Original Article

Evaluation of acute bacterial rhinosinusitis in asthma patients based on clinical parameters and imaging studies, together with ear, nose and throat examination*,**

Avaliação da rinussinusite bacteriana aguda em pacientes asmáticos com base em parâmetros clínicos, exame otorrinolaringológico e estudo de imagem

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Abstract

Objective: To evaluate paranasal sinuses in patients with stable or acute asthma in order to determine the prevalence of acute bacterial rhinosinusitis. **Methods:** A cross-sectional study including 30 patients with acute asthma (73% females) treated in the emergency room and 30 patients with stable asthma (80% females) regularly monitored as outpatients. All patients completed a questionnaire on respiratory signs and symptoms and were submitted to ear, nose and throat (ENT) examination, as well as to X-ray and computed tomography (CT) imaging of the sinuses. **Results:** Based on the clinical diagnosis, the prevalence of acute bacterial rhinosinusitis was 40% in the patients with acute asthma and 3% in those with stable asthma. The ENT examination findings and the imaging findings in isolation were not useful to confirm the diagnosis. **Conclusions:** In themselves, ENT examination findings, X-ray findings and CT findings were not useful for the diagnosis of acute bacterial rhinosinusitis. Our results provide further evidence that a clinical diagnosis of bacterial rhinosinusitis should be made with caution.

Keywords: Asthma; Sinusitis; Radiography; Tomography, X-ray computed; Endoscopy.

Resumo

Objetivo: Avaliar os seios paranasais em asmáticos estáveis e asmáticos agudizados para determinar a prevalência de rinossinusite bacteriana aguda. **Métodos:** Estudo transversal incluindo 30 pacientes com asma aguda (73% do sexo feminino) tratados na sala de emergência e 30 pacientes estáveis (80% do sexo feminino) regularmente acompanhados em ambulatório. Todos os pacientes responderam a um questionário sobre sinais e sintomas respiratórios e foram submetidos a exame otorrinolaringológico e a radiograma e tomografia computadorizada de seios da face. **Resultados:** Com base no diagnóstico clínico, a prevalência de rinossinusite bacteriana aguda foi de 40% nos pacientes com asma aguda e de 3% nos com asma estável. O exame otorrinolaringológico e os exames de imagem isoladamente não foram úteis para a confirmação diagnóstica. **Conclusões:** O exame otorrinolaringológico e o radiograma e a tomografia de seios da face por si só não foram úteis para o diagnóstico de rinossinusite bacteriana aguda. Nossos resultados confirmam a evidência de que o diagnóstico clínico de rinossinusite aguda deve ser dado com cautela.

Descritores: Asma; Sinusite; Radiografia; Tomografia computadorizada por raios X; Endoscopia.

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Introduction

Rhinosinusitis is one of the most commonly reported chronic diseases in the world and is responsible for lost productivity, as well as for a substantial number of medical visits.[1] The most common cause of rhinosinusitis is community-acquired viral infection leading to upper respiratory symptoms that are self-limited in their duration. In 0.5 to 2% of all cases, viral rhinosinusitis evolves to bacterial infection.[2]

The relationship between rhinosinusitis and asthma has long been recognized. The interaction between sinus mucosa membrane inflammation and lower airway inflammation has frequently been studied.[3,4] For decades, studies have reported the high frequency of X-ray findings consistent with rhinosinusitis in patients with respiratory allergies or asthma.[5,6] In addition, clinical investigations have suggested that asthma improves after medical or surgical treatment of the accompanying rhinosinusitis.[7-9]

However, there is little specific information on whether upper respiratory disease contributes to the pathogenesis of asthma or represents an extension of a syndrome of inflammatory airway disease.[10,11] There is a tendency toward a unified approach to treating allergic rhinosinusitis and asthma.[12]

In primary care, a diagnosis of acute bacterial rhinosinusitis is difficult to define, typically being based only on symptoms and clinical examination. This practice leads to many false-positive diagnoses and unnecessary use of antibiotics, since the symptoms are not pathognomonic and can overlap with those of other respiratory disorders.[13]

The aim of this study was to describe the clinical presentation of acute bacterial rhinosinusitis and bacterial exacerbation of chronic rhinosinusitis in patients with stable or acute asthma. In addition, we attempted to determine the diagnostic value of findings obtained through ear, nose and throat (ENT) examination findings, as well as through imaging studies using X-rays and computed tomography (CT) scans.

