The role of local rotational flaps in minimizing sphenoidal and maxillary sinuses ostium stenosis

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Abstract
Introduction: There are several reasons for endoscopic surgery failure; some of the major causes are adhesion formation and ostial stenosis. The commonest anatomic finding in revision endoscopic surgery is an obstructed or stenosed ostium. Adhesion and stenosis after surgery are usually due to scar tissue or granulation formation during the tissue recovery process. The patency and the size of the sinus ostium and limiting cicatricial fibrosis are two significant factors in the evaluation of a successful endoscopic sinus surgery. To limit the spontaneous closure rate; several methods were used to prevent re-stenosis of the sinuses ostium such as the application of mitomycin C which inhibits fibroblast formation after surgery, or placement of a stent or balloon catheter dilatation at the middle meatus.

Objectives: The aim of this study is to evaluate the effect of local rotational flap insertion in maxillary and sphenoid sinus ostia in minimizing postoperative ostium stenosis.

Study design: A prospective study is done on 160 patients diagnosed as having chronic maxillary and/or sphenoid sinuses patients who are divided into two equal groups, a study and a control group. All patients in the study group will undergo rotational flap coverage of the ostia and the control group arm will undergo middle meatal antrostomy and sphenoid ostium enlargement without flaps.

Results: Significant reduction in re-stenosis rate after 9 months of follow up.

Conclusion: Middle meatal antrostomy and sphenoidotomy by this technique have a higher patency rate than the standard techniques after 9 months of surgery.

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1. Introduction

Endoscopic sinus surgery for the treatment of acute and chronic sinusitis was well established by the first third of this century. It was based on commendable anatomical studies of Zuckerkandl, Onodi and Grünwald. Transnasal endoscopic sinus surgery was introduced in the mid 1980s, the term (FESS) was set by Kennedy. The concept of FESS is the
removal of tissues obstructing the osteomeatal complex (OMC) or sphenoid sinus ostium and the facilitation of drainage while conserving the normal non-obstructing anatomy and mucous membrane. The rigid fiber optic nasal telescope provides an intra-operative visualization of the sinuses ostia, allowing the surgery to be focused precisely on the key areas.4

Middle meatus antrostomy is used to treat diseased maxillary sinus mucosa. The diameter of the natural ostium varies from 2 to 7 mm.1 If the natural ostium is judged to be inadequate for ventilation, it can be enlarged. Experiments have suggested that maxillary ostium must be at least 5 mm in diameter in order to allow for adequate gas exchange.5

There are several reasons for endoscopic surgery failure such as abnormality of mucociliary transport, persistent disease and osteomeatal complex obstruction. The last one is of major importance and can be a result of adhesion formation and ostial stenosis.6

A study showed that the commonest anatomic finding in revision endoscopic surgery was an obstructed osteomeatal complex and specifically a stenosed middle meatal antrostomy in 39% of cases stating that the degree of antrostomy patency is directly related to the patient symptoms.7 The reported rates of stenosis of enlarged maxillary sinus ostia are quite low, despite initial concerns over long-term patency. In 1987, Kennedy et al.8 reported a 98% patency rate in a 4- to 32-month follow-up of middle meatal antrostomies. Kame9 reported a patency rate of 96.8%. Krouse and Christmas10 compared the results of conventional endoscopic sinus surgery and powered instrumentation and found pressure rates of 97% and 99%, respectively. However, a 4.4–15% spontaneous closure rate for middle meatal antrostomy has been reported in the literature.11

Moreover, persistent sphenoid sinus disease may result from stenosis from inadequate postoperative debridement or cicatricial scarring of the ostium.12 Also, intensely inflammatory lesions, which cause severe sclerotic sphenoid sinuses usually require a drill to perform the sphenoidotomy leaving circumferentially exposed bony edges.13 This circumferential mucosal stripping around the ostium can further predispose to scarring and re-stenosis.12,14

Adhesion and stenosis after surgery are usually due to excessive scar tissue formation during the tissue recovery process.15 Several methods were tried to minimize re-stenosis of the sinus ostia such as the application of mitomycin C which inhibits fibroblast formation after surgery,16 or placement of a stent or balloon catheter dilatation at the middle meatus.17 Yet on experimental animal model, the placement of a stent at surgically enlarged maxillary sinus ostium increased the risk of stenosis.18

The aim of this study is to evaluate the role of local rotational tissue flaps in minimizing contracture of the maxillary and sphenoid ostia.

