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Original article

Acquired medial external auditory canal stenosis, anterior tympanomeatal angle blunting, and lateralized tympanic membrane: Nosology, diagnosis, and treatment

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ABSTRACT

Objectives: To analyze the etiologies, auditory consequences, diagnostic tools and therapeutic results of three often confused pathologies: acquired fibrous stenosis of the medial part of the external auditory canal (EAC), fibrous anterior tympanomeatal angle blunting, and lateralized tympanic membrane.
Material and methods: Retrospective study of 18 cases operated on over a 16-year period (14 patients: 7 female, 7 male; aged 11–64 years): 8 cases of medial EAC stenosis, 3 of blunting, and 7 of tympanic membrane lateralization.
Results: In all 3 pathologies, otoscopic and radiologic diagnosis was easily established, so that they could not be confused. All 3 induced > 33 dB conductive hearing loss. Medial EAC stenosis was secondary to chronic inflammation of the EAC, aggravated by surgery in 5 cases. Blunting was secondary to surgery altering the anterior tympanic annulus. Tympanic membrane lateralization was secondary to prior surgery without inflammatory process. Underlying EAC cholesteatoma was found in 3 cases of medial stenosis and in 1 case of blunting. Surgical results were disappointing in medial stenosis, with 62.5% recurrence and mean functional gain of 9 dB, and in blunting, with 66.7% recurrence and mean functional gain of 6 dB; auditory results were, however, good in these 2 pathologies when there was no recurrence of fibrosis. Results were significantly better in lateralized tympanic membrane, with 28.6% recurrence and mean functional gain of 16 dB.
Conclusion: The good results obtained in tympanic membrane lateralization seem to justify surgery in patients bothered by their hearing loss. The indication is more questionable in cases of medial fibrous stenosis and blunting, although significant auditory improvement is achieved in case of surgical success.

1. Introduction

Acquired fibrous stenosis of the medial part of the external auditory canal (EAC), fibrous anterior tympanomeatal angle blunting, and tympanic membrane lateralization are 3 distinct pathologies, although sometimes confused in the literature [1,2]. They are non-tumoral, non-traumatic pathologies of the EAC or tympanomeatal junction; all three are acquired, secondary to pathologic healing, often caused or aggravated by previous surgery. The main symptom is hearing loss.

The aim of the present study was to analyze the etiologies and clinical aspects and consequences of these 3 pathologies and to specify treatment, based on our own clinical experience.

2. Material and methods

2.1. Series

A retrospective analysis was performed over a 16-year period, including 18 procedures in 14 patients (two operated on twice and one 3 times): 8 cases of medial EAC stenosis, 3 of blunting, and 7 of tympanic membrane lateralization. The series comprised 7 female and 7 male patients, aged 11–64 years (mean age: 36 years at diagnosis and 37 years at surgery).

2.2. Study criteria

Circumstances at onset, auditory impact, diagnosis, surgical techniques and results at a mean 3.5 years were analyzed.

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2.3. Surgical indications

In EAC stenosis, surgery was mainly indicated due to hearing loss severity (≥ 20 dB) and in case of suspected underlying EAC cholesteatoma. Episodic external otitis or sensation of full ear, on the other hand, were not decision-making criteria.

In fibrous blunting, the main indication was hearing loss, or, in 1 case, suspected underlying EAC cholesteatoma.

In tympanic membrane lateralization, indications were severe hearing loss, and in order to close associated tympanic perforation.

2.4. Surgical techniques

2.4.1. Medial EAC stenosis

The approach was endaural in 4 cases and retroauricular in 4. Surgery consisted in resecting fibrous tissue blocking the canal and circumferential EAC bone reaming to complete fibrous tissue resection and calibrate the canal. As fibrosis involved the eardrum in all cases, the epithelial layer, and sometimes part of its fibrous layer, was resected. The tympanic membrane was reconstituted by cartilage and perichondrial grafts. As residual EAC skin could not be conserved, being inflammatory and included within the fibrosis, the canal was covered with thin skin grafts taken from the posterior side of the auricle, partly covering the tympanic membrane grafts (Fig. 1). In 2 cases, hyaluronic acid film patches (EpiFilm®, Medtronic ENT, Jacksonville, FL) were applied to the reconstituted membrane and skin grafts, to promote healing and prevent recurrence of fibrosis. In 1 case, type II ossiculoplasty was associated to EAC reconstruction.

