

## Acquired medial canal fibrosis

YOUSRY EL-SAYED, F.R.C.S.

### Abstract

Acquired medial canal fibrosis is a discrete clinicopathological entity characterized by formation of fibrous tissue in the bony external auditory meatus.

Over a seven-year period, a total of 14 operative procedures were performed on 12 ears involving 10 patients. Four cases had followed otitis externa, two were complications of suppurative otitis media, and three cases were iatrogenic. The cause could not be identified in three ears involving two patients.

Treatment entails excision of all the fibrous tissue and involved skin, a wide canaloplasty, a meatoplasty, and then reconstruction by split skin graft. Two cases of canal cholesteatoma were encountered. Average follow-up of two years showed hearing improvement in all patients. The only complication was a recurrence of the stenosis in two ears. The paper discusses terminology, aetiology, pathophysiology, diagnosis, and principles of treatment of this condition.

**Key words:** Ear canal, surgery

### Introduction

Acquired medial canal fibrosis (AMCF) is an uncommon clinicopathological entity characterized by formation of mature fibrous tissue in the external auditory meatus lateral to the tympanic membrane. A review of the literature showed that many different terms have been used interchangeably to report the same or similar condition.

This paper presents the author's experience in management of 14 cases; and discusses the terminology and management of this disorder.

### Materials and methods

From 1989 through 1995, 12 ears in 10 patients were seen with AMCF. The diagnosis was based on the presence of partial or complete fibrous obliteration of the medial part of the external auditory meatus. Complete (circumferential) obliteration manifests as a shortened canal ending with a skin-covered barrier which may appear to be a 'lateralized' tympanic membrane. Partial obliteration occurs when fibrosis involves only the anterior tympanomeatal angle (blunting).

The patients were evaluated via a complete history, otomicroscopy, and pure tone and impedance audiometry. A tympanogram was recorded using a 226 Hz probe tone over a pressure range from +200 to -200 daPa. Computed tomography (CT) to the middle and external ears was performed on some patients.

Surgical treatment consists of excision of all fibrous tissue, a wide canaloplasty, a meatoplasty,

and then reconstruction by split skin graft. A post-auricular approach is used. A complete excision of the unhealthy skin and the fibrous tissue, and cholesteatoma if encountered, is performed. Canaloplasty is fashioned by generous widening of the bony canal and completed by meatoplasty. Split skin grafts with thicknesses of 0.6 to 0.8 mm, harvested with a dermatome from the medial surface of the upper arm are used to line the canal and are sutured to the edge of the meatoplasty anteriorly and posteriorly. Patients were followed up via clinical examination and by audiological evaluation.

### Results

A total of 14 surgical procedures were performed on 12 ears in 10 patients (six females and four males); two patients had bilateral disease. Their ages ranged from 26 to 56 years, with a mean of 35 years.

Three patients (including one with bilateral disease) presented with a history of chronic otitis externa, two with a history of chronic suppurative otitis media, and three patients had a history of tympanoplasties. In two patients (three ears) no identifiable cause could be detected.

Ten ears had complete obliteration of the lumen with shallow canal ending in a 'false' tympanic membrane. Two ears had blunting of the tympanic membrane due to obliteration of the anterior tympanomeatal angle. Both ears with blunting were secondary to tympanoplasties.

Pure tone audiometry revealed a mean pre-operative conductive hearing loss (mean value for

500, 1000, and 2000 Hz) of 32 dB with a range of 25 to 55 dB. Impedance and tympanometry studies showed flat curve and absent stapedial reflex in all cases. The average equivalent volume measure of the external auditory meatus was  $0.6 \text{ cm}^3$  (with a range of  $0.4$  to  $1.4 \text{ cm}^3$ ).

CT was performed on eight ears before surgery. It revealed a solid core of soft tissue in the medial part of the external auditory meatus. An invasion of the middle ear by cholesteatoma was suspected radiologically in one ear; and later confirmed operatively.

In ten ears the whole lumen of the deep part of the external canal was occupied by firm fibrous tissue which varied in thickness between 6–18 mm. In two ears the fibrosis was restricted to the antero-inferior tympano-meatal angle. The osseous walls of the canal were normal in all cases except in two where the inferior wall was found to be extremely thick. The skin of the canal was noted to be thick in most cases.

