Rhinology, 35, 154–157, 1997

Prevalence of sinusitis signs on MRI in a non-ENT paediatric population*

F. Gordts[1], P.A.R. Clement[1], A. Destryker[1], B. Desprechins[2], L. Kaufman[3]

[1] Department of Otolaryngology, University Hospital, Free University, Brussels, Belgium
[2] Department of Radiology, University Hospital, Free University, Brussels, Belgium
[3] Department of Biostatistics and Medical Informatics, Free University, Brussels, Belgium

SUMMARY

In a population of 100 children with suspected intracranial neurological disease, the overall prevalence of sinusitis signs on magnetic resonance images (MRI) is 45%. This figure exceeds the adult prevalence of 39%, while the nature of the lesions is more severe in children. Furthermore, paediatric sinuses seem to be affected according to a different pattern: adults have mainly maxillary and anterior ethmoidal lesions, whereas in children the sphenoidal and posterior ethmoidal sinuses are frequently involved too. Among children, the overall prevalence increases in the presence of a history of nasal obstruction (prevalence: 50%) and recent upper respiratory tract infection (prevalence: 81%) as well as when bilateral mucosal swelling (prevalence: 80%) or purulent secretions (prevalence: 100%) are seen on anterior rhinoscopy.

Key words: prevalence, sinusitis, paediatrics, magnetic resonance imaging

INTRODUCTION

Still today, the natural history of chronic rhinosinusitis in children is only partly known. However, knowledge of the natural history is essential to evaluate any kind of treatment, be it extensive or minimal sinus surgery, medical treatment or perhaps absence of treatment. The present study tries to contribute to a better understanding of the natural history of paediatric rhinosinusitis.

Since a population of normal children cannot be submitted to imaging studies with a radiation load, magnetic resonance imaging (MRI) of children with intracranial neurological disease has been used to assess the prevalence of sinusitis signs. Furthermore, the influence of four common clinical parameters has been assessed, and a comparison with adult data has been made.

MATERIAL AND METHODS

Study design

In this prospective study, magnetic resonance images were gathered from children with suspected intracranial neurological disease during two non-consecutive periods (March-June 1995, and March-July 1996). While the patients were having the MRI-scan, the parents were asked if their child had presented with an upper respiratory tract infection within the two preceding weeks and if their offspring suffered from frequent or continuous nasal obstruction. As soon as the child had left the MRI-scan, anterior rhinoscopy was performed and the nature of nasal secretions as well as the presence of mucosal swelling, if any, were noted.

Table 1. Classification of MRI signals.

ND	:	not done
A	:	absent sinus
F	:	fluid level or total sinus opacification
P	:	polyp of cyst
E	:	near-total opacification with yet some remaining air in the sinus
>3	:	estimated thickening of the mucosal lining of more than 3 mm but still parallel with the sinus contours
<3	:	visible mucosal lining, estimated thickness less than 3 mm or sinus present but invisible mucosal lining

MRI evaluation

T_1- and T_2-weighted (turbo-)spin echo sequences routinely obtained in the context of the assessment of cerebral pathology, were used for sinus evaluation. The axial sequences were oriented along a cantomeatal axis using a reference sagittal localizer, obtained with a T_1-weighted Flash or spin echo technique. In the design of this study, only the T_2-weighted spin echo images (TR/TE: 2,500-3,000 ms/82-130 ms) or the T_2-weighted turbo-spin echo images (TR/TE: 6,600/90 or 5,400/90) were considered. The classification as summarized in Table 1 was applied to the MR images. When a single sinus presented with more than one abnormality, only the most marked lesion was taken into account. All MR images were first reviewed by the ENT surge-

* Received for publication May 13, 1997; accepted July 17, 1997

ons and the radiologist separately, after which consensus was reached. Only a mucosal lining exceeding an estimated thickness of 3 mm, a near-total or total sinus opacification as well as an air-fluid level were considered as pathological. Isolated maxillary polyps or cysts were recorded as non-pathological (see Discussion).

