CT imaging and clinical features of sinus fungus ball with bone erosion

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Background: Bone erosion is a common manifestation of sinus fungus ball (SFB) on CT imaging, however, the relationship between CT imaging and clinical features of SFB with bone erosion were not clear. Purpose: To evaluate the CT imaging and clinical features of sinus fungus ball with bone erosion and to explore the possible factors underlying its formation. Material and methods: The clinical data of 175 patients with fungal ball who received surgical treatment at our department from January 2009 to December 2013 were selected continuously and analyzed retrospectively. Patients were divided into the bone erosion group (group A) and non-bone erosion group (group B) according to the CT results. Results: The incidence of bone erosion in CT imaging was 31.43%. The course of patients in groups A and B was 20.35 ± 4.65 and 11.04 ± 2.36 months, respectively (P = 0.023). The incidence of diabetes in fungus ball was 5.14%, and the prevalence in groups A and B was 5.45% (3/55) and 5% (6/120), respectively (P = 0.899). After functional endoscopic sinus surgery, the total fungus ball cure rate was 98.8%, being 98.08% and 99.13% in groups A and B, respectively (P = 0.86). Conclusion: Fungus ball of the paranasal sinus with bony erosion is likely due to long-time mechanical compression; bone erosion does not significantly affect the effectiveness of endoscopic sinus surgery. Journal of Nature and Science, 1(4):e69, 2015

ear nose throat | endoscopic sinus surgery | surgery | skull

Introduction
Fungal rhinosinusitis is a common disease, and its main clinical manifestations include nasal congestion, purulent or blood nasal discharge, headache, and/or an impaired sense of smell [1]. In recent years, the incidence of fungal rhinosinusitis has increased significantly, possibly due to air pollution, allergy, and climate change [2]. Sinus fungus ball (SFB) is the most common subtype of fungus rhinosinusitis [3], defined as noninvasive chronic fungal sinusitis without inspissated allergic mucin, and occurs in immunocompetent hosts [4]. Complete removal of the lesion and adequate drainage of the sinus using an endoscope is the preferred therapeutic schedule for the treatment of SFB, with a lower recurrence rate after surgery [5-6]. Preoperative computed tomography (CT) is important to ensure appropriate treatment for SFB [7], and several studies have reported the CT features of sinus fungus ball, including an abnormal increase in the density of the sinuses, sinus mucosal thickening, calcification, sclerosis of the sinus lateral wall, and bone erosion [4]. Calcification in the sinus is believed to be one of the most specific among those features and has a strong suggestive role for this diagnosis [8].

Bone erosion is a common manifestation of SFB on CT imaging [9] and manifests as discontinuous or infiltrated thinning of bone. However, bone erosion is also common in benign or malignant tumors of the sinuses. When bone erosion is evident on CT imaging, a differential diagnosis should be considered. The main objective of this study was to evaluate the CT imaging and clinical features of fungus ball with bone erosion, and to explore the mechanism underlying its formation.

1. Materials and methods
1.1 Clinical data: The clinical data of all patients with fungal rhinosinusitis of fungal ball who received surgical treatment at our department from January 2009 to December 2013 were continuously selected and analyzed retrospectively. The diagnosis of fungal rhinosinusitis of fungal ball was mainly based on pathology and clinical manifestations, including microscopic examination of fungal hyphae without invasion into mucous membranes, blood vessels, or bone. All cases of invasive fungal rhinosinusitis and allergic fungal rhinosinusitis (AFRS) were excluded; the diagnostic criteria of the latter included allergic mucin and eosinophilic infiltration. All patients underwent CT in the horizontal position preoperatively; bone and soft tissue windows were used, with parallel coronal and sagittal reconstruction. The information extracted from the clinical data included gender, age, initial symptoms, disease course, diabetes status, CT data and type of surgery. The disease course was calculated as the time of initial symptoms until the date of CT examination, whereas surgical results were determined by CT or endoscopic review of the sinus after surgery. CT was performed primarily to evaluate the primary sinus and extent of lesions with or without bone erosion and calcification imaging. CT bone erosion was defined as a fungus ball extending outside of the primary sinus or infringing the nasal cavity, other sinuses and/or surrounding structures. Multiple sinus fungus balls of the primary sinus that were indistinguishable were considered to be associated with bone erosion, while fungal ball that was limited to the anterior or posterior ethmoid sinus was considered to not be associated with bone erosion. Figures 1 show typical CT findings of fungus ball of the maxillary sinus and sphenoid sinus accompanied by bone erosion, respectively. Figure 2 show CT findings of fungus ball of the maxillary sinus, and sphenoid sinus without bone erosion.