2.4.2. Blunting

The approach was retroauricular in 2 cases and transcanal in 1. Surgery consisted in resection of fibrous tissue, usually involving the part of the membrane included in the fibrosis. The eardrum was reconstituted by cartilage and perichondrial grafts under the malleus handle, always under the anterior sulcus. Skin covering the fibrous blunting could be conserved in 1 case; in the other 2, an aponeurosis graft was used in 1 patient and a thin retroauricular skin graft in the other.

2.4.3. Lateralized tympanic membrane

The approach was retroauricular in 6 cases and transcanal in 1. Surgery consisted in resecting the lateralized membrane and reconstituting it with cartilage and perichondrial grafts. If the malleus was present (5 cases), grafts were either placed under the handle or at the same level as the handle via a small slit in the cartilage in case of retraction. If the malleus was absent (2 cases), grafts were applied onto the medial wall of the tympanic cavity. In all cases, grafts were positioned under the sulcus. The anterior tympanomeatal angle was restored by sliding forward the lower part of a posterior tympanomeatal graft (Fig. 2); if rotating the graft led to skin defect in the canal, this was covered by perichondrium or aponeurosis. In 3 cases, EpiFilm® patches were applied on the reconstituted tympanic membrane and its anterior angle at end of procedure, to promote membrane healing and, if possible, prevent recurrence. In 2 cases, a titanium total ossicle replacement prosthesis was implanted, due to complete absence of ossicles in a context of chronic otitis media.

In all 3 pathologies, thin silicone sheaths (Folioxane®, Novatech, France) were left in the EAC for 2 months for calibration and to prevent fibrous adhesion, with local antibiotic-corticosteroid therapy throughout this period.

3. Results

3.1. Etiology

In all of the present 8 cases, acquired fibrous medial EAC stenosis was secondary to inflammation and/or chronic irritation of the canal, especially in contexts of dermatosis (eczema) or iterative external otitis or, in 1 case, of Sjögren syndrome. In 5 of the 8 cases, there was history of tympanoplasty preceding the inflammation and/or dermatosis. The indications for the tympanoplasty were sequelae of chronic otitis media with tympanosclerosis in 1 case and perforation in 4.

The 3 cases of blunting were induced by tympanoplasty (twice for perforated eardrum and once for lateralized tympanic membrane). There was no underlying pathology, but simply postoperative inflammation followed by fibrosis of the anterior angle.

The 7 cases of isolated lateralized tympanic membrane were secondary to tympanoplasty (for perforated eardrum in 4 cases,

