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Prevalence of Pus in Radiologically Diseased Sinuses in Patients Undergoing Surgery For Chronic Rhinosinusitis

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OBJECTIVE: To establish the prevalence of pus in radiologically diseased sinuses in patients undergoing sinus surgery and to correlate this with the bacterial load in the sinuses.

STUDY DESIGN AND SETTING: A prospective study performed on adult patients with the diagnosis of chronic sinusitis undergoing endoscopic sinus surgery at an Adelaide group of academic hospitals. In 45 consecutive and unselected patients, a radiologically diseased sinus was surgically opened, and a specially designed suction aspirator was placed into the sinus under endoscopic control. These aspirates were Gram stained and cultured to quantify the polymorphonuclear neutrophil count, bacterial flora, and bacterial colony count. The CT scans of all patients were graded by using the Lund-Mackay scoring system.

RESULTS: A variety of bacteria, most commonly staphylococci, were cultured from a radiologically diseased sinus in 88% of patients. There was no correlation between the bacterial colony count and presence of pus, and only 11% of patients had microscopic evidence of inflammation in sinus aspirates. There was no correlation between the Lund-Mackay CT score and the presence of pus in the sinus.

CONCLUSIONS: The majority of patients undergoing surgery for chronic sinusitis did not have a purulent exudate, and there was no correlation with the bacterial load. The usefulness of antibiotics in the treatment of chronic rhinosinusitis, in the absence of macroscopic pus, is questionable. © 2005 American Academy of Otolaryngology–Head and Neck Surgery Foundation, Inc. All rights reserved.

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sinuses in patients undergoing sinus surgery and to correlate this with the bacterial load in these sinuses.

MATERIAL AND METHODS

Ethics approval for the study was obtained from The Queen Elizabeth Hospital Ethics Committee. All patients were fully informed about the study before consenting to be enrolled.

A prospective study was conducted at the Otolaryngology Department of The Queen Elizabeth Hospital between September 1999 and December 2002. Diagnosis of CRS was made on the basis of nasal obstruction, facial pain, nasal discharge, or decreased sense of smell for longer than 12 weeks that was associated with inflammatory changes of the sinonasal mucosa on examination and with radiologic changes on CT scanning.7,8 Patients fulfilling these diagnostic criteria who had failed medical treatment and had consented to endoscopic sinus surgery were enrolled in the trial. Patients who had previously undergone sinus surgery were excluded from the study. Patients who had received antibiotics during the 4 weeks before surgery were excluded. Patients’ CT scans were assessed for disease severity at the time of surgery by the operating surgeon and were scored by using the standard Lund-Mackay CT scan scoring system.8 The nose, face, and upper lip of the patient were disinfected with povidone-iodine solution before the sterile draping of the head. The maxillary, ethmoid, and frontal sinuses were surgically opened by using standard endoscopic sinus surgical techniques. A sterile nasal secretion aspirator with a suction port (Medtronic Xomed, Jacksonville, FL) was endoscopically placed into a radiologically diseased sinus, ensuring that the tip of the aspirator did not touch the nasal cavity walls or the turbinates before entering the selected sinus. Once the aspirator was in the sinus, the suction port was closed, and the tip of the aspirator was brought into contact with the mucosa of the sinus. Secretions were aspirated from the sinus. The operator’s finger was moved off the suction port to ensure that no further suction occurred through the aspirator tip while the aspirator was withdrawn from the sinus and nasal cavity. In all patients, 1 mL of sterile heparinized saline then was aspirated to recover any residual mucus from the aspirator tubing into the collection jar. Specimens were immediately transferred to the laboratory, and 0.1-mL aliquots were inoculated onto a blood agar plate (Columbia agar with 5% horse blood) and chocolate blood agar plate (Columbia agar with heated 5% horse blood), incubated at 35°C in CO2 atmosphere for 24 hours, and the number of organisms per milliliter of fluid were quantified as follows: nil, scanty (10^2 organisms per milliliter), light (10^3-10^4 organisms per milliliter), moderate (10^5-10^6 organisms per milliliter), and heavy (>10^7 organisms per milliliter). These organisms were identified by standard means. Part of the specimen was prepared with a Gram-stained smear and examined to quantify polymorphonuclear leukocytes (PML) and the microbial flora. This was examined with oil immersion (total magnification, 1000×), and PML were graded as nil (0 PML per field), occasional (<1 PML per field), few (1-5 PML per field), moderate (6-15 PML per field), and numerous (>15 PML per field).

RESULTS

A total of 45 patients fulfilled the inclusion criteria and had complete data available for analysis. The mean age (±SD) was 47 ± 3.6 years, with the mean for females being 41 years and that for males, 49 years. The sinus aspirates was taken from the maxillary sinus in 35 patients, the agger nasi cell in 1 patient, the sphenoid sinus in 4 patients, the frontal sinus in 3 patients, the posterior ethmoid in 1, and the anterior ethmoid in 1 patient. Only 5 (11%) patients had evidence of inflammation (>1 PML visible per high-power field) in the sinus aspirate. Eight patients (18%) had a negative culture from the radiologically diseased sinus aspirate; the others had bacterial counts ranging from 10 to 50,000 colony-forming units per milliliter. These bacterial colony counts were further quantified by dividing them into no growth (n = 8 patients), scanty with bacterial colony count of between 10 and 10^2 organisms per milliliter (n = 13), light growth with colony count of between 10^2 and 10^3 (n = 13), moderate growth with colony count of between 10^3 to 10^4 (n = 9), and heavy growth with colony count of more than 10^4 (n = 2). Of the 45 aspirates from diseased sinuses, 65 bacterial isolates were identified (Table 1). In 30 (46%) patients, there was a single isolate; in 10 (31%), there were 2 bacterial species, and in 5 (23%) cases, 3 organisms were identified. There was no correlation between the bacterial colony count and neutrophil numbers using Spearman’s correlation coefficient (r = 0.13; Fig 1). The mean (± SD) Lund-Mackay CT scan score for all sinuses was