Figure 1. Computer tomography image showing bone erosion(arrow) of the inner wall in a maxillary sinus (A) and a sphenoid sinus(B) fungus ball.

Figure 2. Computer tomography image showing a sphenoid (A) and a maxillary sinus (B) fungus ball without bone erosion.

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After identification of bone erosion on CT imaging determined following consultation by two otolaryngologists with more than 10 years of experience—and consistent with intraoperative exploration findings—the patients were divided into the bone erosion (group A) and non-erosion (group B) groups, and the locations of bone erosion were recorded.

### 1.3 Statistical analysis: The course of patients and the age of patients were reported with mean ± SEM. The SPSS ver. 13.0 statistical software was used for statistical analysis, χ² test for numerical data, and t-test for measurement data. A P value less than 0.05 was deemed to indicate statistical significance.

### 2. Results

One hundred and seventy-five patients were included in the study—63 males, 112 females; male: female ratio, 1:1.8. The age range was 19–85 years (mean ± SEM, 54.27±0.95 years), with a median of 55 years (Table 1). The sinus CT of 55 patients with fungus ball showed bone erosion. There were 55 cases in group A, and 120 in group B; thus, the incidence of bone erosion was 31.43%. The incidence of bone erosion in males was 38.10% (24/63) and that in females was 27.68% (31/112) (P = 0.157). The mean ± SEM age of patients in group A was 56.45 ± 1.59 years, and 53.27 ± 1.17 years in group B (P = 0.119).

The disease course of patients with fungus ball was 1 week to 10 years, with a mean of 13.87 ± 3.55 months; the disease durations of groups A and B were 20.35 ± 4.65 and 11.04 ± 2.36 months (P = 0.023), respectively. The incidence of diabetes in fungus ball was 5.14%, similar to in previous community surveys [14-15]; thus diabetes, are also thought to be related to the pathogenesis of fungal sinusitis [11]. The pathological feature of non-invasive fungal rhino-sinusitis is that fungal infection is confined to the sinus cavity, with no fungal violations of the mucous membrane and bone wall. In contrast, the pathological feature of invasive fungal rhino-sinusitis is fungal invasion of the sinus mucosa and bone, and possibly spread into the surrounding structures and tissues, such as the eye sockets, anterior skull base, and pterygopalatine fossa [12-13].

Funguses are ubiquitous and present on the surface of food, fruit, cereals, and plants. Fungi cause sinus infections by adhering to airborne dust particles in the sinuses; thus, air pollution may be associated with the pathogenesis of sinus fungus ball. Long-term use of antibiotics and glucocorticoids, and immunosuppression and diabetes, are also thought to be related to the pathogenesis of fungal ball. However, the prevalence of diabetes in patients of this group was 5.14%, similar to in previous community surveys [14-15]; thus the relationship between diabetes and fungal ball requires further investigation.

The mechanism of bone erosion in association with fungus ball is unclear because the causative agent of most cases is *Aspergillus* [16], which has little or no invasion ability. The disease duration in the bone erosion group was significantly longer than that in the non-bone erosion group, suggesting an association between mechanical compression by the fungal mass and prolonged disease duration. Early diagnosis and treatment of fungus ball reduce the incidence of bone erosion.

