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Indications for surgery in acute mastoiditis and their complications in children

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Summary

Objective: To review the clinical charts of 45 paediatric patients treated for acute otomastoiditis at the ORL Department of the University of Brescia (Italy) between January 1994 and March 2005 and to discuss the diagnostic workup and the outcome of treatment.
Methods: Twenty-six males and 19 females were admitted with acute mastoiditis and subperiosteal abscess. Thirteen of them (28.9%) presented an intracranial complication. Only three of them were not operated upon; one received a ventilation tube (VT); all the others underwent a mastoidectomy within 48—72 h. Twenty out of 32 uncomplicated mastoiditis were treated conservatively and the remaining 12 underwent myringotomy $\pm$ VT, associated with a mastoidectomy in 9 cases.
Results: Antibiotics alone or with VTs achieved a full recovery in 28 out of 32 uncomplicated cases. Mastoidectomy resolved the disease in 13 patients (9 with complications). In severe complications, a canal wall down (CWD) ($n = 2$) or an intact canal wall (ICW) mastoidectomy ($n = 7$) were preferred, based on the extent of the lesions and the degree of hearing loss. All children recovered completely at 1 year follow-up. In the uncomplicated cases that were operated upon, the mean hospital stay was 7.8 days (versus 4.3 days for the conservative group). In children with intracranial complications the mean hospital stay was 12.8 days, significantly less than the four non-surgical patients, who remained hospitalized for an average of 18 days.
Conclusion: Acute mastoiditis can fully recover with conservative treatment or myringotomy + VTs. Immediate surgical treatment is indicated for intracranial complications, if the neurological conditions are not critical. A simple mastoidectomy $\pm$ tympanoplasty is warranted in: (1) exteriorization, if the child is older than 30 months or >15 kg of weight, (2) intracranial complications (combined with a neurosurgical procedure as needed) and (3) cholesteatoma or granulation tissue.

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1. Introduction

Prior to the antibiotic era, one quarter to one half of the patients with acute otitis media (AOM) and chronic otitis media (COM) presented with mastoiditis, subperiosteal abscesses and sigmoid sinus thrombophlebitis [1]. Two to 6% of all patients developed an intracranial suppurative complication, with a fatal outcome in three quarters of them [2]. Despite the antibiotics reduced the complication rate to 0.02—0.15%, the mortality is still high (≈20%), especially in populations with lower socioeconomic conditions [3—6].

The incidence of mastoiditis in the paediatric age has consistently increased over the last two decades [7] even in industrialized countries [8,9]. The same negative trend has been observed for suppurative intracranial complications [10]. Abuse of or inadequacy of antibiotic treatment have been attributed a role in selecting resistant bacterial strains [8,11].

The dilemmas that the otologist is facing when dealing with mastoiditis are:

1. the indications for a surgical treatment;
2. the timing of surgery (immediate versus delayed);
3. the choice of the surgical procedure.

The objective of this study was to review the clinical charts of 45 paediatric patients admitted to the ENT Department of the University of Brescia for acute otomastoiditis and discuss the diagnostic workup and the outcome of treatment.

2. Materials and methods

Between January 1994 and March 2005, 45 children were admitted to the Otolaryngology Department of the University of Brescia for an acute mastoiditis. Their age ranged between 2 months and 15 years (mean 5.2 years). There were 26 males and 19 females. Thirteen of them (28.9%) presented an intracranial complication at admission. Exteriorization in the deep neck spaces (Bezold's abscess) was observed in one 6-year-old boy. Retroauricular swelling, skin redness, tenderness and pain at palpation of the mastoid region was the typical picture for 30 little patients, while 15 others were admitted with fowl smell otorrhoea ($n = 13$) and/or torticollis ($n = 3$) or trismus ($n = 1$). Fever was present in 29 patients, headache in 3.

At the time of admission, eight patients had been already taking oral antibiotics for 2—10 days (mean 6.1 days). The drugs prescribed by the family pediatricians had been cephalosporines ($n = 4$) macrolides ($n = 3$) and amoxicillin ($n = 1$). Swabs for bacterial culture were obtained in 27 children at the time of surgery either by exploratory puncture or collection of purulent material from the ear canal.

