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MAIN ARTICLE

Paediatric acute mastoiditis, then and now: is it more of a problem now?

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Abstract

Background: Acute mastoiditis is a significant cause of morbidity in the paediatric population. This paper reviews our experience with this condition over the last 10 years and compares it with historical data from Alder Hey Children's Hospital, Liverpool, UK.

Method: A retrospective case note review of patients who presented between 2003 and 2012 was performed.

Results: Forty-six patients with acute mastoiditis were identified. Imaging with computed tomography and magnetic resonance imaging was carried out in 14 cases (30.4 per cent). Intracranial complications were identified in six patients (13.0 per cent), one of whom required neurosurgical intervention. In 27 cases (58.7 per cent), a surgical procedure was performed. Data from 1995 to 2000 revealed similar rates of imaging (30.0 per cent), but significantly lower rates of surgical intervention (23 per cent). A lower rate of intracranial complications (4.8 per cent) in the historical cohort did not prove to be statistically significant ($p = 0.419$).

Conclusion: The numbers of paediatric patients presenting with acute mastoiditis appears essentially unchanged. Improvement in imaging technology and aids to interpretation may explain the apparent increase of intracranial complications.

Key words: Mastoiditis; Otitis Media; Intracranial Extradural Abscess; Lateral Sinus Thrombosis

Introduction

Mastoiditis has shifted from a primarily surgically treated condition to a more medically treated condition.[1] It remains the most common complication of acute otitis media.[2,3]

A recent retrospective cohort study, which analysed data from the UK General Practice Research Database that included more than two million children, established a stable incidence of mastoiditis of 0.12 per 1000 child-years in the UK.[4] Interestingly, Brook found a reduction of 34 per cent in the incidence of otitis media using the same database for the same time period in the UK.[5] In other parts of the world, an increase in the incidence of mastoiditis has been reported.[2,6] However, these studies were hospital-based and therefore included smaller numbers of patients. It was hypothesised that the reduction in antibiotic use for the treatment of acute otitis media may have been responsible for the increase in mastoiditis.[6]

A retrospective review of our experience of managing paediatric patients with acute mastoiditis over the last 10 years was conducted. We also compared the recent data with historical data from a similar retrospective review carried out at the same hospital, published in 2002.[7]

Materials and methods

A case note review was carried out for a 10-year period, between January 2003 and December 2012. The case notes were identified by searching the hospital admission system for the codes of acute mastoiditis (H70.0) and non-specific mastoiditis (H70.7).

Only cases fulfilling our clinical criteria of acute mastoiditis were included. These were post-auricular swelling, erythema and pinna protrusion, which are the same criteria used in the original study in 2002.[7] Patients with an underlying cholesteatoma were excluded.

Demographic, management and complication data were assessed and compared with data collected in Alder Hey Children's Hospital in the years 1995 to 2000. The Fisher's exact statistical test was used to investigate the differences.

Results

In the 10-year period reviewed, there were a total of 110 344 emergency admissions to Alder Hey Children's Hospital registered on the hospital database. Of these, 2469 were emergency ENT admissions. Fifty-nine were coded for the diagnosis of mastoiditis. Eight of the 59 mastoiditis patients (13.6 per cent) were

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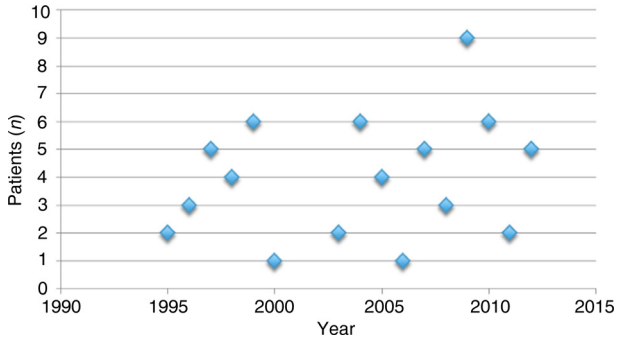

FIG. 1

Number of patients admitted with acute mastoiditis per year for both cohorts (current (2003–2012) and historical (1995–2000) cases), showing no statistically significant increase over time ($R^2 = 0.06459$, $p = 0.882$).

excluded for not meeting the clinical criteria of acute mastoiditis and 5 patients were excluded because of a co-existing cholesteatoma. The remaining 46 patients consisted of 26 female and 20 male children.