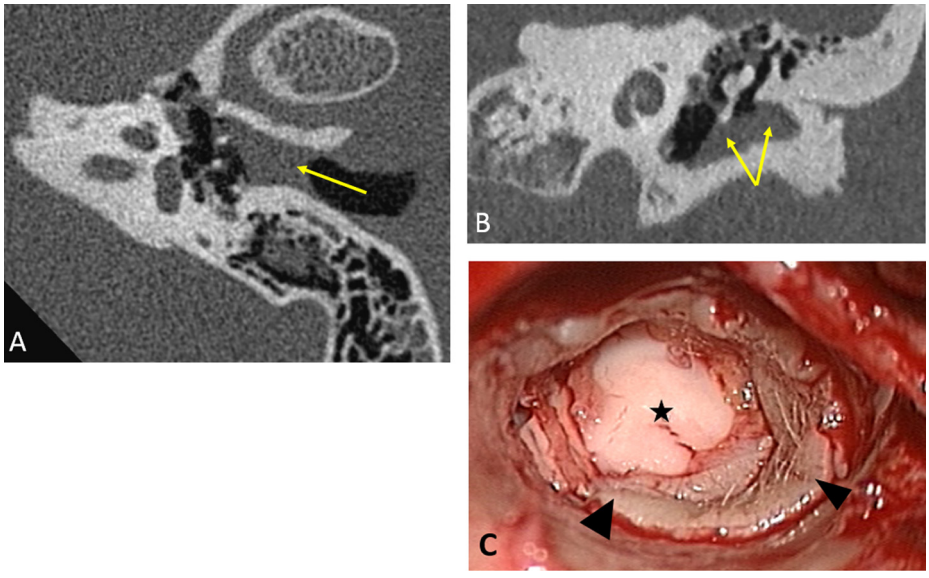

Fig. 1. A and B. Left temporal bone CT showing medial EAC stenosis (arrows) reaching the tympanic membrane. A: axial slice; B: coronal slice; C: intraoperative view of right ear at end of resection of fibrous medial canal stenosis, showing membrane reconstituted with cartilage (asterisk) and reamed bone covered by skin grafts (arrow-heads).

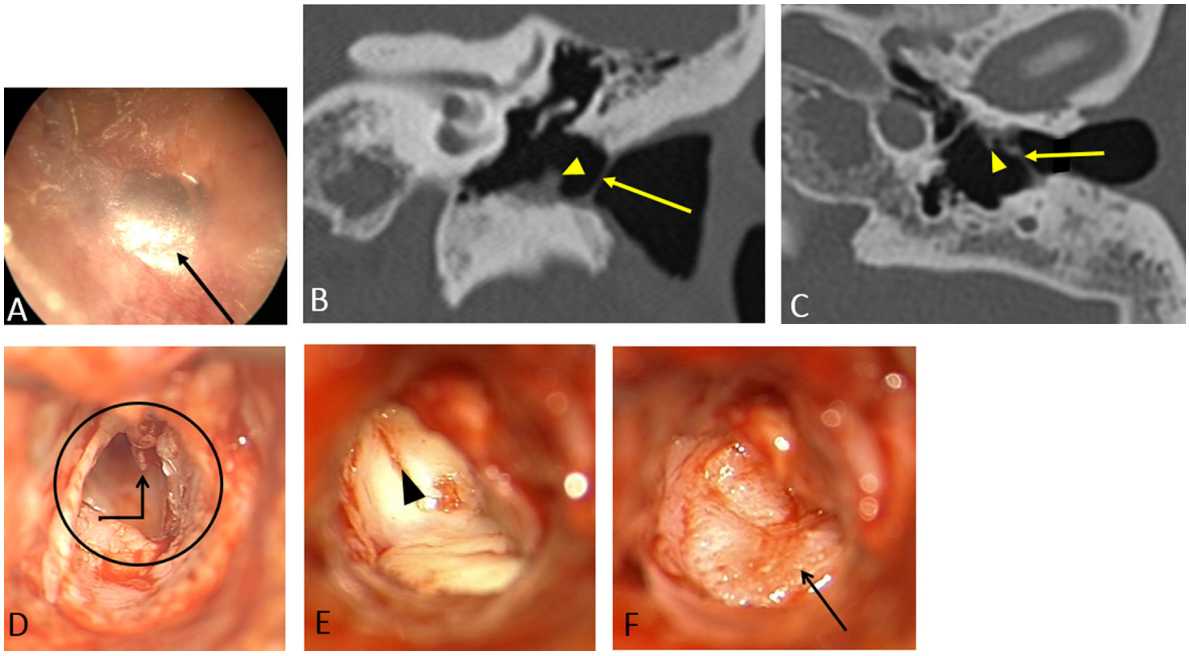

Fig. 2. A. Left lateralized tympanic membrane. B and C. Left temporal bone CT showing lateralized tympanic membrane (arrow) and initial normal position of true tympanic residue (arrow-head). B: coronal slice; C: axial slice; D, E and F: intraoperative views of right ear at end of resection of lateralized tympanic membrane. Circle: initial position of true tympanic residue. Bent arrow: medialized malleus handle. Arrow-head: tympanic membrane reconstituted with cartilage with small slit for malleus handle. Straight arrow: neotympanic membrane covered by posterior-to-anterior rotation of inferior part of posterior tympanomeatal flap.

