The Surgical Management of Tympanic Membrane Retraction Pockets Using Cartilage Tympanoplasty

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Abstract Evaluate the surgical treatment of tympanic membrane (TM) retractions with modified cartilage augmentation tympanoplasty. Retrospective review of subjects with Charachon stage II and III TM retractions who underwent modified cartilage augmentation tympanoplasty following excision of the retracted TM segment. Pre and postoperative symptoms and air-bone gaps were recorded. Forty two ears were included in the study. Twenty six ears were of stage II and 16 were stage III retractions. 35 (83 %) ears had ossicular erosion and cholesteatoma was found in 13 (31 %) ears, all in stage III retractions. Follow-up ranged 12–102 months. The air-bone gap (ABG) improved in 29 (76 %) and worsened in seven (19 %). Ears without cholesteatoma had a greater improvement in ABG. The results of our modified cartilage tympanoplasty technique are comparable to the published literature and should provide a safe and acceptable result. The high rate of cholesteatoma found preoperatively in stage III retractions advocates early surgical intervention.

Keywords Tympanic membrane retraction · Cartilage tympanoplasty · Middle ear surgery

Introduction

A retraction pocket is an invagination of part of the tympanic membrane (TM) into the middle ear cavity as a result of chronic otitis media [1]. It is a common condition and the prevalence of retractions involving the pars flaccida and pars tensa is quoted to be 14–26 % and 0.3–3.7 % respectively, in children aged 5–16 years [2]. It is a distinct clinical entity, affecting either pars flaccida or pars tensa or sometimes both. Often, retraction pockets can be small and self cleansing, without producing any symptoms. When they become progressive, eroding the adjacent structures, they can cause otorrhoea, hearing loss and otalgia.

A thorough understanding of the mechanisms involved in the formation of retraction pockets is required in order to manage them confidently and effectively. It is known that a weakened pars tensa in the presence of persistent eustachian tube dysfunction is the primary factor necessary for retraction [3]. Temporal bone studies demonstrate that the middle fibrous layer of the posterosuperior quadrant of the pars tensa has a looser arrangement than the more compact anterior and posteroinferior quadrants [4]. The posterosuperior quadrant is also subject to greater inflammatory changes during acute otitis media and otitis media with effusion (OME) [4]. As a result, there is selective degradation of the fibrous lamina propria leading to a weakened area that is more susceptible to retraction [5].

Progressive retraction onto the incus can result in erosion of the long process and adhesion to the head of stapes. The TM then retracts into the sinus tympani. As the pocket grows, the stapes superstructure may erode, but often remains intact. The TM may eventually become adherent to the promontory, extending superiorly into the attic and inferiorly into the hypotympanum towards the eustachian tube.

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Sade et al. [6] found that in both pars tensa and pars flaccida regions, 2 % of untreated retractions developed cholesteatoma during an average 3 years follow up period. In cases of patients with OME treated with ventilation tube insertion with or without adenoidectomy, between 1 and 4 % of ears developed attic cholesteatoma [7]. A recent cochrane review on the subject interestingly found no evidence to support or refute the role of surgery in TM retraction pocket [8].

Not only is there wide variation in the severity of disease from mild retraction through to adhesive otitis media, but also a dynamic process that might simply require watchful waiting leading to eventual discharge from clinic, or necessitate surgical intervention at some stage [3]. The dilemma regarding the time of intervention has remained controversial for many years and this has led to a few grading systems to help the clinician decide. The classification by Tos and Poulsen [7] relate to pars flaccida retractions whereas Sade [9] grades pars tensa retractions. Despite these more popular classifications, the senior author finds the Charachon staging system particularly useful in directing management when combined with the patient's symptoms [10] (see Table 1 and Fig. 1).

In order to prevent the complications of retraction, early intervention is often necessary. The options that are available to the clinician are many and a few are listed in Table 2. There are also a myriad of effective surgical techniques chosen on the basis of severity of retraction and status of the ossicular chain [11, 12]. The management of simple mobile retraction pockets (Charachon stage I) with ventilation tube insertion alone or in combination with myringectomy of the retraction pocket has been generally accepted with good reported outcomes [13]. Blaney et al. [14] reserves the latter treatment for more severe retractions that reach the incudostapedial joint or the promontory. Charachon stage II and III are open to more debate. The symptoms of the patient or whether there is cholesteatoma (or keratin) build up within the retraction pocket is not taken into consideration. The senior author operates on all stage III retractions and symptomatic stage II retractions. Symptoms such as persistent or recurrent otorrhoea with or without hearing loss or cholesteatoma build up within the retraction pocket (that is not self cleaning or easy to clean in the office setting) prompted surgical intervention.

