

Surgical treatment options for maxillary sinus fungus balls

A. Dupret-Bories¹, S. Vergez², G. de Bonnecaze², A. Decotte² and E. Serrano²

¹Department of Otorhinolaryngology and Head and Neck Surgery, CHU Hautepierre, Strasbourg, France; ²Department of Otorhinolaryngology and Head and Neck Surgery, CHU Larrey, Toulouse, France

Key-words. *Aspergillus*; canine fossa; endoscopic nasal surgery; fungus ball; middle meatotomy; maxillary sinus; minimally invasive; treatment outcome

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-sinusal 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

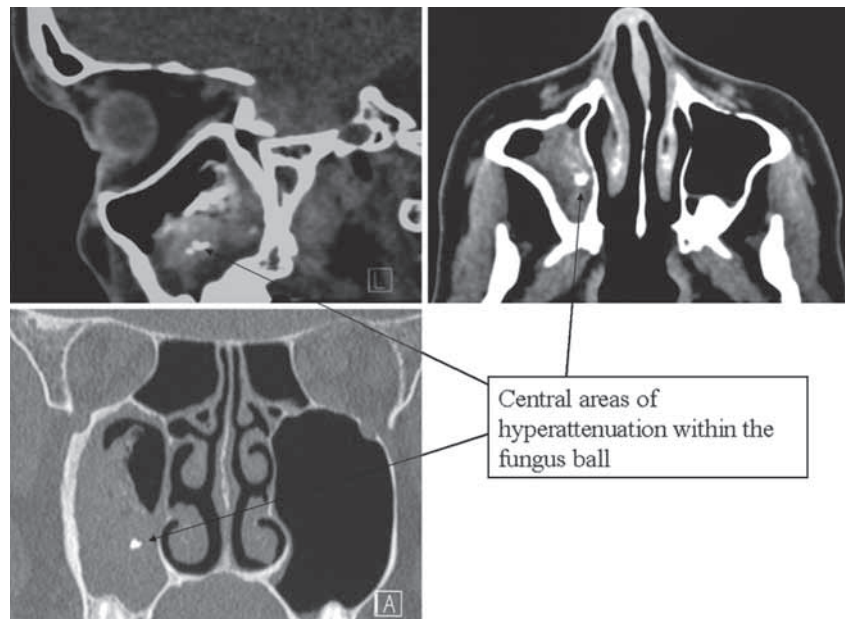


Figure 1

CT scan images of a fungus ball showing heterogeneous opacity in the right maxillary sinus with an area of hyper-attenuation.

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.⁶ 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).

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).⁷ 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.^{7,8}

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

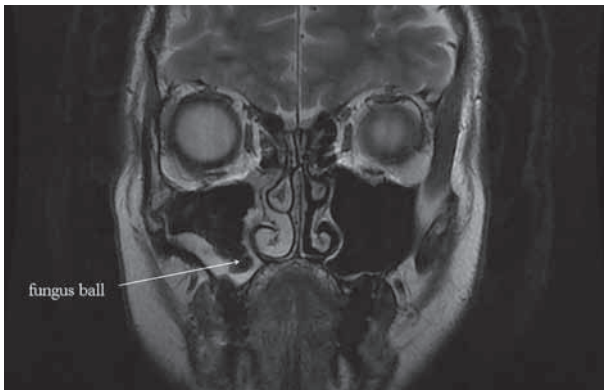


Figure 2

Magnetic resonance imaging (T2-weighted 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.

maxillary sinus fungus balls were treated using an isolated nasal endoscopic approach in our Otorhinolaryngology department. 98 patients were treated with middle meatotomy and two were treated with both middle and inferior meatotomy. All patients underwent pre-operative endoscopic evaluation and a CT scan of their sinuses. Only patients with clinically, surgically, pathologically, and microbiologically confirmed fungus balls were included in this retrospective study. Patients with associated sinonasal pathologies such as polyps were excluded from the study.

After middle meatotomy performed using an anterior to posterior approach, the sinus was irrigated several times with saline in a middle meatal antrostomy to transfer the small fungal balls to the nasal cavity from the maxillary sinus (Figure 3).

