Unilateral Paranasal Sinusitis Detected by Routine Sinus Computed Tomography: Analysis of Pathology and Image Findings

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ABSTRACT

The aim of this study was to evaluate the histopathological findings of unilateral paranasal sinus disease dominated by maxillary sinus opacification on routine non-contrast enhanced paranasal sinus CT.

We performed a retrospective analysis of routine paranasal sinus CT conducted between March 2003 and April 2007. Unilateral maxillary sinus opacification (with or without ipsilateral ethmoid or frontal sinus involvement) was identified. All scans were reviewed by two radiologists under standard soft-tissue and bone windows. The features of maxillary sinus bony erosion, wall thickening, calcification, tissue invasion, and histopathology were noted.

In total, 1256 consecutive scans were reviewed, 134 (10.7%) with unilateral sinus involvement. Histopathology was available for 76 (56.7%) patients including 55 (72.4%) inflammatory disease (acute and chronic), 18 (23.7%) fungal disease, and three (3.9%) neoplasia cases. A single case of malignant lymphoma and two cases of inverted papilloma were also present. Fungal sinusitis was associated with significantly more intrasinus calcification (n = 13; 72.2%) and maxillary sinus-wall thickening (n = 16; 88.9%) than was chronic rhinosinusitis (n = 6; 10.9% and n = 20; 36.4% respectively; both p < 0.05).

In summary, the incidence of unilateral paranasal sinus disease dominated by maxillary sinus opacification on routine paranasal sinus CT scans was 10.7% and the condition is considered uncommon. Chronic rhinosinusitis (fungal and non-fungal origin) comprised up to 96% of cases, with a 4% to 7% incidence of neoplasia.

Chronic rhinosinusitis typically involves the maxillary sinuses and is commonly bilateral; unilateral chronic rhinosinusitis is considered uncommon [1]. Unilateral maxillary sinus opacification is handled cautiously and is carefully investigated in view of its association with malignant neoplasia [2]. Rhinological symptoms alone are less helpful in highlighting this possibility. Although non-contrast-enhanced computed tomography (CT) is currently the imaging method of choice for chronic rhinosinusitis that may require surgical intervention [1, 3], it lacks sufficient soft-tissue contrast to allow a confident differentiation between chronic rhinosinusitis and soft-tissue tumors. Thus, the imaging work-up of unilateral maxillary sinus opacification can be challenging. The disease processes leading to unilateral sinus opacification may be fungal sinusitis, chronic rhinosinusitis, or neoplasia (benign or malignant).

To our knowledge, few published studies have investigated unilateral chronic rhinosinusitis dominated by an
unilateral paranasal sinusitis. In this study, we aimed to describe the incidence and histopathology of unilateral chronic rhinosinusitis dominated by maxillary sinus opacification as detected by a series of consecutive sinus CT studies.

METHODS

We retrospectively analyzed (approved by the Institutional Review Board) non-enhanced sinus CT scans performed between March 2003 and April 2007. CT scans that showed total or near total opacification of a unilateral maxillary sinus with or without sinus opacification of the ipsilateral ethmoid or frontal sinuses were analyzed.

All scans were performed on the same 16-detector CT scanner, the Lightspeed 16 (GE Healthcare, Milwaukee, WI, USA). High-resolution axial images were obtained with the patient in the supine position at a section thickness of 0.625 mm. The source images were then reformatted to 1.25-mm slices at 2.5-mm intervals for axial images, 0.352-mm slices at 3-mm intervals for coronal images, and 0.352-mm slices at 5-mm intervals for sagittal images. No intravenous contrast was administered. All scans were routinely reviewed in bone (width 3200, level 800) and soft tissue windows (width 1700, level 20) by two radiologists.

Demographic data and radiological features regarding ipsilateral ethmoid or ethmoid and frontal sinus opacification, maxillary sinus bony erosion, size, wall thickening, calcification, tissue invasion, and histopathology (where available) were assessed. Statistical analysis was performed using SPSS software (version 14; SPSS Inc., Chicago, IL). The data were analyzed with a Pearson’s χ² test. A two-sided p-value ≤ 0.05 was considered significant.

RESULTS

In total, 1256 consecutive CT scans were reviewed. Of these, 134 (10.7%) scans fulfilled the criteria for unilateral maxillary sinus opacification. The study group consisted of 59 male and 75 female patients with a mean age of 48 years (range 12 to 83 years). A slight preponderance of left-side pathology was noted (left 71, right 63). In all 134 patients, CT was performed for unilateral nasal obstruction that failed to respond to medical therapy. Histopathology was available for 76 (56.7%) patients. Further analysis of disease pattern is based on these 76 patients.

