

Management of stenosis and acquired atresia of the external auditory meatus

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Abstract

The aim of this study was to investigate the aetiology of acquired atresia and stenosis of the external auditory meatus and to present our results for surgical management. Over an 18-year period (from 1986 to 2004), data were collected prospectively from patient cohorts in Dundee and Edinburgh. Stenosis of the auditory meatus was due to chronic otitis externa in 64 per cent of cases, compared with 37 per cent of cases with acquired atresia; the latter had instead a history of chronic suppurative otitis media in 43 per cent. Surgical treatment of canal stenosis with meatoplasty alone achieved a widely patent ear canal in 80 per cent of cases, with 78 per cent of ears remaining free of discharge. Cases of acquired atresia treated with simple surgical excision of the soft tissue plug experienced a 100 per cent failure rate. The additional use of a split skin graft achieved a patent meatus in 70 per cent of cases, with hearing improvement in 79 per cent. However, the ear canal remained unstable and late recurrence was observed.

Key words: Ear Canal; Constriction, Pathologic; Otitis Externa; Otologic Surgical Procedures

Introduction

Acquired atresia of the external auditory canal is a rare condition that has also been known as post-inflammatory medial meatal fibrosis,^{1,2} post-inflammatory medial canal fibrosis,³ post-inflammatory acquired atresia,⁴ canal atresia⁵ and stenosis of the external auditory canal.⁶ Although the term 'canal stenosis' has been used to describe cases of acquired atresia,^{6,7} these are two separate entities. An acquired atresia consists of a soft tissue plug in the proximal portion of the external auditory canal, attached to the lateral surface of the tympanic membrane. The aetiology may be traumatic,^{2,5} post-operative,⁸ neoplastic or post-inflammatory.^{3,9–12}

Otitis externa and chronic suppurative otitis media can predispose to inflammatory acquired atresia. Bonding and Tos⁴ classified the underlying pathology of inflammatory acquired atresia into two types: membranous and solid. In membranous atresia, a circumferential insult to the canal skin leads to the formation of granulation tissue; epithelization occurs from all sides of the canal and a membrane forms. As a result, keratin accumulates behind the atretic membrane.

The more common solid atresia starts with a granular myringitis that extends laterally onto the external auditory canal wall; this process has been observed by the senior author in nine cases. The

granulation tissue fills the deep part of the canal and its lateral surface epithelializes. The resulting soft tissue plug is converted into dense fibrous tissue. This atretic segment can extend as far as the bony cartilaginous junction (Figure 1) and causes a conductive hearing loss. The primary aim of surgery in these cases is improvement of hearing.

Canal stenosis is a narrowing of the length of the external auditory canal that is either caused by a congenital malformation of the external auditory canal¹³ or is acquired, secondary to persistent otitis externa,¹⁴ trauma (surgical or non-surgical), malignancy¹⁵ or irradiation.¹⁶ These conditions produce stenosis by inducing thickening of the subcutaneous tissue and hence narrowing of the external auditory canal, as shown in Figure 2.

The presence of canal stenosis causes associated morbidity. There is often chronic discharge which is difficult to treat medically. In some cases, there is hearing loss, although this is not a prominent feature and in some situations hearing aid provision is difficult. The aim of surgery is to produce a dry, patent ear canal by enlarging the bony canal and cartilaginous meatus and by excising the thickened subcutaneous tissue.

We present our 18-year experience (from 1986 to 2004) of 49 ears (49 patients) with acquired atresia and 45 ears (38 patients) with acquired canal stenosis.