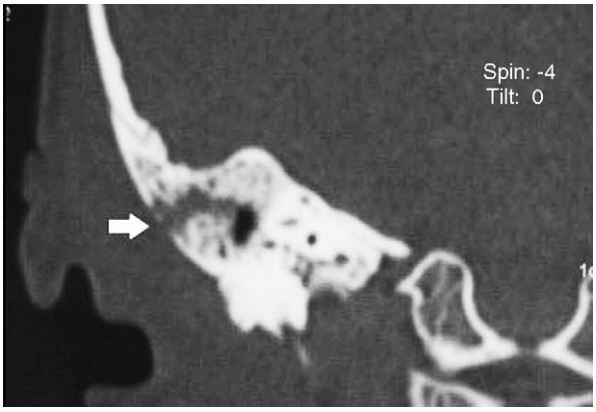

Fig. 1 Right acute mastoiditis in a 6-year-old girl. High definition CT scan of the temporal bone, coronal projection: coalescent mastoiditis with resorption of bony trabeculae; dense material filling the mastoid, attic and tympanic cavity. Note the erosion of the cortical bone (arrow) and the initial swelling of the soft tissues.

A computerized tomography (CT) scan of the brain and a high definition study of the temporal bone was urgently requested at admission when an intracranial complication was suspected ($n = 6$) (Figs. 1 and 2). The CT scan was otherwise postponed (within 24—72 h) in other 11 children. An imaging study was not deemed necessary for 28 children because of the benign clinical course of the disease. An MRI helped defining the complications. Sigmoid sinus thrombosis (SST) ($n = 7$) was assessed by means of CT scan with i.v. contrast and angio-MR in selected

Fig. 2 A 2-month-old child (patient no. 13 with intracranial complication). CT scan of the brain, axial projection: swelling of soft tissues over the mastoid, subperiosteal abscess (arrow), resorption of cortical bone (dotted line). Note the epidural abscess in the posterior cranial fossa, adjacent to the sigmoid sinus (arrowhead).

cases (Fig. 3). Ultrasound Doppler flowmetry detected thrombosis of the internal jugular vein (IJV) in the neck in three of them. Blood clotting laboratory tests excluded a thrombophylic diathesis. Two of the kids with SST presented with VI nerve palsy, due to the extension of the thrombus to the cavernous sinus. Three little patients with SST developed an epidural abscess in the posterior cranial fossa. Intraparenchymal multiple abscesses occurred in another, without SST. Meningitis, confirmed by cerebrospinal fluid analysis through lumbar puncture, was encountered in six patients, two of which with SST.

All patients underwent immediate i.v. antibiotic treatment based on regional bacterial prevalence rates provided by the Institute of Microbiology of the University of Brescia. It consisted of ampicillin/sulbactam (50 mg/kg t.i.d.) during their whole hospital stay, associated, in selected cases with ami-