Methods

This was a cross-sectional study involving patients diagnosed with asthma according to the Global Initiative for Asthma (GINA) criteria.[14] The exclusion criteria were as follows: being a smoker or a former smoker with a smoking history of more than 5 pack-years; presenting cardiac, hepatic, or renal comorbidities; being pregnant or nursing; having undergone sinus surgery; having used antibiotics within the 2 weeks preceding recruitment; and presenting any lower respiratory tract infection at enrollment.

Patients with acute asthma admitted to the emergency room of the *Hospital São Paulo*, located in the city of São Paulo and operating under the auspices of the Federal University of São Paulo/Paulista School of Medicine, were invited to participate in this study. In addition, patients with stable asthma were recruited from the asthma clinic, where they had been monitored for at least 6 months. All participating patients gave written informed consent. The consent form was approved by the ethics committee of the institution.

Acute asthma was defined as acute or subacute episodes of progressively worsening shortness of breath, cough, wheezing, or chest tightness. Severity was defined according to the GINA guidelines.[14]

After clinical evaluation and peak expiratory flow rate measurement, all patients received 400 μg of fenoterol every 15 min until they could safely continue the evaluation.

All patients were submitted to systematic investigation of the following: facial congestion; facial pain; nasal obstruction; purulent postnasal discharge or purulent rhinorrhea; and hyposmia, anosmia or cacosmia.

The patients with stable asthma were under long-term continuous treatment involving the daily use of inhaled corticosteroids. None had a history of emergency room visits or hospitalizations for asthma, nor had any presented upper respiratory

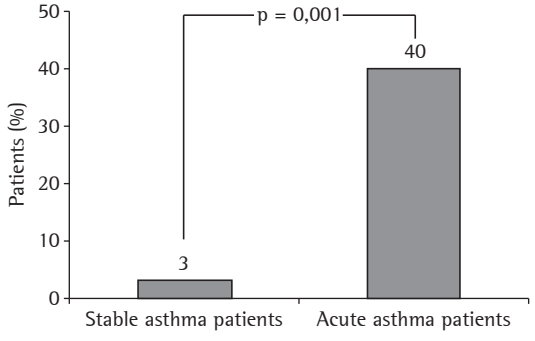

Figure 1 - Prevalence of clinical diagnosis of acute bacterial rhinosinusitis in patients with stable or acute asthma.

tract infections in the preceding 30 days, a change in the use of maintenance medication for asthma in the preceding 30 days, or worsening of the asthma symptoms in the preceding 15 days.[14]

The clinical diagnosis of acute bacterial rhinosinusitis was based on major and minor criteria.[15,16] The major criteria were as follows: facial congestion; facial pain; nasal obstruction; purulent postnasal discharge or purulent rhinorrhea; and hyposmia or anosmia. The minor criteria were fever, fetid odor, dental pain, ear pain, headache, and cough.[16]

Bacterial rhinosinusitis was clinically defined by the presence of at least two major criteria or one major and two or more minor criteria. When the upper respiratory symptoms lasted up to 4 weeks, the case was considered to be acute bacterial rhinosinusitis, but if the symptoms were chronic and worsened in the last 4 weeks, the case was considered to be an exacerbation of chronic rhinosinusitis.

Sinus X-rays were taken with the patient standing (Waters', Caldwell's, and lateral views) and evaluated for the presence of polyps or polypoid swelling (focal mucosal thickening), mucosal thickening, an air-fluid level, or complete sinus opacity.