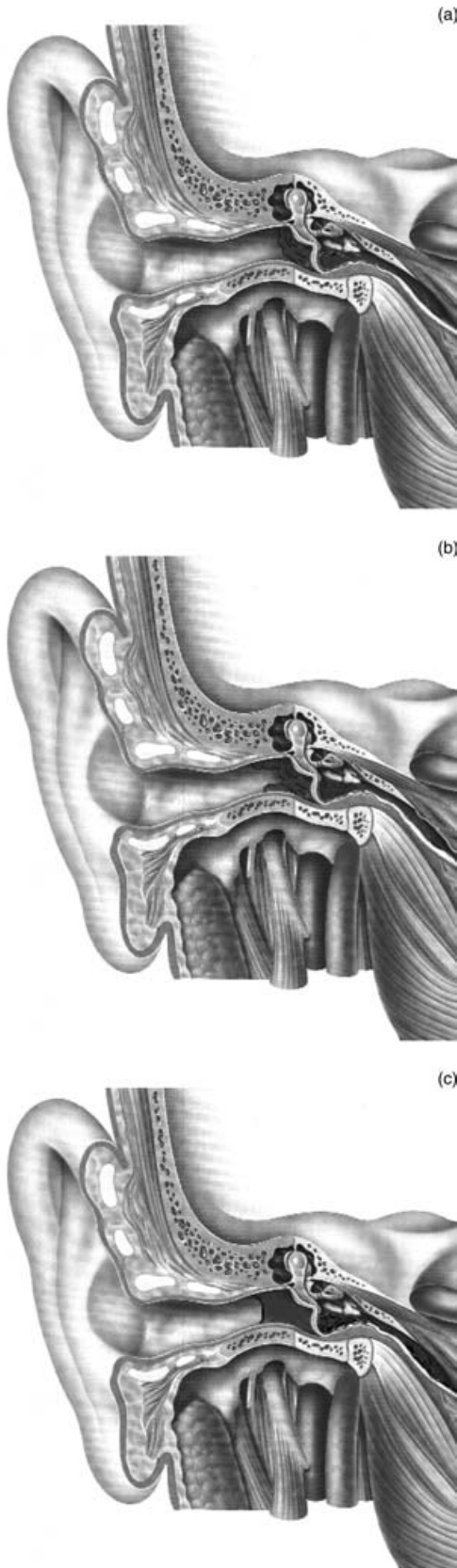


FIG. 1

(a) Granular myringitis involving the entire surface of the tympanic membrane. (b) Granulation tissue has extended from the surface of the tympanic membrane onto the wall of the external auditory meatus. (c) Epithelialization of the lateral surface of the atresia has occurred, producing the characteristic clinical appearance of the 'false fundus'.

Material and methods

Two cohorts of patients were studied. The first comprised all patients with acquired atresia of the external auditory meatus seen by the senior author (RM) in Dundee between 1986 and 1998 and in Edinburgh between 1998 and 2004, some of which had undergone surgical treatment. The second cohort was a series of patients with ear canal stenosis who had failed to respond to adequate medical treatment. All underwent surgery performed by the senior author between 1986 and 2004. Between 1986 and 1998, the surgery was carried out in Dundee, while the later cases received their operations in Edinburgh. Data on both cohorts were collected prospectively using database software (Lotus Approach).

Relevant information from all patients' past medical history was collected to attempt to establish the ear pathology that preceded development of the ear canal abnormality. Details of any previous ear surgery were also noted. In cases of acquired meatal atresia treated surgically, the atresia was classified as solid or membranous, as proposed by Bonding and Tos.⁴ For canal stenosis, we recorded the outcome of surgery in terms of ear canal patency and otorrhoea. For acquired atresia, we recorded the outcome of surgery in terms of impact on hearing and ear canal patency. Pre-operative audiograms were obtained for all patients with acquired atresia. Hearing thresholds (air conduction and bone conduction) were calculated at values of 500, 1000 and 2000 Hz, with the average air-bone gap determined from these frequencies. Post-operative audiograms were obtained in the Edinburgh cohort and their average air-bone gaps also calculated.

Surgical technique

In the early cases of acquired atresia, excision of the soft tissue plug was carried out via an endaural incision. The results with this technique were universally poor and it was therefore abandoned.

