue fluid and thus polyposis. Bernstein[9] had proposed that turbulent flow in the lateral wall of the nose could cause an inflammatory change in the mucous, leading to ulceration and prolapse of the submucosa. The resulting re-epithelialisation and new gland formation eventually lead to polyposis. The same author also felt that genetic factors had a part to play in the pathogenesis of polyps.

There are therefore many possible contributing factors to the formation of sinonasal polyposis. We believe that the following two reasons could help explain the higher prevalence of sinonasal polyposis in our study population: 1) Our patients are exposed to perennial allergy whereas in Babbel's series, the patients would likely be exposed to seasonal allergy. The frequent and constant exposure to allergens may result in enhanced formation of nasal polyps, 2) The nasal structure of Chinese (who formed the bulk of our study population) is different from that of Caucasians. Gnanapragasam[11] suggested that the average Chinese nasal passage was narrower than the average Caucasian nasal passage. This might result either in an increased tendency for injury to the nasal wall as air passes through the narrower passage or an increased likelihood of creating negative pressure in the surrounding tissue, both leading to a greater tendency of polyp formation.

The narrower nasal passage in our study population could also explain for the higher prevalence of Type III disease as it only takes relatively minor inflammatory change in the SER to obstruct it, whereas for the average Caucasian nose, this region would be bigger and therefore less easily obstructed. The lower prevalence of Type I disease here is an observation for which we do not have a ready explanation.

In our series, a statistically significant number of males have sinonasal polyposis when compared to females. Ng et al[12], in their cross-sectional study of 2,868 adults in Singapore, found that males had higher prevalence of allergic rhinitis and this could be the reason why males were more prone to polyposis.

We were unable to study individual ethnic groups and assess their respective patterns of disease due to the small numbers of non-Chinese. Therefore, we grouped the Malays, Indians and Others together as non-Chinese. We found no statistical significance between the Chinese and non-Chinese in the various disease patterns.

We note that we had a slightly higher proportion of Indians (13.6%) in our study population than expected from the Singapore population census (7.1%). This might be due to the fact that the catchment population of our hospital included the Serangoon district which is known to be the hub of the Indian community in Singapore. However, it might still be possible that Indians are prone to sinonasal inflammatory disease. Ng et al[13] found a higher crude prevalence of allergic rhinitis amongst Indians, which supports our observation. The findings however are not conclusive and further studies would be needed to verify the observation.

Our study had a lower proportion of Malays than could be expected from the Singapore population census (14.1%). Gnanapragasam[11], also noted a lower number of Malays in his study. Chia et al[14] found that the prevalence of chronic sinusitis amongst Malays was not significantly different from the Indians and Chinese. It is our impression that Malays are generally more stoical, and that the lower numbers did not represent a lower prevalence of disease, but rather, a decreased tendency to seek medical attention for sinonasal inflammatory diseases which is perceived as a 'minor' complaint.

CONCLUSION

Our population has more Type III and Type IV inflammatory sinonasal diseases than the Caucasian population in Babbel's series. This could be due to the smaller nasal passages of the Chinese. The more constant and frequent exposure to allergens might also play a part resulting in the increased tendency of polyp formation.

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