ORIGINAL CONTRIBUTION

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Reappraising the role of radiography in the diagnosis of chronic rhinosinusitis*

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SUMMARY

Objective: *To revaluate the role of radiography in the diagnosis of chronic rhinosinutis, versus the currently suggested standards of computed tomography (CT) or nasal endoscopy.*

Materials and methods: *In total, 269 children consecutively admitted to our Unit for symptoms suggestive of chronic rhinosinusitis were included in this study; of these 222 were confirmed by fiberoptic nasopharyngeal endoscopy to have chronic rhinosinusitis, while 47 were not. Analysis of sensitivity and specificity of plain radiography by Waters' projection was carried.*

Results: *Radiography had a sensitivity of 84.2% (95% confidence interval 78.8 to 88.8), and a specificity of 76.6% (95% confidence interval 62.0 to 87.7) against the standard of nasal endoscopy.*

Conclusions: *In routine practice, the clinical diagnosis of chronic rhinosinusitis may be obtained in many cases by Waters' projection radiography, limiting more expensive CT scanning or endoscopic techniques, which remain the reference diagnostic tools, to a smaller number of patients.*

Key words: rhinosinusitis, sinus radiology, Waters' projection, nasal endoscopy, children

INTRODUCTION

The prevalence of chronic rhinosinusitis in the general population is scantly investigated. Two surveys performed in the US on adults in the nineties detected by interviews a similar value of about 15% [1,2]. A much lower prevalence – about 2% – was instead reported in a study based on the physician's diagnosis [3]. The few available data on children are similarly contrasting: an old study found by clinical and radiographic evidence that 30% of children aged 1 to 6 years and 15% of those aged 6 to 12 years had sinusitis [4]. More recently, a survey by magnetic resonance imaging (MRI), in an unselected population of children, detected a prevalence of signs of sinusitis in 45%, with a value increasing to 50% in the presence of nasal obstruction and to 100% in the presence of purulent secretions [5].

This draws the attention to the relative importance of signs and symptoms suggesting sinusitis. The recent European Position Paper on rhinosinusitis and nasal polyps suggests that the following symptoms: nasal blockage, congestion or stuffiness, nasal discharge or postnasal drip, often mucopurulent, facial pain or pressure, headache, and reduction/loss of smell should be taken into consideration to asses the diagnosis of rhinosinusitis [6].

Concerning the imaging criteria, plain sinus x-rays are stated as "insensitive and of limited usefulness due to the number of false positive and negative results", while computed tomography (CT) scanning is "the imaging modality of choice confirming the extent of pathology and the anatomy" even though, "it should not be regarded as the primary step in the diagnosis of the condition" [6]. Moreover, CT scanning has a much higher cost and exposes patients to higher radiation doses [7].

We sought to revaluate the diagnostic performances of plain radiography in children with chronic rhinosinusitis established by the combination of clinical symptoms and nasal endoscopy.

METHODS

Patients

The study population included 269 children consecutively admitted to the Pediatric Allergy and Respiratory Pathophysio-

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Table 1. Characteristics of patients.

	N	males/ females	mean age (range)
Patients with chronic rhinosinusitis (positive endoscopy)	222	127 / 95	5.2 (2.1 – 13.9) years
Patients without chronic rhinosinusitis (negative endoscopy)	47	27 / 20	5.7 (1.9 – 12.4) years

logy Unit of the Children's Hospital, Milan, for symptoms suggestive of chronic rhinosinusitis in the period 2003-2005. Of these, 222 had a firm diagnosis of chronic rhinosinusitis established by a fiberoptic nasopharyngeal endoscopy, while in 47 children endoscopy was negative (Table 1).

Clinical diagnosis

The symptoms considered indicative of rhinosinusitis were those generally accepted, i.e nasal blockage, congestion or stuffiness, nasal discharge or postnasal drip, also mucopurulent, facial pain or pressure, headache, and reduction/loss of smell. Chronic rhinosinusitis was defined, according to the European Position Paper on Rhinosinusitis and Nasal Polyps [6], by the presence of two or more of such symptoms (one of which being either nasal blockage/obstruction/stuffiness or nasal discharge) for more than 12 weeks.

Exclusion criteria were maxillary sinus inflammation of suspected dental aetiology, gross anatomical abnormalities or congenital syndromes of the upper airway, immunodeficiency, cystic fibrosis, ciliary dyskinesia, tumour, trauma, and acute asthma.