At the time of writing, surgery was carried out via a post-aural incision. The bony and cartilagenous portions of the ear canal were enlarged with cutting and diamond burrs. The soft tissue plug was excised. The plane between the connective tissue and the outer surface of the tympanic membrane was identified and the plug separated from it by blunt dissection. It was usually possible to complete this process without breaching the drum surface, except in recurrent cases. When this process was complete, the bone in the deep meatus was inevitably completely denuded of skin around its entire circumference. Split skin grafts were harvested from the upper arm and used to line the bony meatus. The grafts were mounted on petroleum jelly gauze to facilitate this process. Once they were in situ, this gauze was peeled off, leaving the graft closely applied to the bone. A 'Swiss roll' of Silastic sheeting was inserted and its lumen packed with ribbon gauze impregnated with bismuth iodoform paste. This was left in situ for two weeks.

All cases of canal stenosis were operated on via a post-aural incision. Following elevation of the canal

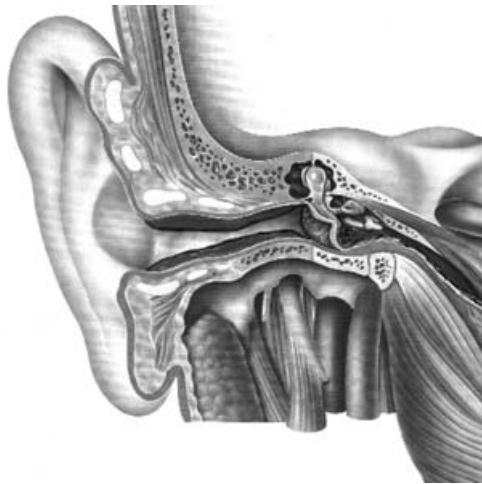


FIG. 2

Acquired stenosis of the external auditory meatus.

skin, the bony meatus was enlarged as described above. This process was continued until the first mastoid air cell was identified. The thickened subcutaneous tissue was then excised with a 15 blade. The skin tube was split and layered into the enlarged bony canal. The meatal opening was enlarged using the Koerner technique, with excision of cartilage. The ear canal was packed with ribbon gauze impregnated with bismuth iodoform paste, which was left in situ for two weeks.

Results

Cohort one (acquired meatal atresia) comprised 49 ears (25 male, 24 female; 18 Dundee procedures, 31 Edinburgh procedures). There were four patients with bilateral atresias. The average age of the patient was 49.2 years (range 20–86 years). The preceding ear pathologies are shown in Figure 3: 30 patients had received no previous surgery; eight cases had undergone previous excision of an atresia (treated with a KTP laser in one), six had undergone myringoplasty, two had undergone mastoidectomy and one had undergone grommet insertion. Pure tone audiometry revealed a mean pre-operative air–bone gap of 29 dB (range 12–53 dB).

Surgery was carried out in 20 ears. It was only at operation that the type of atresia was determined: three ears showed membranous atresia (two diagnosed at surgery and one by endoscopy through a stab incision) and all the other surgical cases showed solid atresia. In Dundee, only four patients received an operation, which involved a simple excision of the soft tissue plug, all of which were unsuccessful. In Edinburgh, 16 (52 per cent) ears underwent surgery. The split skin graft technique was used in 14 cases; eight (57 per cent) remained patent over a four month to four year follow up while four (29 per cent) recurred. One of these recurrences occurred three years after surgery. Two cases received revision surgery, with one going on to develop recurrence. Of the remaining two cases,

