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Cholesteatoma of the External Auditory Canal: Review of Staging and Surgical Strategy

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Introduction: External auditory canal cholesteatomas (EACC) is insidious in nature and rare entity. There are only few case series on EACCs and surgical strategy is not standardized.
Objectives: 1) To elucidate etiology of EACC and cardinal features. 2) To suggest a practical staging of EACC. 3) To enumerate surgical management according to stage of EACC.
Study Design: Retrospective study in a quaternary referral center of 31 consecutive cases of EACC.
Results: Thirty-one patients with EACC were reviewed. Unilateral otorrhea 19 (61.2%), hearing loss 22 (70.9%), and otalgia 8 (25.8%) are cardinal symptoms. Sixteen primary and 15 secondary EACCs were treated. Bone erosion was observed in 20 cases. In the present series, stage III = 12 (38.7%), stage II = 8 (25.8%), stage I = 11 (35.4%) underwent definitive treatment by surgery. Canalplasty with reconstruction was done in 19 cases of stages I and II. Of 12 cases in stage III, 3 cases underwent canalplasty with reconstruction. Subtotal petrosectomy was done in five cases. Intact canal wall mastoidectomy with canalplasty in two cases and radical mastoidectomy in two cases. Fascia, cartilage, muscle, and bone dust were used for reconstruction. Median follow-up period was 6 years and no recurrence of cholesteatoma was observed.
Conclusion: EACC is unique entity. Intraoperative and radiological findings assist in correct and practical staging of EACC. Late stage presentations of EACC are common. Definitive surgical treatment in our series avoided recurrence of cholesteatoma. **Key Words:** Canalplasty—Cholesteatoma—External auditory canal—Subtotal petrosectomy.

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External auditory canal (EAC) is a unique cul-de-sac in the human body which requires undisturbed self-cleansing to keep it patent (1). Any factor that affects patency of EAC may lead to EACC formation. EACCs are broadly divided into primary and secondary (2–4). While primary external auditory canal cholesteatomas (EACCs) are generally idiopathic, secondary cholesteatomas can be congenital, posttraumatic, postoperative, or postinflammatory. EACC rarely presents to a busy otology clinic with an estimated incidence of 1:1,000 of all newly diagnosed patients (1). Although originally described by Toynbee in 1850, it was only in the late 20th century that reliable separation from other EAC pathologies like keratosis obturans was possible (5,6).

EACCs may be difficult to distinguish from the common otitis externa, especially in its early stages, due to the fact that otalgia in EACC gradually disappears with disease progression (7). Naim et al. (8) proposed a staging that was based on rare histologic findings which has been often used in the literature. However, this staging does not correspond to clinical findings or surgical management. The objective of the present series which is one of the largest in the literature was to elucidate causes and presentation of EACCs, review the existing staging system, and suggest the surgical strategies for definite treatment.

PATIENTS AND METHODS

Our center is a quaternary referral center for otology and lateral skull base surgeries. A retrospective chart-review of all patients operated at our center from 1983 to 2017 for all cholesteatomas were conducted and only patients with EACCs were included in this study. At our center, EACCs are defined by the presence of cholesteatoma distinctly arising from the EAC without evidence of origin from any other sites in the middle ear or mastoid.

The inclusion criteria used to select patients were: 1) patients with EACCs, 2) patients with a minimum follow-up of at least 12 months. The exclusion criteria were: 1) patients with any other type of middle ear, mastoid, or petrous cholesteatomas, 2) patients with incomplete case records, follow-up of less than 1 year or those lost to follow-up. This yielded 31 cases for analysis. The data extracted from the case sheets included demographics, laterality, clinical presentation, etiology, past surgeries, intraoperative findings, complications, recurrences, revision-surgeries, preoperative audiometric-data, and follow-up.

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The preoperative audiological data, including pure-tone average (average of 0.5–1–2–4 kHz) of bone conduction, air conduction, and air-bone gap (ABG), according to the Sanna et al. (9) classification of hearing were noted and analyzed. All patients underwent complete preoperative oto-neurologic evaluation, including preoperative otoendoscopy. Preoperative and postoperative facial nerve (FN) function was graded by the House-Brackmann) grading system (10).

