**Acute Mastoiditis Under the age of 6 Months. Do we Need a Different Approach?**

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**Short title:** Short running title for Manuscript [55 characters maximum, including spaces]

**Conflict of Interest Disclosures (includes financial disclosures):** xxxx

**Funding/Support:** xxxx

**Clinical Trial Registration (if any):** Registry name, registration number, web link to study on registry, and data sharing statement

**Abbreviations:**

list and define abbreviations used in the text in alphabetical order

AM – acute mastoiditis

AOM – acute otitis media

CT – computed tomography

IV – intravenous

MRI – magnetic resonance imaging

SPA – subperiosteal abscess

**Table of Contents Summary:**

Required for articles with an abstract. Max 25 words; a brief insight into what the article is about; it should entice the reader to go beyond the table of contents page and read the full article.

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**What’s Known on This Subject:**

Max 40 words; in paragraph style (not bulleted lists)

**What This Study Adds:**

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**Abstract**

**Objective:** This study examined whether acute mastoiditis (AM) is more severe in young infants under the age of 6 months and may need a more aggressive approach, especially concerning imaging policy and indication for surgical treatment. Rate of complications and clinical outcomes were also studied.

**Methods:** A retrospective cohort study of infants hospitalized between 2005 and 2019 at Shaare Zedek Medical Center with a diagnosis of AM under the age of 6 months (group A) was compared to infants with the same diagnosis above the age of 6 months (group B). The clinical course, complications, need for imaging, treatment, and outcome were recorded.

**Results:** A total of 529 children aged 0-18 years with a diagnosis of AM were hospitalized in our institution between 2005 and 2019. Among them 38 (7.18%) were under the age of 6 months (15 were under 4 months). There was no significant difference for the need for computed tomography or magnetic resonance imaging between the two groups (group A: 18.4%, group B: 21.6%, respectively) or for surgical intervention such as mastoidectomy (A: 15.8% vs B: 13%). The rate of complications such as subperiosteal abscess, sigmoid sinus thrombosis, or epidural abscess was not significantly different between the two groups; however, meningitis was seen in 8% in group A vs 0.6% in group B (*P*<0.001). Other significant difference between the 2 groups concern the bacteriology; *Streptococcus pneumoniae* and *Staphylococcus aureus* were significantly more frequent in group A (48.5% and 27.3%, respectively) than group B (29.9% and 10.7%, respectively; *P*=0.03 and 0.01). There were no deaths in our study group.

**Conclusions:** The management of young children below the age of 6 months suffering from AM may be fairly similar to that of older children. There is no need for more aggressive management, especially concerning indications for imaging or surgical treatment. The difference in bacteriology results and the higher frequency of meningitis must be taken in account in this specific population.

**Keywords**: Acute mastoiditis; imaging; surgical treatment; bacteriology; complication; infants; meningitis

# Introduction

Acute mastoiditis (AM) is considered a rare but serious complication of middle ear infection. It is estimated that more than 80% of children will develop at least one episode of acute otitis media (AOM) before the age of 3 years but only a few of them will develop AM.1 After antibiotic treatment became the standard of care for AOM, Palva2 in 1959 reported that 0.4% of patients with AOM may develop AM. By the year 1980 the percentage of patients developing AM dropped dramatically to 0.004%.3

Several studies estimated the annual incidence of AM in developed countries during the 2000s as varying from 1.2 to 6.1 per 100,000 children aged 0-14 years.4-8 Some studies have shown an increased incidence rate or more complicated cases of AM in young children, especially below the age of 2 years.6,9-13 The peak incidence of AM seems to be in the second year of life.14,15 However, the incidence and severity of AM, seem to vary in different countries and between different age groups.10,12 A study from the United States found that, between 2000 and 2012, the national estimated incidence rate of pediatric mastoiditis was the highest in 2006 (2.7/100,000) and the lowest in 2012 (1.8/100,000) in the pneumococcal conjugate vaccine era.16 For an unexplained reason, the incidence of AM seems much higher in Israel than in other developed countries.9,6