Sinus CT was performed using contiguous 3-mm-thick coronal slices through the anterior part of the sinus complex, and subsequently using 5-mm-thick contiguous slices through the posterior part. Axial scans were performed in the inferior orbitomeatal plane using contiguous 5-mm-thick slices from the vertex to the hard palate. The entire nasal cavity and all of the paranasal sinuses were included. A bone algorithm was used, and the films were evaluated using a window width of 2000 Hounsfield units and a window level of 100-400 Hounsfield units. On the CT scan, the presence of complete sinus opacity or of an air-fluid level in one or more sinuses was considered indicative of acute bacterial rhinosinusitis or bacterial exacerbation of chronic rhinosinusitis.[13,15,16] The images were independently evaluated by two radiologists, who were blinded to the clinical data. In cases of discordance, the images were re-evaluated, and the final diagnosis was based on consensus. Using the Waters' view, mucosal thickening of the maxillary sinus was measured as the shortest distance from the air-mucosa interface to the lateral-most part of the maxillary sinus wall. Mucosal thickening was described as the percentage of opacification in relation to the total volume of the sinus.

All patients completed a standardized questionnaire on upper and lower respiratory symptoms, asthma control status, and maintenance medications for asthma. Physical examination, nasal endoscopy, and X-rays were performed on the day of inclusion, and sinus CT was performed within 2 days of enrollment.

The questionnaire elicited information regarding symptoms of nasal obstruction, dental or facial pain, purulent postnasal discharge, hyposmia, anosmia, fetid odor, purulent rhinorrhea, malaise, fever, cough, headache, facial swelling, tearing and sneezing, as well as itching of the pharynx, ears, eyes, and nose.

The ENT examination was performed following the administration of topical oxymetazoline. Nasal endoscopy was used to visualize the middle meatus. If secretions were observed, a Juhn-Tym Tap tube (Xomed Inc., Jacksonville, FL, USA) was used to collect a sample for aerobic/anaerobic culture and sensitivity testing.[17,18]

The chi-square test or Fisher's exact test was used to compare categorical variables between the patients with stable asthma and those with acute asthma. Unpaired t-tests were used to analyze numerical variables. Kappa statistics were used to

Table 1 - Demographic characteristics of the asthma patients evaluated.

Characteristic	Stable asthma (n = 30)	Acute asthma (n = 30)	p
Female, n (%)	24 (80)	22 (73.3)	0.542*
Age (years), mean ± SD	49.3 ± 4.51	42.23 ± 5.03	0.28**
Smoking history (pack-years), mean ± SD	2.1 ± 1.98	2.9 ± 1.98	0.451**
Duration of asthma (years), mean ± SD	27.83 ± 5.53	24.17 ± 5.27	0.333**
Severity of acute asthma exacerbation	N/A	-	N/A
Mild/Moderate, n (%)	-	17 (56.7)	-
Severe, n (%)	-	11 (36.7)	-
Imminent respiratory arrest, n (%)	-	2 (6.6)	-

N/A: not applicable; *chi-square test; and **unpaired t-test.

analyze inter-rater reliability. The level of statistical significance was set at 5%. Data analysis was performed using the Statistical Package for the Social Sciences, version 13.0 for Windows (SPSS Inc., Chicago, IL, USA).

Results

A clinical diagnosis of acute bacterial rhinosinusitis or bacterial exacerbation of chronic rhinosinusitis was made in 12 (40%) of the patients with acute asthma and in only 1 (3%) of the patients with stable asthma (p = 0.001) (Figure 1). The characteristics of the patients are shown in Table 1.

The upper respiratory symptoms and the clinical diagnosis are presented in Table 2. Sneezing and itching (nasal and pharyngeal) were the most common symptoms, and there was little difference between the patients with stable asthma and those with acute asthma in terms of the prevalence of those symptoms. Chronic upper respiratory symptoms were common in both groups. Acute symptoms of rhinosinusitis were identified in 40% of the patients with acute asthma, compared with only 3.3% of those with stable asthma (p = 0.001).

Nasal endoscopy findings were similar in both groups (Table 3). Visible secretion in the middle meatus was observed in 6 patients, and samples of that secretion were collected for analysis. The following microorganisms were identified in five of the six samples: *Staphylococcus aureus*; *Haemophilus influenza*; coagulase-negative staphylococci (in 2 samples); and *Corynebacterium*.