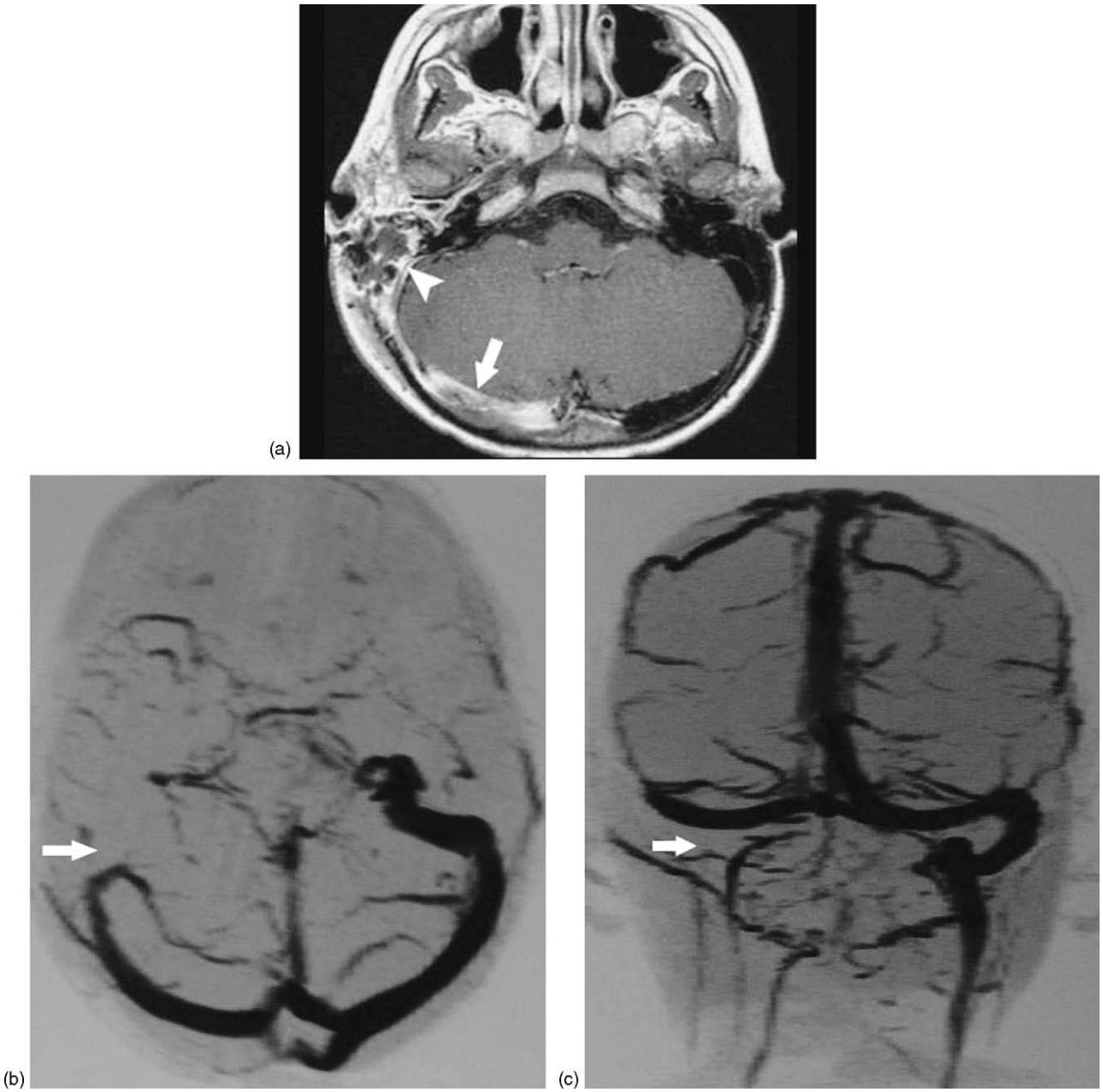

Fig. 3 Patient no. 11 with intracranial complication. (a) T_1-weighted SE axial section of the brain: hyperintense material filling the left mastoid cavity (arrowhead). The homolateral sigmoid sinus enhances backward to the sinuses confluence (arrow), indicating periphlebitis. Note the difference with the controlateral normal appearance. (b) 2D-TOF angio-MR with gadolinium, axial cut: complete occlusion of the left sigmoid sinus at the junction with the transverse segment (arrow). (c) 2D-TOF angio-MR with gadolinium, coronal projection: absence of flow in the left sigmoid sinus and internal jugular vein (arrow).

kacin sulphate (7.5 mg/kg b.i.d.) or netilmicin sulphate (3 mg/kg b.i.d.) for 6 days.

The non-surgical patients were discharged after an average of 4.45 days (range 1—14 days) and the surgically treated children after 13.56 days (range 9—21 days). All of them continued an oral antibiotic (40 patients: amoxicillin/clavulanic acid 25 mg/kg b.i.d.; 4 patients: a third generation cephalosporin active against *Pseudomonas aeruginosa*) for 10—15 days. All the non-surgical children were visited in the office 1 week after discharge and on an individualized basis thereafter.

When surgery was considered, it was undertaken within the first 72 h since admission (mean 2.6 days, range 12 h—12 days). Six patients underwent surgery on the very same day they entered the hospital and most of the others in the first 2 days. The timing of surgery depended upon the general condition of the patient and extension and complications associated with the mastoiditis. Surgery was delayed only in patient #2 (intraparenchymal cerebellar abscess) because of critical neurological conditions. Follow-up for the surgical group consisted in office visits scheduled at 1—2 weeks, 1—3—6—12 months and every 6 months thereafter. Doppler ultrasound scanning of the vessels in the neck was obtained at 3—6—12 months in the three children with IJV thrombosis.

3. Results

Long-term follow-up (range 12—37 months) documented a complete recovery in all 45 children. The CT scan identified 13 intracranial complications. Table 1 summarizes their clinical features and management.