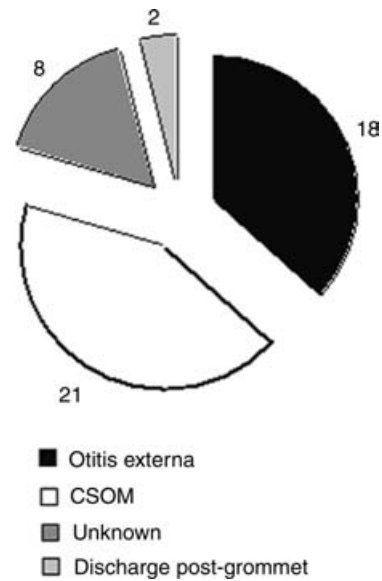


FIG. 3

Preceding conditions in patients with acquired atresia of the external auditory meatus (*n* = 49). Unknown = hemi-hypertrophy of face 1, DXT = radiotherapy pinna 1, ecto-dermal dysplasia 1, RTA = road traffic accident 1, unknown 2; CSOM = chronic suppurative otitis media.

one developed a canal stenosis and the other was lost to follow up. In one case, perichondrium was used rather than a split skin graft but this patient was lost to follow up. Improvement in hearing was achieved in 11 (79 per cent) of the 14 patients receiving a split skin graft; seven (50 per cent) of the cases had a mean air conduction threshold of 30 dB or less. The post-operative average air–bone gaps for these patients are presented in Figure 4. To demonstrate the impact of surgery on binaural hearing, Figure 5 presents the results using the Glasgow-Benefit Plot. This method compares pure tone averages between the operated and non-operated ear, pre- and post-operatively.¹⁷ Operations were not performed if the patient declined or if surgery would not significantly benefit their hearing.

Cohort two (canal stenosis) comprised 45 ears (20 male, 25 female; 13 Dundee procedures, 32 Edinburgh procedures). The average age of the patients was 48 years (range 22–72 years). The conditions preceding development of canal stenosis are presented in Figure 6: 35 patients had received no

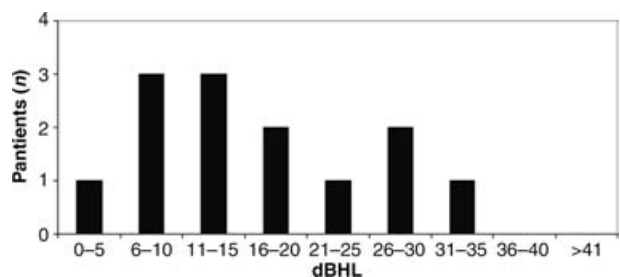


FIG. 4

Post-operative mean air–bone gaps, presented in 5 dB bins. HL = hearing loss.

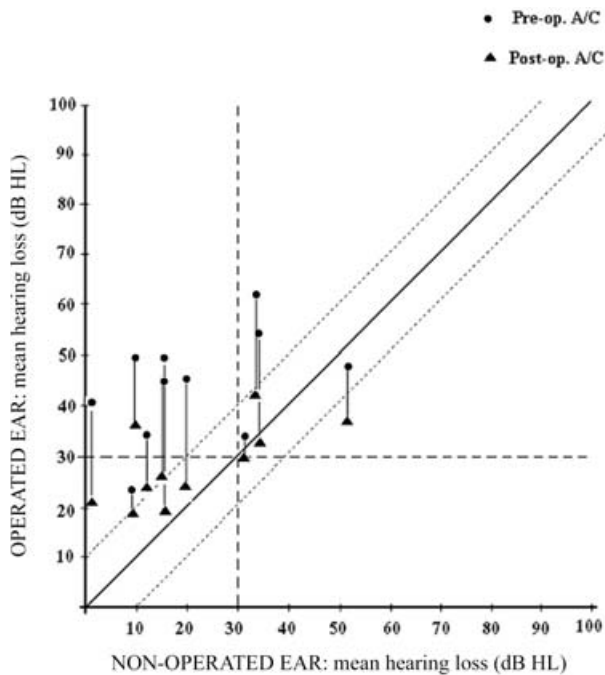


FIG. 5

Hearing results for patients undergoing successful excision of acquired atresia of the external auditory meatus with split skin grafting ($n = 11$). Pre-op = pre-operative; post-op = post-operative; A/C = air conduction; HL = hearing loss.