We used angled surgical equipment (forceps and suction tube) to remove the fungus ball remaining in the inferior or the lateral portions of the maxillary sinus (Figure 4).

The evacuation of the maxillary sinus was verified with a 30° and, when required, a 70° endoscope.

Postoperative care included nasal cleaning with a saline solution and intranasal corticosteroids for one month.

Clinical evaluation including endoscopic follow-up was performed between 1 to 3 months after surgery.

Clinical long-term evaluation was made by means of a telephone survey conducted by experienced interviewers. As Dufour *et al.*⁹ advocated

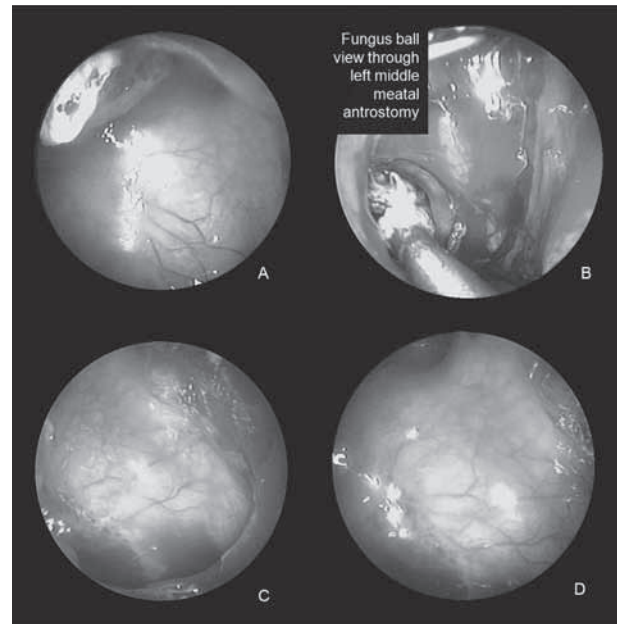


Figure 3

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.

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

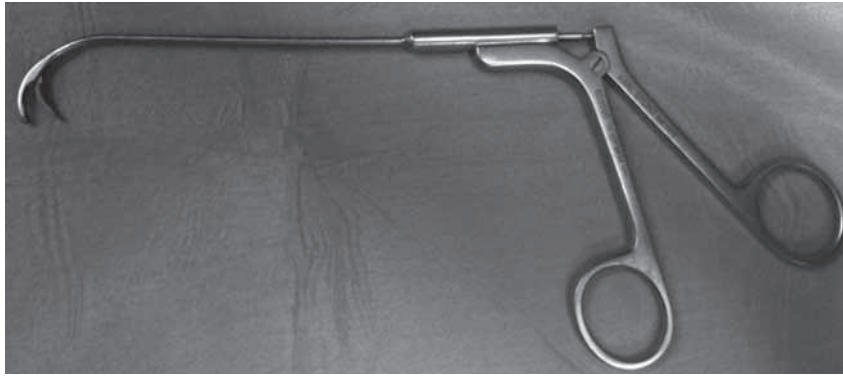


Figure 4

The angled forceps used to remove the fungus ball remaining in the inferior or the lateral portions of the maxillary sinus.

separate institution that used the vestibular approach.

Two patients received both middle and inferior meatotomies. One of these patients was being treated for the failure of a vestibular-approach surgery that was performed at a separate institution. No recurrence or complications were observed in these patients.

Three of the 100 patients had a recurrence following surgery. Four of the 97 patients without recurrence experienced persistence of nasal discharge. The clinical success rate following isolated endonasal surgery performed by our team was 97%, with no complications.

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.

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.