Twelve out of the 32 patients who had uncomplicated mastoiditis (37.5%) and 10 out of 13 children with an intracranial complication (77%) underwent surgery (Table 2). A myringoplasty was associated to the mastoidectomy in three instances. In no case the reconstruction of the ossicular chain, that was found interrupted in two children, was attempted in the first stage.

All seven children with SST underwent a mastoidectomy, either intact canal wall (ICW) ($n = 5$) or canal wall down (CWD) ($n = 2$), based on the extent of the disease. The sinus was surgically managed by skeletonization of the cortical bone in five children, by the evacuation of the thrombus and obliteration of the lumen in one (Table 1, patient #9), and by ligation of the lateral sinus and of the IJV in the neck in another one (Table 1, patient #11). Post-operative course was uneventful in all cases. Two of the three children with IJV thrombosis underwent prolonged anticoagulation (for up to 6 months) with dicumaroles. The blood flow in the vein was re-established at 6 months at ultrasound Doppler scanning in all SST children, except in the two with obliterated or ligated sinus. The latter recovered completely and developed an efficient collateral venous drainage. In no instance a neurosurgical procedure was deemed necessary. In patient #2 the neurosurgeon preferred to abstain from performing a craniotomy, due to the multifocality of the purulent collections in the cerebellum. A delayed ICW mastoidectomy

Table 1 Intracranial complications and their management

Patient		Sex	Age	Pathology	Surgical treatment	Hospital stay
1	G.C.	M	15 years	AOM, meningitis	None	15
2	B.A.	M	14 years	AOM, cerebellar abscess	ICW + MPL	10
3	C.D.	F	3 years	AOM, meningitis, SST, CST	CWD + MPL	10
4	G.A.	M	3 months	AOM, meningitis	None	11
5	M.M.	F	15 months	AOM, meningitis	None	21
6	F.L.	M	3 years	AOM, meningitis	VT	19
7	A.S.	M	14 years	Cholesteatoma, meningitis, SST	CWD + MPL	18
8	C.G.	F	5 years	COM granulation tissue, SST, epidural p.c.f. abscess	ICW + VT	10
9	M.C.	F	8 years	AOM, SST	ICW + VT, SS resection and obliteration	21
10	B.G.	M	6 years	AOM, SST	ICW + VT	16
11	M.A.	M	6 years	AOM + Bezold's abscess, SST, epidural p.c.f. abscess	ICW, SS drainage	12
12	A.A.	M	5 years	AOM, SST, CST	ICW + VT	9
13	L.S.	F	2 months	AOM, epidural p.c.f. abscess	ICW	6

AOM: acute otitis media; COM: chronic otitis media; CST: cavernous sinus thrombosis; CWD: canal wall down mastoidectomy; ICW: intact canal wall mastoidectomy; MPL: myringoplasty; p.c.f.: posterior cranial fossa; SS: simoid sinus; SST: thrombophlebitis of the sigmoid sinus; VT: ventilation tube; m: months; yrs: years.

Table 2 Treatment of acute mastoiditis and its complications

	Therapy	No. of patients	Mean duration of hospital stay and antibiotic T_x (days)
Simple mastoiditis 32 patients	No surgical treatment	20	4.38 (1—14)
	V.T.	3	5.6 (7—8)
	Myringotomy	5	4.2 (2—6)
	Mastoidectomy	1	7
	Mastoidectomy + V.T.	3	7 (6—8)
Mastoiditis + intracranial complication 13 patients	No surgical treatment	3	17 (15—21)
	V.T.	1	19
	Mastoidectomy	5	13 (10—18)
	Mastoidectomy + V.T.	4	12.8 (8—21)

V.T.: ventilation tubes.

(on the 8th day after admission), obtained a complete resolution of the disease. Overall, the mean hospital stay for SST patients was 7.8 days (range 2—21 days).