prior surgery; eight had undergone a cortical mastoidectomy and two had undergone a meatoplasty. All patients with canal stenosis underwent surgery (45 operations in 38 patients). Meatoplasty alone was the most common operation (31), with 24 of these cases presenting with otitis externa. A myringoplasty was performed in addition to a meatoplasty in 11 cases. At the time of writing, 36 ear canals (80 per cent) remained widely patent; of the five (11 per cent) that did not, two had undergone revision surgery. The operated ear remained dry in 35 (78 per cent) cases. In six (13 per cent) cases, the ear continued to discharge. A total of four (9 per cent) patients were lost to follow up before the outcome of surgery could be determined. The follow-up period for the remainder varied between six months and six years.

Discussion

Our study presents an 18-year experience of canal stenosis and acquired atresia, demonstrating the differences in aetiology, surgical management and outcomes for these two conditions.

Canal stenosis can be congenital or acquired. The majority of cases in this study series were patients with acquired canal stenosis, precipitated by otitis externa in 64 per cent. The main presenting complaint for these patients was persistent ear discharge; hearing loss was not a major feature. When medical therapy failed, surgery was shown to be an effective treatment for canal stenosis. Following meatoplasty, 80 per cent of our patients had patent canals, with 78 per cent of cases remaining dry.

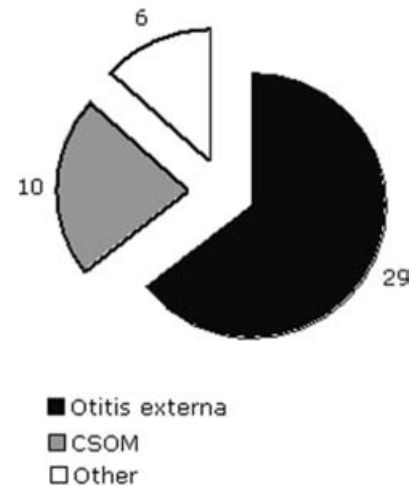


FIG. 6

Conditions preceding acquired canal stenosis ($n = 45$). CSOM = chronic suppurative otitis media.

The surgical techniques used in the management of canal stenosis have varied over the years, with equally good results. In the early years, following widening the bony canal and excision of the stenotic tissue, Soliman *et al.*¹⁸ removed a wedge of skin from the meatal floor, leaving 13 of 16 patients with good results. Adkins and Osguthorpe¹³ covered the skin-deficient canal with a transposition flap in eight cases, with no recurrence. Moore *et al.*¹⁹ lined the canal with a full thickness skin graft in one case, with no recurrence. McDonald *et al.*⁶ used a split thickness skin graft in 22 cases, with two re-stenosing. Bell⁷ used bilateral rotation skin flaps in nine cases, with no recurrence. McCary *et al.*⁸ used split thickness grafts in 18 cases, with one recurrence.

However, it would seem that the use of skin flaps or grafts is not necessary in canal stenosis, unlike acquired atresia, as more recent studies have demonstrated that a meatoplasty alone is sufficient to treat canal stenosis. Lavy and Fagan¹⁴ performed canaloplasty/meatoplasty alone for canal stenosis in 84 patients, with only four recurrences (which were actually cases of acquired atresia that subsequently went on to receive a skin graft). Similarly, Frisch *et al.*²⁰ reported 49 cases of canal stenosis treated with meatoplasty, with all cases achieving a stable, cosmetic result without re-stenosis.

Once the anatomical narrowing has been corrected in canal stenosis, by enlarging the canal and excising the thickened tissue, the condition of the ear is stable. This would suggest that the normal function of the ear is restored, enabling a normal ear cleansing cycle and preventing the vicious cycle of poor canal patency leading to inflammatory episodes. However, why canal stenosis should develop in some cases of otitis externa and not others is still unknown.

