**Acute mastoiditis under the age of six months. Do we need a different approach?**

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**Abstract**

Objective

To examine whether acute mastoiditis (AM) in young infants under the age of six months is more severe 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 the years of 2005-2019 at Shaare Zedek Medical Center with the 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 the years 2005-2019. Among them 38 (7.18%) were under the age of 6 months (15 children below 4 months). There was no significant difference for the need for CT or MRI between the two groups (respectively, group A: 18.4%, group B: 21.6%) or for surgical intervention like mastoidectomy (A: 15.8% vs B: 13%). The rate of complications such as subperiostal 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 pneumonia and Staphylococcus aureus were significantly more frequent in group A (respectively 48.5% and 27.3% in group A vs 29.9% and 10.7% in group B; p=0.03 and 0.01). There was no death in our study group.

Conclusion

The management of young children suffering from AM below the age of 6 months may be fairly similar to this of older children. There is no need for more aggressive management especially concerning indication 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, Palva in 1959 reported that 0.4% of patients with AOM may develop AM2. By the year 1980 the percentage of patients developing AM dropped dramatically to 0.004%3.

Several studies estimated incidence of AM in developed countries during the 2000s varying from 1.2 to 6.1 per 100,000 children aged 0–14 years, per year 4,5,6,7,8. Some studies have shown an increased incidence rate and /or more complicated cases of AM9,10 in young children especially below the age of 2 years6,9,11,12,13. The peak incidence of AM seems to be in the second year of life14,15.However the incidence and severity of AM, seem to vary in different countries and between different age groups10,12. A study from 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 era16. For an unexplained reason, the incidence of AM seems much higher in Israel than in other developed countries9,6.

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 epidemiologic studies of exposed populations19,20. Moreover, children have a longer life expectancy than adults, resulting in a larger window of opportunity for expressing radiation damage19,20. As previously published, imaging is performed only if intracranial complication (ICC) is suspected or in absence of improvement after 24-48 hours of intravenous treatment21,18.

AM in very young children under the age of 6 mouth is rare and only small series has been published in the literature14.

Intuitively these young children may seem more vulnerable to infection with higher rate of complications and possible bad outcome. Some children even are close to the definition of late onset neonatal sepsis that occurs up to 3 months of age22 .

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 if our conservative approach avoiding systematic imaging and surgery is adequate in this for children under 6 months.

**Methods**

A retrospective cohort study of children hospitalized with a diagnosis of AM was performed between the years of 2005-2019 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 re-admittance to hospital within four 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 sub-periosteal abscess under sedation in the emergency room and intravenous antibiotic administration (usually amoxicillin and clavulanic acid). CT was performed only in absence of improvement after 24 to 48 hours of antibiotics IV 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 case of intracranial complications such as epidural abscess or sigmoid sinus thrombosis (SST) but also for some cases in the absence of clinical improvement after a few days of medical treatment, even with no signs of complication were seen in CT.

If additional imaging was needed for follow up, particularly in case of ICC, MRI was performed.

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

**Data analysis**

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

All statistical tests were bi-directional, and with p-value of 5% or less 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 the periods of 2005-2019. Among them, 38 (7.18%) infants were under the age of 6 months (group A) and 491 (92.81%) above the age of 6 months (group B). Sociodemographic characteristics are shown in table 1.

Figure 1 presents the age distribution of the infants of 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. 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 the clinical presentation. Suspicion of ear pain or secretion at presentation were less frequent in group A, 32% vs 51% in group B (p=0.020). As well, on examination of the contralateral ear, signs of acute otitis media (AOM) were more frequently observed in the young age group 43% vs 25% (p= 0.013). Sub-periosteal abscess (SPA) was diagnosed in 39.5% of children in group A and 34% in group B (not significant, p=0.53). The others 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 a CT in group A and 22% (106 children) in group B (p=0.646). The number of MRI's performed was also similar 7.9 vs 7.7%.

Conservative treatment was the treatment of choice in both groups. Only 6 children in group A (16%) underwent a mastoidectomy, and 64 children (13%) in group B (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 pneumonia 48.5% vs 30% in group B (p=0.028). Staphylococcus aureus was also more frequent in younger children: 27% vs 11% (p= 0.01). A positive culture was more frequent also in group A: 87% vs 69% (p= 0.019).

