Factors Affecting the Outcome of Frontal Sinus Surgery: A Prospective Study

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Abstract Chronic frontal sinus disease has always been a difficult problem to treat. We undertook this study to evaluate our results of frontal recess surgery, to determine the factors which affected the surgical outcome and to determine whether the post-operative findings correlated with the symptomatic improvement in the patients. Twenty-four patients with chronic sinus pathologies involving the frontal sinus were included in this study. After failure of maximal medical treatment, they were subjected to endoscopic surgery. The factors assessed included the pneumatisation of the frontal recess on CT scan, the technique of surgery, the intra-operative frontal glow, the state of the frontal recess at the end of surgery, the appearance of the recess on follow-up endoscopy and the symptomatic relief in the patients. 81.2% of well pneumatised frontal recesses had a good outcome while only 42.1% of the poorly pneumatised frontal recesses had a good outcome. 76.2% of cases with a frontal glow seen intra-operatively had a favourable surgical result while 44.4% of cases without a frontal glow intra-operatively had a favourable surgical result. Two-thirds (66.7%) of cases with mucosa-lined frontal recess did well post-operatively while only 33.3% of cases with a raw frontal recess did well following surgery. Well pneumatised frontal recesses, presence of an intra-operative frontal glow and a mucosa-lined frontal recess corresponded with better post-surgical outcomes. A difference in the intra-operative technique did

not influence the result after surgery. Nineteen out of 24 patients (79.2%) were asymptomatic after surgery while 5 patients had residual symptoms.

Keywords Endoscopic frontal sinus surgery · Prognostic factors · Pneumatisation of frontal recess · Mucosa-sparing surgery · Frontal glow

Introduction

Functional endoscopic sinus surgery (FESS) has been accepted as the procedure of choice for the surgical management of chronic sinus pathologies [1–5]. The endoscope has afforded direct visualization of critical landmarks and greater ease of access to remove disease from areas most commonly responsible for obstruction of the frontal recess. The endoscopic technique offers a means of achieving adequate drainage and ventilation of the frontal sinus whilst avoiding the morbidity and cosmetic deformity of more radical external and obliterative procedures.

The ideal technique to restore frontal sinus drainage is to carry out a careful and meticulous dissection from below using the appropriate instrumentation and causing the minimum amount of damage to the mucosa of the frontal recess. The surgical approach should be the one most likely to eradicate the particular disease process in the least invasive manner. The extent of surgery performed is based on the tenet, “Do as little as possible, but as much as necessary.”

However, Kennedy noted that the patients undergoing endoscopic sinus surgery required more follow-up care than patients undergoing obliterative procedures [6]. In the early postoperative period the neo-ostium requires meticulous cleaning and debridement under direct endoscopic visualization [6]. According to Kennedy, “failure to do so

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results in localized mucosal thickening and inflammation, placing the patient at increased risk for re-stenosis” [6].

In our study, we have attempted to identify the factors that are responsible for the outcome of frontal recess surgery. Knowledge of these factors will help the endoscopic sinus surgeon to achieve successful results in frontal recess surgery. It will also help to predict the prognosis of any frontal sinus surgery.

Aims

This study aimed to answer a number of questions concerning frontal recess surgery. Firstly, what was our success rate in frontal recess surgery? Secondly, what were the factors which affected the final surgical outcome? Thirdly, did the post-operative findings correlate with the improvement in the symptoms of the patients? Fourthly, what were the most common complications of these surgeries?

Materials and Methods

This was a prospective study carried out in our department over a period of one and a half years. Out of the 24 patients included in the study, 15 patients had disease involving both the frontal sinuses while the remaining 9 patients had disease involving only one frontal sinus. Hence, the further observations, comparisons and results in this study would be mentioned with reference to 39 frontal recesses, which were operated upon. After a detailed, informed consent, all patients underwent a FESS. During surgery, the frontal recess was operated either by an intact bulla technique or after clearance of all the other sinuses and base skull, depending upon individual anatomy.

The factors assessed included the degree of pneumatization of the frontal recess as was seen on the CT scan, the technique of surgery, whether an intra-operative frontal glow was seen or not, the state of the frontal recess at end of surgery, i.e., whether it was lined by mucosa or it had raw areas, the appearance of the frontal recess as seen on follow-up nasal endoscopy and the relief of symptoms in the patients post-operatively.

Amongst the 39 frontal recesses, 2 sides had a muco-coele, 14 sides had sinusitis, 12 sides had polyposis, 7 sides had allergic fungal sinusitis and 4 sides had frontal headaches due to obstruction of the recess by frontal cells. A high resolution CT scan of the paranasal sinuses (with or without contrast) was performed in all patients. Based on the CT scan, the frontal recesses were classified as well pneumatized (with type I/II/III/IV frontal cells), not well

pneumatized (with only an agger cell) or polypoidal (with polyps in the frontal recesses) (see Fig. 1a, b, c).

