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Incidental magnetic resonance image sinus abnormalities in asymptomatic Australian children

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Abstract

Plain X-rays, computed tomography (CT) and magnetic resonance imaging (MRI) scans performed for non-ENT reasons often reveal incidental sinus mucosal changes. These changes need to be correlated clinically before diagnosing rhinosinusitis. This study examined the prevalence of such changes in MRI scans in children up to age 16. Scans were scored using an adapted Lund-Mackay classification and were positive when one or more sinuses showed abnormalities. Randomly selected scans in the retrospective arm revealed a prevalence of 20 of 62 (32.3 per cent). In the prospective arm 45 of 60 children were defined as truly asymptomatic, of which 14 scans (31 per cent) were positive. Other studies in adults and children using CT and MRI report a prevalence range of roughly 30 to 45 per cent. This variability may be attributed to differences of study design, definitions of population age, definitions of asymptomatic and definition of abnormal sinus. Other plausible factors to explain regional differences are climate and frequency of upper respiratory tract infections.

Key words: Paranasal Sinuses; Magnetic Resonance Imaging; Child

Introduction

The diagnosis of rhinosinusitis in children is primarily by symptoms and signs supplemented by radiology. The latter has evolved rapidly away from plain radiographs to computerized tomography (CT). On both plain X-ray and CT scans of the paranasal sinuses, variable degrees of mucosal thickening, opacification and air-fluid levels are understood to be suggestive signs of rhinosinusitis.[1]

These same changes are also incidentally uncovered in MRI and CT of the brain and head and neck region. Yet not all incidental sinus changes mean clinical rhinosinusitis. Such incidental changes in the general and asymptomatic population have been well studied in both adults and children using plain radiographs[2–4] and CT scans.[5–12] Studies with MRI in adults[13–17] are also established, but in children[18,19] have been fewer.

We sought to establish the proportion of paediatric MRI scans carried out for non-rhinosinusitis indications that showed sinus mucosal changes. Firstly, in a retrospective manner to discover the 'overall incidental' proportion and, secondly, in a prospective manner to ascertain which patients were truly asymptomatic for rhinosinusitis. The prevalence of incidental findings in a general population may not be the same as in a subset of asymptomatic patients.

Method

The study population was derived from out-patient or in-patient children, aged from newborn to 16 years, undergoing MRI scan at the Royal Children's Hospital, Melbourne, Australia. The scans utilized in the study were for non-sinus related conditions and were primarily performed for cranial, orbital and pituitary indications as well as in the assessment of primary soft tissue tumours of the head and neck in a small number of cases. The study was divided into retrospective and prospective components. For the retrospective part, more than 2000 MRI scans were carried out for the above indications from 1997 to 2001, with many repeat scans done for the same patient. Ninety patients were selected at random from a list of approximately 1000 for study without knowledge of prior sinonasal history. However, only 62 were finally studied, as the other films were missing, or had scans that did not include all paranasal sinuses.

Sixty children were prospectively chosen between March to June 2002. Consent was obtained from their parents just before, or in the 24 hours after scanning, and enquiry was made for sinonasal symptoms (i.e. nasal obstruction, snuffliness, rhinorrhoea, postnasal drip and sneezing) in the one week preceding the scan, and their ears, nose and throat

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TABLE I
DISTRIBUTION ACROSS SINUSES OF POSITIVE CHANGES

Sinus	Retrospective	Asymptomatic	Symptomatic
Frontal	1/62 (1.6%)	2/45 (4.4%)	2/15 (13.3%)
Sphenoid	2/62 (3.2%)	3/45 (6.7%)	5/15 (33.3%)
Ethmoid	8/62 (13%)	11/45 (24.4%)	3/15 (20%)
Maxillary	14/62 (22.5%)	10/45 (22.2%)	8/15 (53.3%)

were examined. Children with symptoms whose parents requested follow up were referred to the hospital's Otolaryngology Clinic. Children with recent or current nasogastric tubes were excluded. Two categories were defined according to the presence or absence of symptoms in the preceding one week: (1) asymptomatic, absolutely without any defined symptom; (2) and symptomatic, which included those with one or more symptoms regardless of severity.

The scans were obtained on a General Electric Signa 1.5 Tesla Version 9. Coronal, axial and sagittal T2-weighted images were available. Abnormal sinus mucosa thickness was set at 2 mm and above.

The appearance of the paranasal sinuses was graded by adapting the Lund-Mackay staging system.[20] This system was employed for its simplicity, and is widely accepted and understood. All sinuses were assessed and scored 0, 1 or 2 respectively for normal, partly opacified or totally opacified, except in cases where the age of child was too young for frontal and sphenoid sinuses development, whereupon a score of 0 was given. This borrows from the Lund Mackay system which apportioned a 0 score for frontal sinus aplasia. Partial opacification will include mucosal thickening, air-fluid level and retention cysts.