The imaging findings presented in Table 3 showed that mucosal thickening of 25% or less was the most frequent maxillary sinus abnormality in both groups of asthma patients. Complete sinus opacity and an air-fluid level in one or more sinuses were found on the CT scans of 17 patients: 6 in the stable asthma group and 11 in the acute asthma group.

As can be seen in Table 4, there was no concordance between the clinical diagnosis of bacterial rhinosinusitis and the degree of abnormalities observed on the X-rays of the sinuses (kappa = 0.037) or CT scans of the sinuses (kappa = 0.205). Eleven patients (65%) Among the 17 patients with an air-fluid level or complete opacification on the CT scans, there were 11 (6 in the stable asthma group and 5 in the acute asthma group) who did not receive a clinical diagnosis of bacterial rhinosinusitis.

The inter-rater reliability in the interpretation of complete opacification and an air-fluid level was weak for X-rays (kappa = 0.256) and good for CT scans (kappa = 0.735). The X-ray/CT concordance was also weak (kappa = 0.337). The CT scans allowed better visualization of air-fluid level and opacification than did X-rays in both groups of patients.

Table 2 - Upper respiratory symptoms and clinical diagnosis.

	Stable asthma (n = 30)	Acute asthma (n = 30)	p
Symptom	n (%)	n (%)	
Cough	0 (0.0)	2 (6.7)	0.49*
Rhinorrhea	11 (36.7)	6 (20.0)	0.14**
Postnasal drip	14 (46.7)	6 (20.0)	0.06**
Headache	11 (36.7)	5 (16.7)	0.14**
Nasal obstruction	14 (46.7)	8 (26.7)	0.18**
Facial pain	5 (16.7)	3 (10.0)	0.70*
Hyposmia	7 (23.3)	3 (10.0)	0.29*
Cacosmia	6 (20.0)	5 (16.7)	0.73**
Nasal itching	22 (73.3)	18 (60.0)	0.41**
Pharyngeal itching	18 (60.0)	16 (53.3)	0.79**
Sneezing	19 (63.3)	17 (56.7)	0.79**
Dental pain	3 (10.0)	1 (3.3)	0.61
Clinical diagnosis			
Chronic symptoms of rhinosinusitis	26 (86.6)	25 (83.3)	0.769**
Acute symptoms of rhinosinusitis	1 (3.3)	12 (40.0)	0.001*,***

*Fisher's exact test; **chi-square test; and ***statistically significant.

Table 3 - Ear, nose and throat examination and imaging findings.

Characteristic	Stable asthma (n = 30)	Acute asthma (n = 30)	p
	n (%)	n (%)	
	Middle meatus secretion		
Present	1 (3.3)	5 (16.7)	0.19*
Positive culture	1 (0.0)	4 (6.7)	0.35*
	Nasal endoscopy		
Nasal mucosa			0.15**
Normal	6 (20.0)	1 (3.3)	-
Pale	21 (70.0)	26 (86.7)	-
Erythematous	3 (10.0)	3 (10.0)	-
Hypertrophic turbinates	19 (63.3)	25 (83.3)	0.08**
Sinus polyps	1 (3.3)	3 (10.0)	1.00*
	Radiographic findings in the maxillary sinus		
Normal	6 (20.0)	4 (13.3)	-
Mucosal thickening < 25%	19 (63.3)	16 (53.3)	-
Mucosal thickening 25-50%	2 (6.7)	6 (20.0)	0.33**
Mucosal thickening 50-75%	0 (0.0)	2 (6.7)	-
Complete opacification + air-fluid level	3(10.0)	3 (10.0)	-
	Computed tomography findings		
Normal	4 (13.3))	3 (10.0)	-
Mucosal thickening <25%	20 (66.7)	17 (56.7)	-
Mucosal thickening 25-50%	0 (0.0)	2 (6.7)	0.21**
Mucosal thickening 50-75%	2 (6.7)	0 (0.0)	-
Complete opacification + air-fluid level	6 (20.0)	11 (36.6)	-

*Fisher's exact test; and **chi-square test.