The most frequent ICC observed in the series was SST and the occurrence was slightly higher in group A: 7.9% vs 4.3% but not statistically different (p=0.302). One case of intracranial brain abscess, 3 cases of Gradenigo syndrome and 33 cases of epidural abscesses were found, in group B and no ones in group A but it was also not statistically different (table 5). The only difference in ICC Between the 2 groups concerns the incidence of meningitis. There were 3 cases in both groups:8% vs 0.6%, p<0.001.

**Discussion:**

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

Very few publications concern this very specific group of age exist, since occurrence of AM at this young age is rare. We found one multi-centric publication by Stenfeldt et al. of 17 cases collected from 34 ENT departments in Sweden during a period of 15 years 14. As previously published6 and for an unknown reason, AM is much more frequent in Israel than is other developed countries. We treated in our department at Shaare Zedek Medical Center during 15 years period 529 children suffering from AM. 7.2% among them were under the age of 6 months (38 infants). To our knowledge it is the largest series in the literature and moreover this study is a monocentric one.

Regarding the prevalence and the severity of AM according to the 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 authors have found the opposite 6,10'23. In those publications, the youngest group is usually less than one 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 al. 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 complications12. On the other hand, Groth showed that AM was most common in children younger than two years of age and that younger children have neither more severe AM nor more complications than older ones23.

A study from Italy found no differences in the incidence and complications of AM between patients younger and older than 2 years. Balsamo concluded that greater attention to signs and symptoms in pre-verbal 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 pre-verbal period24.

The multi-centric study from Sweden on infants under the age of 6 months (Seventeen 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 in the age of 0-23 months14. AM was especially rare before 4 months, this was possibly explained by the authors by the presence of maternal antibodies in infants at that age14 and its reduction later. In our series, 23 cases were between 4 to 6 months but we had 15 cases under the age of 4 months (youngest case aged 41 days).

Clinical characteristics:

In our group of children under age of 6 months, ear pathology was not suspected before the clinical appearance of AM in around two third of children. Only 31.6% presented with ear symptoms (i.e. secretion or pain according to the parent’s description) vs 51.7% in older group (p=0.02). It is in accordance with the publication of Balsamo24 that AOM is easily missed in pre-verbal children due to their low ability to describe or locate pain. Generally, older children can express themselves more precisely. Fever and cry are frequently the only symptoms of AOM in young children and ear examination must systematically be performed to detect ear infection. It must be also noted that the examination of the eardrum at a few months age baby is uneasy and sometimes will need a microscopic to confirm or eliminate signs of infection like bulging of the eardrum. In our series although ear complain was 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 in important, especially if fever persist after beginning of treatment. In any doubt on the origin of the persistent fever, we recommend to perform a paracentesis also of the contralateral ear, this may avoid the need for a CT if the fever disappeared after the paracentesis.

Imaging

One of the main goals of this retrospective study was to verify if our policy to avoid as possible CT in children was also applicable in very young children. In one hand, in this young age, radiation of brain may be more harmful19,25,26, in other hand, in a few months year old, the skull is thinner than in older child27 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) complication rate was similar. As previously published21, our policy to ask for a CT at presentation only in severe cases mainly such as child with neurological sign like stupor or very high fever and weakness or after 24 to 48 hours without improvement. The number of MRI performed were also identical 7.9% vs 7.7%. Usually, CT with contrast is performed in first intention.It is a shorter exam, easier to obtain in an emergency fashion and may be done sometime without general anesthesia. MRI was performed for follow up of intracranial complication, mainly SST.

Complications

Epidural abscess, Bezoldt abscess, Gradenigo syndrome were observed only in group B (respectively in 6.7%, 0.2% and 0.6%). SST encountered in both groups, seems more frequent in group A (7.9% vs 4. 3%).For all these cases the difference did not reach a statistical difference. So, we can conclude for this relatively large series that complications of AM in very young age is not more frequent. For us, it is a confirmation that more aggressive treatment in this group is not necessary. The only significantly difference in complications was the frequency of meningitis accompanying AM. This frequency was higher in group A: 7.9% vs 0.6% (p<0.001). Diagnosis was performed by lumbar puncture after a clinical suspicion. To our knowledge this association between AM at age under 6 months and meningitis was not described before. Interestingly in the Sweden series of 17 cases, no intracranial or severe complications were seen.