This middle meatotomy 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 uncinata 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.¹⁰

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.¹¹

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-

lacrimal duct may result from an incision that is too anterior relative to the uncinat process. The injury may also be due to an overly anterior extension of the meatotomy with the retrograde jaw forceps. Calhoun *et al.*¹² showed that the lacrimal sac and the nasolacrimal duct were situated between 1 and 8 mm anterior to the root of the uncinat process. The natural ostium of the maxillary sinus is located at a distance of 0.5-18 mm from the inferior orifice of the nasolacrimal duct. In this region, the lacrimal bone may be particularly small or even absent in 20% of cases.¹³ The enlargement of the meatotomy must be made posteriorly. In a series of 31 patients undergoing surgery for middle meatotomy, Unlu *et al.*¹⁴ reported a 14.9% occurrence of potential lesions of the nasolacrimal 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.*¹⁵ reported a 15% occurrence of occult nasolacrimal duct lesions (7 of 46 patients) following surgeries for middle meatotomy and ethmoidectomy by comparison with 3% reported by Saengpanich *et al.*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.*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.*¹⁸ reported a case of bleeding with peri-operative cauterisation of the sphenopalatine artery in 1,072 patients treated with the endoscopic approach (middle meatotomies 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.*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.*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.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.*⁹ found 5 cases of recurrence in 150 patients treated with an isolated endoscopic approach. Lai *et al.*²² had 3 cases of recurrence in 126 patients. In a series of 135 patients treated with the endoscopic approach, Nicolai *et al.*²³ found no cases of recurrence over a minimum follow-up of 18 months.²³ Chobillon and Jankowski⁸ 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.*²⁴ 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.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 nasolacrimal 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

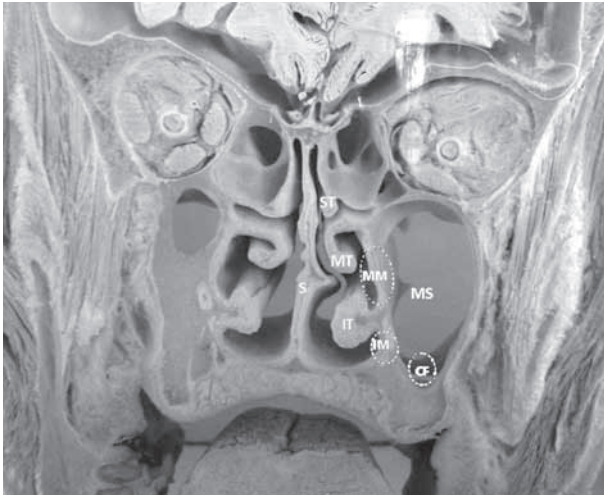


Figure 5

Anatomical frontal view illustrating the surgical approach of the maxillary sinus. S: septum. MT: middle turbinate. ST: superior turbinate. IT: inferior turbinate. MM: the middle meatus approach. IM: the inferior meatus approach. CF: the canine fossa puncture approach.

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.⁸ 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 com-

bination of these two theories.²¹ 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.*²⁵ 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 meatus.

References

1. Grosjean P, Weber R. Fungus balls of the paranasal sinuses: a review. *Eur Arch Otorhinolaryngol.* 2007;264(5): 461-470.
2. Serrano E, Percodani J, Flores P, Dilem S, Pessey JJ. Paranasal sinus aspergilloma. A propos of 45 cases [in French]. *Ann Otolaryngol Chir Cervicofac.* 1996;113(2):86-91.
3. Selvi F, Enoz M, Yazgin I, Cakarer S, Keskin C. Do asymptomatic foreign bodies in the maxillary sinus always need to be removed? *B-ENT.* 2008;4(4):243-247.
4. Wang JH, Lee BJ, Jang YJ. Bacterial coinfection and antimicrobial resistance in patients with paranasal sinus fungus balls. *Ann Otol Rhinol Laryngol.* 2010;119(6):406-411.
5. Klossek JM, Serrano E, Peloquin L, Percodani J, Fontanel JP, Pessey JJ. Functional endoscopic sinus surgery and 109 mycetomas of paranasal sinuses. *Laryngoscope.* 1997; 107(1):112-117.

