

ORIGINAL ARTICLE

Tympanic Atelectasis in Children and Early Surgical Approach: The Ferrara Experience

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Objective: To assess functional and anatomic results of early surgical approach in a group of children, affected by atelectasis of the middle ear. Management of the tympanic membrane atelectasis still represent a challenging problem in paediatric patients, due to clinical application of different classifications, potential unfavourable evolution, different therapeutic options.

Materials and Methods: Retrospective study of paediatric patients with a severe atelectasis and/or retraction pocket/s of the tympanic membrane evaluated and treated surgically between January 2002 and December 2009, c/o the Audiology Department of the University Hospital of Ferrara (Italy), a tertiary referral centre.

Atelectasis of the middle ear was classified according to the Sadé classification by pre- and post-operative microscopy. Pre- and post-operative audiometric evaluation were compared.

Results: The study group consisted fifty-four (54) ears (26 boys and 28 girls), with a median age at the time of diagnosis of 6 ± 3.8 years. All patients underwent myringoplasty with perichondrium or fascia under general anesthesia, via endomeatal approach in most cases. Pre-operative findings were, according to the Sadé classification: tympanic retraction with atrophy 53.7%, atelectasis with incudopexy 16.7%, severe atelectasis with retraction pocket/s 29.6%. Cholesteatoma was detected intraoperatively in 16.7% of the cases (n=9). Post-operatively, at the last follow-up control, at 14 months after surgery on average, we registered a regular otoscopy in 46.3%, mild retraction in 42.6%, neotympanic perforation in 3.7% of the cases.

No deterioration of bone conduction thresholds was found following surgical intervention, neither iatrogenic sensorineural loss postoperatively.

Conclusion: This study demonstrated that surgical intervention on middle ear atelectasis is a safe procedure and has no negative effects on hearing. Nonetheless, surgical intervention could allow tympanic atelectasis management, and, most importantly, early diagnosis of retro-tympanic cholesteatoma.

Submitted : 13 January 2011

Revised: 11 May 2011

Accepted : 15 June 2011

Introduction

It has already been described that retraction pockets of the pars tensa are usually subsequent to a chronic inflammation of the middle ear with local release of various aggressive biochemical mediators (cytokines, reactive oxygen species) and a middle ear negative pressure caused by impairment of transmucosal gas exchanges^[1-4]. Such middle ear pathology may result in severe tympanic retraction, chronic middle ear infection, ossicular damage and even acquired cholesteatoma^[1-9]. Particularly it is reported that in children these retraction pockets can be insidious, as they can progress to infection, polyps or perforation^[1].

Different classifications have already been proposed in the literature to describe tympanic atelectasis and/or

retraction pockets, in both adults and children, as Sadé classification^[3, 4] or the more recent Erasmus Atelectasis Classification^[8]. Despite different staging systems, controversies still exist among the treatment of choice of atelectasis and retraction pockets especially in children, considering the recurrence of pathology after ventilation tubes insertion or inadequate medical treatment^[1-8].

There is also a dilemma about the most suitable moment for intervention as some clinicians prefer watchful waiting in order to avoid the potential risk of iatrogenic hearing loss, while others prefer early intervention in order to limit the chances of incus erosion or progression of disease towards cholesteatoma formation^[10, 11].

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The present study reports the outcome of the surgical treatment of atelectasis and/or retraction pockets in a consecutive series of 54 paediatric patients, managed by minimally invasive myringoplasty.

Materials and Methods

Retrospective study. We reviewed 54 paediatric patients (54 ears) with a severe atelectasis and/or retraction pockets (26 boys and 28 girls; median age 6 ± 3.8) consecutively treated from January 2002 to December 2009 c/o the Audiology Department of the University Hospital of Ferrara (Italy).

The oto-microscopic findings were grouped by degree of severity according to the Sadé classification [3] : grade I refers to retraction of the TM with atrophy; grade II retraction onto the incudostapedial joint (with or without incudostapedial joint erosion); grade III retraction without adhesion of pars tensa to the promontory; and grade IV adhesion to the promontory with retraction pocket/s. The site and grade of retraction pocket were recorded on the basis of the visual findings by three experienced ENT physician (CA, RB, AC).

Pure tone audiometry testing was routinely performed preoperatively (one day prior to surgery) and postoperatively (at 8 weeks and then during the follow up). An Amplaid audiometer calibrated according to ISO 9001 was used. The audiometric procedure was performed using headphones to assess air conduction, and a bone vibrator for bone conduction, within a silent cabin (model E2X2, roll 01008 220V 10A). We defined mild hearing loss as a loss of 45 dB, moderate loss as a loss of 46-70 dB, severe loss as a loss of 71-90, and profound hearing loss as a loss >90 dB, according to ASHA protocols. Play audiometry was employed in selected cases. The air and bone conduction thresholds were evaluated, using the four-tone pure-tone average (PTA 0,5, 1, 2 and 4 KHz).

Audiometry, even in the younger patients, was considered to be reliable, due to the extensive experience in paediatric audiometry of the audiological staff in our tertiary referral centre.

