Acute Mastoiditis: The Role of Imaging for Identifying Intracranial Complications

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Objectives/Hypothesis: Brain CT is performed in patients presenting with acute mastoiditis (AM) to identify intracranial complications (ICC). Recently, however, the need for CT scans in such patients has been questioned owing to concerns regarding long-term effects of brain irradiation, with some clinicians claiming that the decision to scan should be based on a patient's clinical presentation. This study was aimed at characterizing the typical clinical presentation of patients who already have ICCs when diagnosed with AM, and to compare it to that of AM patients presenting without ICCs.

Study Design: Prospective case series.

Methods: All patients hospitalized with AM between July 1997 and December 2009 in an otologic tertiary referral center were divided into those with and those without ICCs on presentation. Prerereferral clinical characteristics and the signs, symptoms, and inflammatory indexes at presentation were compared between the two groups.

Results: Of 71 patients presenting with AM, 10 had at least one ICC (sigmoid sinus thrombosis [nine patients], perisinus empyema [five patients], subdural abscess [one patient], and epidural abscess [one patient]). Patients with and without ICCs did not differ regarding most clinical characteristics or presenting signs and symptoms. None presented with neurological signs or cranial nerve deficits.

Conclusions: It is not possible to define an evidence-based index of suspicion for ICCs in patients with AM. Diagnostic imaging at presentation accordingly remains mandatory.

Key Words: Acute mastoiditis, imaging, intracranial complications.

Level of Evidence: 2c.

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INTRODUCTION

Acute mastoiditis (AM) is the most common of the otogenic complications.1,2 In the preantibiotic era, between 2% and 6% of patients with AM developed suppurative intracranial complications (ICCs), with fatal outcomes in 75% of them.3 Since the introduction of antibiotics, the incidence of AM has declined.4,5 In 1959, Palva et al. reported that 0.4% of their patients with acute otitis media (AOM) developed AM,6 whereas the reported incidence during the 1980s was 0.004%.7 Over the last two decades, however, the incidence of AM has gradually increased.8–13 The reported incidence of AM-related ICCs today is also surprisingly high, ranging between 5% and 29%.14–20

AM-related ICCs may be present at the time of AM diagnosis or may appear later in the course of the disease despite what would be considered adequate treatment.8,11,14,15 Because of the life-threatening nature of otogenic ICCs, AM-related ICCs should be diagnosed as early as possible. Given that delays in diagnosis of otogenic ICCs are associated with increased morbidity and mortality, and because physician delay is recognized as a highly significant delaying factor,21 diagnostic imaging has become a mandatory part of the very early workup of patients with AM.22–24

Accordingly, the aim of the present study was to characterize the typical clinical presentation of patients with AM who also had ICCs at the time of AM diagnosis, in an attempt to differentiate it from the clinical presentation of patients with AM without ICCs.

MATERIALS AND METHODS

All patients referred to our otologic tertiary referral center between July 1997 and December 2009 were enrolled in this prospective study. Diagnosis of AM was based on clinical signs of AOM on otoscopy, inflammatory findings over the mastoid area (tenderness, erythema, edema, and/or abscess), and protrusion of the auricle. Patients with a history of chronic otitis media and cholesteatoma were excluded from the study.

The management protocol was aimed at obtaining a sample for bacterial culture at the earliest opportunity (so that antibiotic treatment could be initiated as early as possible, but without compromising the potential need for culture-based...
Clinical Diagnosis of Acute Mastoiditis

HRCT of the Temporal Bones + Contrast-Enhanced Brain CT

- No clinical diagnosis of subperiosteal abscess
  - No ICC on imaging
  - Surgical drainage of ME (VT)
  - Sampling for bacterial culture
  - Broad-spectrum antibiotics (immediately after sample for bacterial culture is taken)

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Clinical improvement
- Continue antibiotics

No clinical improvement within 24/48 h
- Change antibiotics to culture-based
- Repeat both imaging and drainage

Fig. 1. Management protocol for acute mastoiditis. HRCT = high-resolution computed tomography; CT = computed tomography; ICC = intracranial complication; ME = middle ear; VT = ventilating tube.

change in antibiotic treatment if required in the future) and prompt evaluation for the presence of ICCs. Because the duration that might be required for middle ear drainage is usually more prolonged in patients with AM than in patients with uncomplicated AOM, a ventilating tube was inserted in all cases. To have the patient sedated/anaesthetized only once for both middle ear drainage and the imaging required to exclude ICCs on presentation, as well as to enable draining of a possible localized intracranial suppuration when suggested by the imaging findings, patients diagnosed clinically with AM immediately underwent high-resolution CT (HRCT) of the temporal bones and contrast-enhanced brain CT. According to the imaging findings, patients underwent the required surgical drainage (Fig. 1). As soon as an adequate sample for bacterial culture was available, broad-spectrum antibiotic treatment with intravenous ceftriaxone was initiated. When presented with spontaneous perforation, and the patient’s condition thus did not allow for any delay in initiation of antibiotic treatment, a sample for bacterial culture was immediately taken from the draining ear (after proper cleansing), treatment with antibiotics with broad-spectrum antibiotics was started, and HRCT of the temporal bones and contrast-enhanced brain CT were performed only afterward. Thus, imaging of all patients was performed within the first 24 hours of admission.