The fibrous tissue was easily separated and removed from the lamina propria of the tympanic membrane. The mucosa of the tympanic membrane was intact in all the cases except one. Two cases of cholesteatoma were encountered. In one ear the cholesteatoma was localized to the external canal with an intact tympanic membrane lamina propria. In the other case, the cholesteatoma was found to involve the antero-inferior part of the external canal and to extend into the mesotympanum through a defect in the tympanic membrane. The cholesteatoma was removed completely without difficulty and the tympanic membrane was grafted.

All specimens removed at surgery were studied histologically and revealed unremarkable dense fibrous tissue with a variable amount of chronic inflammatory cell infiltration. Histological confirmation of cholesteatoma was made in the two mentioned cases.

The follow-up period varied from one to five years with an average of 2.5 years. The average hearing improvement in all operated ears was 20 dB. Hearing has not significantly improved in two patients, due probably to tympanosclerosis noted at the time of surgery. In no instance was the hearing worse post-operatively. The average post-operative equivalent volume measure of the external auditory meatus was  $1.6 \text{ cm}^3$  (with a range of  $1.2$  to  $1.9 \text{ cm}^3$ ). The stapedial reflex was elicited in six ears.

The only complication seen was restenosis occurring in two cases. In both conditions, the cause of recurrence probably was failure to use skin grafts because it was thought there was sufficient healthy tissue available in the external auditory meatus. In the immediate post-operative period, granulation tissue formed in the meatal walls and the latter became covered by epithelium. Both ears were re-operated on, using split skin grafts to line the widened canal, with a successful outcome.

## Discussion

Medial canal fibrosis is an interesting type of acquired meatal atresia that is characterized by

formation of a solid core of fibrous tissue in the medial part of the external auditory meatus and abutting the tympanic membrane.

In the literature there is some confusion about the terminology. Many terms have been used interchangeably to describe the same or subtype of this condition. These terms include chronic stenosing external otitis (Paparella and Kurkjian, 1966; Birman and Fagan, 1996) post-inflammatory acquired atresia (Bonding and Tos, 1975), post-inflammatory medial meatal fibrosis (Katzke and Pohl, 1982), obliterative otitis externa (Herdman and Wright, 1990), medial meatal fibrosis (Keohane *et al.*, 1993), and acquired atresia of the external auditory meatus (Cremers and Smeets, 1993).

The term AMCF best describes this entity with regard to the pathology and the pathophysiology of the condition. This term distinguishes the condition from congenital meatal atresia, and from non-fibrotic atresia (e.g., neoplasm) which have different pathogenesis. On the other hand, it includes all acquired causes of meatal fibrosis such as inflammation (otitis externa and media), allergy (dermatitis), and trauma (surgical or non-surgical). Consequently, the author believes that tympanic membrane blunting should be considered as an AMCF. This later point is not in agreement with Katzke and Pohl (1982) who stated that the post-inflammatory medial meatal fibrosis should be 'sharply' differentiated from blunting of the tympanomeatal angle. Similarly, the author believes that what is now called tympanic membrane lateralization is one form of AMCF. The term 'lateralization of the tympanic membrane' is not accurate because what is seen at the medial end of the external auditory meatus is not a tympanic membrane. It is a fibrous barrier lined laterally by skin and extending medially to a normally located tympanic membrane or to its remnant. In fact, in most cases it is usually easy to separate the obliterative fibrous tissue from the underlying lamina propria.

The incidence of AMCF is not known but it seems to be an uncommon disorder. Bonding and Tos (1975) reported the first relatively large series in 1975. They reported 17 cases (14 complete and three partial) of post-inflammatory atresia. Previous to this report, only seven cases were documented in the literature. Thereafter, some authors reported a small series (Table I). The latest of these reports, published by Slattery and Saadat (1997), has demonstrated the rarity of the condition. They reported only 24 patients with 'post-inflammatory' medial canal fibrosis seen over a 30-year period at the House Ear Clinic, Los Angeles.