All patients were followed up post-operatively by performing a nasal endoscopy. The appearance of the frontal recess was classified as healthy (if the recesses had normal or oedematous mucosa) (see Fig. 2a) or unhealthy (if the recesses had polyps or were not visualized due to middle meatus adhesions or fibrosis of the frontal recess area) (see Fig. 2b). These patients who had adhesions in the middle meatus or fibrosis of the frontal recess area were then evaluated on symptomatic basis.

Observations and Results

The CT scans of all the patients were studied with respect to the pneumatization of the frontal recess. The findings of these are mentioned in Table 1.

The presence of a frontal glow at the end of the surgery (see Fig. 3) was looked for and documented in each case. A frontal glow was seen in 21 cases (see Table 2).

Depending upon individual anatomy, the frontal recess was operated by either the intact bulla technique or after clearing the ethmoid sinuses (see Table 3).

The state of the frontal recess was assessed at the end of each surgery. The results for the same are given in Table 4.

The post-operative nasal endoscopy findings of the patients are mentioned in Table 5.

On comparing the CT scan finding with the post-operative result, it is seen that in cases with a poorly pneumatized frontal recess, only 42.1% were healthy post-operatively; whereas, in cases with well pneumatized frontal recesses, 81.2% were healthy post-operatively (see Fig. 4).

When we correlated the intra-operative frontal glow with the post-operative result, we found that when the frontal glow was present during surgery, 76.2% of the cases had a favourable post-operative result. However, it is also interesting to note that out of the cases where we could not document a frontal glow during surgery, 44.4% of the cases had a favourable post-operative result (see Fig. 5).

Depending of the intra-operative technique, when we compared the results between the intact bulla technique group and the post-ethmoidectomy technique group, we found the results of surgery comparable to each other (see Fig. 6).

With an increased knowledge about the physiology of the nose, the importance of mucosa-sparing surgery has been realised over the years. We made an attempt to preserve the mucosa of the frontal recess in all the cases. On comparing the post-operative result between the groups where the frontal recess was lined by mucosa to the group where there were raw areas in the frontal recess, we found

Fig. 1 **a** CT scan showing well pneumatized frontal recess.
b CT scan showing poorly pneumatized frontal recess.
c CT scan showing polypoidal frontal recess

that 66.7% of the recesses were healthy in the mucosa-lined group, while only 33.3% of the recesses were healthy in the group with raw areas (see Fig. 7).

On correlating post-operative symptoms in the patients with the condition of the frontal recess, we found that out of the 24 healthy frontal recesses, 17% continued to cause symptoms. Contrarily, of the 15 unhealthy recesses, 7 (46.7%) did not cause any clinical symptoms (see Fig. 8).

We evaluated the patients post-operatively based on their clinical symptoms. Out of the 24 patients included in this study, 19 patients (79.2%) were asymptomatic, 4 patients (16.7%) had frontal headaches while 1 patient (4.2%) had recurrent nasal discharge. Amongst these 5

patients, 3 of them had a lateralised middle turbinate which caused headaches, 1 of them had a psychogenic cause for the headache while 1 patient had recurrence of polyps causing nasal discharge. However, the symptoms of these 5 patients were managed medically and none of them required revision surgery.

Discussion

On review of the available literature on frontal sinus surgery, we did not find any study in the literature which

Fig. 2 **a** Nasal endoscopy showing healthy frontal recess. **b** Nasal endoscopy showing unhealthy frontal recess

Table 1 CT scan findings

CT finding	Number of frontal recesses
Poorly pneumatised	19
Well pneumatised	16
Frontal recess polyps	4

Table 2 Intra-operative frontal glow

Intra-operative frontal glow	Number of frontal recesses
Present	21
Absent	18

Fig. 3 Intra-operative frontal glow (marked by *black arrows*)

Table 3 Operative technique

Operative technique	Number of frontal recesses
Intact bulla technique	11
Post-ethmoidectomy technique	28

Table 4 Intra-operative frontal recess finding

Status of frontal recess (at end of surgery)	Number of frontal recesses
Raw area	6
Mucosa-lined	33

combined multiple factors to assess the prognosis of frontal sinus surgery.

In our study, we tried to determine whether we could prognosticate the results of frontal sinus surgery based on certain parameters. These included the pneumatisation of the frontal recess as seen on CT scan, the presence or absence of the frontal glow during surgery and the state of the frontal recess at the end of surgery. We also analysed our results in terms of the state of the frontal recess post-operatively and based on the symptoms of the patients post-operatively.