If no clinical improvement was observed within 24 to 48 hours, the antibiotic treatment was changed to a culture-based choice. When clinical deterioration was noticed or development of a complication was suspected or both, repeated imaging and redrainage were considered.

Patients were divided into those who had ICCs on presentation and those who did not. The two groups were compared with regard to prerereferral clinical characteristics (age, history of AOM, history of AM, predisposing factors, duration of symptoms, prior antibiotic treatment and its duration), signs and symptoms at presentation (protrusion of the auricle, postauricular swelling, postauricular erythema, postauricular fluctuation [i.e., subperiosteal abscess], tympanic membrane erythema, tympanic membrane bulging, otorrhea, fever, neurological signs), and inflammatory indexes at presentation.

The data were evaluated by SPSS software, version 17 (SPSS, Inc., Chicago, IL). The Fisher exact test was used to detect differences in the prevalence of categorical variables (gender, history of AOM, history of AM, and prior antibiotic treatment) between the two groups of patients. The Mann-Whitney U test was used to compare differences in age, duration of symptoms, duration of prior antibiotic treatment, and inflammatory indexes. A value of \( P < .05 \) was considered significant.

RESULTS

During the 12-year study period, a total of 71 patients were hospitalized with AM in our institution. Ten of them had at least one ICC. The types of complications and their incidence are listed in Table I.

Table II summarizes the prerereferral clinical characteristics of the two groups of patients, those with ICCs and those without them. There were no significant differences between the patients in the two groups with regard to any of the listed prerereferral characteristics.

Table III summarizes the signs and symptoms of the two groups of patients at the time of presentation with AM. Although the groups did not differ with regard to most of the presenting signs and symptoms, significantly more patients in the ICC group than in the non-
ICC group had postauricular fluctuation (subperiosteal abscess) \((P = 0.0004)\) and otorrhea \((P = 0.048)\). However, 60% of the group with ICCs did not present with otorrhea, and 50% did not present with a subperiosteal abscess.

Indexes of inflammation at presentation (white blood cell count and C-reactive protein) did not differ between the two groups (Table IV).

None of the patients in either group had neurological signs or cranial nerve deficits at presentation. Later in the course of disease, three patients in the ICC group developed weakness of the 6th cranial nerve, and one patient (who suffered from common variable immunodeficiency) developed unilateral deafness. All four of those patients were treated with acetazolamide (Diamox).

The duration of hospitalization was significantly longer for patients in the ICC group (mean \(\pm\) standard deviation [SD], 17.8 \(\pm\) 9.28 days; range, 6–30 days) than for those in the non-ICC group (mean \(\pm\) SD, 7.26 \(\pm\) 1.77 days; range, 4–12 days; \(P = 0.001\)).

All patients recovered. The cranial nerve palsy in the three affected patients resolved within 3 months. The patient who developed profound unilateral sensorineural hearing loss did not recover his hearing.

**DISCUSSION**

Despite the use of more potent types of antibiotics, AM-related ICCs still occur and are potentially fatal.\(^{15,24}\) Their incidence is high, ranging in different studies between 5% and 29% of patients.\(^{14–20}\)

In the present prospective study, out of 71 patients consecutively admitted with AM, 10 (14%) had one or more AM-related ICC. By far the most common complication was sigmoid sinus thrombosis, seen in nine of these 10 patients, and this was followed by perisinus empyema, seen in five patients (Table I). Similar findings have been reported in other studies over the last decade.\(^{17,18}\)

The prereferral clinical characteristics of the patients included in the present series (Table II) are in accordance with previous reports.\(^{8,10,20,24,27,28}\) Both in our study and in several earlier ones,\(^{8,13,15,18,29}\) most patients were children under the age of 8 years old. Likewise, as in our study, the duration of symptoms prior to diagnosis of AM ranged in most cases between 1 and 30 days,\(^{8,13,15,18,21,25}\) and a significant number of patients had been treated with antibiotics adequate for AOM prior to the presentation of AM. Thus, our findings reemphasize earlier findings\(^{8,11,15,18,24,28}\) that the use of antibiotics for AOM is not an absolute safeguard against AM and its complications.