Of the 46 patients, 10 (21.7 per cent) were referred by their general practitioner, 21 (45.7 per cent) by the accident and emergency department (A&E) and 14 (30.4 per cent) by a peripheral hospital. One patient (2.2 per cent) was admitted via the ENT clinic. Compared to the historical data from Alder Hey Children's Hospital, there was no significant difference in the numbers of admissions with acute mastoiditis ($p = 0.882$) (Figure 1).

Median age was recorded as 17.5 months (range, 1 month to 14 years and 8 months). Fifteen children (32.6 per cent) were below one year of age. There was no significant difference in the number of infants in our cohort compared to the historical data ($p = 0.571$) (Table I).

TABLE I
COMPARISON OF HISTORICAL AND CURRENT CASE SERIES

Variable	Current cases (2003–2012)	Historical cases (1995–2000)	*p*
Total cases	46	21	
Males	20	7	
Females	26	14	
Median age (range)	1 y 5 m (1 m – 14 y 8 m)	5 y (3 m – 14 y)	
Number of infants	15	5	0.571
Initial blood tests	40	10	0.002
Previous antibiotics	27	10	0.422
Microbiology swabs	32	4	0.0002
CT ± MRI	14	7	1
Intracranial complications	6	1	0.419
Surgically treated patients	27	5	0.0095
Average hospital stay (range); days	5 (1–16)	5 (2–13)	

Data represent numbers of cases unless indicated otherwise. y = years; m = months; CT = computed tomography; MRI = magnetic resonance imaging

TABLE II
ANTIBIOTICS USED DURING HOSPITAL ADMISSION

Antibiotics	Cases (*n* (%))
Intravenous	
– Cefotaxime + metronidazole	14 (30.4)
– Cefuroxime + metronidazole	12 (26.1)
– Cefotaxime	7 (15.2)
– Co-amoxiclav	6 (13.0)
– Cefuroxime	3 (6.5)
– Benzylpenicillin	1 (2.2)
– Cefotaxime + metronidazole + clindamycin	1 (2.2)
– Cefotaxime + metronidazole + vancomycin	1 (2.2)
– Cefotaxime + metronidazole + flucloxacillin	1 (2.2)
Topical ear drops	
– Ciprofloxacin	24 (52.2)
– Sofradex	2 (4.4)

On average, the onset of symptoms was 5.1 days prior to admission to Alder Hey Children's Hospital. This is unchanged compared to the historical data from our hospital.

Antibiotic use prior to hospital admission was recorded in 27 of 44 cases (61.4 per cent): oral antibiotics in 25 cases and topical antibiotics in 2 cases. In two cases, it was unclear whether the patient received any antibiotic treatment prior to their presentation to Alder Hey Children's Hospital. In the historical cohort, 10 of the 21 patients (47.6 per cent) were pretreated with antibiotics: 9 received oral antibiotics and 1 received topical antibiotics. Despite more patients in the current group receiving antibiotic treatment prior to admission, no significant difference between the two groups could be established ($p = 0.422$).

On admission, patients' average temperature was 37.4 °C. Fifteen children (32.6 per cent) had a temperature of 38 °C or greater. Aural discharge was found in 24 cases (52.2 per cent). Initial blood tests were requested in 40 cases (87.0 per cent). The results showed an average white cell count of $18.29 \times 10^9/l$ (range, $5.7–42.8 \times 10^9/l$) and an average C-reactive protein level of 101.3 mg/dl (range, 4–329 mg/dl) at admission. In the historical group, 10 patients (47.6 per cent) were investigated with blood tests on admission. There were significantly more initial blood tests requested in the current case series ($p = 0.002$).

All 46 patients received intravenous antibiotics, and 26 of the children (56.5 per cent) received additional topical eardrops. The most common antibiotics used were a combination of a cephalosporin and metronidazole, in 26 cases (56.5 per cent), followed by cephalosporin or co-amoxiclav alone, in 10 cases (21.7 per cent) and 6 cases (13.0 per cent) respectively (Table II). On average, intravenous antibiotics were administered for 4.5 days (range, 1–16 days).

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Radiological investigations were carried out in 15 children (32.6 per cent). Imaging using computed tomography (CT) alone was carried out in seven cases (15.2 per cent), and CT and magnetic resonance imaging (MRI) were used in seven cases (15.2 per cent). In two children, ultrasound scanning was chosen to investigate the post-auricular swelling. One of these children proceeded to undergo CT and MRI after the ultrasound. In the historical cohort, radiological investigations were carried out in 10 patients (47.6 per cent): plain radiography was performed in 3 patients (14.3 per cent), CT alone in 4 patients (19.1 per cent), and CT and MRI together in 3 patients. The use of CT and MRI was equally distributed between the historical and current cohort, with no significant difference in numbers ($p = 1$).