Discussion

The prevalence of acute rhinosinusitis, characterized by exacerbation of cough, purulent postnasal drip, headache, malaise, nasal obstruction, facial pain, hyposmia, and pharyngeal itching, was higher in the patients with acute asthma exacerbation. Although the 40% prevalence observed among those patients might appear high, the prevalence of acute bacterial sinusitis has been shown to range from 50 to 80% in adult patients seeking treatment at otolaryngology centers.[19-21]

Our study confirms the high prevalence of rhinosinusitis chronic symptoms in patients with stable asthma and in those with acute asthma, with no evidence of a statistical difference.

Despite technological advances, the clinical confirmation of a diagnosis of acute bacterial rhinosinusitis continues to be problematic.[12,16,22] Various authors have suggested that, in the identification of patients with sinusitis, symptoms and signs are only moderately useful in comparison with sinus aspiration/puncture findings[23,24] or findings consistent with sinusitis on X-rays and CT scans.[25,26]

The gold standard for the diagnosis of acute bacterial rhinosinusitis is a positive culture obtained from a maxillary sinus aspirate. However, this procedure is invasive and is not recommended as a routine screening test in primary care. Another limitation is the rarity of middle meatus secretion, even when a (minimally) invasive procedure, such as nasal endoscopy, is used.[16,18] This was confirmed, in our study, by the fact that only 6 patients (5 in the acute asthma group and 1 in the stable asthma group) presented secretion in the middle meatus. This limitation might hinder the validation of positive culture as the gold standard for confirming a diagnosis of acute bacterial rhinosinusitis.[27]

In all of the asthma patients evaluated, the most common finding in the imaging studies (X-ray and CT) was mucosal thickening of 25% or less, a finding that is not diagnostic of acute bacterial rhinosinu-

Table 4 - Concordance between clinical diagnosis of bacterial rhinosinusitis and extent of sinus disease on X-rays and computed tomography scans.

Clinical diagnosis of bacterial rhinosinusitis[a]	X-ray			Computed tomography		
	Rhinosinusitis –	Rhinosinusitis +[b]	kappa	Rhinosinusitis –	Rhinosinusitis +[b]	kappa
Absent	42	5	0.037	36	11	0.205
Present	12	1		7	6	
Total	54	6		43	17	

[a]defined as the presence of at least two major criteria (facial congestion, facial pain, nasal obstruction, purulent postnasal discharge/purulent rhinorrhea, or hyposmia/anosmia) or one major and two or more minor criteria (fever, fetid odor, dental pain, ear pain, headache, or cough); and [b]rhinosinusitis diagnosed through imaging (complete opacification, air-fluid level or both).

sitis, since studies have shown that there is slight thickening of the sinus mucosa even in individuals with a common cold,[28] as well as in asymptomatic individuals.[29]

The CT and X-ray hallmarks of acute bacterial rhinosinusitis are an air-fluid level or complete opacification in one or more sinuses.[26] Although X-ray might be less expensive than other diagnostic modalities, it failed in providing adequate diagnostic information, and also presented a lower rate of inter-rater reliability than did CT. A meta-analysis comparing X-ray findings with those of sinus puncture revealed that X-ray had moderate sensitivity (73%) and specificity (80%) for identifying bacterial rhinosinusitis.[30]

There is a dissociation between clinical symptoms and CT findings in asthma, as evidenced in the present study by the fact that, of the 17 patients in whom CT scans revealed an air-fluid level or complete opacification in one or more sinuses, 11 did not receive a clinical diagnosis of acute bacterial rhinosinusitis.

In patients with recurrent or complicated sinus disease, CT is typically required in order to define the anatomy of the sinuses prior to surgery and to inform the diagnosis and management of recurrent or chronic rhinosinusitis.[16,28,29]

Rhinosinusitis has been considered a precipitating factor in acute asthma. Among the acute asthma patients evaluated in the present study, the prevalence of acute bacterial rhinosinusitis was 40%. However, the scarcity of middle meatus secretion was an obstacle to establishing a gold standard definition of the disease. The CT findings showed poor concordance with the clinical diagnosis of acute bacterial rhinosinusitis. In isolation, ENT examination findings, X-ray findings and CT findings were of little use in confirming the diagnosis. These results provide further evidence that a clinical diagnosis of acute bacterial rhinosinusitis should be made with caution.

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