Fifty-five patients (72.4%) had chronic rhinosinusitis; 18 (23.7%) had fungal disease; three (3.9%) had neoplastic disease (Table 1). Aspergillus accounted for all cases of fungal sinusitis. The three cases of neoplasia were due to malignant lymphoma, inverted papilloma, and inverted papilloma with severe dysplasia (carcinoma in situ).

No intrasinus calcification, bony destruction, or transcompartmental invasion was evident in the cases of neoplasia. In the two cases of inverted papilloma, complete opacification of the unilateral maxillary, ethmoid, and frontal sinuses was present.

In patients with chronic rhinosinusitis, 18 (32.7%) cases showed isolated maxillary sinus opacification, 10 (18.2%) involved the ipsilateral ethmoid sinus, and 27 (49.1%) involved the ipsilateral ethmoid and frontal sinuses compared with two (11.1%), nine (50%), and seven (38.9%) cases, respectively, among patients with fungal sinusitis (Table 2). The pattern of distribution was statistically significant (p = 0.019). In patients with chronic rhinosinusitis, six (10.9%) cases of intrasinus calcification and 20 (36.4%) cases of maxillary sinus-wall thickening were present, compared with 13 (72.2%) and 16 (88.9%), respectively, in fungal sinusitis (both p < 0.05). Bony erosion was present in five (9.1%) cases of chronic rhinosinusitis and two (11.1%) cases of fungal sinusitis, but this difference was not significant (p = 0.801). In fungal sinusitis, calcification was distributed centrally in 11 and peripherally in two cases; three linear, three nodular, and seven fine punctate-type calcifications were present.

DISCUSSION

Unilateral paranasal sinus disease dominated by opacification of the maxillary sinus is an uncommon finding that was present in 10.7% of the 1246 patients in this study. The reported incidence in the literature varies from 2.5% to 23.1% [1, 4-6]. The wide variation in incidence may be due to differences between study designs. Our cases were referred for evaluation of sinusitis, whereas the study by Romashko [5] was based on patients who underwent functional endoscopic sinus surgery. In the study by Rudralingam et al. [1], the authors did not define the imaging extent of unilateral sinus opacification. Although our criteria for unilateral sinus opacification were similar to those of Ahsan [4], the discrepancy in incidence may be accounted for by the differences in the study population and the thresholds for CT referrals from the otorhinologic clinic. A recent Korean
series [6] based on sinus surgery patients reported a higher incidence of 23.1%.

Chronic rhinosinusitis (72.4%) was the most common cause of unilateral maxillary sinus opacification in our study. This incidence is within the range of 46.4% to 79% previously reported [1, 5-8] (Table 3). Some features suggest that chronic rhinosinusitis may be the cause of unilateral paranasal sinus disease. In a study of 12 patients, Silver et al. [9] found that chronic rhinosinusitis was correlated with a decrease in sinus size. Other features included a thickened sinus wall, focal bony erosions in areas of normal dehiscence, and an absence of effects on the pterygomaxillary fissure. They concluded that pterygomaxillary fissure involvement was specific for neoplastic disease. In contrast, the majority of our patients (Fig. 1) displayed normal maxillary sinus size (89.1%) and wall thickness (60%) and showed no bony erosion (90.9%). Our data indicated that wall thickening was a prominent feature of fungal sinusitis (88.9%) compared with chronic rhinosinusitis (36.4%).

Intrasinus calcification is often cited as a common finding in fungal sinusitis. In this study, we found a significantly higher incidence of intrasinus calcification in patients with fungal sinusitis (72.2%) compared with patients with chronic rhinosinusitis (10.9%). Our data showed that 84.6% of patients with fungal sinusitis had centrally located calcification (Fig. 2). Yoon et al. [10] assessed 510 patients and found that 51% with fungal sinusitis had intrasinus calcification versus 3% for non-fungal sinusitis. They found that a central, fine punctate, and irregular calcification margin was most likely caused by fungal disease. No invasive fungal sinusitis, which is commonly accompanied by bony destruction and invasion of the adjacent tissue, was evident in our case series. Previous studies [11] have demonstrated that invasive fungal sinuses often present with unilateral sinus disease.

The incidence of neoplasia in unilateral paranasal sinus disease ranges from 11% to 42.9% [1, 4, 6-8]. Our reported incidence of 3.9% was based on histologically-proven cases. By scaling the ratio for all unilateral sinus patients in our sample and histologically-proven cases, the upper limit of incidence could be 6.9%. This incidence may be explained by the relatively low biopsy rate of 56.7% in our series and by differences in the ethnicity of the studied populations. Inverted papilloma is the most common neoplasia reported. In the present study, we found two cases of inverted papilloma in three of neoplastic disease (Fig. 3).