A high-resolution computed tomography scan of the temporal-bone was obtained in all patients. We devised staging based on intraoperative and radiological findings. Our patients were divided into three stages based on radiological evaluation determining the presence or absence of bone erosion, extent of the disease and involvement of surrounding structures. This was also confirmed intraoperatively. Surgeries adopted in this series included: 1) Canalplasty with or without reconstruction, 2) Intact canal wall mastoidectomy with canalplasty, 3) Radical mastoidectomy, 4) Subtotal petrosectomy. These procedures are described elsewhere (11). Operative notes were analyzed for location, bone erosion and extent of disease, surgical technique used and reconstruction methods (Table 1).

Review of the Literature

A PubMed search was performed using appropriate search words between 2000 till date. All case series with over 10 cases of EACCs were included in the review. The etiology, clinical features, surgical technique, graft materials, complication, recurrence, and revision rates with follow-up time were tabulated and compared. The present study was approved by the Institutional Review Board of Casa Di Cura, Piacenza, Italy for ethical research (Table 2).

RESULTS

Of the 7020 cases of cholesteatomas operated in our center from 1983 to 2017, 31 patients with EACCs were analyzed. The incidence was around four per thousand temporal bone cholesteatomas and one per thousand for all otological/lateral skull base, in patients operated at our center.

Demography and Etiology

The mean age of the study population was 41.2 years, range (6–75 yr) with male:female ratio of 1:1.63, 15 (48.3%) were right ears and 16 (51.6%) were left ears. Sixteen (51.6%) cases were primary and 15 (48.3%) cases were secondary EACCs. Among the 15 secondary EACCs, poststenotic 4 (26.6%) and postoperative 4 (26.6%) were the most common etiology. Followed by posttraumatic 3 (20%), posttumorous 3 (20%), and post-inflammatory 1 (6.6%) cases.

Clinical Features

Of the 31 patients, 22 (73%) had hypoacusis, followed by otorrhea 19 (63%) otalgia 8 (27%). Six (20%) of patients had complaints of chronic itching in the ear and about 5 (17%) of the study group had dizziness/vertigo. Two (6.4%) of the patients among 31 had anacusis.

Audiological Analysis

Of the 22 cases with hearing loss was more common in secondary EACCs 12 (54.5%) when compared with primary cases 9 (40.9%). Of these, two patients with anacusis and five cases of subtotal petrosectomy (STP) were excluded. Audiological analysis was done for ABG. The pre and postoperative mean ABGs in primary EACCs were 28.75 dB and 6.87 dB respectively ($p < 0.0019$). Similarly among secondary EACCs, the

TABLE 1. *Patient and EAC cholesteatoma characteristics*

Patient and Cholesteatoma Characteristics	n (%)
Demography	
Patients	31 (100)
Mean age (yr)	41.2
Male: female	12:19
Unilateral: bilateral	31:0
Incidence among temporal bone cholesteatomas	4/1,000
Incidence among otology/lateral skull base cases	1/1,000
Etiology	
Primary (Idiopathic)	16 (51.6)
Secondary	15 (48.3)
Stenosis	4 (26.6)
Postoperative	4 (26.6)
Posttraumatic	3 (20)
Posttumorous	3 (20)
Postinflammatory	1 (6.6)
Clinical features	
Hearing loss	22 (70.9)
Otorrhoea	19 (61.2)
Otalgia	8 (25.8)
Chronic itching ear	6 (19.3)
Dizziness/vertigo	5 (16.1)
Anacusis	2 (6.4)
Intraoperative signs and structures involved	
Bone erosion	20 (64.5)
Temporomandibular joint exposed	7 (22.5)
Facial nerve exposed	5 (16.1)
Dura exposed	2 (6.4)
Lateral semicircular canal fistula	2 (6.4)
Jugular bulb exposure	1 (3.2)
Meningoencephalic herniation	1 (3.2)
Stage classification	
I	11 (35.4)
II	8 (25.8)
III	12 (38.7)
Location	
Inferior	16 (51.6)
Posterior	7 (22.5)
Anterior	4 (12.9)
Superior	2 (6.4)
Circumferential	2 (6.4)
Middle ear extension	2 (6.4)
Surgical approaches	
Canalplasty	20 (64.5)
Canalplasty + myringoplasty	2 (6.4)
Canalplasty + mastoidectomy	2 (6.4)
Radical mastoidectomy	2 (6.4)
Subtotal petrosectomy	5 (16.1)
Follow-up	
Median follow-up period	6 yr
Recurrence of cholesteatoma	0 (0)
Tympanic membrane reperforation	3 (9.7)