Sub periosteal abscess (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 sometimes a persistent fever. The CT as performed will detect the abscess. The rate of sub periosteal abscess was identical in both group: 39.5% vs 34.4% (p=0.53).

Bacteriology:

The rate of positive culture was significantly higher in group A: 87% vs 69% (p=0.018), this may be explained by the fact that only one third had symptoms connected to the ear before the suspicion of mastoiditis and thus, only 26% of the child get antibiotics before arriving to 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 the 9 cases in group A were Oxacillin susceptible and no change was made in the treatment of Amoxicillin-Clavulanic acid which was begun 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 two months, four months and a year. A vaccine covering 7 strains (PCV7) entered the vaccine program in July 2009, followed by a vaccine covering 13 strains (PCV13) in November 201028. Obviously, no child under 6 months could receive the 3 doses, but a child is considered as immune after 1 or two doses. Since the vaccination period begun during the study period, and a change from PCV7 to PCV13 occurs also in this period, moreover, part of the children received one dose, other 2 doses, and some child did not receive any pneumococcal vaccination, 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 case of intracranial complication, antibiotic with good penetration of blood-brain barrier was choose. The most frequent combination was Ceftriaxone and Metronidazole, both IV.

Surgical treatment

In the series of 38 children aged less than 6 months, only 6 underwent mastoidectomy, 3 because of SST detected on imaging, one because of severe clinical picture at presentation (high fever, and apathy despite the absence of complication on imaging) and 2 infants 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 sub periosteal abscess under sedation if present and IV antibiotics for around one week. The percentage of surgery in this group: 15.8% was identical to group B (13%, p=0.62). In the paper of Stenfeldt et al14, he wrote that out of the 17 children all but one underwent a surgical treatment. However, they included paracentesis and drainage of SPA in the group of surgical treatment. 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 subperiosteal abscess when present and IV antibiotic 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 young age group but in fact did not significantly changed the treatment since most bacteria were sensitive to amoxicillin-clavulanic acid which is our first choice in uncomplicated AM.

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

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| **Table 2.** Clinical Characters |
|   |  **Group A: 6 mo.>****7.18% (n=38)** | **Group B: 6 mo.<** **92.81% (n=491)** | **P-value** |
|  |  |  |  |
| Ear side RT LT | 50.0 (19)50.0 (19) | 51.7 (221)48.3 (204) | p=0.837 |
| Fever | 57.9 (22) | 67.4 (331) | P=0.230 |
| URTI\*  | 47.4 (18) | 35.6 (175) | p=0.148 |
| Apatic symptoms | 5.3 (2) | 3.5 (17) | p=0.565 |
| Ear Symptoms | 31.6 (12) | 51.1 (251) | **p=0.020** |
| Contralateral Ear AOM | 43.2 (16) | 24.7 (121) | **p=0.013** |
| Sub-periosteal abscess | 39.5 (15) | 34.4 (169) | P=0.529 |
| Medical history | 7.9 (3) | 7.1 (35) | p=0.860 |
| Hospitalization duration | 7.34±4.6 (38) | 7.14±4.6 (491) | P=0.798 |
| WBC | 18.66±5.23 | 17.21±6.18 | P=0.163 |
| CRP | 7.45±8.04 | 11.30±9.08 | P=0.113 |
| \*Upper Respiratory Tract Infection |  |  |  |

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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** |
|  |  |  |  |
| CT | 18.4 (7) | 21.6 (106) | p=0.646 |
| MRI | 7.9 (3) | 7.7 (38) | p=0.972 |
|  |  |
| Mastoidectomy  | 15.8 (6) | 13.0 (64) | p=0.629 |
| Conservative treatment  | 84.2 (32) | 82.1 (403) | p=0.740 |
| Tubes insertion only | 0 (0) | 4.7 (23) | p=0.397 |
| Amoxicillin and clavulanic acid  | 89.5 (34) | 96.9 (476) | p=0.017 |
| Cranial cover antibiotics | 10.5 (4) | 12.6 (62) | p=0.706 |
| Other antibiotics | 10.5 (4) | 6.9 (34) | p=0.407 |
| Clexane injections  | 7.9 (3) | 4.1 (20) | p=0.266 |
| \*PICU  | 5.3 (2) | 3.9 (19) | p=0.672 |

 \*pediatric intensive care unit

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