### 3. Discussion

Fungal rhino-sinusitis can be divided into invasive fungal rhino-sinusitis and non-invasive fungal rhino-sinusitis clinically [10]. Non-invasive fungal rhino-sinusitis can be divided into fungal ball and allergic fungal rhino-sinusitis according to the pathology, whereas invasive fungal rhino-sinusitis can be divided into acute invasive fungal rhino-sinusitis and chronic invasive fungal rhino-sinusitis [11]. The pathological feature of non-invasive fungal rhino-sinusitis is that fungal infection is confined to the sinus cavity, with no fungal violations of the mucous membrane and bone wall. In contrast, the pathological feature of invasive fungal rhino-sinusitis is fungal invasion of the sinus mucosa and bone, and possibly spread into the surrounding structures and tissues, such as the eye sockets, anterior skull base, and pterygopalatine fossa [12-13].

### Abbreviations: SEM, standard error of the mean; CT, computed tomography. *P*<0.05

<table>
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<th>Group</th>
<th>Group A</th>
<th>Group B</th>
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<tr>
<td>Sex (male/female)</td>
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<td>Age in years (mean ± SEM)</td>
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<td>Diabetes</td>
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<tr>
<td>Course in months(mean ± SEM)</td>
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<td>11.04 ± 2.36</td>
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<tr>
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<td>99</td>
<td>0.999</td>
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<td>Ethmoid sinus</td>
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<td>Frontal sinus</td>
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<td>Cure</td>
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<td>114</td>
<td>0.565</td>
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</table>

Cure

Lost to follow up

CT calcification

Primary site

Maxillary sinus

Sphenoid sinus

Ethmoid sinus

Frontal sinus

Multi-sinususes

Lost to follow up

Cure

Abbreviations: SEM, standard error of the mean; CT, computed tomography. *P*<0.05

Fungus ball was most common in the maxillary sinus (136/175, 77.71%), followed by the sphenoid sinus (18/175, 10.25%); the ethmoid sinus (14/175, 8.04%) and that in females was 27.68% (31/112) (P = 0.157). The mean ± SEM age of patients in group A was 56.45 ± 1.59 years, and 53.27 ± 1.17 years in group B (P = 0.119).
the sphenoid sinus of 47.8% (11/23) [17]. Therefore, bone erosion is a useful CT imaging finding for the diagnosis of fungus ball. The presence of bone erosion on CT imaging in cases of sinus fungus ball enables differentiation of benign and malignant of sinus tumors. In the present study, all cases of fungal ball bone erosion in the maxillary occurred in the natural ostium, and most showed expansive growth. The latter findings represented different erosion features from those of sinus tumors because sinus tumor erosion on CT imaging usually manifests as irregular growth, and was frequently not limited to the sinus ostium. Familiarity with these CT image features will assist differential diagnosis of sinus fungus ball.

Complete removal of the lesions under endoscopy is the preferred method for treating fungal ball. Similar to previous reports, the overall cure rate of patients in the present study was satisfactory—98.8% at the 6-month follow-up. Moreover, bone erosion had no marked effect on the results of surgical sinus fungus ball treatment. The main limitations of this study were as follows. First, CT-scan can be performed in different ways. It is not likely that these scans were performed in the most accurate way for scientific purpose since it was performed for clinical use. Therefore, small erosions could have been missed. Second, this was a retrospective study, and most cases had no fungal culture results. Although previous reports indicated that most cases of fungus ball were caused by Aspergillus, an association between bone erosion and fungal taxon could not be ruled out.

In conclusion, bony erosion due to fungus ball in the paranasal sinus was directed mainly to the natural ostium, likely due to long-term mechanical compression by the fungal mass. Bone erosion has no significant influence on the effect of endoscopic sinus surgery, and the differential diagnosis of fungus ball with bone erosion should be considered.

Acknowledgments
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