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TABLE 2. *Review of the literature of EAC cholesteatoma*

Case series	Patients (n) 1°/2° EACC	Bil (n)	Signs and Symptoms n (%)	EACC location (A-I-P-S-C)(n)	Air-bone Gap	Surgery Type (n)	Follow-up (yr) (median)	Recurrence (n)	Adjacent Structures involved (n)	Meatoplasty (n)	Special points
Vrabec et al., 2000	(39) 13/26	(5)	Or 4 (10.2) Ot 5 (12.8) Pr 7 (17.9)	(A + I) (39)	NA	NA (25)	(NA)	(0)	NA	NA	Spontaneous EACC managed by aural toilet. Mentions HA, cerumen, Cotton tip use as risk factors for 1° EACC.
Heilbrun et al., 2003	(13) 8/5	(0)	Or 6 (46.1) Ot 3 (9.6) HL 4 (12.9) BE 13 (100)	5-8-8-0-2	NA	CP CWD (13)	(15)	(0)	FN (2) ME (5) MAS (4) TT (1)	NA	Aural toilet in Spontaneous EACC.BE was found in all cases.
Naim et al., 2005	(17) 17/0	(0)	Or 12 (70.5) Ot 3 (17.6) HL 4 (23.5)	0-1-12-1-0	NA	NA (17)	(4)	NA	MAS (1)	NA	Histopathologic Staging
Owen et al., 2006	(48) 25/23	(3)	Or 6 (13) Ot 18 (38) HL 5 (10) Pr 10 (21)	41-47-45-2-0	NA	CP + R (44)	(2)	(2)	FN (1) TMJ (11) MAS (8) M E (3)	NA	1°EACC in 48% reported mechanical trauma Conservative treatment for post-radiotherapy EACCs.
Dubach et al., 2008	(34) 13/22	(1)	Or 22 (65) Ot 4 (12) HL8 (27) BE 34 (100)	1°EACC 4-14-5-0-0 2°EACC 11-12-13-1-0	Preop >20 dB (27%) Postop NA	(n = 30) CP (4) TC (6) CWD (11)	(1)	(0)	FN (2) MAS (14) Dura (2) LSCC (1)	(30)	Surgical exploration for correct staging. 1°EACCs had more tobacco consumption.
Lin et al., 2009	(45) 34/11	(7)	Or 28 (62.2) Ot 23 (51.1)	1°EACC 0-32-0-0-0 2°EACC 10-5-0-0-0	NA	NA (42)	NA	NA	NA	NA	HL more common in 2° EACC.
Shin et al., 2010	(29) 14/15	(0)	Or 12 (41) Ot 17 (59) HL 17 (59)	10-20-17-10-0	NA	CP (14) CP + TP (3) CP + MT (10) MCFA (2)	(0.6)	(2)	ME (3) MAS (1) TMJ (2) MCF (1)	NA	Radiological staging
Konishi et al., 2016	(28) 22/6	(1)	Or 28 (100) Pr 28 (100) Ot 2 (7)	14-8-7-0-0	NA	CP + MP (10) CWD + OB (19)	(1.8)	(1)	TMJ (14) ME (8) MAS (7)	(28)	Early intervention avoids recurrence Concept of multilayered reconstruction
Present series	(31) 16/15	(0)	Or 19 (61.2) Ot 8 (25.8) HL 22 (70.9) Pr 6 (19.3) Ve 5 (16.1) BE 20 (64.5)	4-16-7-2-2	Pre-op 1° 40.9% 28.75dB 2° 59.09% 42.85dB Post-op 1° 6.87dB 2° 10dB	CP (20) CP + M P (2) CP + MT (2) RP (2) STP (5)	(6)	(0)	FN (5) TMJ (7) JB (1) Dura (2) MEH (1) LSCC (2) ME (2)	(10)	Simple practical staging based on surgical & radiologic findings. Definitive treatment strategy.