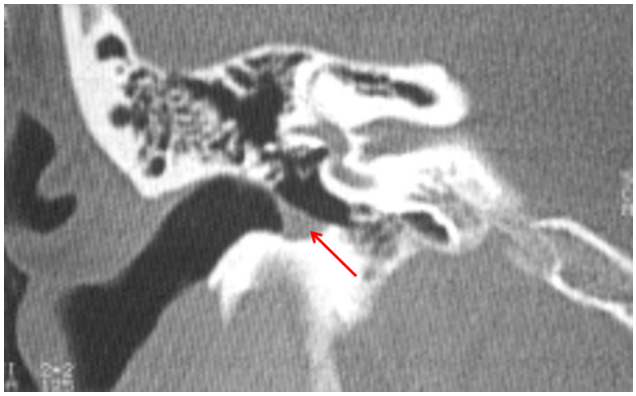

Fig. 3. Temporal bone CT axial slice showing anterior tympanomeatal angle blunting (arrow).

cholesteatoma in 2, and fibrous medial EAC stenosis in 1). No inflammatory process was observed.

3.2. Otoscopic and radiologic data

In acquired fibrous medial EAC stenosis, there was a highly characteristic aspect of an opaque fibrous plug on otoscopy. CT, when performed to screen for associated pathology such as EAC cholesteatoma, found soft tissue filling of half or of the medial third of the canal, touching the membrane but not involving the middle ear (Fig. 1).

In fibrous anterior tympanomeatal angle blunting, the blunted angle was visualized on otoscopy. CT, when performed, found soft tissue opacity filling the anterior angle (Fig. 3).

In tympanic membrane lateralization, otoscopy found the membrane close to the outer ear canal, perpendicular to the examiner's eye, with reduced diameter and no malleus handle footprint (Fig. 2). In 2 of the 7 cases, the lateralized membrane showed perforation. CT, when performed to differentiate lateralization from EAC stenosis and/or to screen for EAC cholesteatoma, showed a membrane that was sometimes thickened, lateralized within the canal and separated by air from the middle ear, with no soft tissue filling (Fig. 2).

3.3. Preoperative audiometric data (Supplementary data)

Mean preoperative conductive hearing loss was 34 dB [± standard deviation (SD) 7 dB] in acquired fibrous medial EAC stenosis, 33 ± 7 dB in blunting, and 34 ± 6 dB in tympanic membrane lateralization.

3.4. Postoperative results

Mean follow-up was 2.7 years in medial stenosis, 4.3 years in blunting, and 4 years in tympanic membrane lateralization.

3.4.1. Morphologic data

Recurrence rates were 5/8 (62.5%) in medial stenosis, 2/3 (66.7%) in blunting, and 2/7 (28.6%) in lateralized tympanic membrane. Underlying cholesteatoma, easily resected, was found in the most medial part of the canal (adjacent to the tympanic membrane) in 3 cases of stenosis and 1 of blunting.

3.4.2. Postoperative audiometric data (Supplementary data)

In medial stenosis, mean postoperative air-bone gap was 25 ± 7 dB, with gain of 9 dB. In blunting, it was 27 ± 6 dB, with 6 dB gain. And in lateralized tympanic membrane, it was 18 dB with 16 dB gain. Without recurrence, however, in the 3 cases of stenosis gain was 18 dB and, in the 1 case of blunting, 19 dB. Associating ossiculoplasty, in 1 case of stenosis and 2 of lateralization, did not affect functional results.

4. Discussion

Acquired fibrous medial EAC stenosis, anterior tympanomeatal angle blunting and lateralized tympanic membrane are 3 distinct

pathologies often wrongly grouped as one [1,2]; all derive from pathologic healing, but the otologic and radiologic aspects and treatments differ.

4.1. Etiology

Medial EAC stenosis is usually associated with underlying pathology: dermatitis, external otitis, chronic otorrhea, hearing-aid use or irradiation [3]. Resulting chronic inflammation is followed by granulation tissue formation and a fibrous plug within the medial part of the canal up to the tympanic membrane [3]. Five of the present 8 cases had history of tympanoplasty; this was certainly not coincidental, and suggests that any inflammatory EAC pathology should be effectively managed before indicating tympanoplasty, even if this means abstention in recalcitrant cases. The middle ear and ossicular chain are usually spared by the pathology [4]. Distal EAC stenosis has been less often described in the literature and was not encountered in our own experience, but is also usually due to underlying pathology, sometimes aggravated by trauma or surgery [3,4].

