A Study of Anatomy of Frontal Recess in Patients Suffering from ‘Chronic Frontal Sinus Disease’

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Abstract A study designed to describe the anatomical features of the frontal recess area in patients suffering from chronic frontal sinusitis. A prospective study done in adult patients admitted in our hospital between July 2009 to June 2011. Tertiary level, private ENT care centre. 50 adult patients of chronic frontal sinusitis who did not have history of previous sinus surgery. The frontal recess anatomy was studied by 2 mm slice CT scans pre-operatively. CT findings were confirmed intra operatively by meticulous dissection in frontal recess area endoscopically with aid of image guided system. A chart prepared for each patient of different anatomical variations present in frontal recess on each nasal side and analyzed. Agger nasi cell was found in 94 % of cases. The superior attachment of the uncinate was to the lamina papyracea in 82 % of cases. Type 1 frontal recess cells were found in 44 %, type 2 in 8 %, type 3 in 48 % and type 4 in 2 % of the cases. Over all 74 % of cases had frontal recess cells. The management of frontal sinusitis is a challenge to endoscopic surgeon and as more and more rhinologists got expertise in endoscopic sinus surgery skills; the next challenge is management of frontal sinus. Hence, the need arises for more precise study of frontal recess anatomy. Detailed studies of anatomic features of the frontal recess by coronal and sagittal CT scans are very important and helpful for endoscopic frontal sinus surgery. Our study suggests that there is high prevalence of frontal recess cells in Indian population suffering from frontal sinusitis.

Keywords Frontal sinus · Sinusitis · Frontal recess · Anatomy

Introduction

Since the introduction of concept of endoscopic sinus surgery in late 80s of last century, it has become clear that “frontal recess” or outflow tract of the frontal sinus is the key area in pathogenesis of frontal sinus disease. Although overall results of surgical treatment of chronic sinus disease has improved a lot in recent years, frontal sinus disease still poses a significant challenge to most of the endoscopic sinus surgeons. This is because frontal recess is a difficult area to operate because of its small size, the sensitive structures nearby, and the awkward angle one must often assume to adequately view and instrument this area [1]. This results in the frontal recess being the most likely area for the recurrence of sinus disease [2]. So it is apparent that a thorough knowledge of frontal recess anatomy is important for the surgeon to perform a safe and successful frontal sinus surgery.

Although literature about frontal recess anatomy is appearing in the western journals in last few years [3–5], there is paucity of Indian studies about the frontal recess anatomy. In this study we have recorded the main variations of frontal recess anatomical features in our patients who are suffering from “chronic frontal sinusitis”.

Materials and Methods

This prospective study was undertaken in 50 adult patients who were suffering from chronic frontal sinusitis over a period of 2 years (July 2009 to June 2011). These patients were hospitalized in our hospital. Patients below the age of

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AN – agger nasi, K1 – Type 1 frontal recess cell, K3 – Type 3 cell ,

Fig. 1 CT scan at frontal recess area showing agger nasi cell (AN), type 1 frontal recess cell (K1), type 3 frontal recess cell (K3)

18 years, those having history of previous sinonasal surgery or nasal trauma were excluded from the study. The diagnosis was established by detailed clinical history, nasal endoscopy and pre-operative CT scan findings. (Figs. 1, 2).

All the pre-operative CT scans were done on a 64 slice, high resolution CT machine. 1 mm thin axial scans were taken for each patient, reformed images of 2 mm coronal and few sagittal cuts were finally obtained as CT scan films. Anatomical details of frontal recess of each side of all the patients were recorded. The structures that block the frontal sinus drainage pathway such as agger nasi cells, superior attachment of uncinate process, the presence or absence of various types of frontal recess cells, supraorbital ethmoidal cells (SOEC) and midline frontal cells were subjects of our study.