1° indicates primary EACC; 2°, secondary EACC; A-I-P-S-C, anterior-inferior-posterior-superior circumferential; BE, bone erosion; Bil, bilateral; CP, canalplasty; CWD, canal wall-down mastoidectomy; EACC, external auditory canal cholesteatoma; FN, facial nerve; HA, hearing aids; HL, hearing loss; JB, jugular bulb; LSCC, lateral semicircular canal; MCFA, middle cranial fossa approach; ME, middle ear; MEH, meningo encephalic herniation; MP, myringoplasty; NA, not available; OB, obliteration; Or, otorrhea; Ot, otalgia; Pr, prurigo; R, reconstruction; RP, radical petrosectomy; STP, subtotal petrosectomy; TMJ, temporomandibular joint; Ve, vertigo.

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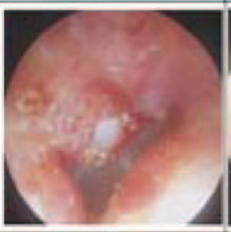
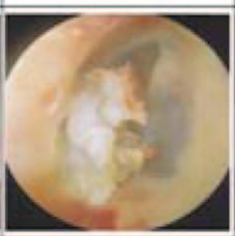
Location	Superior	Inferior	Anterior	Posterior	Circumferential
					
Stage I	2	3	1	5	2
Stage II	1	7	2	2	0
Stage III	3	6	6	6	0

FIG. 1. Stage-wise location of EACC. EACC indicates external auditory canal cholesteatoma. [From left to right in this figure: image 1(R), image 2(L), image 3(L), image 4(L), image 5(R). R, right ear; L, left ear].

pre and postoperative mean ABGs were 42.85 db and 10 db respectively ($p < 0.006$).

Intraoperative Findings

Review of the operation records showed that 20 (64.5%) of the cases had bone erosion. Temporo-mandibular joint (TMJ) was the most common surrounding structure exposed due to bone erosion in seven (22.5%) cases, followed by FN in five (16.1%), dura two (6.4%), lateral semicircular canal fistula in two (6.4%), meningoencephalic herniation in one (3.2%), and jugular bulb exposure in one (3.2%) (Table 1).

Location and Extensions

Among 31 cases of EACC, 16 (51.6%) cases were located in the floor of EAC. Seven (22.5%) cases were located in posterior wall and four (12.9%) cases in the anterior wall of EAC causing TMJ erosion. Two (6.4%) cases had involvement of superior and attic wall. Circumferential extension and location of cholesteatoma was seen in two (6.4%) of cases. About two (6.4%) of the study group had EACCs extending into the middle ear. The location and extension of the EACCs has been depicted in Figure 1.

Staging

Among 31 patients in our study group, 11 (35.5%) cases without bone erosion were classified as stage I. Eight (25.8%) cases that had bone erosion but no involvement of adjacent structures were staged as II and 12 (38.7%) cases that had bone erosion with involvement of adjacent structures but no complications were stage IIIA. None of our patients had a stage IIIB disease (Fig. 2).

Surgical Results

Most of our patients presented with advanced stages of EACCs according to our classification. Canalplasty was performed in 20 (64.5%) of cases, canalplasty with myringoplasty in 2 (6.4%), and canalplasty with mastoidectomy in 2 (6.4%) of the cases. Subtotal petrosectomy was done in five (16.1%) and radical mastoidectomy with reconstruction in two (6.4%) of cases.

Follow-up and Recurrence

The median follow-up period in our study is 6 years and none of the 31 cases had recurrence after definitive surgical treatment. Tympanic membrane reperforation in anteroinferior quadrant observed in 3 of 31 cases was corrected later by myringoplasty.