As published by our center17 and others18 there is a shifting trend to treat medically part of AM and reserve surgical treatment only for severe or complicated cases. We try also to limit the need for computed tomography (CT) in AM. Children are considerably more sensitive to radiation than adults, as demonstrated in epidemiological studies of exposed populations.19,20 Moreover, children have a longer life expectancy than adults, resulting in a larger window of opportunity for expressing radiation damage.19,20 As previously published, imaging is performed only if intracranial complication is suspected or in absence of improvement after 24-48 hours of intravenous (IV) treatment.21,18

AM in very young children under the age of 6 months is rare and only a small series has been published in the literature.14

Intuitively these young children may seem more vulnerable to infection with higher rates of complication and possible poor outcomes. Some children are even close to the definition of late-onset neonatal sepsis, which occurs up to 3 months of age.22

The aim of this study was to compare the subgroup of children under the age of 6 months suffering from AM to older children with the same pathology. Specifically, we wanted to understand whether our conservative approach, avoiding systematic imaging and surgery, is adequate for children under 6 months.

# Methods

A retrospective cohort study of children hospitalized with a diagnosis of AM was performed between 2005 and 2019 in Shaare Zedek Tertiary Medical Center in Jerusalem.

The inclusion criteria included diagnosis of AM based on relevant clinical findings (postauricular tenderness, erythema or swelling, protruding auricle, palpable/fluctuating mass), together with systemic signs (fever, lethargy, irritability, poor feeding, diarrhea) and otoscopic-microscopic evidence of AOM.

Exclusion criteria included children with concurrent/history of cholesteatoma and children after cochlear implants with AM. A new episode of AM or readmittance to hospital within 4 weeks was considered to be residual AM, but recurrences after that period were considered to be a new episode of AM.

During this period, our protocol of treatment for AM was usually the same for all children whatever the age.

If no intracranial complication was suspected at presentation, the protocol included: systematic paracentesis with culture of pus, drainage of clinically suspected subperiosteal abscess (SPA) under sedation in the emergency room and IV antibiotic administration (usually amoxicillin and clavulanic acid). CT was performed only in absence of improvement after 24-48 hours of IV antibiotic treatment. In severely ill children at presentation (very high fever, alteration of conscience or neurological sign), CT was performed immediately.

Surgery was performed mostly in cases of intracranial complications, such as epidural abscess or sigmoid sinus thrombosis, but also for some cases in the absence of clinical improvement after a few days of medical treatment, even with no signs of complication seen on CT.

If additional imaging was needed for follow-up, particularly in cases of intracranial complication, magnetic resonance imaging (MRI) was performed.

We collected demographic information, patients' history, immunization status, clinical signs, and symptoms, laboratory data (white cell blood count), C-reactive protein, microbiological cultures, radiological and microbiological findings, treatment during hospital stay, management and outcomes of AM, and complication rate.

## Data Analysis

The characteristics of the study population were compared between infants younger than 6 months (group A) and children older than 6 months (group B). Comparison of a quantitative variable between two independent groups was assessed using the *t* test or the Mann-Whitney *U* test. The standard (Pearson) chi-square or Fisher´s exact test was used to test homogeneous distribution of qualitative variables.

All statistical tests were bidirectional, and a *P* value <0.05 was considered statistically significant. Statistical analysis was performed with SPSS package version 24 (SPSS, Chicago, IL, USA). The Institutional Review Board of Shaare Zedek Medical Center (in accordance with the Declaration of Helsinki) approved the study.

# Results

A total of 529 children aged 0-18 years with a diagnosis of AM were identified between 2005 and 2019. Among them, 38 (7.18%) infants were under the age of 6 months (group A) and 491 (92.81%) were over 6 months (group B). Sociodemographic characteristics are shown in Table 1.

