

ORIGINAL RESEARCH

The Role of Ostiomeatal Complex Obstruction in Maxillary Fungus Ball

Tung-Lung Tsai, MD, Yuan-Ching Guo, MD, Ching-Yin Ho, MD, PhD, and Ching-Zong Lin, MD, Taipei, Taiwan

OBJECTIVE: The aim of this study was to clarify the role of ostiomeatal complex obstruction in maxillary fungus ball.

STUDY DESIGN AND SETTING: Comparative study in a hospital setting of the mean Lund-Mackay scores for the anterior ethmoid and frontal sinuses of 54 versus 48 patients with maxillary fungus ball versus chronic unilateral rhinosinusitis, respectively.

RESULTS: In cases with partial opacification in the maxillary sinus, the anterior ethmoid and frontal sinuses were diseased in the chronic unilateral rhinosinusitis group but not in the maxillary fungus ball group. In cases with total opacification in the maxillary sinuses, all anterior ethmoid and frontal sinuses in both groups were diseased, but the disease condition of the frontal sinuses was significantly less severe in the maxillary fungus ball group ($P < 0.001$).

CONCLUSION AND SIGNIFICANCE: In this era of evidence-based medicine, we provide statistical data supporting the principle that maxillary fungus ball is not associated with ostiomeatal complex obstruction and that another as-yet-unexplained mechanism must be responsible.

EBM rating: B-3b

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As the number of immunocompromised patients increases, the importance of paranasal sinus fungal infection becomes more evident. According to the histopathological finding, most authors have classified fungal sinusitis into invasive or noninvasive groups.^{1–14} The noninvasive group is composed of allergic fungal sinusitis and fungus ball. The diagnostic criterion for allergic fungal sinusitis is the presence of characteristic laminated, eosinophil-rich allergic mucin containing fungal elements. However, in sinus fungus ball, eosinophilic mucin is not present in the sinona-

sal tract, and the histopathologic finding of sinus mucus and debris shows dense accumulations of hyphae in concentric layers forming a fungus ball. The noninvasive type fungal sinusitis (including fungus ball) occurs mostly in immunocompetent patients, but the possibility of transforming to an invasive type when the patient became immunocompromised was suggested.³

Little has been reported regarding the pathogenesis of fungal infection of the paranasal sinus, and the etiology of fungal sinusitis has been unclear. Stammberger¹⁵ regarded mycotic sinusitis as a special form or complication of chronic recurring sinusitis. From the results of endoscopic investigations, he concluded that most *Aspergillus* mycoses of the paranasal sinus were secondary to a chronic recurring sinusitis, the focus of which usually lay in the diseased anterior ethmoid sinus. He hypothesized that the pathogenesis of fungal sinusitis began with nourishment of the fungus by purulent secretions from bacterial and viral superinfection that was followed by the growth of fungal hyphae in a low-pH environment provided by the stenosed ostiomeatal complex. However, he did not mention another different type of fungal sinusitis, the maxillary fungal ball. Eloy et al⁸ suggested that sinus hypoventilation secondary to ostial dyspermeability plays an important role in trapping fungal spores and providing anaerobic conditions for the development of sinus fungus ball. However, deShazo⁶ thought that the pathogenesis of sinus fungus balls is unknown, and in most of his patients, a source of infection remained to be determined. But in another earlier article, he speculated that fungus balls may develop in any poorly ventilated sinus and that fungal exposure and poor sinus ventilation may be the only risk factors that are required.⁷ Furthermore, Klossek et

From the Department of Otolaryngology, Veterans General Hospital-Taipei, Taipei, Taiwan (Drs Tsai, Guo, Ho, and Lin), and the Institute of Clinical Medicine (Dr Tsai), National Yang-Ming University, Taipei, Taiwan.

Reprint requests: Chiny-Yin Ho, MD, PhD, Department of Otolaryngology, Veterans General Hospital-Taipei, 201 Section 2, Shih-Pai Road, Taipei, Taiwan 112, R.O.C.

E-mail address: tltsai@vghtpe.gov.tw

al¹¹ reported 2 cases of recurrent paranasal sinus fungus balls in which small fungal balls were extracted from the patent middle anastomy 17 and 23 months after surgery. They also reported 1 case of fungus infection in the superior meatus, which suggests that fungus may grow even in well-ventilated parts of the nose.