DISCUSSION

Scholefield (12) introduced the term EACC in 1893 but the precise definition was given by Piepergerdes et al. (6), in 1980. The incidence of EACCs is 1.2 to 7.1 cases per 1,000 new otologic patients per year (13,14). In our center the incidence is 1 case per 1,000 new otologic inpatients or 4 per 1,000 cases of temporal bone cholesteatomas (15–17).

Etiopathogenesis of EACC

The pathogenesis of spontaneous ear canal cholesteatoma is attributed to factors like 1) microtrauma to the external canal skin; 2) retention of hard or adulterated cerumen; 3) focal osteitis; 4) hypoxia leading to angiogenesis via scatter factor, tyrosine-kinase c-Met receptor, and vascular endothelial growth factor; and 5) decreased epithelial migration secondary to aging; or 6) erratic keratin deposition and poor blood supply in the floor of EAC (4,8,18,19). The differential migration velocity theory of the canal epithelium between healthy and EACC ears has been refuted by Makino and Amatsu (20). The enhanced expression of mind bomb 1 antibody-positive proliferating cells, transforming growth factor-alpha, and epidermal growth factor receptor in the basal and suprabasal layers of the epithelium in cholesteatomas has been found (18). Bonding et al. (21), and Hickey et al. (22), were able to associate idiopathic EACC with congenital anomalies like a rudiment of the first branchial cleft (23). Chronic use of cotton-tipped applicators has been described as a potential risk factor but whether this is a cause or occurs as an epiphenomenon attributable to ottorhea remains an open question. In contrast secondary EACCs are due to obstruction (auditory canal stenoses, exostoses, mycetomas) or defects of the EAC affecting the mastoid cell

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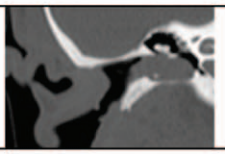
Stage	Naim's classification	Present proposed classification	Radiological findings	Intervention	Graft material
I	Epithelial hyperplasia	EACC without bone erosion and ME extension (n=11)		Canalplasty +/- Reconstruction	Fascia, Perichondrium
II	Periostitis	EACC with bone erosion, ± ME extension (n=8)		Canalplasty + Reconstruction	Fascia, Perichondrium, Bone dust, Cartilage, Muscle
III	Bone erosion	EACC with bone erosion + extension to adjacent structures (TMJ, mastoid, Fallopian canal, JB, dura) (a) Without complications (n=12), (b) With complications (egg. FN palsy) (n=0)		Canalplasty + Reconstruction (n=3) Canalplasty + Mastoidectomy (n=2) Radical mastoidectomy (n=2) Subtotal petrosectomy (n=5)	Fascia, cartilage, Fat
IV	Extension to surrounding structures				

Abbreviations: ME: middle ear, TMJ: temporomandibular joint, JB: jugular bulb, FN: facial nerve

FIG. 2. Comparison between Naim's classification and our present classification of external auditory canal cholesteatoma (EACC) and treatment.

system (posttraumatic, postoperative, posttumor remission, or postchemoradiotherapy) (21).

EACCs have been classified as primary and secondary in all studies. In some studies the secondary EACCs are more than the primary (idiopathic) type. In study by Dubach and Häusler (1), EACCs were divided into primary 13/34 cases and secondary EACCs 22/34 cases. Vrabec published a series of 39 patients of EACC where there were 29 cases of secondary EACCs compared with 12 primary cases since some had bilateral pathology (4).

Staging of the Disease

Four progressive histologic stages described previously by Naim et al. are as follows: 1) focal epithelial hyperplasia, 2) followed by accumulation of inflammatory cells in adjacent stroma leading to periosteitis, 3) accumulation of keratin debris causing erosion of the bony canal, and 4) erosion of adjacent structures (8,24).

Our review of the operation records and videos in this study showed 20 (64.5%) of 31 cases with bone erosion. Heilbrun et al., in their study on clinical and imaging spectrum of EACC on 8 primary and 5 secondary causes of EACCs, bone erosion was found in all 13 cases of EACC (1,4,18,25,26).