All the patients were operated under general anesthesia. Image guided system was used intraoperatively to improve the accuracy of the findings. Standard Messerklinger's technique of anterior to posterior dissection was done. As a first step uncinctomy was done. Infundibulotomy and middle meatal antrostomy were done if required. A careful dissection of frontal recess was done keeping the bulla intact if possible. All the variations of anatomy of frontal recess were noted while approaching the frontal sinus opening. 70° endoscope was routinely used. 90° endoscope

was used in all the cases of difficult anatomy. Microdebrider with rad 40 and 60 blades were used. Often special instruments for frontal sinus operation were used as and when required. All the features in pre-op CT findings of frontal recess anatomy were confirmed endoscopically on both sides of nasal cavity of each patient. In case of any dispute in findings, an endoscopic intra-op finding was recorded as 'FINAL' entity. A final chart of variations of frontal recess anatomy was prepared for each patient and analyzed subsequently.

Results

The age range of the patients included in this study was 18–72 years with the mean age as 32.8 years. Most of the patients ($n = 17$) were in the age group of 16–25 years. The male to female ratio was 4:3 (29 and 21).

Headache and nose block were the common complaints in these patients. Other complaints included are frequent cold attacks, post nasal drip, sneezing, ear discharge, cough and cheek pain (Fig. 3). 32 patients were diagnosed as having DNS + Ch sinusitis, 11 as chronic sinusitis, 5 patients as DNS + bilateral sinonasal polyposis and 2 cases as fungal sinusitis. (Fig. 4).

K4 – Type 4 cell , SOEC – Supra orbital ethmoidal cell, Mid line frontal cell

Fig. 2 CT scan showing type 4 cell (K4), supraorbital ethmoidal cell (SOEC), midline frontal cell

Fig. 3 Chief complaints in the study group

Fig. 4 Diagnosis in the study group

Agger nasi cell was found in 94 % of cases (right—12 %, left—4 %, bilateral—78 %) (Fig. 5). The superior attachment of uncinata to lamina papyracea was found in 82 % of the cases, to middle turbinate it was 4 % and to the skull base it was 14 %.

Type 1 frontal recess cell was found in 44 % of the cases (on right side—20 % of the cases, left side—18 % and bilateral in 6 % of the cases). Type 2 frontal recess cells were found in 8 % of cases (right—2 %, left—2 %, bilateral—4 %). Type 3 frontal recess cells were found in 48 % of cases (right—18 %, left—16 %, bilateral—14 %). Type 4 frontal recess cell was found in 2 % of cases (right—2 %). SOEC were found in 26 % of the cases (right—2 %, left—8 %, bilateral—16 %). Big midline frontal cell was found in 1 patient (right side—2 %) (Fig. 6).

Discussion

The surgical treatment of frontal sinus disease is one of the most challenging aspects of otolaryngologists work. It is not surprising that the anatomy of this region has generated a lot of interest for a long time. As early as in 1905 Turner [6] stated that “the existence in many instances of incomplete bony septa and partitions within the interior of

Fig. 5 Incidence of agger nasi cell in patients with Ch frontal sinusitis

Fig. 6 Showing incidence of frontal recess cells in 50 patients with frontal sinusitis

the frontal sinus gives rise to one or more diverticula or recess” and claimed that failures in operation have been caused by non recognition of such recess. Schaeffer [7] coined the term “frontal cell” to describe the accessory frontal sinus cells. Kasper [8], Van Alyea [9] (1936 and 1941) had also contributed significantly in description of anatomy of this area.

There is a renewed interest in anatomy of this area in recent years as it became evident that frontal recess is the “Key” area in endoscopic surgical treatment of frontal sinus disease. Bent et al. [10] in 1993 standardized the definition of different types of frontal recess cells, which was later on modified by Wormald and Chan [11] in 2003. In our study we have followed this modified version of frontal cell classification for recording our findings.

According to Wormold [12], agger nasi cells are the key to understanding the anatomy of frontal recess. In this study, the prevalence of agger nasi cells was 94 %. In the literature distribution of agger nasi cells are between 78 and 98.5 % of the patients. According to Landsberg and Friedman [13] agger nasi cells were found in 78 % of scans. Bolger et al. [14] has found the prevalence in 98.5 % of their cases. Other studies [1, 9, 15] have coated figures which lie between these two extremes. Our study confirms

that agger nasi cells are almost universal in frontal recess area (94 %). Contrary to popular belief, in our experience a big agger nasi cell makes life easier for the surgeon while trying to open frontal sinus ostia pathway.