The ostiomeatal complex is a functional entity of the anterior ethmoid complex that is the final common pathway for drainage and ventilation of the frontal, maxillary, and anterior ethmoid cells.¹⁶ If the pathogenesis of the maxillary fungus balls originates from an ostiomeatal complex obstruction, the diseased condition in the anterior ethmoid and frontal sinuses would be similar to that associated with chronic unilateral rhinosinusitis. In this study, we used the Lund-Mackay computed tomography (CT) staging system¹⁷ for rhinosinusitis (referred to hereafter as the Lund score) as a tool to investigate whether the condition of the anterior ethmoid and frontal sinuses is any different in cases of maxillary fungus balls and cases of chronic unilateral rhinosinusitis. The specific hypothesis to be tested in this study was that the Lund scores for the anterior ethmoid and frontal sinuses will be no different in the 2 kinds of cases.

SUBJECTS AND METHODS

Fifty-four consecutive patients who underwent endoscopic sinus surgery and all of whose histopathological sections revealed paranasal sinus fungus balls without eosinophil-rich allergic mucin received preoperative sinus CT scans. The CT scans were performed in both the coronal and axial planes, with contiguous 4-mm (slice thickness) sections. Only bone algorithms and bone windows were used for this study. No contrast agent was administered to study subjects. Patients who had undergone any previous sinonasal surgery were excluded from the study group. The control group was composed of 45 consecutive patients who underwent endoscopic sinus surgery for chronic unilateral rhinosinusitis. All patients in the control group fulfilled diagnostic criteria for chronic rhinosinusitis as defined by the American Academy of Otolaryngology–Head and Neck Surgery¹⁸ and had failed to respond to medical management. The study protocol was reviewed and approval by the local institutional review board of Taipei Veteran General Hospital.

The data were analyzed using the SPSS statistical system (SPSS Inc, Chicago, IL). First, the cases of maxillary sinus with Lund scores of 0 (no abnormalities) on the infected side were excluded. Then, the Lund scores of the anterior ethmoid and frontal sinuses on the infected side were stratified according to the Lund score of the maxillary sinus (ie, divided into 2 groups: the maxillary sinus of 1 group had a Lund score of 1 [partial opacification] and that of the other group had a Lund score of 2 [total opacification]). In both the study and control groups, we first checked whether the anterior ethmoid and frontal sinuses were in a diseased condition or not. The mean Lund scores of the anterior

ethmoid and frontal sinus were compared with 0 (normal sinus condition) using a 1-sample *t* test. A significant difference confirmed that these sinuses were in the diseased condition. Then, a 1-way analysis of variance test was performed to compare the difference between the study and control groups. All the tests were 2 tailed, and $P < 0.05$ was selected as the level of significance.

RESULTS

Study and control groups after exclusions comprised 50 cases of maxillary fungus balls and 43 cases of chronic unilateral rhinosinusitis, respectively. Excluded from the study group were cases of isolated sphenoid fungal sinusitis. Excluded from the control group were 2 cases of chronic unilateral rhinosinusitis with only anterior ethmoid and sphenoid sinus involvement. The distributions of Lund scores of the anterior ethmoid and frontal sinuses in the study and control groups are summarized in Figures 1 and 2.

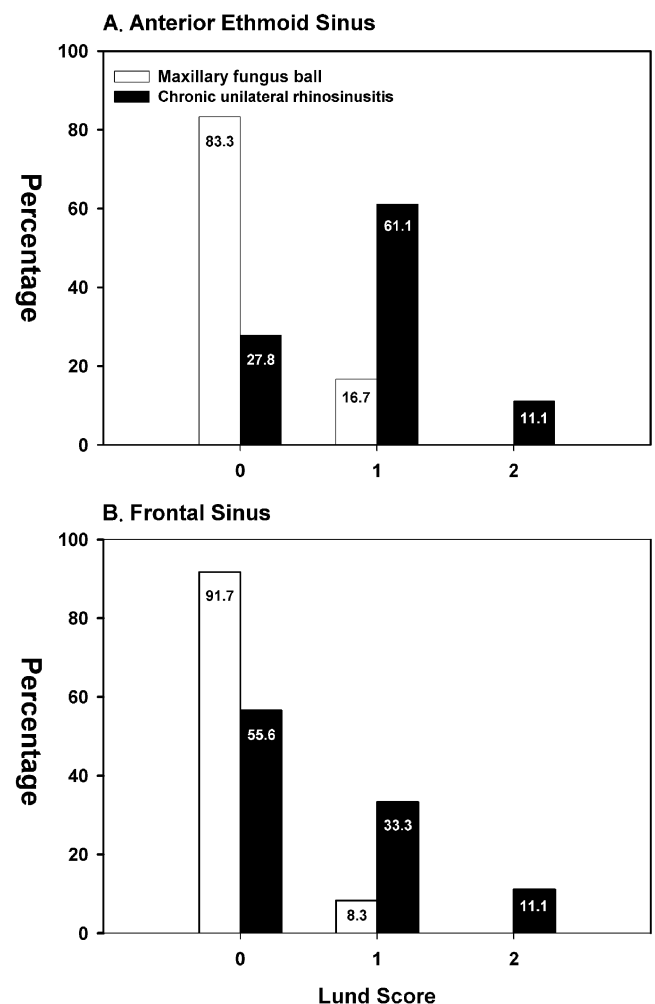


Figure 1 The distribution of Lund score of the anterior ethmoid and frontal sinuses in patients with partial opacification in the maxillary sinus (Lund score = 1).