Figure 1 presents the age distribution of the infants in group A. The youngest child was 41 days old and 5 children were under 3 months of age. The mean age at hospitalization was 4.2±1.18 months in group A, and 27.08 ±25.1 months in group B. A total of 68.4% of the infants in group A were males compared with 51.3% in group B (*P*=0.042).

Some differences were observed in clinical presentation. Suspicion of ear pain or secretion at presentation was less frequent in group A at 32% vs 51% in group B (*P*=0.020). Also, on examination of the contralateral ear, signs of AOM were more frequently observed in the younger age group at 43% vs 25% (*P*=0.013). SPA was diagnosed in 39.5% of children in group A and 34% in group B (not significant, *P*=0.53). The other clinical signs are detailed in Table 2 and were not significantly different between the 2 groups.

Concerning the need for imaging, no difference was observed between the 2 groups, 18% (7 children) underwent CT in group A and 22% (106 children) in group B (*P*=0.646). The number of MRIs performed was also similar at 7.9% vs 7.7%.

Conservative treatment was the treatment of choice in both groups. Only 6 children in group A (16%), and 64 children (13%) in group B underwent a mastoidectomy (not statistically different). The other modalities of treatment are detailed in Table 3.

Bacteriology was different between the 2 groups (Table 4). The most frequent pathogen detected in group A was *Streptococcus pneumoniae* at 48.5% vs 30% in group B (*P*=0.028). *Staphylococcus aureus* was also more frequent in younger children at 27% vs 11% (*P*=0.01). A positive culture was more frequent also in group A at 87% vs 69% (*P*=0.019).

The most frequent intracranial complication observed in the series was sigmoid sinus thrombosis and the occurrence was slightly higher in group A at 7.9% vs 4.3% but not statistically different (*P*=0.302). One case of intracranial brain abscess, 3 cases of Gradenigo’s syndrome and 33 cases of epidural abscesses were found, in group B and none in group A, but this was also not statistically different (Table 5). The only difference in intracranial complication between the 2 groups concerned the incidence of meningitis, of which there were 3 cases in both groups (8% vs 0.6%, *P*<0.001).

# Discussion

The results of this retrospective study describe the clinical course and outcome of children suffering from AM under the age of 6 months compared to older children, in one medical center. No practical differences in management of these two groups was highlighted.

Very few publications concerning this specific age group exist, as occurrence of AM at this young age is rare. We found one multicentric publication by Stenfeldt et al14 of 17 cases collected from 34 ear nose and throat departments in Sweden during a period of 15 years. As previously published6 and for an unknown reason, AM is much more frequent in Israel than is other developed countries. We treated 529 children who were suffering from AM in our department at Shaare Zedek Medical Center during a period of 15 years; 7.2% (38 infants) were under the age of 6 months. To our knowledge, this will be the largest series in the literature and moreover, this is a monocentric study.

Regarding the prevalence and the severity of AM according to age, there are some controversies. It has been reported by some authors that young children suffer from more severe episodes and a higher incidence of complications than older children. Others have found the opposite.6,10,23 In those publications, the youngest group is usually under 1 year. A study from Israel of 116 patients6 concluded that the clinical picture of AM was more severe in infants and young children. Palma et al12 concluded the importance of careful attention to the clinical assessment of children under 2 years, as they seem to be more exposed to the risk of clinical complications. On the other hand, Groth et al23 showed that AM was most common in children younger than 2 years of age, and that younger children have neither more severe AM nor more complications than older ones.

A study from Italy found no differences in the incidence and complications of AM between patients younger and older than 2 years. Balsamo et al24 concluded that greater attention to signs and symptoms in preverbal children is needed, because AOM or AM may be misdiagnosed and appropriate treatment may be delayed because of the difficulty in obtaining verbal information in the preverbal period.