Accurate study of upper attachment of uncinate process has received lot of attention in the literature regarding a key point in opening frontal sinus ostium. According to Lessa et al. [16], the frontal sinus ostium may most of times be exposed after removing the uncinate process upper portion. In our study the superior attachment of the uncinate process to lamina papyraceae was 82 %, to middle turbinate was 4 % and to the skull base was 14 %. According to Landsberg and Friedman [13], the uncinate process main superior attachment onto the surrounding structures was found to have the following distribution; 52 % to the lamina papyraceae, 18.5 % to posteromedial wall of agger nasi cell, 17.5 % to the lamina papyraceae and the junction of the middle turbinate with the cribriform plate, 3.6 % to ethmoid roof and 1.4 % to the middle turbinate. In a study in Taiwanese population, Liu et al. [17] had found that single insertion of the uncinate process onto the lamina papyraceae was the most common type (70.4 %) as in our study. They also concluded that “the distribution of the uncinate process insertion types with respect to ethnicity was statistically significant ($p < 0.01$).

Delgaudio et al. [18] has found that type 1 frontal recess cells were most common, found in 15.6 % of cases overall and type 2 cells were found in 1.4 % of cases, type 3 in 6.2 % of cases and type 4 in 2.4 % of cases. In our study prevalence of type 1 frontal recess cell was 44 %, type 2—8 %, type 3—48 % and type 4—2 % of cases, as compared to Lee et al. [15] (37, 19, 8, and 0 %). In the study of Thomas and Pallanch [19] prevalence of Khun type 1 cells were 28 %, type 2 cells 6 %, type 3 cells 11 %. The prevalence of type 3 cell is quite high in our study as compared to the literature. Over all in our study out of 50 cases, 37 patients had frontal recess cells (74 %). According to Delgaudio et al. [18] overall incidence of frontal recess cells in their study was 33 %. Likewise Meyer et al. [3] found that incidence of frontal recess in their study was 20.4 %. Incidence of frontal recess cells is much higher in our study as compared to the literature. As all our cases had frontal sinusitis, it may be concluded that high incidences of frontal recess cells are probably a contributing factor in genesis of frontal sinusitis. Meyer et al. [3] has noted in their study that the prevalence of frontal mucosal thickening was increased in individuals with type 3 and type 4 cells compared with individuals without frontal cells (38.5 and 69 vs. 17.1 %, $p = 0.04$ and $p < 0.07$).

In this study the prevalence of SOEC were 26 % as compared to that of 15 % in Owen and Khun's [1] study, 62 % in Lee et al. [4] study and Van Alyea's [9] 6 %. Hence the prevalence of SOEC in our study falls within the range of the literature. Midline frontal cell was found in

10 % of the patients in our study as compared to 14 % in Lee et al's [4] study, and 11 % in Thomas and Pallanch's [19] study.

Even after widespread application of functional endoscopic sinus surgery principles, the management of chronic frontal sinusitis still remains one of the most difficult surgical challenges. As more and more endoscopic surgeons are attempting to clear the frontal recess and frontal sinus disease, a study like ours in Indian population will be of great help for future surgeons. A comparative study including greater number of patients with and without frontal sinusitis will be of great help to suggest the role of frontal recess anatomical variations in genesis of frontal sinusitis. In the end we will like to caution that frontal recess surgery is not meant for ‘neophytes’.

Key Messages

1. “Frontal recess” or outflow tract of the frontal sinus is the key area in pathogenesis in inflammatory diseases of frontal sinus.
2. A detailed study of frontal recess anatomy in thin coronal and sagittal ‘cuts’ in the CT scans is important for the surgeon undertaking frontal recess work.
3. Our study shows that agger nasi cells are almost universal in finding. The most common superior attachment of uncinate process is to the lamina papyraceae.
4. There is a high prevalence of frontal recess cells in patients suffering from frontal sinus disease.
5. Endoscopic sinus surgery of frontal recess area should be undertaken by experienced surgeons only.
6. K 3 cell is more common in Indian population having frontal sinusitis. The surgeon should identify this before proceeding to frontal recess as K3 cell is a challenge in frontal recess surgery.

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