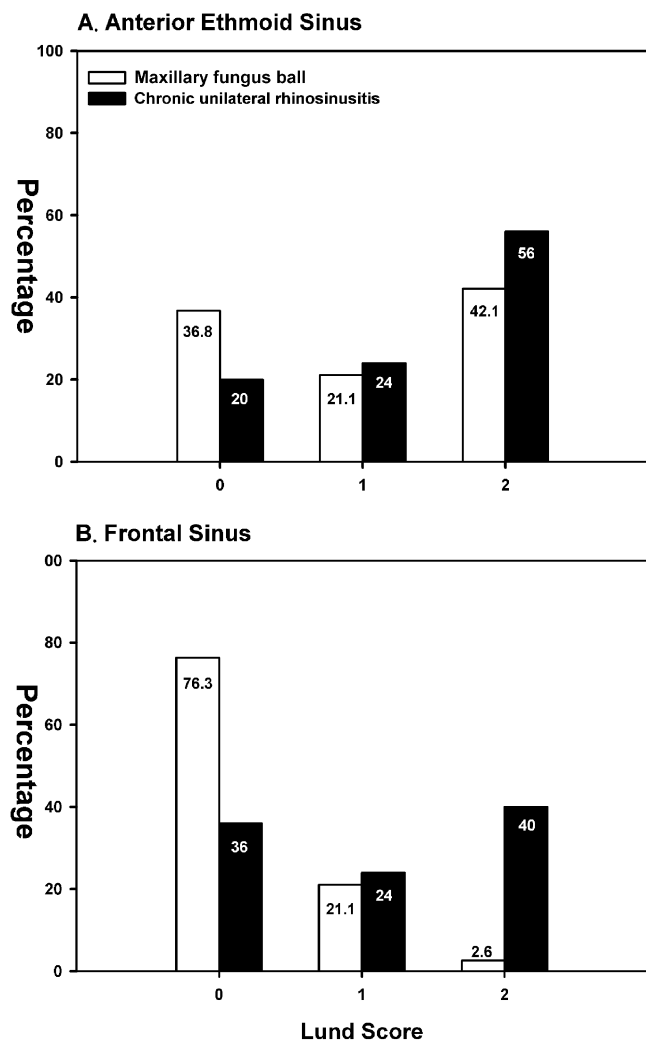


Figure 2 The distribution of Lund score of the anterior ethmoid and frontal sinuses in patients with total opacification in the maxillary sinus (Lund score = 2).

The mean Lund scores of the anterior ethmoid and frontal sinuses in both groups are summarized in Tables 1 and 2.

When we checked the condition of the anterior ethmoid and frontal sinuses on the side of infected maxillary sinus, the Lund score of anterior ethmoid and frontal sinuses in all patients in both the study and control groups, except for the

patients having fungus ball with partial opacification in the maxillary sinus (Lund score of the maxillary sinus = 1), was significantly different from 0 (1-sample *t* test), meaning the condition of these sinuses was diseased. However, in the group of patients having fungus ball with partial opacification in the maxillary sinus (Lund score of the maxillary sinus = 1), the mean Lund scores of anterior ethmoid and frontal sinuses was not different from 0. This suggests that most of the anterior ethmoid and frontal sinuses in patients having maxillary fungus ball with partially opacification were not diseased. In fact, as high as 83.3% of the anterior ethmoid sinuses and 91.7% of the frontal sinuses were not diseased in this group.

When using the 1-way analysis of variance test for multiple measurements to compare the difference in Lund scores for the anterior ethmoid and frontal sinuses between groups with maxillary Lund scores of 2 (total opacification in maxillary sinus), a significant difference was detected in the mean Lund scores of the frontal sinuses of patients in the study and control groups ($P < 0.001$). The maxillary fungus ball group had significantly more frontal sinuses with only minor disease than did the chronic unilateral rhinosinusitis group.