The multicentric study from Sweden on infants under the age of 6 months (17 cases), found a rare incidence of AM in the younger group with 1.24/100,000 compared to 12.9–15/100,000 per year between the ages of 0 to 23 months.14 AM was especially rare before 4 months and this was explained by the authors by the possible presence of maternal antibodies in infants at that age14 and a reduction later on. In our series, 23 children were between 4 to 6 months, but we had 15 who were under the age of 4 months (youngest aged 41 days).

## Clinical Characteristics

In our group of children under the age of 6 months, ear pathology was not suspected before the clinical appearance of AM in around two-thirds of children. Only 31.6% presented with ear symptoms (ie, secretion or pain according to the parent’s description) vs 51.7% in the older group (*P*=0.02). This is in accordance with the publication of Balsamo et al24 that AOM is easily missed in preverbal children due to their poor ability to describe or locate pain. Generally, older children can express themselves more precisely. Fever and crying are frequently the only symptoms of AOM in young children and ear examination must systematically be performed to detect ear infection. It must also be noted that examination of the eardrum in a baby at only a few months of age is difficult and sometimes a microscopic device is needed to confirm or eliminate signs of infection, such as bulging of the eardrum. In our series although ear complaints were less frequent at presentation in group A, contralateral AOM, systematically researched, was also diagnosed in 43% of cases vs 25% in group B (*P*=0.013). Examination and follow-up of contralateral ear is important, especially if fever persists after the beginning of treatment. If there are any doubts on the origin of the persistent fever, we recommend also performing a paracentesis of the contralateral ear as this may avoid the need for CT if the fever disappears after the paracentesis.

## Imaging

One of the main goals of this retrospective study was to verify whether our policy to avoid CT in children was also applicable in very young children. On one hand, at this young age, radiation of the brain may be more harmful19,25,26, whereas on the other hand, in a child who is only a few months old, the skull is thinner than in older children27 and a higher rate of complications may be intuitively anticipated. The results show that the percentage of children who underwent CT in both groups was similar, 18.4% (group A) vs 21.6% (group B), *P*=0.646, and except for meningitis (for which imaging is not the optimal tool of choice for diagnosis) the complication rate was similar. As previously published21, our policy is to ask for a CT at presentation only in severe cases (such as a child with neurological signs such as stupor or very high fever and weakness or after 24 to 48 hours without improvement). The number of MRIs performed were also identical at 7.9% vs 7.7%. Usually, CT with contrast is performed initially as this is a shorter exam, it is easier to obtain in an emergency setting and may be performed without general anesthesia. MRI was performed for follow-up of intracranial complications, mainly for sigmoid sinus thrombosis.

## Complications

Epidural abscess, Bezold abscess and Gradenigo’s syndrome were observed only in group B (in 6.7%, 0.2% and 0.6% of cases, respectively). Sigmoid sinus thrombosis was encountered in both groups, and seemed to be more frequent in group A (7.9% vs 4.3%). For all these cases the difference did not reach statistical significance. So, we can conclude for this relatively large series that complications of AM in very young children is not more frequent. For us, this is confirmation that more aggressive treatment in this group is not necessary. The only significant difference in complications was the frequency of meningitis accompanying AM. This frequency was higher in group A at 7.9% vs 0.6% (*P*<0.001). Diagnosis was performed by lumbar puncture after clinical suspicion. To our knowledge, this association between AM at an age under 6 months and meningitis has not been described before. Interestingly, in the Sweden series of 17 cases, no intracranial or severe complications were seen.

SPA was not included as complication. In our opinion, SPA when present is a part of the diagnosis of AM. The diagnosis of SPA is in most cases performed clinically by palpation of a fluctuation in the retro auricular area. In any doubt, a small incision is performed under sedation in the emergency room. In some rare cases the SPA may be more anterior and deeper in front of zygomatic cells. It may explain a persistent fever. The CT as performed will detect abscesses. The rate of SPA was similar in both groups at 39.5% vs 34.4% (*P*=0.53).