Intracranial complications were found in six children (13.0 per cent). The children with intracranial complications were admitted via A&E in three cases, transferred from another hospital in two cases and referred to Alder Hey Children's Hospital by their general practitioner in one case. There were four intracranial collections and three venous sinus thromboses noted. In one patient with thrombosis of the sagittal sinus, transverse sinus and the internal jugular vein, neurosurgical intervention was needed; a ventriculoperitoneal shunt was inserted in light of persistent raised intracranial pressure. There was one patient (4.8 per cent) with lateral sinus thrombosis described in the original study.[7] No statistically significant difference was found between the numbers of intracranial complications in the historical and the current cohort ($p = 0.419$).

Overall, 27 patients (58.7 per cent) received surgical treatment. Incision and drainage of a post-auricular abscess was performed in 16 patients (34.8 per cent). Of these, 10 patients (21.7 per cent) had a myringotomy, and in 4 cases (8.7 per cent) a ventilation tube was inserted at the same time. Cortical mastoidectomy was carried out in eight patients (17.4 per cent) as a primary treatment. Three patients (6.5 per cent) required cortical mastoidectomy following incision and drainage. This was performed on average 6.7 days (range, 2–12 days) after the original surgery.

Compared to the original case series, where five children (23.8 per cent) were treated surgically, significantly more operations were performed in the current study ($p = 0.0095$). Further elective surgery after the acute admission was necessary in four patients, ventilation tube insertion in three patients and examination under anaesthesia in one patient. Of all operations performed in this cohort, only one complication (wound dehiscence) was documented in the case notes. There were no mortalities.

Ear and wound swabs were taken at the time of surgery in 32 cases (69.6 per cent). The most common bacteria identified were *Streptococcus pyogenes* (group A), *Streptococcus pneumoniae* and *Pseudomonas aeruginosa*, in six, five and two cases respectively. There were four cases of *S pneumoniae* resistance to ciprofloxacin: three were of intermediate resistance and one was of full resistance. Further resistant cases included one case of *P aeruginosa* resistance to cefotaxime, one case of *Fusobacterium necrophorum* resistance to vancomycin and one case of *Enterobacter cloacae* resistance to co-amoxiclav. In the historical cohort, microbiology swab results were recorded in four cases (19.1 per cent). Significantly more microbiology swabs were requested in the current series ($p = 0.0002$).

Discussion

Our review does not show a significant increase in the number of acute mastoiditis cases managed in Alder Hey Children's Hospital. There is controversy about a change in acute mastoiditis incidence. A recent study in the USA investigating the incidence of mastoiditis between 1997 and 2006 did not find an increase in mastoiditis cases.[8] When the authors searched the literature for mastoiditis, they found a significant difference between non-population-based studies and population-based studies. According to their findings, 63 per cent of occurrence-based studies reported an increase in mastoiditis, but none of the incidence studies demonstrated such an increase.

Limiting factors

The identification of patients treated for acute mastoiditis depends on correct International Classification of Diseases coding. In our review, we identified eight cases (13.6 per cent) coded for acute mastoiditis that did not fulfil the clinical criteria for this disease. It is likely that some patients with mastoiditis were not included in this study if they were given an incorrect International Classification of Diseases code. Given the design of our study, we were not able to identify incorrectly coded patients.

A recent Swedish study investigated coding errors in mastoiditis.[9] In this national study, the authors found that 18 per cent of the patients did not have mastoiditis, and that over-diagnosis, for instance in patients with otitis externa wrongly coded as mastoiditis, was common. In our study, 13.6 per cent of the patients identified in the hospital database were coded incorrectly as acute mastoiditis cases, despite their diagnosis being unrelated to any form of mastoiditis.

Surgery

The number of patients undergoing surgery for acute mastoiditis has significantly increased in our institution. In many of the cases, surgery was carried out in order to drain an abscess. However, in most cases it was difficult to establish retrospectively from the notes the exact indication for surgery.