Among the 32 uncomplicated cases (Table 2), no statistically significant differences were found between a conservative management with antibiotics alone ($n = 20$) and the surgical treatment ($n = 5$ myringotomies, $n = 3$ myringotomy + VTs, $n = 4$ cortical mastoidectomies). All recovered fully, although the relief of symptoms was somewhat slower in the non-surgical group. Also the mean hospital stays were not different: 4.2 and 5.6 days for the myringotomy and myringotomy + VTs group, respectively, versus 7 days in the four children who underwent a mastoidectomy. Ventilation tubes were spontaneously extruded within 6—8 months in all cases except in one; no otorrhoea or perforations persisted at 1 year follow-up. Only patient #10 had recurrent AOM on the same side at 3 months after surgery, up to the longest follow-up (37 months). He recovered without any further surgery, by means of a 10 days course of cephtriaxone, neither developing sequelae nor suffering of other recurrences.

4. Discussion

Although the majority of middle ear infections involves the mastoid cellular tract, a subperiosteal abscess or an exteriorization into the neck (Bezold's abscess) nowadays occurs in less than 2% of AOM episodes [5,12,13]. Acute mastoiditis can develop without a previous history of recurrent AOM [14] or after a single episode of AOM, such as in 38.5% of Ghaffar et al.'s young patients [7]. A "masked" mastoiditis should be suspected if there is persistent pain or otorrhoea despite 2 weeks of antibiotic treatment [11]. In our series, 37 of the 44 patients (84%) developed mastoidites after the first recognized episodes of AOM.

Antibiotic treatment prior to admission does not seem to prevent the onset of mastoiditis [11,15,16]. Only a limited number of children of the present study were taking antibiotics before hospital admission (8/45 = 17.8%). In contrast with the literature, where *Streptococcus pneumoniae* ranks first [17,18], *Streptococcus pyogenes* was the most common pathogen isolated from the ears of our patients.

The incidence of complications we observed (13/45 patients: 28.9%) is set at the upper limits reported in the literature, that ranges between 7 and 35% [7,11,15,19,20], and resembles those of developing countries [21]. Reasonable explanation is the characteristics of tertiary referral centre of our institution and the significant rate of immigration from developing countries in the last decade. Complications aroused in 11 children after an isolated episode of AOM and in two others during the course of COM.

The CT yields a sensitivity of 97% and a positive predictive value of 94% in detecting intracranial complications [22,23]. The common "shadowing" of the mastoid air cell tract in a CT scan performed during AOM is not a sign of mastoiditis that, instead, is indicated by resorption of bony trabecula and erosion of the cortical bone (Figs. 1 and 2). Based on this high rate of complications, we suggest to obtain not only for the patients with clear neurological signs but in every patient with acute mastoidites. If a complication is found, MRI should follow, to help the surgical planning [22].

The commonest complication in the present study was SST ($n = 7$), often associated with other co-morbidities (IJV thrombosis in three, cavernous sinus thrombosis in two, epidural abscesses in the posterior fossa in three and meningitis in two). A mastoidectomy, with toilette of the periphlebitis or perisinus abscess proved to be sufficient and successful in five of them. Evacuation of the thrombus through an incision of the sinus, followed by obliteration in one child and by IJV ligation in another,

were necessary in order to prevent the dispatch of septic emboli to the pulmonary circulation.

Meningitis was the second most common neurological complication ($n = 6$). Three of the little patients with meningitis recovered with pharmacological therapy alone. In one child myringotomy and VTs were beneficial. The last two children underwent a mastoidectomy because of SST ($n = 2$) and associated VIth nerve palsy ($n = 1$), and full recovery ensued.

The role of surgical treatment, and especially of mastoidectomy, is questioned by some authors [24]. The recovery rate with i.v. antibiotics and myringotomy ranges between 60.4 and 87% [20,25,26]. Furthermore, some studies point out that no statistically significant differences are observed between the cure rates for children treated with myringotomies + VTs and those managed more aggressively with mastoidectomies [27,28]. Conversely, an immediate drainage of the mastoid abscess could theoretically reduce the use of antibiotics and the hospital stay, and would prevent an intracranial spread of the infection. In some centres a cortical mastoidectomy is performed in all instances, including very young children, starting from 8 months of age [29]. Other management options include the evacuation of the subperiosteal abscess by incision and drainage [30,31] and the exploratory puncture, either alone [32] or associated with myringotomy [33]. Based on our experience, we agree with the clinical studies that recommend mastoidectomy only for complications or failures to improve with antibiotics and myringotomy [25,34,35]. In our series the hospital stay and the duration of the antibiotic treatment were not significantly reduced when compared with more conservative approaches; this reflects the greater severity of the disease leading to a mastoidectomy.