## Bacteriology

The rate of positive culture was significantly higher in group A at 87% vs 69% (*P*=0.018), and this may be explained by the fact that only one-third had symptoms connected to the ear before suspicion of mastoiditis and thus, only 26% of the children had antibiotics before arriving at the hospital (vs 39.5% in group B). *Staphylococcus aureus* was isolated in a high proportion of cases (27.3% in group A vs 10.7% in group B). All 9 cases in group A were susceptible to oxacillin and no change was made to the treatment of amoxicillin-clavulanic acid, which was started before the result of the culture. *Streptococcus pneumoniae* was also statistically more frequent in group A (48.5% vs 29.9%, *P*=0.028). This fact is possibly connected to the vaccination against *Streptococcus pneumoniae*. In Israel, the vaccine is given as part of a three-dose vaccine program at the age of 2 months, 4 months, and 1 year. A vaccine covering 7 strains (PCV7) entered the vaccine program in July 2009, followed by a vaccine covering 13 strains (PCV13) in November 2010.28 Obviously, no child under 6 months could receive all 3 doses, but a child is considered as immune after 1 or 2 doses. Because the vaccination period started during the study period, and a change from PCV7 to PCV13 also occurred in this period, some children received 1 dose, others received 2 doses, and some did not receive any pneumococcal vaccination. The precise correlation between the higher percentage of *S. pneumoniae*, young age and vaccination status is difficult to establish and will require multifactorial analysis on larger numbers. In any case, *S. pneumoniae* was also the most frequent bacteria detected in the series by Stenfeldt et al14.

Most children were treated with IV amoxicillin-clavulanic acid. In the case of intracranial complication, antibiotics with good penetration of the blood-brain barrier were chosen. The most frequent combination was IV ceftriaxone and metronidazole.

## Surgical Treatment

In the series of 38 children aged less than 6 months, only 6 underwent mastoidectomy, 3 because of sigmoid sinus thrombosis detected on imaging, 1 because of severe clinical picture at presentation (high fever and apathy, despite the absence of complication on imaging) and 2 because of persisting fever after a few days of IV antibiotic treatment. All the surgeries were without complication. The 32 remaining children were treated conservatively with paracentesis, incision and drainage of SPA under sedation if present and IV antibiotics for around 1 week. The percentage of surgery in this group was 15.8% and was similar to group B (13%, *P*=0.62). In the paper of Stenfeldt et al,14 they found that out of 17 children all but one underwent surgical treatment; however, they included paracentesis and drainage of SPA in the group of surgical treatments. In fact, only 3 children in their series underwent mastoidectomy.

# Conclusions

The results of this study confirm that children under the age of 6 months suffering from AM can be managed in the same manner as older children. Except for meningitis, complications are not more frequent and imaging is not necessary for every case.

Conservative treatment, including paracentesis, incision and drainage of SPA when present and IV antibiotics is a good option; mastoidectomy is reserved for complicated cases or when no improvement is seen after a few days of conservative treatment. The bacteriological results were different in the younger age group but in fact did not significantly change the treatment, as most bacteria were sensitive to amoxicillin-clavulanic acid, which is our first choice in uncomplicated AM.

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| **Table 1**. Sociodemographic Characteristics | | | |
|  | **Group A: <6 mo**  **7.18% (*n*=38)** | **Group B: >6 mo**  **92.81% (*n*=491)** | ***P* value** |
| Age, mo (mean±SD) | 4.2±1.18 | 27.08±25.16 |  |
| Sex  Male  Female | 68.4 (26)  31.6 (12) | 51.3 (252)  48.7 (239) | **0.042** |