Holt (3) in 1992 was the first to distinguish three stages of EACC in his macroscopic studies as superficial defect, localized canal pocket, and extension into the mastoid which lead to development of similar competing staging systems by Naim, Ho-ki Lee et al., in 2010 (2,27). Unlike the rare observations of patients in early stages of EACC by Naim et al. (8), reports on EACC in advanced stages predominate in the literature; perhaps because early stages of EACC are mostly asymptomatic and more often than not, go undetected. Literature review suggests that radiological evaluation followed by surgical confirmation leads to correct staging. High-resolution computed tomography of the temporal bone is recommended in EACCs to assess involvement of middle ear, mastoid, labyrinth, facial canal, and tegmen (18). Our proposed staging of EACCs into three stages is based on radiological evaluation and surgical confirmation of bone erosion and involvement of surrounding structures as this is best assessed intraoperatively and influences decision making in surgery (Table 3).

Radiological and surgical findings revealed that among the 31 cases in this series of EACC, 16 (51.6%) cases were located in the floor of EAC. Literature review suggests idiopathic EACCs are typically located at the floor of the auditory canal and secondary EACCs have a more random and multifocal location in the EAC (1,3,6,8,13,14). An atypical location suggests the presence of a secondary or complicated form of the disease (1). Location and extension of EACCs in this series has been depicted in Figure 1.

Clinical Features

EACCs are typically accompanied by otorrhea and dull pain because of local invasion of squamous tissue into the bony EAC. This erosion results in the destruction of the adjacent tissue, of the EAC (1). Among 31 patients in our series the cardinal symptoms were unilateral otorrhea 19 (61.2%) along with hearing loss 22

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TABLE 3. *Our proposed classification of external auditory canal cholesteatoma (EACC) and treatment*

Stage	Present Proposed Classification	Intervention	Graft Material
I	EACC without bone erosion and ME extension (n = 11)	Canalplasty ± reconstruction	Fascia, perichondrium
II	EACC with bone erosion, ± ME extension (n = 8)	Canalplasty + reconstruction	Fascia, perichondrium, bone dust, cartilage, muscle
III	EACC with bone erosion + extension to adjacent structures (TMJ, mastoid, fallopian canal, JB, dura) (a) Without complications (n = 12), (b) With complications (egg. FN palsy) (n = 0)	Canalplasty + Reconstruction (n = 3) Canalplasty + Mastoidectomy (n = 2) Radical mastoidectomy (n = 2) Subtotal petrosectomy (n = 5)	fascia, cartilage, fat

FN indicates facial nerve; JB, jugular bulb; ME, middle ear; TMJ, temporomandibular joint.

(70.9%) and otalgia 8 (25.8%). Similar studies by Dubach and Häusler (1), Owen et al. (14), Lin (25), Shin et al. (27) showed that otorrhea, otalgia, and hearing loss are common symptoms in EACC. Hearing loss was slightly more common than otorrhea which could be due to late stage presentation of EACCs to our center. In a study by Lin (25), hearing loss was more common in secondary EACCs. Similar to some of the other cases series 13 (59.09%) of 22 patients who had hearing loss in our study group were secondary EACCs. Very rarely EACCs can present as meningoencephalic herniations, especially in posttraumatic cases following temporal bone fractures. In our study we had one case of EACC with meningoencephalic herniation (28).

The differential diagnosis of ear canal cholesteatoma includes malignant tumor (EAC carcinoma), keratosis obturans or late complication of a langerhans cell histiocytosis, and malignant (necrotising) otitis externa (1,14,24,29).