In the uncomplicated cases who were operated upon, the mean hospital stay was 7.8 days versus 4.3 days for the conservative group, whereas for patients with intracranial complications the mean hospital stay was 12.8 days (range 8—21), significantly less than in the four non-surgical patients, who remained hospitalized for an average of 18 days (range 15—21). Special consideration is to be given to the little patients who develop meningitis: the spectrum of clinical presentation may vary from slight meningeal signs, for which a prudent "wait and see" policy under antibiotic coverage or myringotomy is warranted, to the occurrence of the more severe drug-resistant otorrhoea and osteitic lesions, which drive the Otosurgeon into action. In our experience, myringotomy and VTs have also accelerated the recovery of meningitis following AOM episodes and therefore, it could have possibly shortened the long hospital stay (mean 17 days) also in the three children who were not operated upon.

Reluctance to perform a mastoidectomy is mainly related to the anesthesiological risks in very small children, although excessive blood loss is absolutely rare. The surgical hazards are minimal in a simple cortical mastoidectomy, whose purposes are to clear the purulent collection in the mastoid and to recreate a correct ventilation pathway through the aditus ad antrum, without disturbing the middle ear cavity or endangering the labyrinth and the Fallopian canal. In our experience, mastoidectomy led to complete recovery in all nine complicated mastoidites in whom it was performed, and it did not overload the morbidity of the disease in any respect. On the other hand, 20 out of 32 of our children with no intracranial complications recovered without any surgical treatment. This could lead to the assumption that a mastoidectomy is unnecessary in the majority of acute mastoiditis. Actually, this subgroup represented a milder form of the disease, and not even myringotomy was felt necessary because of normal eardrums and tympanograms. Most likely, the purulent material was segregated into the mastoid by a blocked aditus ad antrum, while the tympanic cavity was free.

The decision to proceed to surgery reflected a more severe clinical course of the disease. Myringotomies $\pm$ VTs were reserved for children with consistent retroauricular swelling and bulging of the eardrum, while the mastoidectomy was performed in 4 uncomplicated cases who failed to respond to antibiotics and in 9 out of 13 with complications.

When intracranial complications are identified, otologic surgery is carried out soon after the neurosurgical procedure, in order to clear the source of infection. It can be performed in the same surgical session, or it can be delayed until the neurological conditions have stabilized. Epidural abscesses in the posterior cranial fossa can also benefit from the otologic procedure alone, as demonstrated by the experience in three of our children (#8, #11 and #13).

Overall, all children with intracranial complications who submitted to a mastoidectomy, either ICW ($n = 7$) or CWD ($n = 2$) achieved complete control of their mastoiditis. In patient #3, the reason for a CWD mastoidectomy was the extension of the osteitic lesions and granulation tissue in the mastoid and attic, associated with SST, perisinus abscess and meningitis. Myringoplasty completed a CWD mastoidectomy in one cholesteatoma, as it is routinely done in COM surgery. In two other cases, one would argue if it was safe to seal a spontaneous drainage route after AOM. Actually, these two kids had suffered of recurrent AOM episodes that always healed

spontaneously, until they developed mastoiditis. At surgery coalescent mastoidites was found in one and SST in other one. In both cases, the surgeon was confident of having achieved a complete clearance of the disease and repair of the eardrum was judged harmless.

By reviewing our clinical experience and in agreement with other authors [29,32], our current indications to mastoidectomy for acute mastoiditis are the following: (1) exteriorized mastoid abscess, age $>$ 30 months (or weight $>$ 15 kg), (2) intracranial complications, (3) cholesteatoma and (4) purulent otorrhoea and/or granulation tissue, resistant to topical and systemic antibiotics for more than 2 weeks.

The cut-off age of 30 months is related to the anestesiological risk of blood loss in toddlers lighter than 15 kg in weight. A more cautious approach is recommendable in such cases, i.e. immediate myringotomy and observation of the clinical course under proper antibiotic treatment. When a mastoidectomy is indicated, it should be performed within 48—72 h. This allows a prompt improvement of the clinical picture, often paralleled by a shortening of the hospital stay [35].