Whatever surgical modality is undertaken for the retractions, the main outcome measures to be analysed, are the recurrence of the retraction, dry ear rate and change in hearing. Various techniques and materials have been employed to treat retracted TMs [15]. Successful reinforcement of the retraction pocket following tympanoplasty is expected in 50–80 % of cases dependant on the severity of the retraction, irrespective of technique or

Table 1 The Charachon grading system for tympanic membrane retraction pockets

Charachon stages	Definition
I to III	
I	Mobile retraction pocket fully visible under microscope
II	Fixed and controllable. Retraction pocket fully visible under microscope
III	Fixed and uncontrollable. Deepest part of retraction pocket invisible under microscope

Fig. 1 Examples of the Charachon grading system. **I** Stage I, arrow depicting a mobile retraction pocket. **II** Stage II. **III** Stage III

material used [16]. Thus long-term results should be judged by the viability of the reconstructed TM and the presence of socially useful hearing.

The aim of this study was to evaluate our experience with the surgical management of TM retractions using our modified technique of cartilage tympanoplasty.

Table 2 Treatment options for tympanic membrane retraction pockets

Pars Tensa retractions	Attic retractions
Watch and wait	Watch and wait
Medical treatment	Medical treatment
Ventilation tube insertion	Atticotomy and tympanoplasty
Excision of retraction ± ventilation tube insertion	
Tympanoplasty procedures with augmentation of tympanic membrane	
Cortical mastoidectomy	
Mastoid venting	

Methods

This work was approved by the local institutional board at Arrowe Park hospital and fulfilled the criteria set out by the declaration of Helsinki (2008). A retrospective review of all patients regardless of age or sex with TM retractions who underwent primary modified cartilage augmentation tympanoplasty over a period of 9 years (2001–2010), was undertaken. Patients were consecutively selected and all operations were carried out by the senior author (VS).

Pre-operative imaging was not obtained in any of the cases. Pre-operative audiograms were always recorded and the pure tone audiogram at the most recent follow up appointment was used for analysis. Hearing outcomes were measured using the American Academy of Otolaryngology-Head & Neck Surgery (AAO-HNS) guidelines [17]. Retraction recurrence, perforation and otorrhoea rates were also recorded.

Surgical Technique—Modified Cartilage Tympanoplasty

Surgical intervention in the form of cartilage tympanoplasty with reinforcement of the retracted segment was carried out in all cases via an endaural approach. Disease in the retraction pocket or middle ear was cleared and if spreading into the attic necessitated an atticotomy. The facial recess was exposed and the sinus tympani was inspected for disease with an endoscope and cleared if necessary. If the long process of the incus was eroded, it was removed.

Cartilage was harvested from the tragus without perichondrium and thinned to 0.5 mm with a Kurz® Precise Cartilage Knife (Heinz Kurz GmbH, Berlin, Germany). Separate cartilage pieces were placed in the different areas of retraction, if there was more than one. For example, one cartilage piece was placed in the attic and another in the posterior–superior quadrant. The cartilage was placed over the incus if present. A temporalis fascia graft was placed

over the cartilage and under the handle of malleus. A ventilation tube was not inserted at the time of surgery as it was felt not necessary [18]. Spongostan® (Johnson & Johnson, New Jersey, U.S.A.) was placed in the middle ear to support the graft. In cases of ossicular erosion, formal ossiculoplasty was not performed. In patients where cholesteatoma was found, every effort was made to clear all the disease. Only if the cholesteatoma was localised to attic and/or middle ear and the surgeon was confident of total removal, cartilage tympanoplasty was undertaken. All operated patients are intended to be followed up for life.

Results

Between 2001 and 2010, a total of 42 ears (41 patients) were identified of which five were children and 36 adults. The age ranged from 8 to 66 years (mean 38). Twenty six (62 %) ears were Charachon stage II and 16 (38 %) were Charachon stage III retractions. As their primary complaint, all patients had troublesome otorrhoea and 32 (76 %) some degree of hearing loss.