Anterior tympanomeatal angle blunting is usually caused by surgery. The angle formed by the anterior wall of the EAC and anterior part of the tympanic membrane ranges between 27° and 60° [5,6]. Some authors suggest that risk of blunting is higher with acute angles [5,6]. The dense and permanent fibrous scar tissue [7] may reach the umbo or malleus handle [6,8]. The implicated surgical procedure may involve excessive release of the anterior rim of the annulus, malpositioned within the bone sulcus at end of procedure, damage to anterior EAC skin, or "overlay" tympanoplasty, inducing dense fibrosis at the anterior angle, without underlying pathology. Blunting rates vary widely in the literature [6–8].

Lateralized tympanic membrane is usually secondary to surgery [2,7], and notably overlay tympanoplasty with graft applied to the deepidermized fibrous membrane. In the "overlay" technique, the graft is applied on the deepidermized fibrous membrane, malleus handle and annulus, and then follows the process of healing and lateral migration of the squamous epithelium toward the outer ear canal [7]. Lateralized tympanic membrane may also be caused by malpositioning of the annulus. The absence of any fixation of the tympanic membrane graft, subject to variations in atmospheric pressure, also very likely contributes to lateralization. Lateralized tympanic membrane is also classical in surgery for type-2 auricular atresia with EAC stenosis [2]. Although large series have not reported lateralized tympanic membrane in "over-under" type-1 tympanoplasty (over the malleus handle and under the fibrous residue) [9,10], we have personally seen such cases, although only partial, while we have never encountered this with "underlay" techniques (under the malleus handle and fibrous residue).

4.2. Clinical and radiologic data

The symptomatology of the 3 pathologies basically concerns hearing loss, even if tinnitus, l ear fullness, otalgia and otorrhea have also been reported [1–4,6]. In some cases, there may be epidermal retention with actual EAC cholesteatoma [2,3]. In the present series, underlying cholesteatoma was found in 1 case of blunting and 3 of stenosis.

Although some articles run the 3 pathologies together [1,2], otoscopy is usually clear enough to distinguish diagnosis. Perforation is also reported in lateralized tympanic membrane [2].

We consider radiologic assessment useful, especially in medial EAC stenosis and lateralized tympanic membrane, to rule out associated EAC and/or middle ear pathology such as iatrogenic cholesteatoma [2,3], bone lysis or osteoneogenesis, or, more rarely, a tumoral process, and to assess tympanic cavity status.

4.3. Preoperative audiometric data

The literature confirms the severity of hearing loss associated not only with medial stenosis or blunting but also with lateralized tympanic membrane. In a series of 12 patients with medial EAC stenosis, mean conductive hearing loss was 32 dB (range, 25–55 dB) [1], comparable to the present finding (34 dB). The present study found no direct link between degree of fibrosis and degree of hearing loss, as medial stenosis and blunting induced similar deficits; but the present cases of blunting, operated on because of subjectively unacceptable hearing loss, were advanced forms with non-negligible fibrosis. 3D geometric tympanic membrane modeling showed that membrane compliance diminished and impedance increased with increasing anterior blunting, especially for low and medium frequencies; malleus handle and stapes footplate displacement also decreased [8]. Doppler laser vibrometry of the round window membrane (RWM) further showed that blunting reduced RWM vibration amplitude by as much as 52%, especially at low and medium frequencies [6].

The hearing loss induced by severe lateralized tympanic membrane is often itself severe. In a series of 14 cases, mean preoperative air conduction threshold was 63 dB, with 39 dB deficit [2]: i.e., even greater than in the present series (34 dB hearing loss), highlighting the harmful effects of some tympanoplasty procedures.

4.4. Surgical techniques

The surgical techniques reported in the literature for these pathologies were comparable to those used in the present study.