Statistical analysis

The chi-square test with continuity correction was used to compare frequencies in various groups of children, except for the comparison of the groups of children with or without pus, for which a two-tailed Fisher's exact test was applied.

RESULTS

The study was continued till an MR image was obtained from each of 100 children. The mean age of the children was 4.96 years (standard deviation: 3.73 years; range: 1 month-15 years). Exactly 75 out of 100 children were below the age of 7 years. There were 58 boys and 42 girls.

Table 2. Number of sinuses unavailable for analysis.

	maxillary sinuses	anterior ethmoidal sinuses	posterior ethmoidal sinuses	frontal sinuses	sphenoidal sinuses
absent (A)	1	0	0	134	38
not done (ND)	10	0	0	32	0
total (UA)*	11	0	0	166	38

Number of children with recent upper respiratory infections (URI) and/or pus on anterior rhinoscopy.

	pus present	pus absent
URI+ (n=37)	5	32
URI– (n=63)	0	63

Number of children with a history of nasal obstruction and/or mucosal swelling on anterior rhinoscopy.

	mucosal swelling unilateral	mucosal swelling bilateral	mucosal swelling absent
nasal obstruction:			
present (n=32)	2	10	20
absent (n=68)	5	15	48

*UA: unavailable for analysis

Due to the age-related development of the different sinus groups, 1 maxillary sinus, 38 sphenoidal and 134 frontal sinuses could not be identified or were absent (labelled as "A" in Tables 1-2). In five patients MRI slices were not low enough to visualise the region of the maxillary sinuses, while in 16 patients MRI slices did not reach the region of the frontal sinuses (labelled as "ND" in Tables 1-2). Due to the low number of frontal sinuses, it was decided to exclude them from statistical analysis. The uni- or bilateral distribution of the presence or absence of lesions over the different sinus groups is given in Table 3.

The total population was subdivided into one group of children below the age of 7 years and the other group above the age of 7 years (see Discussion). Among the children below 7 years of age the overall prevalence of pathological signals was higher (48% compared to 40%; Table 4). This difference was not statistically significant. Since we were struck by the fact that many small children had total or near-total opacification of their tiny maxillary or sphenoidal sinuses, we further subdivided the younger age group in children below or above the age of 2 years (Figure 1). In the youngest age group there were more and quite severe lesions, particularly for the maxillary and sphenoidal sinuses. With age, there seems to be a progressive decrease in the overall prevalence of pathological signals (<2 years: 54%; 2-7 years: 45%; >7 years: 40%). Since this last subdivision was introduced retrospectively, proper statistical analysis cannot be applied.

Thirty-seven children had had an upper respiratory infection recently. Only five of them had purulent nasal secretions (Table 2). Furthermore, the parents of 32 children mentioned that their offspring suffered from frequent or continuous nasal obstruction. In 25 children bilateral mucosal swelling was present (Table 2). Each of the four clinical parameters investigated had an obvious influence on the overall prevalence of pathological sinus signals: 50% for the children with complaints of nasal obstruction, 80% if

Table 3. Number of children with respect to uni- or bilateral distribution of pathology over the different sinuses.

	maxillary sinuses	anterior ethmoidal sinuses	posterior ethmoidal sinuses	frontal sinuses	sphenoidal sinuses
unilateral pathology [1]	16	9	7	2	13
bilateral pathology	19	7	8	0	11
unilateral absence of pathology [2]	0	0	0	2	1
bilateral absence of pathology	60	84	85	14	57
bilateral unavailable for analysis	5	0	0	82	18
total number of children	100	100	100	100	100

[1] contralateral sinus unavailable for analysis or absence of pathology
[2] contralateral sinus unavailable for analysis

Table 4. Distribution of pathological signals (maxillary polyps excluded) over the different sinus groups in the total populations.