6. Dhong HJ, Jung JY, Park JH. Diagnostic accuracy in sinus fungus balls: CT scan and operative findings. *Am J Rhinol*. 2000;14(4):227-231.
7. Masterson L, Al Gargaz W, Bath AP. Endoscopic Caldwell-Luc technique. *J Laryngol Otol*. 2010;124(6):663-665.
8. Chobillon MA, Jankowski R. What are the advantages of the endoscopic canine fossa approach in treating maxillary sinus aspergillomas? *Rhinology*. 2004;42(4):230-235.
9. Dufour X, Kauffmann-Lacroix C, Ferrie JC, Goujon JM, Rodier MH, Karkas A, Klossek JM. Paranasal sinus fungus ball and surgery: a review of 175 cases. *Rhinology*. 2005;43(1): 34-39.
10. Duncavage J, Becker S, Ed. *The Maxillary Sinus: Medical and Surgical Management*. Thieme, New-York: 2010.
11. Bleier BS, Schlosser RJ. Prevention and management of medial rectus injury. *Otolaryngol Clin North Am*. 2010;43(4):801-807.
12. Calhoun KH, Rotzler WH, Stiernberg CM. Surgical anatomy of the lateral nasal wall. *Otolaryngol Head Neck Surg*. 1990;102(2):156-160.
13. Cohen NA, Antunes MB, Morgenstern KE. Prevention and management of lacrimal duct injury. *Otolaryngol Clin North Am*. 2010;43(4):781-788.
14. Unlu HH, Goktan C, Aslan A, Tarhan S. Injury to the lacrimal apparatus after endoscopic sinus surgery: surgical implications from active transport dacryocystography. *Otolaryngol Head Neck Surg*. 2001;124(3):308-312.
15. Bolger WE, Parsons DS, Mair EA, Kuhn FA. Lacrimal drainage system injury in functional endoscopic sinus surgery. Incidence, analysis, and prevention. *Arch Otolaryngol Head Neck Surg*. 1992;118(11):1179-1184.
16. Saengpanich S, Kerekhanjanarong V, Chochaipanichnon L, Supiyaphun P. Nasolacrimal duct injury from microscopic sinus surgery: preliminary report. *J Med Assoc Thai*. 2001;84(4):562-565.
17. Serdahl CL, Berris CE, Chole RA. Nasolacrimal duct obstruction after endoscopic sinus surgery. *Arch Ophthalmol*. 1990;108(3):391-392.
18. Bambule G. Endoscopic surgery of chronic sinusitis [in French]. *Rev Med Suisse Romande*. 2001;121(10):735-741.
19. Robinson SR, Baird R, Le T, Wormald PJ. The incidence of complications after canine fossa puncture performed during endoscopic sinus surgery. *Am J Rhinol*. 2005;19(2): 203-206.
20. Bernal-Sprekelsen M, Kalweit H, Welkoborsky HJ. Discomforts after endoscopy of the maxillary sinus via canine fossa. *Rhinology*. 1991;29(1):69-75.
21. Costa F, Polini F, Zerman N, Robiony M, Toro C, Politi M. Surgical treatment of Aspergillus mycetomas of the maxillary sinus: review of the literature. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2007;103(6):e23-29.
22. Lai JC, Lee HS, Chen MK, Tsai YL. Patient satisfaction and treatment outcome of fungus ball rhinosinusitis treated by functional endoscopic sinus surgery. *Eur Arch Otorhinolaryngol*. 2011;268(2):227-230.
23. Nicolai P, Lombardi D, Tomenzoli D, Villaret AB, Piccioni M, Mensi M, Moroldi R. Fungus ball of the paranasal sinuses: experience in 160 patients treated with endoscopic surgery. *Laryngoscope*. 2009;119(11):2275-2279.
24. Lee JY, Lee SH, Hong HS, Lee JD, Cho SH. Is the canine fossa puncture approach really necessary for the severely diseased maxillary sinus during endoscopic sinus surgery? *Laryngoscope*. 2008;118(6):1082-1087.
25. Dufour X, Kauffmann-Lacroix C, Goujon JM, Grollier G, Rodier MH, Klossek JM. Experimental model of fungal sinusitis: a pilot study in rabbits. *Ann Otol Rhinol Laryngol*. 2005;114(2):167-172.

Agnès Dupret-Bories, M.D.
 Department of Otorhinolaryngology and Head and Neck Surgery
 CHU Hautepierre
 avenue Molière
 67098 Strasbourg, Cedex, France
 Tel.: 0388127654
 Fax: 0388127656
 E-mail: agnes.dupret@chru-strasbourg.fr