Treatment

Literature suggests early stage EACCs can be managed by aural toilet at regular intervals in the outpatient clinic with or without local anesthesia. This requires a good compliance and elaborate follow-up (1). We emphasize definitive treatment. EACCs require surgical intervention for definitive treatment and the signs suggestive of that are 1) otorrhea uncontrolled by local medical treatment, 2) significant hearing loss with middle ear or mastoid invasion, 3) present or potential complications. Treatment of EACC depends on the stage and degree of invasion. In the literature various techniques and approaches (transcanalicular, endoaural, retroauricular) have been described (1). Surgical excision for histology and reconstruction of a self-cleaning, saucerised canal surface is achieved by either canalplasty or canal wall up, or canal wall down procedures (4,30). Konishi et al. (7) advocated a multilayered reconstruction with enlarged bony meatoplasty to bring about dry self-cleaning of the EAC in advanced stage EACC. It contributed not only to creating a good structure for EAC, but also to preventing the retraction that may cause reconstructive recurrent cholesteatoma (31). At our institution we use a standard postauricular approach. Elevation of the meatal skin flap with or without the tympanic membrane, removal of the pathological skin, and complete exposure of the healthy bone by canalplasty, over a sufficiently wide area with burrs are mandatory to avoid recurrence. The bony defect should be obliterated with cartilage and bone paste or muscle tissue. The temporalis fascia is laid over and the meatal skin flap is replaced over the fascia. A split-thickness free skin graft may be required to cover sufficiently both the fascia and the exposed bone (11). Although the suggested treatment plan is primarily based on the stage of the EACC, it should also be adapted to the patients' needs (1,8,23). The staging and the extent of the EACC which is best assessed intraoperatively influences the treatment and decision making in surgery. In our series of 31 EACCs as per our proposed staging 11 (35.4%) patients belonged to stage I without bone erosion underwent canalplasty with or without reconstruction. Eight (25.8%) cases that belonged to stage II with bone erosion without involvement of adjacent structures underwent canalplasty with reconstruction with fascia, perichondrium, or cartilage or bone dust. As in literature late stages of EACC predominate in our series too. Of the 12 (38.7%) cases of stage III EACCs, 3 (25%) cases with bone erosion involving mastoid and TMJ exposure underwent canalplasty with reconstruction with fascia and cartilage, 5 (41.6%) cases with FN exposure, ossicle erosion, and TMJ exposure underwent subtotal petrosectomy.

Then radical mastoidectomy with meatoplastly was done in two (16.6%) cases with lateral semicircular canal fistula and involvement of mastoid, with use of muscle, fascia, and cartilage for reconstruction. Intact canal wall mastoidectomy with canalplasty was required in two (16.6%) cases of stage III.

Canalplasty

The success of canalplasty is defined by the shape of the ear canal, which should be conical at the end of surgery, with no damage to the TM, ossicular chain (more commonly malleus), FN, and TMJ. Drill canal plasty is usually done via retroauricular approach that allows full view of EAC and hence reduces the risk of complications (Fig. 3, A–F). The important point to keep in mind is that surgery of EAC places the facial nerve at risk because it courses vertically in the posterior canal wall. The relationship of the facial nerve to annulus in EAC is variable. The facial nerve courses lateral to the plane of the annulus in 70% of the cases, always in the posteroinferior quadrant and is more vulnerable to injury in this area.

