Surgical treatment options for maxillary sinus fungus balls

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Abstract. Surgical treatment options for maxillary sinus fungus balls. Objective: 1) To evaluate the effectiveness and side-effects of endoscopic surgical treatment for maxillary sinus fungus balls, and to describe approaches to limiting recurrence of the disease and surgical complications. 2) To compare the results of this nasal endoscopic treatment with the results of treatment using a vestibular approach to the anterior wall of the maxillary sinus as described in the literature. Patients and methods: An institutional retrospective review was conducted for patients undergoing treatment for a maxillary sinus fungus ball using endonasal surgery alone from January 2005 to December 2010. Results: A total of 100 patients were included in the study (58 women and 42 men, average age 54 years). The median follow-up time was 32 months. Three patients had a recurrence after our team performed endonasal surgery. No patients experienced complications. Conclusion: Our results are consistent with previous findings, indicating that the postoperative complication rate for endonasal surgery is low by comparison with the vestibular approach. Both techniques have similar outcomes. The nasal endoscopic route offers similar rates of success with a negligible complication rate.

Introduction

As a result of technical advances in endoscopy and medical imaging, fungal sinusitis has been clearly described as invasive, with fungal infiltration of tissues, or non-invasive. The latter includes allergic fungal rhinosinusitis, IgE-dependent rhinitis, and fungus balls.

Fungus balls are the most common form of fungal sinus infection in Europe, and the incidence of fungus balls is rising steadily. The most common fungal species that causes the disease is Aspergillus fumigatus (93% of cases). Fungus ball formation occurs through the creation of tangled mats of hyphae within a sinus cavity. The most common site is the maxillary sinus (94%), whereas fungus ball formation in the sphenoid is more rare (4 to 8%).1 It is currently estimated that 13-28.5% of maxillary sinus surgeries are for the treatment of fungal infection. Elderly patients are mainly affected, with the average patient age being 64 years. In addition, more women are affected (there is a 2:1 female to male ratio). A few cases associated with pulmonary infection have been described.2 There is currently no evidence of person-to-person spread. The only proven predisposing factor is prior maxillary dental treatment.3 Intra-sinus dental material containing zinc oxide is a favourable environment for the spores that permits fungi to grow gradually. Changes to the drainage of the sinus create an ideal milieu for bacterial growth. This explains why the fungus ball is frequently associated with recurrent bacterial rhinosinusitis, mainly sustained by Staphylococcus aureus.4

Common clinical symptoms include facial pain, followed by rhinorrhoea, nasal obstruction, or cacosmia.

Rhinoscopic examination in patients with this type of sinus mycosis is not useful between bacterial episodes of infection because it produces normal results. Examination with a rigid or flexible endoscope is still necessary. Klossek et al.5 found that 52% of pre-operative examinations are considered normal. Purulent nasal drainage and polyps may be seen in 38% and 10% of cases respectively. The computed tomography (CT) scan is the standard...
Fungus balls can only be cured with surgery and adjuvant medical treatment is not required for non-invasive fungal sinusitis. In 1893, Caldwell-Luc described the first surgical technique for treating this condition with a direct vestibular approach through the anterior wall of the maxillary sinus. The Caldwell-Luc procedure is associated with a high incidence of post-operative complaints (i.e., pain, facial numbness, localised swelling and bleeding). The endoscopic approach involving a meatotomy, which allows for sinus drainage and a regeneration of mucociliary clearance while maximising the conservation of maxillary sinus mucosa, became the favoured surgical technique in the 1980s. The Caldwell-Luc approach is not now accepted as the first-line treatment option. More recently, the preferred treatment for maxillary fungus balls has become a topic of controversy and the subject of numerous articles. The proposed methods are: endoscopic nasal surgery (the current gold standard) and puncture of the canine fossa. The puncture of the canine fossa is an endoscopic Caldwell-Luc technique in isolation or in combination with endoscopic nasal surgery. Some authors believe the isolated endoscopic nasal approach is insufficient.