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| **Table 2.** Clinical Characteristics | | | |
|  | **Group A: <6 mo**  **7.18% (*n*=38)** | **Group B: >6 mo**  **92.81% (*n*=491)** | ***P* value** |
|  |  |  |  |
| Ear side  Right  Left | 50.0 (19)  50.0 (19) | 51.7 (221)  48.3 (204) | 0.837 |
| Fever | 57.9 (22) | 67.4 (331) | 0.230 |
| Upper respiratory tract infection | 47.4 (18) | 35.6 (175) | 0.148 |
| Apatic symptoms | 5.3 (2) | 3.5 (17) | 0.565 |
| Ear symptoms | 31.6 (12) | 51.1 (251) | **0.020** |
| Contralateral ear acute otitis media | 43.2 (16) | 24.7 (121) | **0.013** |
| Subperiosteal abscess | 39.5 (15) | 34.4 (169) | 0.529 |
| Medical history | 7.9 (3) | 7.1 (35) | 0.860 |
| Hospitalization duration | 7.34±4.6 (38) | 7.14±4.6 (491) | 0.798 |
| White blood cells | 18.66±5.23 | 17.21±6.18 | 0.163 |
| C-reactive protein | 7.45±8.04 | 11.30±9.08 | 0.113 |
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| **Table 3.** Management | | | | | |
|  | | **Group A: <6 mo**  **7.18% (*n*=38)** | | **Group B: >6 mo**  **92.81% (*n*=491)** | ***P* value** |
|  | |  | |  |  |
| Computed tomography | | 18.4 (7) | | 21.6 (106) | 0.646 |
| Magnetic resonance imaging | | 7.9 (3) | | 7.7 (38) | 0.972 |
|  |  | |
| Mastoidectomy | | 15.8 (6) | | 13.0 (64) | 0.629 |
| Conservative treatment | | 84.2 (32) | | 82.1 (403) | 0.740 |
| Tubes insertion only | | 0 (0) | | 4.7 (23) | 0.397 |
| Amoxicillin and clavulanic acid | | 89.5 (34) | | 96.9 (476) | 0.017 |
| Cranial cover antibiotics | | 10.5 (4) | | 12.6 (62) | 0.706 |
| Other antibiotics | | 10.5 (4) | | 6.9 (34) | 0.407 |
| Clexane injections | | 7.9 (3) | | 4.1 (20) | 0.266 |
| Pediatric intensive care unit | | 5.3 (2) | | 3.9 (19) | 0.672 |

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| **Table 4.** Bacteriology | | | | |
|  | **Group A: 0-6 mo**  **% (*n*=38)** | **Group B: >6 mo**  **% (*n*=491)** | | ***P* value** |
| Previous antibiotic treatment  Positive culture | 26.3 (10)  86.8 (33) | 39.5 (193)  68.8 (338) | | 0.109  **0.019** |
| Negative culture | 7.9 (3) | 21.6 (106) | | 0.044 |
| No culture | 5.3 (2) | 9.6 (47) | | 0.563 |
| *Streptococcus pneumoniae* | 48.5 (16) | 29.9 (101) | | **0.028** |
| *Fusobacterium necrophorum* | 3.0 (1) | 6.8 (23) | | 0.710 |
| *Haemophilus influenzae* | 6.1 (2) | 15.1 (51) | | 0.198 |
| *Staphylococcus aureus* | 27.3 (9) | 10.7 (36) | | **0.010** |
| *Streptococcus pyogenes* | 24.2 (8) | 41.7 (141) | | 0.051 |
| **Table 5.** Complications | | | | |
|  | **Group A: <6 mo**  **7.18% (*n*=38)** | | **Group B: >6 mo**  **92.81% (*n*=491)** | ***P* value** |
| Sigmoid sinus thrombosis | 7.9 (3) | | 4.3 (21) | 0.302 |
| Facial nerve palsy | 0 (0) | | 0.2 (1) | 0.781 |
| Subdural or epidural abscess | 0 (0) | | 6.7 (33) | 0.099 |
| Meningitis | 7.9 (3) | | 0.6 (3) | **<0.001** |
| Bezold abscess | 0 (0) | | 0.2 (1) | 0.781 |
|  |  | |  |  |
| Brain abscess | 0 (0) | | 0.2 (1) | 0.781 |
| Gradenigo’s syndrome | 0 (0) | | 0.6 (3) | 0.629 |
|  |  | |  |  |