5. Conclusions

Mastoidectomy is an effective treatment for acute mastoiditis associated with one of the following: subperiosteal abscess or exteriorization, cholesteatoma, intracranial complications and otorrhoea persisting for more than 2 weeks despite adequate antibiotic treatment, in children $>$15 kg of weight. The rational of the procedure is to clear the suppurative process in the mastoid cell tract, avoiding the risk of further intracranial spread, and re-establish a ventilation route through the aditus ad antrum. In the present series it did not add morbidity to the pathology and achieved complete recovery in all cases in whom it was performed. When indicated, it is preferably performed within 48—72 h. It can otherwise be delayed, in the presence of intracranial complications, until the neurological compromise is stabilized. A craniotomy is unnecessary for epidural abscesses, since clearing of the mastoid focus is sufficient to control the disease. More cautionary approaches, including antibiotics alone or associated with myringotomy and ventilation tubes, are equally effective in the less severe forms of the disease, as well as in meningitis following AOM. Early myringotomy is advocated in smaller babies with the typical acute mastoiditis. Following these rules, all our children recovered completely at 1 year follow-up. Children with intracranial complications remained in the hospital for a longer period if they were not operated upon (18 days versus 12.8 days), related to greater severity of the disease.

References

[1] C.A. Proctor, Intracranial complications of otitic origin, Laryngoscope 76 (1966) 288—308.

[2] S. Gower, W.F. McGuirt, Intracranial complications of acute and chronic infectious disease; a problem still with us, Laryngoscope 93 (1983) 1028.

[3] J. Kangsanarak, S. Fooanant, K. Ruckphaopunt, N. Navacharoen, S. Teotrkakul, Extracranial and intracranial complications of suppurative otitis media. Report of 102 cases, J. Laryngol. Otol. 107 (1993) 999—1045.

[4] M.A. Matin, A.H. Khan, F.A. Khan, A.A. Haroon, A profile of 100 complicated cases of chronic suppurative otitis media, J. R. Soc. Health 117 (1997) 157—159.

[5] U. Osma, S. Cureoglu, S. Hosoglu, The complications of chronic otitis media: report of 93 cases, J. Laryngol. Otol. 114 (2000) 97—100.

[6] K.M. Shamboul, An unusual prevalence of complications of chronic suppurative otitis media in young adults, J. Laryngol. Otol. 106 (1992) 874—877.

[7] F.A. Ghaffar, M. Wordemann, G.H. McCracken, Acute mastoiditis in children: a seventeen-year experience in Dallas, Texas, Pediatr. Infect. Dis. J. 20 (2001) 376—380.

[8] D.A. Van Zuijlen, A.G. Schilder, F.A. Van Balen, A.W. Hoes, National differences in incidence of acute mastoiditis: relationship to prescribing patterns of antibiotics for acute otitis media? Pediatr. Infect. Dis. J. 20 (2001) 1012—1013.

[9] A.I. Ruiz Diaz, F. del Castillo Martin, A. Bilbao Garitagoitia, C. Diaz Roman, M.J. Garcia Miguel, C. Borque Andres, Acute mastoiditis: an increasing entity, An. Esp. Pediatr. 57 (2002) 427—431.

[10] C. Go, M.J. Bernstien, A.L. De Jong, M. Sulek, E.M. Friedman, Intracranial complications of acute mastoiditis, Int. J. Pediatr. Otorhinolaringol. 52 (2000) 143—148.

[11] M. Luntz, A. Brodsky, S. Nusem, J. Kronenberg, G. Keren, L. Migirov, et al., Acute mastoiditis—the antibiotic era: a multicenter study, Int. J. Pediatr. Otorhinolaryngol. 57 (2001) 1—9.

[12] J.H. Spiegel, L.R. Lustig, K.C. Lee, A.H. Murr, R.A. Schindler, Contemporary presentation and management of a spectrum of mastoid abscesses, Laryngoscope 108 (1998) 822—828.

[13] G. Marioni, C. De_Filippis, A. Tregnaghi, R. Marchese_Ragona, A. Staffieri, Bezold's abscess in children: case report and review of the literature, Int. J. Pediatr. Otorhinolaryngol. 61 (2001) 173—177.

[14] E. Kvestad, K.J. Kvaerner, I.W. Mair, Acute mastoiditis: predictors for surgery, Int. J. Pediatr. Otorhinolaryngol. 15 (2000) 149—155.

[15] T.E. Linder, H.R. Briner, T. Bischoff, Prevention of acute mastoiditis: fact or fiction? Int. J. Pediatr. Otorhinolaryngol. 56 (2000) 129—134.