<table>
<thead>
<tr>
<th>Organism</th>
<th>Number (%) of patients infected</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Growth</td>
<td>8 (18%)</td>
</tr>
<tr>
<td>Coagulase-negative staphylococci</td>
<td>24 (53%)</td>
</tr>
<tr>
<td>Citrobacter koseri</td>
<td>2 (4%)</td>
</tr>
<tr>
<td>Coliform (unspecified)</td>
<td>1 (2%)</td>
</tr>
<tr>
<td>Corynebacterium species</td>
<td>2 (4%)</td>
</tr>
<tr>
<td>Moraxella catarrhalis</td>
<td>3 (7%)</td>
</tr>
<tr>
<td>Proteus mirabilis</td>
<td>2 (4%)</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>5 (11%)</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>15 (33%)</td>
</tr>
<tr>
<td>Streptococcus intermedius</td>
<td>1 (2%)</td>
</tr>
<tr>
<td>Streptococcus pneumoniae</td>
<td>2 (4%)</td>
</tr>
</tbody>
</table>

Table 1
Culture results of endoscopically-guided aspirates of radiologically diseased sinuses in patients with chronic sinusitis
13.03 ± 6.36. The mean (± SD) CT scan scores for patients with a positive culture or a negative culture were 12.94 ± 7.15 and 13.32 ± 5.24, respectively. This was not statistically different when analyzed by using a 1-way analysis of variance (0.416).

DISCUSSION

In this study, significant inflammation (as defined by PML > 1 per high-power field) was present in only a small minority of patients with a positive bacterial culture from a radiologically diseased sinus. Furthermore, the surface mucosal bacterial colony count did not correlate with the microscopic neutrophil count, suggesting that presence of bacteria in the sinuses in most cases does not elicit a significant host neutrophilic inflammatory response. In addition, the presence or absence of bacteria on sinus aspirate did not relate to the radiological severity of disease. In this study, considerable attempts were made to reduce the likelihood of bacterial contamination of the specimen, and despite this, the most prevalent organisms were coagulase-negative staphylococci recovered from half of the patients, followed by Staphylococcus aureus in a third (33%). Although coagulase-negative staphylococci are widely believed to be contaminants, their role as a pathogen in chronic sinusitis is yet to be agreed upon, and they have been commonly identified in the sinuses of patients in whom swabs were taken at the time of surgery and in patients on systemic corticosteroids.5,9 Gram-negative bacteria increasingly have been implicated in CRS. Bolger9 found gram-negative isolates in 34% of patients with CRS, where the isolates were attained by endoscopically guided culture. It was suggested that a “gram negative shift” may occur because of antibiotic treatment of inpatients with CRS. Hsu et al10 found Pseudomonas isolates in 17% of CRS patients. High numbers of gram-negative isolates also were demonstrated by Nadal et al.5 Factors implicated in this shift to gram-negative organisms are prior surgery, prior use of oral steroids, and prior use of nasal irrigations. Our patients had a lower incidence of Gram-negative bacteria, with about 10% having coliforms and a similar number being infected with Pseudomonas aeruginosa. This finding may be due to the fact that we excluded patients who had had previous sinus surgery

This study has found little correlation between the bacterial colony counts, neutrophil numbers, and the extent of disease as seen on the CT scan. The absence of pus in the majority of our patients with diseased sinuses demonstrates that even though bacteria are present in the sinuses of patients with CRS, there is a lack of a neutrophilic response that is typical of infections produced by pyogenic bacteria in the sinus secretions.11 Further studies of mucosal biopsies to determine whether there is a chronic mononuclear inflammatory reaction would be of value. Nevertheless, these findings have led us to change our treatment protocol for patients with CRS. Antibiotics now are prescribed only when pus is seen macroscopically on nasal endoscopy, in which case the pus is cultured and the antibiotic therapy is targeted according to the bacterial culture and sensitivity results.

This approach is supported by the observations of Jiang et al,12 who demonstrated in patients with CRS with no evidence of pus that a 2-week course of amoxycillin-clavulanate therapy before surgery had no effect on the bacteriology of the sinuses when compared with the case of patients who received no antibiotics. They found that 41% of patients treated with antibiotics and 42.5% of patients not treated with antibiotics had a positive culture from the maxillary or anterior ethmoid sinuses. It is unclear whether this was caused by the bacteria in the sinuses being in a form such as a biofilm in which they would be resistant to antibiotics. In contrast to the results of the Jiang et al study and of this study, Klossek et al13 demonstrated the presence of pus in 36.3% of middle meatal swabs in patients with CRS.

The idea that the use of antibiotics may be of little benefit in patients with CRS without pus needs further clinical investigation. No prospective clinical trials have examined the benefits of treating patients with CRS with antibiotics and adjuvant treatment (typically saline irrigations and topical nasal steroids) versus adjuvant treatment alone. Retrospective studies have indicated a benefit in treating patients with medical treatment14,15 but have not separated patients treated with antibiotics and adjuvant treatment from those treated with adjuvant treatment alone. Such a double-blinded randomized study would improve our understanding of the pathophysiology of CRS and may help reduce the increasing bacterial resistance to antibiotics seen today.

In conclusion, this study found that bacteria in radiologically diseased sinuses did not elicit a significant neutrophilic immune response in most patients. The usefulness of
antibiotics in the treatment of CRS, in the absence of pus, is questionable.

REFERENCES