The pathophysiology of this disorder is only speculative, as there are no experimental animal models (Keohane *et al.*, 1993). An insult to the external auditory meatus and tympanic membrane epithelium initiates the process. This may be infectious or traumatic or arises *de novo* in patients with associated dermatitis. This initial insult produces granulation tissue on the tympanic membrane and the external canal wall epithelium. Subse-

TABLE I  
PREVIOUSLY PUBLISHED AND THE PRESENT STUDY DATA

Author	Term used	No. of ears/ patients	Causes	Cholesteatoma	Recurrence
Bonding and Tos (1975)	Post-inflammatory acquired atresia	17/14	O.M. and O.E.	1 (5.9%)	Not reported
Adkins and Osguthorpe (1981)	Canal stenosis	8/5	Congenital, O.E. and trauma	None	None
Katzke and Pohl (1982)	Post-inflammatory medial meatal fibrosis	6/6	O.E. and O.M.	None	Not reported
Tos and Balle (1986)	Post-inflammatory acquired atresia	22/19	O.E. and O.M.	4 (18.8%)	4/22 (18%)
McDonald <i>et al.</i> (1986)	Stenosis of external auditory canal	22/20	Congenital, O.E. and trauma	Not specified	2/22 (9.1%)
Herdman and Wright (1990)	Obliterative otitis externa	8/6	O.E.	Not specified	1/8 (12.5%)
Keohane <i>et al.</i> (1993)	Medial meatal fibrosis	15/9	Trauma, O.E., O.M. and dermatitis	None	1/15 (6.7%)
Cremers and Smeets (1993)	Acquired atresia of external auditory meatus	17/15	O.E. and trauma	2 (11.8%)	0
Birman and Fagan (1996)	Medial canal stenosis	12/11	O.E. and trauma	None	2/12 (16.7%)
Slattery and Saadat (1997)	Post-inflammatory medial canal fibrosis	38/24	O.E., dermatitis and idiopathic	None	3/14 (21.4%)
Present study	Acquired medial canal fibrosis	12/10	O.E., O.M., trauma and idiopathic	2 (16.6%)	2/12 (16.7%)

O.E.: otitis externa.

O.M.: otitis media.

quently, the granulation tissues become infected and form fibrous plugs occluding the external auditory meatus, and lined by skin.

Most cases seem to follow chronic otitis externa and/or media, or as a complication of ear surgery. Rarely, AMCF may be caused by non-surgical trauma such as thermal and chemical burns, or gunshot injuries. In this 12 ears series, six cases followed otitis externa and media, and three cases were iatrogenic following tympanoplasties. There was no obvious underlying disease in three ears. Likewise, Slattery and Saadat (1997) reported four (of 24) patients who had no identifiable disease before the development of the meatal fibrosis.

Most authors found AMCF to be more prevalent in females for no apparent reason. The condition may occur at any age. Bonding and Tos (1975) found the post-inflammatory fibrosis to be more prevalent among elderly patients who have been wearing a hearing aid for many years or who have been fitted with a hearing aid for an ear with tympanic membrane perforation. Few cases have been reported in the paediatric population (Keohane *et al.*, 1993).

The history, clinical examination, and audiometry establish the diagnosis of AMCF. In most cases, there is usually a history of otitis externa or media, dermatitis, or an ear operation. In 'complete' AMCF cases, ear examination shows shortened external canal with funneling of its medial part. The canal ends in a skin-covered barrier and not in tympanic membrane. In 'partial' cases (blunting) only the anterior tympanomeatal angle is obliterated.

Pure tone audiometry usually shows a 20–40 dB conductive hearing loss. Tympanometry typically demonstrates a low compliance and a flat curve with absence of the acoustic reflex. Also, equivalent volume measure of the external auditory meatus is

usually less than normal. In this series the mean average volume measure of the external auditory meatus was 0.6 cm<sup>3</sup> (with a range of 0.4 to 1.4 cm<sup>3</sup>). Radiographs are not always indicated; but CT may be needed to exclude middle-ear pathology.

The differential diagnosis includes histiocytosis X, gummatous lesions of tertiary syphilis, lupus erythematosus, and primary carcinoma of the external auditory meatus (Keohane *et al.*, 1993). Histology should be performed on all cases.

In this study, two cases were found to have canal cholesteatoma within the fibrous plug; and in one of them the squamous epithelium was invading the middle ear. Both cases were sequelae to myringoplasties by the onlay technique. The cholesteatoma formation could have been caused by surgical entrapment of viable squamous epithelium in the deep external auditory meatus especially in the anterior area. Of interest, Plester and Pusalkar (1981) studied histologically 49 healthy looking cadaveric specimens and reported at the anterior tympanomeatal angle there was a fold of epithelium penetrating deep in the subepithelial tissue in 15 (31 per cent) cases.