Kvaerner *et al*. argue that most cases of acute mastoiditis could be treated solely with intravenous antibiotics.[10] However, other authors routinely perform a myringotomy at the same setting.[1,11] The benefits of a myringotomy are two-fold. First, draining the pus

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from the middle ear gives immediate pain relief. Second, the fluid can be sampled for culture and sensitivities.[1] This is particularly important given the threat of increasing drug resistance.[12] We found significantly more resistant bacteria in the current series. However, as very few cultures were performed in the original study,[7] it was impossible for us to compare antimicrobial sensitivity patterns.

The reason for the increase in surgical management of acute mastoiditis in the recent cohort remains unclear. The patients in the current case series do not appear to be more unwell than the children represented in our historical data. There were less pyrexial children admitted in the current group and the hospital stays were equal, at 5 days.

Intracranial complications

Intracranial complications in acute mastoiditis vary. More intracranial complications were found in the current cohort. Even though the increase was not statistically significant, this is a worrying finding.

The increase in intracranial complications is possibly affected by the mode of referral to Alder Hey Children's Hospital. The original study (conducted in 2002) did not contain any tertiary referrals.[7] In our current review, two of the six patients with intracranial complications were tertiary referrals.

The amount of CT and MRI scans performed certainly has an impact on the number of intracranial complications detected. A recent study investigating the correlation between clinical signs and radiological findings concluded that an 'evidence-based index of suspicion for intracranial complications in patients with acute mastoiditis' was not possible.[13] This may explain the reason why, in a case series of 214 children in Denmark, not a single intracranial complication was noted.[14] Because of a very restricted approach to CT in children, the author had performed only a single CT scan. In our case series, it does not seem that more radiological investigations were ordered to image suspected mastoiditis in recent years compared to the data published in 2002.[7] In the original study, CT and MRI were performed in seven (30 per cent) and in three patients (14.3 per cent) respectively. In our review, CT was conducted in 14 cases (30.4 per cent) and MRI in 7 cases (15.2 per cent).

Certainly, the image quality has improved since the historical data were evaluated, making it more likely that subtle pathology could be detected. In the original case series,[7] the first patients were imaged in 1995. At this time, single-slice CT scanners were used. However, these were soon replaced by multi-slice scanners with helical scanning capabilities. The MRI scanners at this time were 1.5 T in strength.

In Alder Hey Children's Hospital, the CT scanner in use before 2009 could only achieve 3 mm slices. Theoretically, these slices could potentially miss small intracranial abnormalities by sampling above and below the abnormality. In 2009, the CT machine available in Alder Hey Children's Hospital was upgraded to one capable of volume acquisition (ultrathin helical slices). Thereafter, more subtle intracranial abnormalities, which might previously have been missed, could be identified.

Similarly, there has been improvement in MRI technology over the time frame in question. In 2009, Alder Hey Children's Hospital installed a 3 T MRI scanner. The increased field strength of the magnet compared to a 1.5 T machine improves the signal-to-noise ratio, which improves resolution and the consequent capability of the scanner to identify small areas of abnormality.[15]

Antibiotic treatment

In our case series, 61.4 per cent of the patients received antibiotics prior to hospital admission. Some authors claim a direct correlation between decreased antibiotic use and an increasing incidence of mastoiditis.[6] However, a study from Iceland demonstrating such a correlation needs to be interpreted carefully.[6] The authors correlated the incidence of mastoiditis with general sales data of antibiotics provided by the Ministry of Health in Iceland. This might present a significant bias, as it assumes an equal reduction of antibiotic prescribing in all medical fields. Other authors are more cautious in interpreting a direct relationship between antibiotic use and mastoiditis incidence. They claim that a routine antibiotic treatment of acute otitis media has not been confirmed to prevent intracranial complications.[2] In our current series, we did not find a reduced use of antibiotics.

- **Acute mastoiditis is the most common complication of acute otitis media**
- **Reports from clinical case series suggest a possible increase in acute mastoiditis incidence**
- **In Alder Hey Children's Hospital, there was no significant increase in mastoiditis cases managed over the last 10 years**
- **Increasing numbers of surgery performed for acute mastoiditis demonstrate a trend towards more surgically orientated management**
- **The increase in intracranial complications can be explained by more tertiary referrals and improvements in radiological techniques**

Conclusion

The incidence of acute mastoiditis in Alder Hey Children's Hospital seems unchanged. There has been a significant increase in the number of operations performed for this condition in our hospital. The reasons for this are unclear. More intracranial complications were observed in the current study. However,

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the increase was not statistically significant and may easily be explained by the improved quality of imaging scans and a higher number of tertiary referrals.

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