All children were operated by the same surgeon (AM) as a day-case procedure under general anaesthesia. Patients were treated according to the severity of the atelectasis. Most of the cases have been managed via endomeatal approach (83.3%), only few required a retro-auricular approach. Grafting have been performed with pericondrium in 54.3% of the cases; fascia was used in all the remaining cases (45.7%). In none of the cases a cartilage graft was provided.

Treatment outcome was assessed with regard to anatomic and functional results as measured by pure tone audiometry (PTA), considering air-bone gap before treatment and over a follow-up period of 14 ± 10 months.

Statistical analysis. Audiometric data collected (PTA values) have been analyzed using descriptive statistic studies by an SPSS application for Windows based systems. Level of significance was considered at p< 0.05. Non-parametric tests (Wilcoxon and Mann-Whitney) have been used in order to evaluate threshold shifts between patients.

Results

Fifty-four children (54 ears), 26 boys and 28 girls, M/F = 0.92, median age 6 ± 3.8, age range 2-17, affected by severe tympanic atelectasis were included in this study.

Pre-operative oto-microscopic findings, according to the Sadé classification were (Table 1): tympanic retraction with atrophy 53.7% (grade I), atelectasis with incudopexy 16.7% (grade II) and severe atelectasis with deep retraction pocket/s 29.6% (grade IV). Preoperatively, no signs of cholesteatoma were detected in none of the cases.

Table 1. Pre-operative and post-operative oto-microscopic findings within the series presented.

ANATOMIC RESULTS			
PRE-OPERATIVE		POST-OPERATIVE	
Tympanic retraction	(grade I) 53.7% n=29	No signs of retraction	46.3% n=25
Atelectasis with incudopexy	(grade II) 16.7% n=9	Tympanic retraction (grade I)	42.6% n=23
Severe atelectasis	(grade IV) 29.6% n=16	Tympanic perforation	3.7% n=2
Intraoperative findings	cholesteatoma 16.7% n=9		
	incus erosion 18.5% n=10		
	fixed stapes 1.8% n=1		

An endomeatal approach was preferred in most of the cases (83.3%); only 9 patients (16.6%) had a retroauricular approach. A cholesteatoma was detected intraoperatively in 16.7% of the cases of grade IV stage; other relevant findings were incus erosion in 18.5% and minor malformations (fixed ossicular chain, presumably congenital) in 1.8%.

All patients were followed up after surgery by microotoscopy on a regular basis (mostly every 4 months). Microotoscopic findings at the last follow-up control, median 14 months after surgery (14 ± 10 months), were: regular otoscopy in 46.3%, mild retraction in 42.6% (grade I), neotympanic perforation in 3.7% of the cases. Unfortunately, four cases (7.4%) are missing as voluntary interrupted the follow-up.

None of the patients required mastoidectomy, and none had injuries to the facial nerve or iatrogenic sensorineural loss postoperatively.

At the audiometric testing (Table 2), the outcome of grade I stage was good (no iatrogenic sensorineural

hearing loss in any case) as the average pre-operative air bone gap (ABG) was 10.6 dB HL and the post-operative ABG was 8.8 dB HL. The difference between the preoperative and postoperative ABG was not statistically significant ($p=0.54$). Also the outcome of grade II stage was good as the average pre-operative air bone gap (ABG) was 13.6 dB HL and the post-operative ABG was 13.5 dB HL; the difference between the preoperative and postoperative ABG was not statistically significant ($p=0.31$). Also, the outcome of grade IV stage was fine as the average pre-operative ABG was 22.7 and the post-operative ABG was 14.5; even in this group, the difference between the preoperative and postoperative ABG was not statistically significant ($p=0.21$). Finally, particularly looking at those cases with incus erosion and retro-tympanic cholesteatoma, no statistically significant differences were found between the preoperative and postoperative ABG within both groups ($p=0.50$ and $p=0.48$ respectively) (Table 3).

Table 2. Mean pre- and postoperative bone and air conduction thresholds (PTA 0,5-4KHz), for the different disease stages of the presented group and main air-bone gap values.

	Bone conduction (dB)		Air Conduction (dB)		Air-Bone Gap ABG (dB)	
	pre-operative	post-operative	pre-operative	post-operative	pre-operative	post-operative
I	10.9	10.4	21.5	19.2	10.6	8.8
II	14.5	15.7	29.3	29.2	13.6	13.5
IV	11.5	10.2	34.2	24.7	22.7	14.5

Table 3. Mean pre- and postoperative bone and air conduction thresholds (PTA 0,5-4KHz) in cases with incus erosion and retro-tympanic cholesteatoma.

	Bone conduction (dB)		Air Conduction (dB)		Air-Bone Gap ABG (dB)	
	pre-operative	post-operative	pre-operative	post-operative	pre-operative	post-operative
Incus erosion	14.3	15.5	28.3	28.2	14.0	12.7
Retro-tymp. cholesteatoma	11.7	10.8	34.6	25.3	22.9	14.5

Discussion

Retraction pockets of the pars tensa, as well as severe tympanic atelectasis, can be progressive and if not treated may result in incudo-stapedial joint erosion and acquired cholesteatoma. The primary aim of management therefore is the establishment of a safe dry ear in which the hearing can be maintained or restored to the normal level [1-4].