	overall preval.	maxillary sinuses	anterior ethmoidal sinuses	posterior ethmoidal sinuses	frontal sinuses	sphenoidal sinuses
total paediatric population	(45%)	29%	11%	11%	6%	22%
children <7 years	(48%)	40%	17%	17%	3%	31%
children >7 years	(40%)	26%	12%	8%	13%	24%
total adult population	(39%)	19%	14%	2%	2%	3%

Table 5. Influence of clinical parameters on the prevalence of pathological signals.

	number of children	overall prevalence	maxillary sinuses	anterior ethmoidal sinuses	posterior ethmoidal sinuses	sphenoidal sinuses
URI+	37	81%	74% (25/34)*	35% (13/37)	35% (13/37)	53% (16/30)
URI–	63		16% (10/61) p<0.001	5% (3/63) p<0.001	3% (2/63) p<0.001	15% (8/52) p<0.001
pus+	5	100%	100% (5/5)	80% (4/5)	40% (2/5	80% (4/5)
pus–	95		33% (30/90) p=0.006	13% (12/95) p=0.002	14% (13/95) N.S.(2)	26% (15/52) p=0.024
bilateral with mucosal swelling	25	80%	73% (16/22)	40% (10/25)	32% (8/25)	48% (10/21)
bilateral without mucosal swelling	75		26% (19/73) p<0.001	8% (6/75) p=0.001	9% (7/75) p=0.015	23% (14/61) N.S.
nasal obstruction+	32	50%	44% (14/32)	28% (9/32)	16% (5/32)	30% (9/30)
nasal obstruction–	68		33% (21/63) N.S.	10% (7/63) p=0.048	15% (10/68) N.S.	29% (15/52) N.S.

* 34 children of the 37 URI+ had evaluable maxillary sinuses; 25 of these children had pathological signals in at least one of their sinuses
N.S. = difference statistically not significant (p>0.05)

bilateral mucosal swelling was present, 81% for those with recent upper respiratory infection, and 100% if purulent nasal secretions were seen on rhinoscopy (Table 5). Not only the overall prevalence but also the sinus-specific prevalence was clearly influenced by those four parameters. These differences in prevalence were nearly always statistically significant, except for the children with complaints of nasal obstruction (Table 5).

DISCUSSION

Upper respiratory infection is far more common in children than in adults (Gwaltney et al., 1981). Since – on imaging – rhinitis and sinusitis often seem to be one continuum of disease (Gwaltney et al., 1994; Manning et al., 1996), the authors expected a higher overall prevalence of sinusitis among children. At first sight, the overall paediatric prevalence of 46% (one child with maxillary polyps included) is lower than the prevalence of 60% we found among adults (Gordts et al., 1996). Since the present study was conducted during spring and summer, it can be argued that the prevalence might have been higher if autumn and winter had been included. However, the high adult prevalence is probably flawed by the frequently present maxillary polyps or cysts. In children these lesions are very rare: only one child had bilateral isolated maxillary polyps. This paucity of maxillary polyps/cysts is confirmed by other (non-MRI) studies (Glasier et al., 1986; Diament et al., 1987). Furthermore, the presence of maxillary polyps or cysts in adults is not linked with a higher prevalence of pathological signals at the level of the other sinuses. We therefore consider these lesions as non-pathological (Gordts et al., 1996). In this manner the true adult prevalence drops from 60% to 39% (with a decrease from 40% to 19% for the maxillary sinuses), while the paediatric prevalence remains nearly unchanged at 45% instead of 46%. This figure is also comparable to data available from other studies: In a recent but heterogeneous CT/MRI study (Manning et al., 1996), 47% of the children had abnormalities of their sinus images. Other paediatric prevalence data are available only from CT-scan studies with sometimes a quite different design: 41% overall prevalence (Lesserson et al., 1994), 50% for the maxillary or ethmoidal sinuses (Diament et al., 1987).