This was a descriptive study, therefore the data were not analysed statistically.

Results

The retrospective study consisted of 62 children, 24 of whom were male, with a mean age of 6.5 years. Twenty films (32.3 per cent) had at least one sinus with opacification.

Similarly, in the prospective study, consent was gained from the parents of 60 children to proceed. The gender makeup was even at 30 each, with a mean age of seven. Overall, 23 MRI scans were found to have at least one sinus with abnormalities, meaning an incidence of 38 per cent. For asymptomatic patients 14 of 45 scans, or 31 per cent, were positive. Nine of 15 (60 per cent) symptomatic patients had positive sinus changes.

Table I shows that the maxillary sinus is still the most common sinus involved, regardless of the symptom state. However, involvement of the frontal and sphenoid sinuses becomes more common with positive symptoms.

Lund-Mackay scores for the respective symptomatic and asymptomatic groups were totalled and averaged. For the prospective symptomatic group of 15, the total score was 41, making the average 2.73. The asymptomatic group likewise was 58/45 for 1.28.

When scores were examined when sphenoid sinuses were involved, regardless of the symptom state, an average score of 6.9 was obtained, in contrast to when they were not involved with an average score of 4.57.

Discussion

There have been studies of a generation ago with plain films on incidental sinus mucosal changes.[2–4] At that time some of the reasons for findings of sinus opacification included the small size of sinuses in children, angulation of the X-ray beam, and nasal secretions, including tears.[10] Persistent mucosal thickening after an upper respiratory tract infection (URTI) can also contribute to opacification.[11] Patient movement, positioning, redundant mucosa and superimposed bony structures have been mentioned.[9]

More recently, studies on this theme have confirmed that several series of CT and MRI scans done for non-sinus diagnoses have an inevitable proportion of incidental paranasal sinus changes. However, there is great variability to their results. (Tables II and III. Study population that were defined prospectively as asymptomatic are defined as strict, those otherwise as loose.) Our study, in comparison, reports a retrospective general incidence of 32.3 per cent, and when asymptomatic patients were prospectively screened for, the result was 31 per cent.

TABLE II
ADULT CT AND MRI STUDIES

Author	Imaging	Year	Population definition	Proportion (%)
Bolger *et al.*[5]	CT	1991	Strictly asymptomatic	41.7
Calhoun *et al.*[6]	CT	1991	Loosely asymptomatic	16.3
Havas *et al.*[10]	CT	1988	Strict	42.5
Jones *et al.*[11]	CT	1997	Loose	17.0
Cooke and Hadley[13]	MRI	1991	Loose	37.5
Gordts *et al.*[14]	MRI	1996	Loose	60.0
Moser *et al.*[15]	MRI	1991	Loose	24.7
Patel *et al.*[16]	MRI	1996	Loose	49.2
Rak *et al.*[17]	MRI	1991	Strict	69.0

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TABLE III
PAEDIATRIC CT AND MRI STUDIES

Author	Imaging	Year	Population definition	Proportion (%)
Diament *et al.*[7]	CT	1987	Loose	45
Glasier *et al.*[8]	CT	1986	Loose	31
Glasier *et al.*[9]	CT	1989	Strict	67
Lesserson *et al.*[12]	CT	1994	Strict	41
Gordts *et al.*[14]	MRI	1997	Loose	45
Manning *et al.*[19]	MRI	1996	Loose	47

Our study adapted the Lund-Mackay staging system. This staging system is one of many designed to quantify the changes of chronic sinusitis on CT scans in a manner that comparisons can be made for assessing different treatment modalities. Criticism may be levelled at the use of this system because it is primarily for CT scan changes on bony windows of paranasal sinuses, but it is a system which is simple to understand and to implement. The scoring was ultimately quite straightforward after what constituted an abnormal mucosal thickness was defined, in this case more than 2 mm. Thickened mucosa, air-fluid levels and any changes short of total opacification was graded as partial and scored 1. The Lund-Mackay system has been used to score sinus changes in CT scans done for non-sinus diagnoses,[21] which found that the mean score of the general population is not zero, reflecting an incidental prevalence of sinus changes in the asymptomatic population.

The Lund-Mackay system was not designed for interpreting MRIs. The part that scores for the ostiomeatal complex could not be applied because it relies on bony anatomy, which obviously is not seen on MRI. However, it did not impact on the current study, as sinus mucosa was the element of interest.