Notably, comparison between the two groups of patients, those with ICCs and those without, showed that they did not differ with regard to their prereferral

| TABLE I. Intracranial Complications in 10 Patients With Acute Mastoiditis. |
|-----------------|-----------------|-----------------|
| Type of Complication | No. of Patients* |
| Sigmoid sinus thrombosis | 9 |
| Perisinus empyema | 5 |
| Epidural abscess | 1 |
| Subdural abscess | 1 |

*In some patients more than one intracranial complication was diagnosed.

| TABLE II. Prereferral Clinical Characteristics. |
|-----------------|-----------------|
| Age, yr, mean \(\pm\) SD (range) | \(2.10 \pm 1.55\) (0–7) | \(3.92 \pm 4.83\) (1–16.5) |
| Gender, male, no. (%) | 31 (51) | 2 (20) |
| Prior history of AOM, no. (%) | 23 (38) | 2 (20) |
| Prior history of AM, no. (%) | 2 (3%) | 0 (0) |
| Predisposing factors, no. | 0 | 1 (CVID) |
| Symptom duration, d, mean \(\pm\) SD (range) | \(5.43 \pm 6.27\) (1–30) | \(5.6 \pm 2.4\) (2–10) |
| Prior antibiotic treatment, no. (%) | 19 (32) | 6 (60%) |
| Antibiotic treatment, d, mean \(\pm\) SD (range) | \(4.73 \pm 3.76\) (1–14) | \(2.71 \pm 1.49\) (1–5) |

*Mann-Whitney \(U\) test.  
Fisher exact test.  
ICC = intracranial complication; SD = standard deviation; AOM = acute otitis media; AM = acute mastoiditis; CVID = common variable immunodeficiency.

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characteristics or to most of the presenting signs and symptoms observed (Tables III and IV). Significant differences were found between them for two presenting signs, otorrhea and postauricular fluctuation (subperiosteal abscess) (Table IV). Our finding that AM patients who present with otorrhea are more likely to develop ICCs than those who do not confirms an earlier report by our group in this connection.15

On the other hand, although our results showed that in patients with AM the presence of otorrhea or subperiosteal abscess at presentation increases the risk of developing an ICC, the fact that 60% of our patients who presented with ICC did not have otorrhea, and that 50% of those who presented with ICC did not have a subperiosteal abscess, indicates that the absence of otorrhea and subperiosteal abscess at presentation in an AM patient does not necessarily imply that the patient does not have an ICC. This means that it is not possible, merely on the basis of signs, symptoms, or laboratory inflammatory indexes at presentation, to differentiate those AM patients who present with ICCs from those who do not, and that diagnostic imaging is required for that purpose.

Bilavsky et al.19 reported that children with complicated mastoiditis, defined as AM with either extracranial (CT finding of a subperiosteal abscess or clinical finding of CN [cranial nerve] palsy) or intracranial complications (CT finding of sinus vein thrombosis or osteomyelitis, or clinical finding of CN palsy) had significantly higher fever, absolute neutrophil counts, and C-reactive protein levels than children without such complications of AM. In our study, fever was more common (although not significantly) in the non-ICC group, and the two groups did not differ in fever grade or in inflammatory indexes (Tables III and IV). Bilavsky’s study,19 however, was aimed at differentiating between complicated (extra- or intracranial) and uncomplicated AM, and not—as in our study—between AM patients with and without intracranial complications. Mallur et al.24 also emphasized the absence of specific clinical symptoms indicative of ICCs in patients with AM. Other authors20 have suggested that it is possible to decide on the need for CT in patients with AM on the basis of the clinical picture in each patient. To the best of our knowledge, however, no previous studies have aimed at characterizing the typical clinical presentation of AM patients who already have ICCs at the time of AM diagnosis, and at differentiating such a clinical presentation from that of AM patients without ICCs.

CONCLUSION

AM patients with and without ICCs share largely similar clinical presentations. It is thus not possible to define an evidence-based index of suspicion for ICCs in patients with AM, which could be used to identify those AM patients in whom cranial imaging should be performed at presentation and those in whom it should be withheld. Because of the life-threatening nature of otogenic ICCs and the potential for rapid clinical deterioration in such cases (further morbidity and long-term sequelae as well as mortality3,11,22,28), their prompt diagnosis is mandatory. Owing to the high incidence of ICCs in patients with AM, the presentation of AM itself can be considered to represent a risk for developing otogenic ICCs. Therefore, because cranial imaging is considered the gold standard for the diagnosis of otogenic ICC complications, we consider it mandatory in patients presenting with AM.

BIBLIOGRAPHY