A spontaneous decrease in the prevalence of sinusitis after the age of 7 years has been suggested before (Van der Veken et al., 1992; Otten et al., 1992). In the present study, however, age-related prevalence differences were statistically not significant. Other authors (Manning et al., 1996) found a similar phenomenon, but limited the assessment of an age influence, if any, on the maxillary and ethmoidal sinuses. On the other hand, and in accordance with the latter authors, the fact that 75% of our study population is below the age of 7 years reflects a greater necessity for head-imaging procedures for neurological diagnosis in this age group.

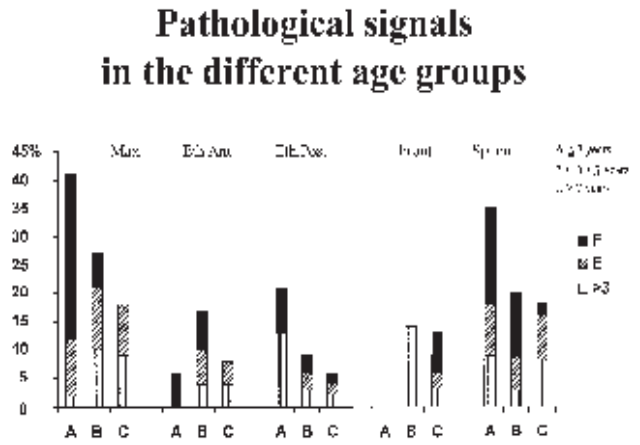

Figure 1. Pathological signals in the different age groups. Right and left sinuses are grouped. Percentages on the ordinate refer to the number of sinuses available for evaluation (See Table 1 for the symbols of the different signals).

All of the four clinical parameters investigated gave rise to an increased overall as well as sinus-specific prevalence (Table 5). Only for children with nasal obstruction complaints was this difference statistically non-significant. Indeed, complaints of nasal obstruction relate better with adenoid hyperplasia than with sinusitis (Wang et al., 1994). Pus on anterior rhinoscopy has the most dramatic influence on sinusitis signs. However, absence of pus on rhinoscopy is by no means a guarantee that sinusitis is absent: 35% of the children without purulent secretions showed the two most severe sinusitis signs: near-total or total opacification and/or fluid level.

Even if this study fails to show a significant prevalence decrease with age, the nature of the lesions is more severe in the younger age group. Adults present rarely with total opacification or fluid levels, while such severe lesions are often seen in children (Figure 1).

The distribution of the lesions over the different sinus groups is also striking: much unlike adults, in children the sphenoidal sinuses are the most affected paranasal cavities after the maxillary antra, while the posterior ethmoidal cells are quite often affected too (Table 4). This same distribution pattern is consistently repeated when the four clinical variables are assessed (Table 5).

Bolger et al. (1991) have suggested that among adults a characteristically different "pattern" of mucosal abnormalities exists for subjects with and without chronic sinusitis. Another CT-scan study (mainly with adult subjects) could not support the well-accepted concept that most sinus infections start in the middle meatus (Lloyd et al., 1990). Other authors failed to observe a specific "pattern" of involvement among children, as evident in this study. This is partly due to the inability of CT to adequately visualise all of the sinuses, especially in the youngest children: in one (mixed CT/MRI) study the sphenoid sinuses could be evaluated only in one patient from the 1-3 years age group (Manning et al., 1996). Another, however CT-scan, study provides no data for the sphenoid sinuses in children younger than 2 years (Diament et al., 1987). Only Lesserson et al. (1994) confirm a 17% sphenoid opacification on CT in children. Still another CT-scan study mentions that 72% of the maxilla of children below 1 year are either opacified or not identifiable (Glasier et al., 1986). These same authors mention 100% normal sphenoidal sinuses, both in the URI-positive and URI-negative group. Moreover, anterior and posterior ethmoids are coupled, so that the emergence of a potential different pattern is unlikely.