Radiography

The radiography of paranasal sinuses was performed by the Waters' or occipito-mental projection. This was made with the patient's chin positioned against the case, with the head in a backward position. The parents cooperation was needed for younger patients. The orbitomeatal line was set at an angle of 40° with the case, to avoid overprojection of the maxillary sinuses by the petrosal bones, and to obtain the complete outline of the maxillary sinus. All radiographs were made by the same team of radiographers with standardized procedures. The maxillary and frontal sinus radiographs were considered to be abnormal if they showed mucosal thickening > 4 mm (Figure 1), or complete opacification (Figure 2), or an air-fluid level (Figure 3).

Figure 1. Male 5 yrs old, rhinosinusitis. Bilateral thickening of more that 4 mm is visible in both maxillary sinuses.

Nasal endoscopy

Nasopharingeal endoscopy was performed by fiberoptic flexible nasopharingoscope Storz 11101 SK of 2.5 mm of diameter (Karl Storz GmbH & Co. KG D, Tuttlinghen, Germany); in all cases endoscopic evaluation included nasal turbinates, middle meatus, and the rhinopharynx. The diagnosis of rhinosinusitis was confirmed by the following endoscopic signs: mucopurulent discharge primarily from the middle meatus, and/or oedema or mucosal obstruction primarily in the middle meatus. A single otolaryngologist performed all the assessments.

Statistical analysis

Sensitivity (true positive proportion) was calculated as the proportion of children with positive sinus radiography among children with endoscopically confirmed chronic rhinosinusitis; specificity (true negative proportion) as the proportion of children with negative radiography among non-diseased (i.e., with a negative endoscopy) subjects. We calculated 95% confidence intervals for these proportions using the exact binomial method.

RESULTS

In the group with demonstrated chronic rhinosinusitis, a positive radiography of maxillar or frontal sinuses was present in 187 out of 222 children, corresponding to a sensitivity of 84.2% (95% confidence interval 78.8 to 88.8); in the group without

Figure 2. Female 6 yrs old, rhinosinusitis. Complete opacification of right maxillary sinuses is evident. The left maxillary shows an air-fluid level.

rhinosinusitis a negative radiography was present in 36 out of 47 children, with a specificity of 76.6% (95% confidence interval 62.0 to 87.7).

Table 2. Radiographic findings in maxillary sinuses among patients with confirmed chronic rhinosinusitis.

	Right maxillary sinus		Left maxillary sinus	
Normal	74	33.3%	57	25.7%
Mucosal thichening > 4 mm	76	34.2%	103	46.4%
Opacification	69	31.1%	59	26.6%
Air-fluid level	3	1.3%	3	1.3%
Total	222	100.0%	222	100.0 %

Table 2 shows the kind of radiographic alterations in maxillary sinuses among the subjects with confirmed rhinosinusitis, which were detected in 185 children (83.3%). The alterations were monolateral in 57 cases (25.7%) and bilateral in 128 cases (57.6%). The right and the left maxillary sinuses were involved in 148 (66.7%) and in 165 children (74.3%), respectively.

Table 3. Radiographic findings in frontal sinuses among patients with confirmed chronic rhinosinusitis.

	Right frontal sinus		Left frontal sinus	
Normal	192	86.5 %	196	88.3 %
Mucosal tickening > 4 mm	21	9.5 %	12	5.4 %
Opacification	9	4.0 %	14	6.3 %
Air-fluid level	0	0.0 %	0	0.0 %
Total	222	100.0 %	222	100.0 %

Table 3 shows the kind of radiographic alterations in frontal sinuses among the rhinosinusitis group, detected in 42 children (18.9%), in 28 cases monolateral (12.6%), and in 14 bilateral (6.3%). The right and the left frontal sinuses were involved in 30 (13.5%) and in 26 (11.7%) children, respectively.

In the non-diseased group radiographic alterations were detected only in maxillary sinuses, in 7 cases monolateral (14.9%), and in 4 bilateral (8.5%). In the right maxillary sinus thickening of the mucosa > 4 mm in 5 children (10.6%) was detected, and no other alteration, while in the left maxillary sinus there was thickening of the mucosa > 4 mm in 10 children (21.3%).

DISCUSSION

Plain radiography of the paranasal sinuses is a non-invasive and fast examination to evaluate maxillary, frontal, sphenoid and posterior ethmoid sinuses, while it is inadeguate to assess the anterior ethmoid, and the infundibular, middle meatus and frontal recess air passages [8]. When maxillary and frontal sinuses are the main objective of x-ray examination, the Water's projection is the most useful.