In medial EAC stenosis, treatment associates ablation of all fibrous and cutaneous tissue obstructing the EAC, EAC bone reaming and tympanic membrane reconstruction after resection of the fibrous layer when involved by the pathologic process [4]. EAC skin reconstruction uses perichondrial or aponeurotic grafts covered by thin skin grafts. Meatoplasty is required to promote healing and canal aeration and, according to some authors, to improve the surgical approach [1,3].

In blunting, treatment associates ablation of all fibrous tissue, sparing EAC skin, and tympanic membrane reconstruction after resection of the fibrous layer, which is generally involved by the pathologic process; thin skin grafts are applied only when the skin of the anterior wall of the EAC is affected, exposing the bone. Meatoplasty is often useful, but not systematic; some authors recommend anterior canalplasty to improve exposure of the anterior sulcus [7].

In lateralized tympanic membrane, remaining healthy EAC skin must be conserved. The membrane is reconstructed by underlay grafts under the residual annulus and malleus handle when this exists and is not too retracted [7]. Anteroinferior rotation of the tympanomeatal flap is also recommended by certain authors, and was performed in the present series; we find it useful in reconstituting the anterior tympanomeatal angle [2,7].

In all 3 pathologies, it is interesting to use cartilage for grafting, associated to aponeurosis or perichondrium, as this material is stable and undeformable, optimizing neotympanic membrane stability. Cartilage was associated with better rates of surgical success than perichondrium alone, without jeopardizing auditory outcome [11]. Hyaluronic acid film patches to promote healing and prevent recurrence need further study to analyze their contribution in these difficult cases. As well as several weeks' local antibiotic-corticosteroid therapy, some authors, like ourselves, recommend leaving silicone sheaths in the canal for around 2 months, to prevent fibrous adherence and, to some extent, recurrence [12,13].

4.5. Postoperative results

4.5.1. Morphologic data

In medial EAC fibrous stenosis, the main complication is recurrence, with rates ranging from 6% to 27% [3]; in the present series, the rate was 5/8 (62.5%), doubtless because we operated only on particularly advanced forms.

In blunting, the lack of audiometric data in the literature is doubtless due to this pathology often being included under EAC fibrous stenosis. In the present series, two-thirds of cases showed partial or complete recurrence, highlighting the difficulty of combating even partial fibrosis once it becomes established.

In lateralized tympanic membrane, although some authors reported good results [12], the risk of recurrence is high, as seen in a series of 14 surgical cases in which the rate was 23% [2], comparable to the present 28.6%.

4.5.2. Audiometric data

In medial EAC fibrous stenosis, a mean gain of around 20 dB was reported [1], much better than the present 9 dB. In the 3 cases in the present series in which there was no recurrence of stenosis, however, gain was 18 dB. Results seem to be "all or nothing", and excellent in the absence of local postoperative inflammation. There are no postoperative audiometric data in the literature for blunting. The mean gain of 6 dB in the present 3 cases was very moderate; but gain was zero in the cases with recurrence, whereas in the 1 case without it was 19 dB.

In lateralized tympanic membrane, mean gain was 10 dB in the above-cited 14-case series [2]. In the present series, it was 16 dB, perhaps because we preferred the underlay technique whenever the malleus handle was present, and systematically performed forward rotation of the posterior tympanomeatal flap in reconstituting the anterior tympanomeatal angle. The absence of cutaneous inflammation in this pathology is an important factor for the stability of results over time.

5. Conclusion

Acquired fibrous medial EAC stenosis, blunting and isolated tympanic membrane lateralization induce considerable hearing loss. The 3 are often classed together but should be distinguished, as etiology and otoscopic and radiologic aspects differ.

The absence of inflammation probably explains why considerable auditory improvement is found after lateralized tympanic membrane procedures, warranting surgery if hearing loss bothers the patient. In stenosis and blunting, on the other hand, surgery often fails, probably due to persistent inflammation, which is the basic cause of fibrosis. Even so, rare but undeniable cases of auditory improvement may warrant surgery when hearing loss is disabling, on condition that the patient be informed of the uncertainty of outcome.

Disclosure of interest

The authors declare that they have no competing interest.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.anorl.2018.12.002.

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