We performed a retrospective study that included patients treated only with the nasal endoscopic approach between 2005 and 2010. We discuss the middle meatotomy approach, which helps to prevent the recurrence of the disease and potential complications. We compare the advantages and disadvantages of this technique with those of a canine fossa approach and a combined approach. Our conclusions are based on the results of our study as well as data from the literature.

Materials and methods

Institutional Review Board approval was obtained from Larrey University Hospital. From January 2005 to December 2010, 100 patients (58 women and 42 men) who presented with symptoms of radiological examination for this condition. Characteristic CT findings include heterogeneous opacity within a sinus (62%), associated with a hyper-attenuating zone (99% of cases) at the site of the fungus ball (Figure 1). Bony erosion is found in 4-17% of cases, which does not correlate with an invasive form of infection. On magnetic resonance imaging, sinonasal fungal balls showed iso-intensity or hypo-intensity on T1-weighted images and marked hypo-intensity on T2-weighted images (Figure 2). Laboratory evaluation generally does not contribute to the diagnosis (particularly in the absence of eosinophilia).

Figure 1
CT scan images of a fungus ball showing heterogeneous opacity in the right maxillary sinus with an area of hyper-attenuation.
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in their retrospective study, the questionnaire included three requests:
- Have you been re-operated for the same problem?
- Do you still have symptoms resembling the pre-operative symptoms?
- Do you consider yourself cured?

Results

A total of 100 patients were included in this retrospective study. The average age of the patients was 54 years (range, 20-80 years) with a majority of women (58 women, 42 men). The median follow-up time was 32 months (range, 5-72 months).

Of the 100 patients, 98 were treated with isolated middle meatotomy. The remaining two patients were treated for the failure of a previous endonasal surgery performed at a different centre. No peri-operative or postoperative complications were observed. Three patients had a recurrence following surgery. Two of these patients successfully underwent a repeat operation 2 months and 1 year after the first surgery. The third patient underwent a successful repeat operation 2 years after the first surgery at a

Figure 2
Magnetic resonance imaging (T2-weighed sequence with gadolinium) shows the typical appearance of fungus ball in the right maxillary sinus: hypo-intensity of the fungus ball and inflamed mucosal membranes appearing as hyperintense.

Figure 3
Left middle meatotomy
(A) Endoscopic view of a fungal ball in the left maxillary sinus
(B) An angled suction tube is used to remove the fungus ball through the middle meatal antrostomy.
The complete evacuation of the maxillary sinus is verified using a 0° (C) and 30° (D) endoscope.
This middle meatootomy surgical procedure is not that simple and failure to perform a proper maxillary sinus antrostomy is the frequent cause of recurrent maxillary sinusitis. This surgical error - the “missed ostium sequence” - is one source of the iatrogenic recirculation phenomenon. An unresected or partially resected uncinate process can contribute to scarring and stenosis of the middle meatal antrostomy. The resulting persistence of inflammation at the location of the maxillary ostium can impede drainage of the osteomeatal complex.

During surgery, any trephination above the inferior wall of the bullous system should be avoided. The initial exposure of the ostium, starting with a pre-uncinate incision, ensures the identification of the inferior wall of the orbit. Transgression of the medial orbital wall (lamina papyracea) places the orbit at risk. Peri-operative signs suggesting orbital injury include the transmission of movement with pressure on the globe, extrusion of orbital fat, subconjunctival haemorrhage, or exophthalmos. Extrusion of orbital fat does not generally result in adverse effects if observed by the surgeon.

The surgical complication that most commonly reflected true comorbidity was a lesion of the medial rectus muscle. This is extremely rare, however, and it was observed in only 1 out of 735 cases described in a study involving 10 endonasal surgery centres over 5 years.

In our series, which included 100 patients undergoing isolated endonasal surgery, there were no complications. These excellent results were probably the consequence of our strict adherence to the surgical rules.