2. Materials and methods

This prospective study was conducted at the Misr University for Science and Technology and the Ain-Shams University hospitals from April 2010 to December 2012 following Institutional Review Board approval. According to the principles of the Helsinki declaration, the nature of the procedure was explained to the patients and informed consents were obtained before the operations.

This study included 160 adult patients diagnosed as chronic maxillary or sphenoid sinusitis presented to the Misr University for Science and Technology (MUST) and the Ain-Shams University hospitals out-patient clinics. Their ages ranged from 18 to 56 years (mean 26.4) with no sex preference. Inclusion criteria included all patients with chronic maxillary and/or sphenoidal rhinosinusitis proven by endoscopic and radiological studies and who did not respond to medical treatment (Broad spectrum systemic Antibiotics for 6 weeks, Topical corticosteroids, alkaine nasal sprays and local decongestants) and were scheduled for functional endoscopic sinus surgery. Exclusion criteria included pediatric cases, patients with allergic nasal polyps, neoplasms, granulomas, recurrent cases or syndromes such as cystic fibrosis.

All patients were subjected to history taking, clinical examination using a 2.7 mm sino scopic examination of the nose after application of local anestheisa and decongestants, CT scans paranasal sinuses coronal cuts 2 mm thickness and an informed consent.

Patients were divided randomly into 2 groups: group A (control group), included 80 patients who were subjected to standard FESS with opening of the diseased maxillary and/or sphenoid sinuses. Group B (study group) included 80 patients who were subjected to the same procedure together with the use of local rotational tissue flaps to cover osteal denuded bone of maxillary & sphenoid sinuses (see Fig. 1 and 2).

2.1. Surgical technique for group B

2.1.1. Maxillary sinus

After removal of the uncinate process and opening the middle meatus, evacuation of any sinus content or polypoidal mucosa, a local L shaped rotational flap from inferior turbinate was elevated and rotated to cover the whole postero-inferior border of the maxillary antrostomy. A large piece of sponge gel is tucked into the antrostomy to keep the flap in place.

2.1.2. Sphenoid sinus

A trans-nasal sphenoidotomy approach was adopted to expose sphenoid ostium after lateralization of middle turbinate. Two longitudinal incisions immediately medial and lateral to sphenoid ostium were made together with a transverse incision joining them (H shaped) and two rotational flaps were elevated (superiorly & inferiorly based on sphnoid rostrum,) bony edges

Figure 1 Shows a posterior, inferiorly based rotational flap from inferior turbinate mucosa elevated to cover posterior edge of maxillary sinus ostium.
of sphenoid ostium were circumferentially removed and flaps were rotated inwards and tucked into sinus cavity and kept in-place by a large sponge gel pledge.

3. Post-operative evaluation and follow up

All patients were followed up by office endoscopy every 3 days for the first 2 weeks for cleaning the nose and removal of crustations. All patients underwent endoscopic assessment at 2 weeks, 1 month, and 2 months after the operation at the outpatient clinic to observe the condition of sinus ostia until complete healing. All patients had regular follow-up visits at 3, 6 and 9 months post operative. The nose was locally anaesthetized and examined by rigid nasal endoscopes (0 and 30 degrees) to assess the patency and size of the maxillary or sphenoid sinus ostia. Measurements at 9 months were done for all patients in both group A and B. For sphenoid sinus, different suction tips were used with different sizes (4, 6, 8 mm width.) while for the maxillary sinus a millimeter graded meter was used (Figs. 3 and 4).

According to the size of maxillary and sphenoid sinus ostium postoperatively at 9 months both groups were subdivided into 3 subgroups each ostium is measured separately with reference to the standards as follows:

(I) Complete obstruction and fibrosis of the ostium.
(II) More the 50% reduction in ostium size.
(III) Less than 50% reduction of ostium size.

4. Results

The current study included 160 patients, 102 males (63.75%) and 58 females (36.25), their ages ranged from 18 to 56 (mean 26.4).

Of 80 patients in group A (constituting 160 maxillary and 160 sphenoid sinus) 131 maxillary sinus and 92 sphenoid sinus had sinus disease, while in group B, (constituting 122 maxillary sinus and 98 sphenoid sinus had sinus disease). In group A 13 patients were lost for follow-up compromising 20 affected maxillary and 15 affected sphenoid sinuses. In group B 16 patients were lost for follow-up compromising 22 affected maxillary and 16 affected sphenoid sinus and these procedures were excluded from the results.

Follow up of sinus ostia after 9 months showed that more than 50% of patients in group A had the sinus ostium wide more than half of its size interoperative (Table 1), while in group B more than 90% of patients had the sinus ostium wide more than half of its size interoperative (Table 2). When comparing the two groups, the results were highly statistically significant (Tables 3 and 4) (Figs. 5 and 6).