By contrast, acquired atresia is caused by the formation of a soft tissue plug lateral to the tympanic membrane. Otitis externa was a precipitating factor in only 37 per cent of cases, while 43 per cent were

caused by chronic serous otitis media (CSOM) in our series. A small number (8 per cent) had an unknown cause; this has also been noted in other studies.^{3,21} This suggests that there may be other, as yet undetermined factors involved in the development of this condition.

In acquired atresia, patients' main complaint was hearing loss. Surgery was aimed at improving this deficit by restoring and maintaining the patency of the ear canal. When compared with surgical outcomes for canal stenosis, those for acquired atresia were not as good. In many cases, a hearing aid represented a better alternative.

Surgical techniques for the management of acquired atresia have evolved since 1966.²² All agree that removing the fibrous plug alone is inadequate.²³ This was demonstrated by our four cases that received only removal of the fibrous plug, resulting in 100 per cent failure. The bony canal should be widened and meatoplasty performed.⁹ The denuded canal wall, unlike canal stenosis, should not be allowed to granulate¹⁴ as this will lead to recurrence of the atresia; some form of canal lining is required. Different techniques have been used: transposition flaps,^{13,24} full thickness skin grafts¹⁹ and, most commonly, split skin grafts,^{2,3,8,11,12,21,23} but all techniques used have some degree of recurrence. Some argue that skin from other sites lacks the normal sebaceous and apocrine gland properties of ear canal skin⁸ and hence a higher rate of re-stenosis occurs secondary to recurrent infection. Full thickness grafts have been advocated instead of split skin grafts in certain situations as they theoretically produce less contracture when healing¹⁹ and so reduce the incidence of stenosis. Dhooge and Vermeersch²⁴ proposed that unless the skin used is well vascularized, such as that from a flap, poor graft uptake onto the underlying ear canal cortical bone occurs. From our series, using the split skin graft technique, 57 per cent of ear canals remained patent, with atresia recurring in 21 per cent in one to two years. Regardless of technique used, recurrence has been seen at six months,²³ one year,^{2,25} three years^{9,10} and nine years.¹⁰ This demonstrates that acquired atresia produces an unstable ear canal, but whether this is secondary to the underlying disease process or due to the operative procedure, or a combination of the two, is still unclear. Long-term follow up is required.

This instability of the ear canal in acquired atresia is also reflected in the conductive hearing deficit. Our study demonstrated that 79 per cent of patients had an improvement in their hearing, on average decreasing their air-bone gap (ABG) from 29 to 17 dB, which is comparable with the findings of Slattery and Saadat.¹⁰ However, over time, the hearing improvement has been shown to reduce; Tos and Balle²³ showed in their study that 81 per cent of patients had an initial ABG within 20 dB but that this dropped to 58 per cent after two years. Similarly, a later study¹¹ showed that 82 per cent of patients had an initial ABG < 30 dB but after two years this reduced to 51 per cent. In our patients, 64 per cent had a post-operative ABG

of < 20 dB; that is, lower than the results of previous studies (Cremers and Smeets²¹ achieved a post-operative ABG < 20 dB for 94 per cent of their patients, while Tos and Balle²³ achieved the same result for 81 per cent of their patients). The audiograms used for our study were recorded at variable intervals following patients' surgery; hence, in some cases, we may be demonstrating deterioration in the hearing, as suggested by Tos and Balle.²³ Some have argued that there is an element of middle-ear disease in these patients that contributes to the ABG, or the conductive deafness may be secondary to progressive tympanosclerosis caused by the operative procedure.²⁶

- **Acquired atresia consists of a soft tissue plug in the proximal portion of the external auditory meatus, caused by trauma, surgery, neoplasia or inflammation; the aim of surgery is to improve hearing**
- **Canal stenosis is a narrowing of the length of the external auditory canal, which is congenital or acquired secondary to persistent otitis externa, trauma, malignancy or irradiation; the surgical aim is to produce a dry and patent ear canal**
- **Management of acquired atresia requires a skin graft to cover the deficient ear canal, in addition to plug excision. However, the ear canal remains unstable and recurrence can occur**

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