[16] M. Romer, H.R. Briner, T. Linder, Effect of antibiotics on the occurrence and course of acute mastoiditis, Schweiz. Med. Wochenschr. Suppl. 125 (2000) 20S—22S.

[17] M. Francois, T. Van den Abbeele, P. Viala, P. Narcy, Acute external mastoiditis in children: report of a series of 48 cases, Arch. Pediatr. 8 (2001) 1050—1054.

[18] M. Nussinovitch, R. Yoeli, K. Elishkevitz, I. Varsano, Acute mastoiditis in children: epidemiologic, clinical, microbiologic, and therapeutic aspects over past years, Clin. Pediatr. (Phila.) 43 (2004) 261—267.

[19] P. Vera_Cruz, R.R. Farinha, V. Calado, Acute mastoiditis in children—our experience, Int. J. Pediatr. Otorhinolaryngol. 50 (1999) 113—117.
[20] J. Spratley, H. Silveira, I. Alvarez, M. Pais_Clemente, Acute mastoiditis in children: review of the current status, Int. J. Pediatr. Otorhinolaryngol. 56 (2000) 33—40.
[21] I. Khan, F. Shahzad, Mastoiditis in children, J. Laryngol. Otol. 117 (2003) 177—181.
[22] E. Vazquez, A. Castellote, J. Piqueras, S. Mauleon, S. Creixell, F. Pumarola, C. Figueras, J.C. Carreno, J. Lucaya, Imaging of complications of acute mastoiditis in children, Radiographics 23 (2003) 359—372.
[23] L. Migirov, Computed tomographic versus surgical findings in complicated acute otomastoiditis, Ann. Otol. Rhinol. Laryngol. 112 (2003) 675—677.
[24] R. Cohen-Kerem, N. Uri, H. Rennert, N. Peled, E. Greenberg, M. Efrat, Acute mastoiditis in children: is surgical treatment necessary? J. Laryngol. Otol. 113 (1999) 1081—1085.
[25] S. De, Z.G. Makura, R.W. Clarke, Paediatric acute mastoiditis: the Alder Hey experience, J. Laryngol. Otol. 116 (2002) 440—442.
[26] P.W. Bauer, K.R. Brown, D.T. Jones, Mastoid subperiosteal abscess management in children, Int. J. Pediatr. Otorhinolaryngol. 15 (2002) 185—188.
[27] E.S. Lee, S.W. Chae, H.H. Lim, S.J. Hwang, H.K. Suh, Clinical experiences with acute mastoiditis—1988 through 1998, Ear Nose Throat 79 (2000) 884—888, 890—892.
[28] E.H. Harley, T. Sdralis, R.G. Berkowitz, Acute mastoiditis in children: a 12-year retrospective study, Otolaryngol. Head Neck Surg. 116 (1997) 26—30.
[29] G. Michalski, T. Hocke, K. Hoffmann, D. Esser, Therapy of acute mastoiditis, Laryngorhinootologie 81 (2002) 857—860.
[30] L. Migirov, J. Kronenberg, Bacteriology of mastoid subperiosteal abscess in children, Acta Otolaryngol. 124 (2004) 23—25.
[31] L. Migirov, A. Eyal, J. Kronenberg, Intracranial complications following mastoidectomy, Pediatr. Neurosurg. 40 (2004) 226—229.
[32] M.F. Taylor, R.G. Berkowitz, Indications for mastoidectomy in acute mastoiditis in children, Ann. Otol. Rhinol. Laryngol. 113 (2004) 69—72.
[33] A. Khafif, D. Halperin, I. Hochman, R. Gertler, I. Poria, D. Shindel, G. Marshak, Acute mastoiditis: a 10-year review, Am. J. Otolaryngol. 19 (1998) 170—173.
[34] R.S. Bahadori, R.H. Schwartz, M. Ziai, Acute mastoiditis in children: an increase in frequency in Northern Virginia, Pediatr. Infect. Dis. J. 19 (2000) 212—215.
[35] V. Tarantino, R. D'Agostino, G. Taborelli, A. Melagrana, A. Porcu, M. Stura, Acute mastoiditis: a 10 year retrospective study, Int. J. Pediatr. Otorhinolaryngol. 66 (2002) 143—148.