Table 2. Comparison of CT Features of Chronic Rhinosinusitis and Fungal Sinusitis

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Chronic (n = 55)</th>
<th>Fungal (n = 18)</th>
<th>Significance (Pearson’s χ² test)</th>
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</thead>
<tbody>
<tr>
<td>Sinus involved</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isolated maxillary</td>
<td>18 (32.7)</td>
<td>2 (11.1)</td>
<td>0.019</td>
</tr>
<tr>
<td>Ethmoid</td>
<td>10 (18.2)</td>
<td>9 (50.0)</td>
<td></td>
</tr>
<tr>
<td>Ethmoid &amp; Frontal</td>
<td>27 (49.1)</td>
<td>7 (38.9)</td>
<td></td>
</tr>
<tr>
<td>Calcification</td>
<td>6 (10.9)</td>
<td>13 (72.2)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wall character</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thickening</td>
<td>20 (36.4)</td>
<td>16 (88.9)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Erosion</td>
<td>5 (9.1)</td>
<td>2 (11.1)</td>
<td>0.801</td>
</tr>
</tbody>
</table>

% in parenthesis.

Table 3. Summary of Unilateral Paranasal Sinus Disease Studies

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Sample size</td>
<td>1256</td>
<td>1118</td>
<td>524</td>
<td>372</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Unilateral</td>
<td>134 (10.7)</td>
<td>28 (2.5)</td>
<td>121 (23.1)</td>
<td>20 (6.0)</td>
<td>64</td>
<td>43</td>
</tr>
<tr>
<td>Inflammatory</td>
<td>55 (72.4)</td>
<td>13 (46.4)</td>
<td>97 (80.2)</td>
<td>14 (70.0)</td>
<td>39 (60.9)</td>
<td>24 (56.0)</td>
</tr>
<tr>
<td>Neoplasia</td>
<td>3 (3.9)</td>
<td>12 (42.9)</td>
<td>24 (20.0)</td>
<td>6 (30.0)</td>
<td>7 (11.0)</td>
<td>16 (37.0)</td>
</tr>
</tbody>
</table>

% in parenthesis. Inflammatory group includes fungal causes. Neoplasia group includes benign and malignant tumors.
Figure 1. Chronic rhinosinusitis. Coronal CT of the paranasal sinus showed complete opacification of left maxillary, ethmoid and frontal sinuses. There was absence of wall thickening or erosion.

Figure 2. Fungal sinusitis. Coronal CT of the paranasal sinus showed complete opacification of left maxillary and ethmoid sinuses. There is a cluster of linear calcifications and maxillary wall thickening.
Inverted papilloma can be difficult to differentiate from chronic rhinosinusitis or fungal disease by routine sinus CT because no intravenous contrast is administered. However, both cases of inverted papilloma showed choanal extension, which is uncommon in chronic rhinosinusitis. Furthermore, tumor-induced sinusitis showed unilateral paranasal sinus disease in as many as 93% of cases in previous studies [12].

In summary, much effort has been made to differentiate tumor-induced sinus disease from ordinary chronic rhinosinusitis in unilateral sinus disease. The differential diagnosis can be challenging. Lee [6] reported higher Lund–Mackay scoring in patients with malignant neoplasia due to obliteration of the ostiomeatal unit. Although relatively rare, the early detection of a nasomaxillary carcinoma is clinically important, as it carries a poor prognosis in view of the advanced stage at first presentation. The detection of unilateral paranasal sinus disease dominated by unilateral maxillary sinus opacification may be alarming; however, this pattern of sinusitis is commonly due to ordinary chronic rhinosinusitis. In histopathological studies of 790 patients who underwent routine endoscopic sinus surgery, no neoplasms were found in the 13.9% of patients with unilateral sinusitis [5]. With the aid of careful history assessment and comprehensive clinical examinations, neoplastic disease is distinguishable [1, 4-6].

This retrospective study has some limitations. Of the cases studied, 43.3% lacked histopathological evidence. Our reported incidence of neoplasia and chronic rhinosinusitis may therefore not reflect study population. The current guidelines for the management of rhinosinusitis involve oral medication [13], local sinonasal drainage and irrigation [14], and sinonasal surgery following adequate medical treatment [15]. This may explain why not all the patients undergo surgery or surgical biopsy. Another shortcoming was the review of the CT images without correlation to relevant history, clinical examination, or endoscopic examination.

CONCLUSIONS

The prevalence of unilateral paranasal sinus disease dominated by maxillary sinus opacification on routine paranasal sinus CT scans was 10.7%, and the condition is considered uncommon. Chronic rhinosinusitis (fungal and non-fungal origin) constituted up to 96% of cases, with a 4% to 7% incidence of neoplasia. Comprehensive evaluation of the symptoms and CT findings would therefore aid the diagnosis of unilateral sinus disease.
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