The average score obtained for the symptomatic group (2.73) is more than double that of the asymptomatic group (1.28), which is as expected. When the sphenoid sinuses are involved the score is higher than when they are not, as reflected in scores of 6.9 to 4.57. This supports the viewpoint that the involvement of the sphenoid sinuses usually means a more extensive involvement of the sinuses radiologically. These observations underscore the usefulness of an adapted Lund-Mackay system.

Tables II and III show the wide range of results obtained from different studies. Lesserson commented and cited reasons of differential methods of study; different age groups, different groups of patients, and different definitions of 'not normal'.[12]

In those studies on children, the youngest were in Glasier's later study, which concentrated on infants.[9] Others started from birth, one month old and above, one year old and above, until 15 to 17 years old. The former study yielded the highest incidence, 70 per cent, which is supported by Diament and Gordts' studies that showed higher incidences with very young age.[7,18]

Each study defined its subject group differently. Some were retrospective with no knowledge of the patient's sinonasal status. Those studies that had a prospective element either assumed that non-sinus related indication for scan meant an asymptomatic patient, or actually assessed each patient for sinonasal symptoms to ensure a truly asymptomatic group. Our study has discrete retrospective and prospective populations, but results from each were similar. Symptoms can also be under-reported, resulting in a falsely larger asymptomatic group, which could ultimately distort final numbers.

The definition of 'not normal' or positive findings on MRI scans varied amongst studies. Cooke described degrees of mucosal thickening by the fraction of cross sectional area opacified.[13] Patel described significant thickening as more than 2 mm.[16] Gordts considered 3 mm as pathological.[14,18] Rak found mucosal thickness 3 mm or less on MRI scans as lacking significance in asymptomatic patients, as it was found just as commonly in symptomatic and asymptomatic children. He suggested that 4 mm and above to be a better marker of a symptomatic patient.[17] More descriptive pathology was also included by most studies, such as mucosal polyps and air-fluid levels, but Gordts put 'minor' changes, retention cysts and polyps in the normal category.[14]

Different imaging modalities may result in different results. This is implied by Gordts, who states that in comparison to CT, MRI is more sensitive to minute mucosal inflammation and therefore better depiction of tiny sinuses in young children. Therefore this avoids the over-interpretation that is inherent in CT scanning of paediatric sinuses.[14,18] Our study had a figure significantly lower than some of the other studies, perhaps because these were CT studies that may have overestimated sinus abnormalities.

Gordts viewpoint is opposed by some who believe in MRIs 'hypersensitivity' in detecting minute inflammation and mucosal thickening makes it prone to over-interpretation. Rak suggested that ethmoid sinus mucosal thickening of up to 2 mm on MRI as probably normal nasal cycle changes.[17] Moser concluded that MRI will often detect abnormalities unrelated to presenting symptoms.[15]

Perhaps the factor that most plausibly explains the difference between our study and the others is the environment that we were in. Melbourne, Australia has a warmer climate than the other Northern hemisphere locations of the other studies. Eccles' recent hypothesis that cold air negatively affects the nasal mucosal defence system supports this proposition.[22] Compromised defences mean a vulnerability to infection. Manning, amongst others, has stated that sinus mucosal changes in children were mostly

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resolving changes of upper respiratory tract infections.[19] So, with a warmer climate maybe fewer URTIs, and hence fewer changes on imaging, meaning regional differences of the prevalence of incidental sinus mucosal changes.

- **It is well known that patients having routine radiological investigations may be found to exhibit mucosal changes in the paranasal sinuses**
- **This paper examines radiological changes seen on MRI scans performed in children up to the age of 16 years. The scans were undertaken for non-sinus related conditions**
- **The study retrospectively examined 62 children whose scans were selected on a random basis. It also prospectively studied 60 further cases**
- **The prevalence of changes in the sinuses in each group is presented for both asymptomatic and symptomatic patients**
- **The paper compares their findings with previous series in the literature**

Our study also compares to other studies in one aspect. We found that the maxillary and ethmoid sinuses are the ones most likely to be opacified incidentally, as can be seen in the retrospective and asymptomatic prospective groups. This finding is common in many other studies, both on CT and MRI studies.[7,13,16]

Conclusion

The variability across many studies only underscores the fact of the inevitable prevalence of incidental radiological sinus mucosal abnormalities, regardless of the clinical context. Perhaps individual geographical regions could determine their respective incidental prevalence rates to reflect local conditions.

Awareness of incidental findings is noteworthy for two reasons. Firstly, clinical correlation to symptoms and signs is needed before a diagnosis of rhinosinusitis is final, avoiding unnecessary treatment for rhinosinusitis. Secondly, in a situation despite suggestive symptoms such as headache and facial pain, sinus mucosal changes should not automatically qualify as rhinosinusitis.

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