Management of retraction pockets and severe tympanic atelectasis is still controversy in the literature. It is reported that treatment in first instance can be preventive. Preventative medical treatments advocated range from forced middle ear insufflations techniques through to nasal decongestants and oral antibiotics [12, 13].

Ventilation tubes have proven to be an effective symptomatic treatment: they can immediately correct the conductive hearing loss associated. Nonetheless, it has been reported that, in the long term, neither the tympanic membrane nor the hearing, can benefit from tubes [14, 15]. In fact, it has been described that ventilation tubes can cause local tympanic atrophy; this abnormality can be found in the majority of the treated ears [16, 17]. Ventilation tubes have also been proven to be ineffective in preventing the development of severe atelectasis or attic retraction [16, 17].

The Erasmus experience in children is an interesting reported series [8]; in this paper of 169 ears, the Authors demonstrated that surgical intervention, from the simple excision of atelectatic membrane till the myringoplasty had a favourable effect on hearing level across all stages. Particularly, regarding the surgical treatment with myringoplasty, it has been reported that tympanic reinforcement lowers the risk of retraction recurrence in comparison with excision of the retraction pocket with ventilation tube [7, 18]. Mainly perichondrium/cartilage composite graft is considered to be an easy-taking graft for myringoplasty with high efficiency and reliability [18-21]. Also myringoplasty with fascia is a beneficial procedure in the paediatric population in the hands of a skilled and experienced surgeon, and if performed properly not only prevents from severe atelectasis, but also stands a good chance of hearing restoration in children [22-24].

It is also clear to the Authors that in the literature the use of cartilage is mainly recommended to reinforce

tympanic membrane, and that cartilage should be preferred to fascia and/or perichondrium in order to lower the risk of retraction recurrence [7, 19, 21]. Nonetheless, within the series presented the use of fascia or perichondrium graft, could also allow a successful management of tympanic retraction or atelectasis correction. Since this is a group of children, we did not use cartilage for two main reasons: (i) to avoid the opacity limits of the new eardrum, thus always allowing a clear inspection of the tympanic cavum, in an attempt to reduce the need to recur to post-operative CT scans or to a second look; (ii) to use a minimally invasive surgical procedure, limiting the surgical sequelae / scars. There are other experiences in the literature, as well, of reported successful management of tympanic retraction without cartilage grafting [25-27].

It is difficult to compare the data from our series to those of other surgical experiences, in children, present in the recent literature (Table 4), mainly due to different staging system used, different materials employed, different timing of follow up, presence of functional (audiometric data) not always available. However, we observed that Cassano M. and Cassano P. have presented their findings as in this report, classifying their result for each stage of Sadè system and having an average follow up of 24 months. Most of the series available just report an overall outcome, across the staging system used, showing an incidence of retraction recurrence and/or perforation after surgery ranging from 0% to 48% (Table 4) [7, 28-32].

Another interesting point is the intra-operative finding of cholesteatoma (16.7% of our series, n=9). A retro-tympanic, likely due to middle ear dysventilation, cholesteatoma was detected in the more severe cases of tympanic retraction (grade IV) of our series, and in all cases the early diagnosis could allow an adequate treatment.

In all stages, the preoperative audiograms did not show a large conductive hearing loss. In all these stages the mean ABG remained below 25 dB. Postoperatively, the hearing was shown to have improved (for each stage there was a ABG improvement, even if not statistically significant, between the preoperative and postoperative ABG), and this could be due to better ventilation of the middle ear after surgery.

Table 4. Outcome of other surgical experiences in children present in the recent literature.

Author	Year	n° Ears	Outcome (Recurrence of retraction or perforation)
Cassano (1)	2010	45	Grade I and II : 6 % (Vent. Tubes) Grade III and IV : 24,2 % (Cartilage)
Albirmawy (28)	2010	82	Cartilage composite graft : 5% Fascia : 23,8 %
Mendes Neto (29)	2008	23	Cartilage composite graft :17,4 %
Ozbek (30)	2008	45	Cartilage composite graft: 0% Fascia : 29,8 %
Anderson (31)	2004	64	Cartilage composite graft: 6% Fascia : 48 %
Coulogner (7)	2003	60	Cartilage composite graft: 8 %
Uzun (32)	2003	59	Cartilage composite graft: 0% Fascia : 15,8 %

This study demonstrated that surgical intervention on middle ear atelectasis is a safe procedure and has no negative effects on hearing. Nonetheless, surgical intervention could allow the atelectasis management, as well the early diagnosis of retro-tympanic cholesteatoma. Nonetheless, larger, prospective randomized study would be required in order to demonstrate the presence of a positive impact of early surgical intervention on the natural history of the disease.

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