Until the development of CT, and MRI, radiography was the mainstay of imaging in sinusitis. In the latest decade CT scanning became the recommended imaging technique because it accurately depicts the sinus anatomy, including soft tissue changes, the ostiomeatal complex, and the possible complications involving the orbit or intracranial structures [9,10]. The comparison of MRI and CT shows better performances of the former concerning diagnosis of neoplastic processes, while CT has the advantage in defining the bony structure, and to our interest, in detecting chronic rhinosinusitis [11].

However, while CT remains the gold standard for sinus disease with surgical indications, its use in the routine diagnosis of chronic rhinosinusitis is debatable because of the higher amount of radiation exposure and the much higher cost in respect to plain radiography. Regarding the first aspect, data from a large radiology department showed that CT accounted for 15% of the procedures but 75% of the radiation dose [12], and this is especially important for children [7]. Moreover, the direct comparison of plain radiography in the recommended Waters' projection, and CT scanning resulted in contrasting observations. In a study performing Waters' view radiography, and high resolution CT, in the same day in 134 patients, and using CT findings as the gold standard, plain radiography had a sensitivity of 68%, and a specificity of 87% [13]. Instead, in a study on 40 patients with suspected chronic maxillary sinusitis undergoing Waters' projection, and CT as the reference standard, the former had a sensitivity of 83.3%, and a specificity of 69.2% [14]. In another survey on 91 children with clinically significant chronic sinusitis, sensitivity and specificity against CT of 76% and 81%, respectively, were observed [15]. In a comparison study, incidences of matched diagnosis of plain radiography and CT were 78.4% for maxillary sinus and 71.1% for frontal sinus [16]. Of note, Waters' view gave better performance when interpreted by radiologists or ENT surgeons [17].

In the present study, conducted on a large population of children with suspected chronic rhinosinusitis, a plain radiograph by Waters' view interpreted by a radiologist had a sensitivity of 84.2% (95% confidence interval 78.8 to 88.8), and a specificity of 76.6% (95% confidence interval 62.0 to 87.7). These values were obtained using a different reference standard, that is, nasal endoscopy, which allows direct vision of the nasal cavity, nasal septum, middle meatus, turbinates, sphenoetmoidal recess, choane, adenoid, and the nasopharyngeal part of the Eustachian tube. Such a procedure is recommended in the diagnosis of rhinosinusitis in the most recent consensus document [6] and correlated well with CT in past studies on patients with chronic rhinosinusitis [18]. We recently used it to achieve a firm diagnosis of sinusitis in children with the aim to evaluate its relationship with middle ear dysfunction [19]. However, nasal endoscopy is hardly feasible as a routine procedure, mainly because of the high cost of the materials. A recent cost-analysis in the UK found that the cost of disposable sheaths for nasal endoscopy averaged about 4000 pounds per month over a six months peri-

od [20]. If the sheaths are not used, the nasoscope must be sterilized or disinfected each time (that is a less expensive but still effective hygiene measure), because each endoscopy has an associated infection risk classified as "semicritical" or "intermediate" risk, requiring high level disinfection [21].

In any case, the diagnosis of chronic rhinosinusitis must rely upon parameters more solid than clinical symptoms alone. A recent survey on 703 adult patients with the common symptoms reported for chronic rhinosinusitis, such as nasal obstruction or congestion, discharge, headache, facial pressure, and dysosmia, which had as reference the CT findings [22], concluded that no symptom was able to distinguish between normal and diseased subjects, apart from dysosmia, which obtained the only significant difference ($p = 0.008$). By contrast, in children with acute rhinosinusitis the diagnosis by clinical symptoms is confirmed by nasal endoscopy in 89% of cases [23].

The results of the present study indicate that in children with symptoms suggesting chronic rhinosinusitis, a plain radiography by Waters' projection is able to identify about 85% of subjects suffering from CRS, as confirmed by nasal endoscopy, while maintaining a satisfactory specificity in disease free subjects. This suggests that in most cases of suspected chronic rhinosinusitis a Waters' projection radiography may help in establishing the diagnosis and in suggesting further procedures. It could indicate the most appropriate technique, for example CT when a surgical indication is apparent. Thus, the findings from Waters' projection may limit the need to resort to more expensive or risky radiologic or endoscopic techniques, even if plain radiography cannot replace neither CT nor nasal endoscopy as a reference diagnostic tool. In particular, about 16% of our patients should have been considered not diseased by radiography, while rhinosinusitis was actually diagnosed by nasal endoscopy.

In conclusion, in routine practice, the clinical diagnosis of chronic rhinosinusitis in children may be obtained in many cases by Waters' projection radiography, limiting more expensive CT scanning or endoscopic techniques, which however remain the reference diagnostic tools, to a smaller number of patients.

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