The main strength of MRI over CT resides perhaps in its ability to accurately visualise even minute mucosal inflammation. This allows a better depiction of the tiny sinuses in young children. The dramatic influence of the four clinical parameters on the prevalence and nature of the lesions demonstrates that MRI is indeed a sensitive tool. This sensitivity for inflammatory lesions may therefore not lead to over-interpretation (Gordts et al., 1996). The lesions seen on MR images probably reflect ongoing or resolving upper respiratory tract inflammation (Manning et al., 1996). MRI should be considered neither as a routine examination nor as a "gold standard" to diagnose sinusitis (Gordts et al., 1996). However, in the future, MRI may become a tool to help define the natural history of sinusitis in a large number of patients (Lusk, 1996).

The present prevalence study – by correlating clinical parameters and by making a comparison with adult data – has tried to contribute to a better understanding of the natural history of rhinosinusitis in children. The more severe lesions and the different "pattern" of involvement observed in children are perhaps another evidence suggesting that sinusitis in children does not mirror adult sinusitis, and quoting Younis and Lazar (1996): "*There is more to paediatric sinusitis than anatomic abnormalities and ostiomeatal complex obstruction.*"

REFERENCES

1. Bolger WE, Butzin CA, Parsons DS (1991) Paranasal sinus bony anatomic variations and mucosal abnormalities: CT analysis for endoscopic sinus surgery. Laryngoscope 101: 56-64.
2. Diament MJ, Senac MO, Gilsanz V, Baker S, Gillespie T, Larsson S (1987) Prevalence of incidental paranasal sinuses opacification in paediatric patients: A CT study. J Comput Ass Tomogr 11: 426-431.
3. Glasier CM, Ascher DP, Williams KD (1986) Incidental paranasal sinus abnormalities on CT of children: Clinical correlation. Amer J Neuro-Radiol 7: 861-864.
4. Gordts F, Clement PAR, Buisseret TH (1996) Prevalence of sinusitis signs in a non-ENT population. ORL 58: 315-319.
5. Gwaltney JM, Sydnor A, Sande MA (1981) Etiology and antimicrobial treatment of acute sinusitis. Ann Otol Rhinol Laryngol 90: 68-71.
6. Gwaltney JM, Philips CD, Miller RD, Riker DK (1994) Computed tomographic study of the common cold. N Engl J Med 330: 25-30.
7. Lesseron JA, Kieserman SP, Finn DG (1994) The radiographic incidence of chronic sinus disease in the paediatric population. Laryngoscope 104: 159-166.
8. Lloyd GAS (1990) CT of the paranasal sinuses: Study of a control series in relation to endoscopic sinus surgery. J Laryngol Otol 104: 477-481.
9. Lusk RP (1996) Anatomic variations in pediatric chronic sinusitis. A CT study. Otolaryngol Clin N Amer 29: 75-91.
10. Manning SC, Biavati MJ, Phillips DL (1996) Correlation of clinical sinusitis signs and symptoms to imaging findings in paediatric patients. Int J Pediatr ORL 37: 65-74.
11. Otten FWA, Van Aarem A, Grote JJ (1992) Long-term follow-up of chronic therapy resistant purulent rhinitis in children. Clin Otolaryngol 17: 32-33.
12. Van Der Veken PJ, Clement PAR, Buisseret TH, Desprechins B, Kaufman L, Derde MP (1992) Age-related CT-scan study of the incidence of sinusitis in children. Am J Rhinology 6: 45-48.
13. Wang D, Clement PAR, Kaufman L, Derde MP (1994) Fiber-optic evaluation of the nasal cavity and nasopharyngeal anatomy in children with snoring. J Otolaryngol 23: 57-60.
14. Younis RT, Lazar RH (1996) Criteria for success in paediatric functional endonasal sinus surgery. Laryngoscope 106: 869-873.

Dr. Frans Gordts
ENT Department
University Hospital
Free University
Laarbeeklaan 101
B-1090 Brussels
Belgium