Discussion

Maxillary sinus fungus balls can only be cured with surgery. Three operative approaches have been described: the endoscopic nasal approach, the vestibular approach and the combined approach. The first choice for our group was minimally invasive endoscopic nasal surgery. This choice was justified by the comparison of the operative techniques. On the basis of the results from our study, as well as data from the literature, the endoscopic nasal treatment of maxillary fungus balls appears to have a lower complication rate than the vestibular approach.

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The prevention of injury to the nasolachrymal duct requires awareness of any prior surgery or facial trauma through the careful analysis of pre-operative CT scans to evaluate for possible dehiscence of the lamina papyracea. Injury to the naso-
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lachrymal duct may result from an incision that is too anterior relative to the uncinate process. The injury may also be due to an overly anterior extension of the meatotomy with the retrograde jaw forceps. Calhoun et al.\textsuperscript{12} showed that the lachrymal sac and the nasolachrymal duct were situated between 1 and 8 mm anterior to the root of the uncinate process. The natural ostium of the maxillary sinus is located at a distance of 0.5-18 mm from the inferior orifice of the nasolachrymal duct. In this region, the lachrymal bone may be particularly small or even absent in 20\% of cases.\textsuperscript{15} The enlargement of the meatotomy must be made posteriorly. In a series of 31 patients undergoing surgery for middle meatotomy, Unlu et al.\textsuperscript{14} reported a 14.9\% occurrence of potential lesions of the nasolachrymal duct (demonstrated by the absence of contrast near the inferior meatus following the application of fluorescent dye) without clinical manifestation (absence of epiphora). Bolger et al.\textsuperscript{15} reported a 15\% occurrence of occult nasolachrymal duct lesions (7 of 46 patients) following surgeries for middle meatotomy and ethmoidectomy by comparison with 3\% reported by Saengpanich et al.\textsuperscript{16} (1 of 32 patients). In each of these series, no symptomatic sequelae were described; in particular, there was an absence of epiphora or dacryocystitis. The absence of clinical symptoms following injury to the duct was due to the formation of a supplemental drainage system in the middle meatus or spontaneous healing of the duct. The incidence of epiphora following endonasal surgery ranged from 0.1-1.7\% for Serdahl et al.\textsuperscript{17}

Peri-operative or postoperative bleeding from an injury to the sphenopalatine artery is rare and easily treated by coagulation using a nasal bipolar forceps. Bambule et al.\textsuperscript{18} reported a case of bleeding with peri-operative cauterisation of the sphenopalatine artery in 1,072 patients treated with the endoscopic approach (middle meatotomy with or without ethmoidectomy).

By comparison with the isolated endoscopic approach, the postoperative complication rate for the canine fossa approach is higher. The principal risk of this technique is injury to the infra-orbital nerve and superior alveolar nerves. In 21 patients treated with this technique, Robinson et al.\textsuperscript{19} reported that 38\% had cheek oedema, 32\% had facial pain, 30\% had numbness in a V2 distribution, 27\% had dental pain, 24\% had gingival complications, and 16\% had facial paraesthesia. The majority of complica-
tions resolved during the first postoperative month. However, 16\% of the patients had chronic symptoms, with the most frequent being facial paraesthesia or V2 numbness. Bernal-Sprekelson et al.\textsuperscript{20} found that 30\% of patients had facial anaesthesia 2 weeks after surgery, 6\% had chronic persistence of anaesthesia, and 3\% had chronic paraesthesia. Cases of dental discoloration have also been described. In addition, the vestibular approach to the maxillary sinus for a fungus ball may compromise future sinus lift, which may be a constraint for elderly patients.\textsuperscript{21}