DISCUSSION

Our results did not support the hypothesis that maxillary sinus fungus ball originates from obstruction of the ostiomeatal complex or is a complication of recurrent sinusitis. First, in the chronic unilateral rhinosinusitis group with partial opacification in maxillary sinus (Lund score of maxillary sinus = 1), the mean Lund score of the anterior ethmoid and frontal sinuses revealed the presence of disease, that is to say, the ostiomeatal complex was obstructed and prevented the drainage and ventilation of all dependent sinuses. However, in the fungus ball group with the same disease condition in the maxillary sinus (Lund score of 1), most of the anterior and frontal sinuses were clear, and the 1 sample *t* test failed to show difference between their mean Lund score and 0. That means, in cases with the maxillary sinus partially occupied by fungus, the ostiomeatal complex still functioned normally for the drainage and ventilation of

Table 1
Mean Lund scores of the anterior ethmoid and frontal sinus in patients with partial opacification in the maxillary sinus (Lund score = 1)

	Mean Lund score	
	Anterior ethmoid sinus	Frontal sinus
Maxillary fungus ball group (n = 12)	0.17 ± 0.39#	0.0833 ± 0.29#
Chronic unilateral rhinosinusitis group (n = 18)	0.83 ± 0.62*	0.56 ± 0.70*

$P = .166$ and $.339$, $>.05$ when compared with 0 using a one-sample *t* test.

* $P < .001$ and $= .004$, $<.05$ when compared with 0 using a one-sample *t* test.

Table 2
Mean Lund score of the anterior ethmoid and frontal sinus in patients with total opacification in the maxillary sinus (Lund score = 2)

	Mean Lund score	
	Anterior ethmoid sinus	Frontal sinus
Maxillary fungus ball group (n = 38)	1.05 ± 0.9	0.26 ± 0.5*
Chronic unilateral rhinosinusitis group (n = 25)	1.36 ± 0.81	1.04 ± 0.89

* $P < .001$, $< .05$ when compared with chronic unilateral rhinosinusitis group using the one-way ANOVA test.

the other dependent sinuses. This result indicated that the growth of maxillary fungus ball was not necessarily caused by ostiomeatal complex obstruction.

Second, in the groups with total opacification in maxillary sinus (Lund score of the maxillary sinus = 2), there was still a difference in the mean Lund score of the frontal sinus in the maxillary fungus ball versus unilateral chronic rhinosinusitis group; the mean Lund score in study group patients was significantly less than in the control group patients. This means that the diseased condition of frontal sinuses in cases of maxillary fungus ball with total opacification was less severe. In fact, 76.3% of the frontal sinuses in the study group remained clear, but only 36% in the controlled group were clear. If the pathogenesis of maxillary fungus ball comes from ostiomeatal complex obstruction, as chronic rhinosinusitis does, all the drainage of dependent sinuses would be blocked, and the disease condition in the anterior and frontal sinuses would be similar between the 2 diseases. However, even in cases with total opacification of the maxillary sinus, our data still showed a difference in the extent of diseased condition of the frontal sinus between the 2 diseases. Anatomically, the frontal sinus is farther away from the maxillary sinus than the anterior ethmoid sinus is; the orifice of frontal sinus is in the upper portion of ostiomeatal complex and away from maxillary sinus orifice. Possibly, in cases in which the maxillary sinus is totally occupied by fungus, the overgrowth of fungus comes in contact with the anterior ethmoid sinus mucosa, and the local toxicity of the fungus (mycotoxins), as Eloy et al suggested,⁸ causes this the anterior ethmoid sinus to become diseased. However, because the frontal sinus is further away from the maxillary sinus, the local toxicity effect of the fungus is usually less.

Our results revealed that the diseased conditions of the anterior ethmoid and frontal sinuses in patients with maxillary sinus fungus ball were different from those in patients with chronic unilateral rhinosinusitis. This finding contradicts the hypothesis that maxillary fungus ball is a complication of chronic recurring sinusitis and comes from ostiomeatal complex obstruction. From the results of this study, we suspect that maxillary fungus ball does not originate from an ostiomeatal complex obstruction. Our findings support our contention that exploration of the anterior ethmoid bulla and frontoethmoid recess when performing endoscopic

sinus surgery for maxillary fungus ball is not necessary in all cases, and thereby the risk of postoperative scarring to these sinus ostia can be avoided in most cases with only minor disease in the frontal or anterior ethmoid sinuses.

CONCLUSION

An obstruction of the ostiomeatal complex, the common passage for the anterior, frontal, and maxillary sinuses, was evident in the diseased condition of all 3 sinuses in patients with unilateral chronic rhinosinusitis. However, from the difference in the diseased conditions of the anterior ethmoid and frontal sinuses of patients with unilateral chronic rhinosinusitis versus those with maxillary fungus ball, with almost all patients with maxillary fungus ball having partial opacification showing clear anterior ethmoid and frontal sinuses, we concluded that the ostiomeatal complex seems not to be obstructed in, and therefore would not seem to be the cause of, maxillary fungus ball. In this era of evidence-based medicine, we provide statistical data supporting the principle that maxillary fungus ball is not associated with ostiomeatal complex obstruction and that another as-yet-unexplained mechanism must be responsible.

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