In the literature, there are few reports documenting canal cholesteatoma in association with AMCC (Table I). The cholesteatoma is not exclusively seen in cases occurring following surgery. Marlowe (1972) described a patient who developed bilateral atresia with meatal cholesteatoma four months after an infection in both auditory canals.

Once the diagnosis of AMCF is secured, the only effective treatment is surgical reconstruction of the external auditory meatus. The main aim of surgery is to restore and maintain patency of the canal for the normal sound condition and self-cleaning functions. Another important purpose for the treatment is to control canal cholesteatoma.

The surgical techniques used to perform canaloplasty were initially set by Paparella (1966) and Paparella and Kurkjian (1966) and have remained relatively unchanged with only minor differences occasionally being presented. The details of surgical technique have been documented by many authors (Katzke and Pohl, 1982; McDonald *et al.*, 1986; Keohane *et al.*, 1993; Parisier *et al.*, 1996).

Treatment involves excision of all fibrous tissue and the involved skin, a wide canaloplasty, a meatoplasty, and then reconstruction by skin graft. The main challenge of surgery is to prevent restenosis. Adherence to the following surgical procedures is necessary in order to reduce the incidence of recurrence.

- (1) Adequate exposure is necessary. Some authors (Tos and Bonding, 1979; Katzke and Pohl, 1982; Tos and Balle, 1986) have used the endaural approach with good outcome. However, the author, in accordance with others (Cremers and Smeets, 1993; Birman and Fagan, 1996), advocates the post-auricular incision in order to achieve adequate exposure to the anterior sulcus and anterior tympanomeatal angle. A combination of the endaural and the post auricular approach is used by some authors (Parisier *et al.*, 1996).
- (2) Removal of all fibrous tissue and the unhealthy canal skin is also mandatory. It is usually easy to separate the fibrous tissue from the underlying lamina propria of the tympanic membrane. Tos and Balle (1986) believed that restenosis could occur due to failure to remove all the fibrous tissue, especially at the anterior recess.
- (3) Generous widening of the bony canal is a key step in the procedure. In many cases, bony narrowing is encountered due to thick tympanic bone. This has to be drilled down with removal of the spine of Henle and smoothing of the tympanosquamous and tympanomastoid sutures. The posterior bony canal wall can be widened until some mastoid cells are encountered. The bone of the anterior canal wall can be thinned until it becomes translucent and the glenoid fossa periosteum is discerned (Parisier *et al.* 1996).
- (4) Meatoplasty (widening the cartilaginous lateral opening of the external auditory meatus) is an essential part of canaloplasty. Creation of a wide meatus tends to preserve normal lateral migration of cerumen and desquamated keratin, allowing it to extrude easily (Parisier *et al.*, 1996). In addition, it provides good ventilation to the canal.
- (5) The denuded bony canal wall should not be allowed to granulate and contract which invariably results in further stenosis. The use of ear moulds by earlier writers (Marlowe, 1972; Beales, 1974) has not remained in favour. In most cases, skin grafting will be needed to prevent healing by secondary intent. The most popular material is used to cover the raw areas

is split-thickness skin grafts. Adkins and Osguthorpe (1981) used a superiorly based pre-auricular transposition flap. The principle advantage is transfer of a flap of skin and subcutaneous tissue with an effective blood supply which can be extended the entire length of the superior external auditory meatus, lessening the likelihood of repeat contracture. Moore *et al.* (1984) used full thickness skin graft from the post-auricular area. They found that this type of skin contracts less than a split-thickness skin graft. In addition, it contains glandular elements that help to lubricate the transplanted skin.

The incidence of recurrence in the published series is displayed in the table (Table I). With such a small number in any study it is impossible to compare results properly. Recurrence can occur many years after the initial procedure.

In conclusion, AMCF is an uncommon condition characterized by formation of fibrous tissue in the medial part of the bony canal. Most cases are caused by middle and/or external ear infections, or are iatrogenic. The otologists should be familiar with the problems this disease entity may present. Surgical treatment is required in most cases to correct the conductive hearing loss and to remove associated canal cholesteatoma. Adherence to strict surgical protocol minimizes post-operative recurrence.

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Address for correspondence:  
Dr Yousry El-Sayed,  
Department of Otorhinolaryngology,  
King Abdel-Aziz University Hospital,  
PO Box 245,  
Riyadh 11411,  
Saudi Arabia.

Fax: 4775748  
e-mail: f35n002@ksu.edu.sa