At surgery 35 (83 %) ears had ossicular erosion and cholesteatoma was found in 13 (31 %) ears all of whom had stage III retraction pockets. Follow up postoperatively ranged from 12 to 104 months (mean 38 months). There were a total of three patients (7 %) with complications. Of these, one patient had a re-retraction a year later, another a recurrent cholesteatoma 18 months following surgery, and a third patient had ongoing otorrhoea 6 months later. Complications all occurred in stage III retractions.

The audiology results have been separated according to severity of retraction. Charachon stage II retraction pre and post operative air-bone gap (ABG) changes have been charted in Fig. 2. Stage III retraction pre and post operative ABG data are displayed in Fig. 3. Data was unavailable on four patients (three in stage II, one in stage III).

Overall, the ABG improved in 29 (76 %) ears, stayed the same in 2 (5 %) ears and was made worse in 7 (19 %) ears. If that is divided into stage of retraction (see Fig. 4), within Charachon stage II the ABG improved in 20 (87 %), no change occurred in 1 (4 %), and was made worse in 2 (12 %) ears. Charachon stage III fared worse with improvement in 9 (60 %), no change occurred in 1 (7 %), and was made worse in 5 (33 %) ears. The ABG for all patients changed from a preoperative average of 24 dB to a postoperative average of 17.3 dB, an improvement of 6.7 dB. Stage II retractions improved from 24 to 17.3 dB on average (8.6 dB change) and Stage III retractions from 23 to 20 dB (3 dB change). In cases where cholesteatoma was present, the ABG roughly stayed the same (worsening of 0.5 dB on average) as apposed to the non-cholesteatoma ears (improvement of 10 dB on average). All 13 ears with

Fig. 2 Charachon stage II retractions displaying the change in preoperative and postoperative air-bone gap (ABG) averaged at 0.5, 1, 2 and 3 kHz. Patient data is arranged in order of magnitude of preoperative ABG. X axis is patient number, Y axis is in dBHL

Fig. 3 Charachon stage III retractions displaying the change in preoperative and postoperative air-bone gap (ABG) averaged at 0.5, 1, 2 and 3 kHz. Patient data is arranged in order of magnitude of preoperative ABG. X axis is patient number, Y axis is in dBHL

cholesteatoma had erosion of the incus. In cases of ossicular erosion the incus was removed and a type III tympanoplasty performed.

Discussion

Whatever the aetiological mechanism, once a retraction pocket develops, it behaves as a dynamic pathology. Further deterioration or resolution depends on the persistence of the secretory otitis media and negative pressure in the middle ear cleft [10]. One of the main difficulties in the treatment of retraction is the timing of the surgical intervention. This largely depends on the progression of the retraction and the consequent symptomatology. Early recognition and monitoring with the judicious use of surgical

intervention is therefore vital. Asymptomatic, self cleansing retractions where the full extent is visible, can be managed conservatively. However, surgical treatment is required in the following situations: retractions where the full extent is not visible, persistent or intermittent otorrhoea and obvious keratin accumulation. Though several grading systems are available, Charachon's grading appears to be most clinically relevant and helpful in decision making regarding surgical intervention [10]. The senior author believes that operating on Charachon stage III retractions and symptomatic stage II retractions will prevent further damage to the middle ear structures. Charachon stage III constitute retractions where the deepest part cannot be seen and therefore may hide pathology. A retraction may contain cholesteatoma but is not necessary for a Charachon classification.

Fig. 4 Overall change in air-bone gap following surgery according to Charachon stage of retraction

In our series, at the time of surgery there was a high incidence of cholesteatoma, 13 out of 42 (31 %), which all occurred in stage III retractions. Sade et al. [6] found that in both pars tensa and pars flaccida regions, 2 % of untreated retractions developed cholesteatoma during an average 3 year follow up period. Similar rates of cholesteatoma of between 1 and 4 % were reported by Kokko and Tos [7, 19]. 35 out of 43 (83 %) ears in our series had ossicular damage in keeping with published literature that retraction pockets cause bony erosion. A high ossicular erosion rate coupled with the high cholesteatoma rate, supports early, aggressive management of symptomatic or uncontrollable (Charachon stage III) retractions.