Table 1 Summarizes the follow up results of group (A) after 9 months.

<table>
<thead>
<tr>
<th>Group A</th>
<th>Maxillary</th>
<th>Sphenoid</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>8 (7.2%)</td>
<td>4 (5.19%)</td>
</tr>
<tr>
<td>II</td>
<td>47 (42.3%)</td>
<td>24 (31.1%)</td>
</tr>
<tr>
<td>III</td>
<td>56 (50.4%)</td>
<td>49 (63.6%)</td>
</tr>
</tbody>
</table>

Table 2 Summarizes the follow up results of group (B) after 9 months.

<table>
<thead>
<tr>
<th>Group B</th>
<th>Maxillary</th>
<th>Sphenoid</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>II</td>
<td>6 (6%)</td>
<td>3 (3.7%)</td>
</tr>
<tr>
<td>III</td>
<td>94 (94%)</td>
<td>79 (96.3%)</td>
</tr>
</tbody>
</table>
5. Discussion

It is widely accepted that the concept of FESS is the removal of tissues obstructing the Paranasal sinus Ostia regions such as middle meatus or sphenoid sinus ostium and the facilitation of drainage while conserving the normal non-obstructing anatomy and mucous membrane. The majority of maxillary and sphenoid sinusitis originates as a result of meatal inflammation or compromise due to infection, edema or anatomical causes. The importance of re-establishing ventilation and drainage in the therapy of maxillary and sphenoid sinusitis is well accepted.

Mucy and Kountakis reported that, the commonest anatomic finding in revision endoscopic surgery was an obstructed osteomeatal complex and specifically a stenosed middle meatal antrostomy in up to 39% of cases. Moreover, it is suggested that the degree of antrostomy patency is directly related with the patient symptoms.

On the contrary, Lavelle and Harrison reported a 94% patency rate in 150 patients over a 20-year-period. Also, Kennedy et al. reported 98% patency in 98 procedures with follow-up between 4 and 32 months while another study reported 96.8% patency in 94 procedures with average follow-up period of 7.5 months.

Several methods are used now to prevent ostium re-stenosis but neither of them is widely practiced. Local application of mitomycin-C for few minutes was tried, but the long term results regarding prevention of re-stenosis were not satisfactory. Others used a stent or catheter with balloon at the surgically enlarged maxillary sinus ostium. Yet, an animal model proved that this can increase the risk of stenosis.

The aim of our study was to utilize a new method to prevent re-closure of sinus ostia or at least to guarantee minimal degree of patency of the ostia if fibrosis is inevitable after endoscopic surgery, by applying local rotational flaps to cover the exposed bony edges of maxillary and sphenoid ostea after their enlargement using the standard techniques in order to decrease fibrosis and re-stenosis, and to examine the long-term patency of maxillary and sphenoid ostia (9 months post-operatively) when using these local rotational tissue flaps.

Our results showed patency of the studied maxillary Ostia as follows: 94% widely patent, 6% patent, 0% blocked in comparison to 50.4%, 42.3% and 7.3% respectively in the control arm group. Regarding Sphenoid sinus ostia, the results were 96.3% widely patent, 3.7% patent and 0% totally obliterated in comparison to 63.6%, 31.1% and 5.3% respectively. These results demonstrate the significance of using the readily available adjacent nasal mucosa as rotational tissue flaps in order to provide the surgical site with viable mucosa with its rich blood supply in such a way that it covers the exposed bone, minimizing fibrosis and essentially re-closure of the sinus ostia and hence failure of surgery and recurrence of symptoms. Performing this technique definitely will add time to the procedure (average 10–15 min) when performing bilateral maxillary and sphenoid flaps. This outweighs the need for revision surgery in cases of re-stenoses with all its economic, psychological consequences as well as increased risks of complications.
Thompson et al.\textsuperscript{20} used a mini nasoseptal flap to prevent closure of sphenoid sinus ostium in recurrent sphenoid sinusitis. Their findings demonstrate the nasoseptal flap prevented re-stenosis of sinus ostium which supports our results.

Our technique can be considered as a method to minimize and prevent post-operative ostea stenosis and closure, thus decreasing the possibility of recurrence, without any added morbidity to the patient.

6. Conclusion

We conclude from this study that middle meatal antrostomy and sphenoidotomy with the use of local rotational tissue flaps, have a higher patency rate than the standard techniques.

Conflict of interest

All authors declare that they have no conflict of interests nor did they receive any funding.

References