In terms of effectiveness (i.e., absence of recurrence), the results of our study (a 97\% success rate) are similar to rates reported in the literature. Dufour et al.\textsuperscript{22} found 5 cases of recurrence in 150 patients treated with an isolated endoscopic approach. Lai et al.\textsuperscript{23} had 3 cases of recurrence in 126 patients. In a series of 135 patients treated with the endoscopic approach, Nicolai et al.\textsuperscript{24} found no cases of recurrence over a minimum follow-up of 18 months.\textsuperscript{25} Chobillon and Jankowski\textsuperscript{26} compared three series of patients with fungus balls who were treated with three surgical techniques: middle meatotomy (n = 10), meatotomy with the canine fossa approach (n = 9), and the canine fossa approach alone (n = 12). No recurrences were noted for any of the surgical approaches used. Only a single case of injury to the sphenopalatine artery was described in the group treated with the double approach. With a follow-up time of 1 year, Lee et al.\textsuperscript{27} found no difference in the recurrence rate between a group treated with the canine fossa approach (n = 11) and a group treated with middle meatotomy (n = 13). A significant difference was observed, however, in postoperative complications. In their cohort, 53\% of patients in the former group had complications, by comparison with 0\% in the latter group.

The canine fossa puncture approach is much easier to perform and takes less time than the nasal endoscopic approach. However, a small but significant number of patients will experience complications.\textsuperscript{19}

Recurrence typically occurs as a result of the persistence of fungal debris in the maxillary sinus. The principal technical challenge in the endoscopic approach is the lack of visualisation of the angle formed by the nasolachrymal duct and the anterior wall of the maxillary sinus. In difficult cases, the addition of an inferior meatotomy permits the irrigation of the base of the maxillary sinus via the
inferior meatal opening with a mounted syringe (angled suction tube) and the mobilisation of the remaining *Aspergillus* fragments. An alternative to inferior meatal antrostomy is the puncture of the canine fossa using a trochar alongside the endonasal approach (double approach) (Figure 5). It is, however, rare for this approach to be required (in the order of 3% as reported by Nicolai *et al.*23) and we prefer an isolated endoscopic nasal surgery to reduce morbidity.

The success rate for an isolated vestibular approach appears to be very satisfactory, approaching 100% according to data available in the literature. No series to date, however, has been described with more than 12 patients treated by isolated canine fossa puncture for maxillary sinus fungus balls.4 These excellent results in terms of effectiveness are, according to the data currently available in the literature, not easily compared with the results of endonasal surgery due to the small number of patients.

The opening of the ostium for treating maxillary fungus balls also has theoretical and practical justifications. Three theories are currently being debated as possible aetiological explanations for fungus balls: the theory of contaminated aeration, the theory of iatrogenic odontological contamination (colonisation of the maxillary sinus secondary to an iatrogenic oral-sinus communication), and a combination of these two theories.23 The presence of dental material in the maxillary sinus may remain asymptomatic for many years, with clinical symptoms of sinusitis appearing after bacterial superinfection facilitated by the failure of sinus drainage. The occlusion of the ostium facilitates the proliferation of anaerobic organisms and lowers pH, transforming the maxillary sinus into a medium that is highly favourable for fungi and bacteria. The theory that the failure of normal clearance of the maxillary sinus facilitates the invasion of *Aspergillus* is supported by animal studies. Dufour *et al.*26 compared two series of rabbits that were inoculated with *Aspergillus fumigatus* in the maxillary sinus: one series of 14 animals in which the ostium was previously occluded and a second series without ostial occlusion. In the first series, 12 animals developed an invasive *Aspergillus* infection, whereas only 2 developed the condition in the second series.

The practical justification is that the opening allows for the fibre-optic endoscopic examination of the middle meatus after surgery through direct visualisation, and patients can be evaluated for signs of infectious recurrence.

**Conclusion**

The goal of surgical treatment for a maxillary fungus ball is the complete evacuation of the maxillary sinus to prevent recurrence while avoiding any complications, a normal aim in the treatment of a benign pathology. The procedure that complies best with these criteria is the isolated endoscopic approach with middle meatotomy.

**References**

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