The authors believe that the TM should be reconstructed with a material that has greater strength than temporalis fascia and for this reason the use of cartilage is advocated. Cartilage has been used as an effective graft material for nearly 50 years. A number of studies have demonstrated its resilience to retraction without affecting hearing [20]. A significant disadvantage with using cartilage is that it obscures keratin pearls behind the graft and therefore either second look surgery or high resolution computed tomography (CT) of the middle ear must be performed for follow up. In patients where cholesteatoma was found at surgery, every effort was made to clear all the disease. Only if the surgeon was confident of total cholesteatoma removal, cartilage tympanoplasty was undertaken.

CT scanning to look for residual cholesteatoma has been superseded by new magnetic resonance imaging (MRI) techniques utilising non-echo planar sequences to detect cholesteatoma, thereby reducing patient radiation exposure [21], although at present there seems to be a learning curve with the use of these newer MRI techniques [22]. Without the newer diagnostic MRI techniques, Dornhoffer states that patients should undergo second look surgery if there is

major disruption of the cholesteatoma sac during initial surgery. However, any delay in diagnosis of recurrent or residual cholesteatoma due to posteriorly placed cartilage does not tend to produce any major complications and will become evident anteriorly or as a recurrence of a conductive hearing loss [23]. We advocate the importance of long term follow up in order to detect recurrences of cholesteatoma in cases where cartilage has been used to strengthen the TM. The recurrence rate of cholesteatoma within our series was 1 out of 13 ears (8 %), which occurred in a stage III retraction after 18 months of follow up. The patient developed a conductive hearing loss and intermittent otorrhoea. At the time of initial surgery, the cholesteatoma was within the postero-superior quadrant and it was felt that complete removal had taken place.

The previously held notion that cartilage tympanoplasty diminishes acoustic transfer does not seem to be a dilemma when examining reported literature [20]. Dornhoffer [24] compared the hearing results of patients after cartilage perichondrial grafting versus perichondrium alone and found no statistical difference. He concluded that cartilage tympanoplasty offers the possibility of a rigorous TM reconstruction with excellent postoperative hearing results. Page et al. [25] observed that the use of cartilage grafts provides good functional results but audiometrically left a residual Rinne of about 10–15 dB. In our series the 0.5 mm thinned cartilage graft did not adversely affect acoustic transfer and was effective in preventing retraction. A novel study using Doppler interferometer and cadaver cartilage by Zahnert et al. [26] confirms that a cartilage thickness of 0.5 mm to be a good compromise between sufficient mechanical stability and low acoustic transfer loss. The rate of re-retractions after cartilage tympanoplasty is reported to be low and would reflect our one ear (2 %) re-retraction rate [20].

In terms of hearing results after cartilage tympanoplasty surgery, our results compare favourably with Page et al. [25] who overall, improved hearing in 64 %, had no change in 21 % and worsened in 15 % of cases. In our series, the ABG improved in 29 (76 %), stayed the same in 2 (5 %) and was made worse in 7 (19 %) of ears. The results when split into Charachon stage II and III retractions show a better audiological result with stage II retractions postoperatively as would be expected (see Fig. 4). Stage II retractions compared to stage III retractions were more likely to have a reduction in ABG (87 vs 60 %) and by a greater margin (8.6 vs 3 dB). The ABG for all patients altered from a preoperative average of 24 dB to a postoperative average of 17.3 dB, an improvement of 6.7 dB. Ears with cholesteatoma had on average a negligible difference (0.5 dB) in ABG change post operatively compared to a 10 dB reduction in ABG with non-cholesteatoma ears. This difference is

thought to be due to the presence of ossicular erosion in ears with cholesteatoma.

The results of our surgical technique of cartilage tympanoplasty for symptomatic Charachon stage II and III retraction pockets on the whole are comparable to the published literature. The high rate of cholesteatoma found preoperatively in our stage III retractions is somewhat alarming and advocates early surgical intervention of all Charachon stage III retractions. Managing TM retraction pockets causes controversy amongst clinicians due to the nature of the disease. Using our method of assessing the retraction with the Charachon grading system along with our technique of modified cartilage tympanoplasty to intervene surgically when indicated should provide a safe and acceptable result for most patients and clinicians.

Conflict of interest None.

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