Table 5 Post-operative frontal recess finding

State of frontal recess (post-operative)	Number of frontal recesses
Healthy	24
Unhealthy	7
Not visualised: due to middle meatus adhesion	6
Not visualised: due to fibrosis of frontal recess	2

Fig. 4 Comparison of CT scan finding with post-operative result

Fig. 7 Comparison of state of frontal recess (at the end of surgery) with post-operative result

Fig. 5 Comparison of intra-operative frontal glow with post-operative result

Fig. 8 Comparison of post-operative healing of frontal recess with relief in symptoms

Fig. 6 Comparison of intra-operative technique with post-operative result

The frontal recesses which were well pneumatised tended to heal well post-operatively. This can be logically explained by the fact that more the number of frontal cells, wider are the boundaries of the frontal recess itself. However, it is imperative that each and every cell be identified on the CT scan and then be meticulously removed in order to get an ideal result. Frontal recess polyps also tend to widen the frontal recess area. Intra-operatively these frontal recesses appear widely patent; but, the prognosis on long-

term follow-up is guarded due to the recurrent nature of the disease.

A frontal glow is the lighting up of the frontal sinus as seen externally on the forehead, when the endoscope is placed at the opening of the frontal sinus (see Fig. 3). Presence of the glow suggests that all the frontal recess cells have been cleared and the frontal sinus mucosa is relatively healthy. This was a fairly reliable parameter to predict outcome. More than 75% of the patients who had a positive frontal glow intra-operatively, finally showed healthy frontal recesses on long-term follow-up. In contrast, only 45% of patients in whom the frontal glow was absent intra-operatively had healthy frontal recesses in the long term. If the glow is absent intra-operatively, every attempt must be made to identify and dissect out any frontal cells that may have been inadvertently missed. All the same, the absence of a frontal glow at the end of surgery does not always necessarily indicate a poor surgical technique. The glow may be absent due to other factors such as oedematous mucosa within the sinus, a thick bony anterior wall and dark skinned individuals.

One of the most important factors which can impact the prognosis of frontal sinus surgery is how the frontal recess

area looks at the end of the surgery. At the end of every surgery, the surgeon must assess the appearance of the frontal recess; whether it appears to be wide and mucosal-lined or is it denuded of mucosa exposing raw area or bare bone? This series showed that 66% of frontal recesses which had a mucosal lining healed well post-operatively. The 34% of cases who did not do well in spite of a good mucosal lining were mainly patients of polyposis. In contrast, only 33% of raw, denuded frontal recesses showed good healing post-operatively.

A difference in the surgical technique, i.e., whether the frontal sinus was accessed by the intact bulla technique or after all the other sinuses had been operated, did not show any significant difference in the final outcome of surgery.

The only complication in this series was an accidental damage to the lamina papyracea on one side which took place in the intact bulla technique, due to the limited space available for manoeuvring the instrument. The orbital periosteum was however intact. There was no incidence of anterior ethmoidal artery bleeding or CSF leak in this series.

We had taken pre-operative and post-operative CT scans in our patients. In pathologies like mucocoele, the post-

operative CT scan outcome was excellent (see Fig. 9) as compared with the pre-operative CT scan. However, in pathologies like allergic fungal sinusitis with panpolyposis, the post-operative CT scan could often show some amount of mucosal thickening and soft tissue haziness (see Fig. 10). However, the post-operative CT scan findings and the clinical symptoms did not necessarily correlate. The decision to re-operate depended primarily upon the severity and frequency of the patient's symptoms along with the post-operative nasal endoscopy and CT scan findings.

In cases where the outcome of the surgery is a healthy frontal recess, more than 80% of them correlate with a symptomatic improvement of the patients. However, what is important to understand is that even in cases where the outcome of surgery is an unhealthy frontal recess; almost 50% of the recesses are symptom-free. Hence, the decision to re-operate must not be based on endoscopic findings alone.

Key Message

Highly pneumatised frontal recesses tend to show better post-operative healing and a positive surgical outcome.

Fig. 9 Pre-operative and post-operative CT scan (mucocoele)

Fig. 10 Pre-operative and post-operative CT scan (allergic fungal sinusitis with panpolyposis)

The presence of an intra-operative frontal glow corresponds with a better post-operative outcome. However, an absent frontal glow does not always mean a poor outcome.

The most important prognostic parameter in determining the final result is the condition of the frontal recess at the end of the surgery. Mucosa-lined frontal recesses have a significantly better prognosis than raw, denuded frontal recesses.

Both the intact bulla technique and the post-ethmoidectomy technique have their own advantages and disadvantages. Final surgical outcome, however, does not depend on the technique used.

CT scan and nasal endoscopy findings need not always co-relate with the clinical symptoms of the patient. A decision to re-operate on the patient should be taken by assessing these findings together.

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