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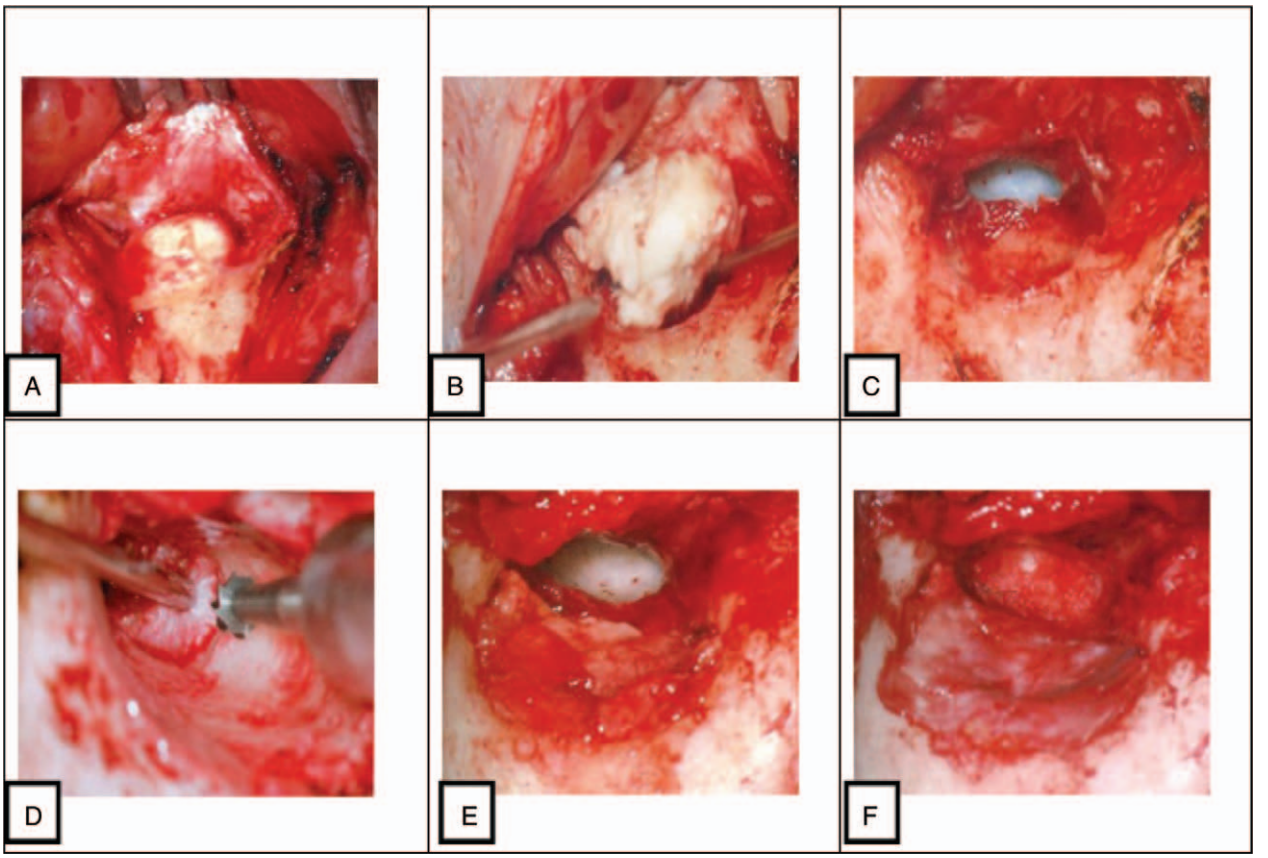

FIG. 3. *A–F*, Excision of the Stage II EACC in right ear with canalplasty and reconstruction. EACC indicates external auditory canal cholesteatoma. Surgical steps: A: EACC cholesteatoma of the posterior wall has been exposed, B: Removal of the cholesteatoma without leaving matrix, C: After complete removal, posterior meatal wall is seen eroded, D: Canaplasty, E: Reconstruction with connective tissue, F: Temporalis muscle fascia reinforcement.

Injury to the FN can be avoided by circumferential drilling and refraining drilling blindly when the TM is not visible (32,33).

In our series STP was done in five (16.1%) EACC cases that are chronic and involve the adjacent important structures with no realistic chance of reconstruction of conductive apparatus. The procedure of STP has been described and discussed in detail elsewhere (34–36). All the operated cases were followed up regularly and the minimum follow-up period was 1 year and the longest was 20 years. The median follow-up period in our study group was 6 years. In our series, there were no recurrences of cholesteatoma leading to a 100% disease control. Three patients with reperforation of the tympanic membrane in the anteroinferior quadrant underwent myringoplasty later.

Factors Associated With Failure of Complete Healing

Literature review suggests reperforation of the tympanic membrane is often observed in its inferior quadrant. It is due to insufficient blood supply to the inferior part of EAC because of tissue necrosis induced by surgical intervention. Also inadequate canalplasty predisposes to recurrent cholesteatoma which further hampers blood supply and prevents healing of the tympanic membrane (7).

CONCLUSION

EACC is insidious in nature and rare but treatable effectively without recurrence. Late stage presentations of EACC are common. Due to proximity of the external auditory canal to important structures, like facial nerve, temporomandibular joint, jugular bulb, and dura the possibility of EACC should be always considered in differential diagnosis for lesions of the external auditory canal. Hence understanding the common symptomatology of EACC is important. Preoperative radiological evaluation and surgical exploration leads to a correct and practical staging of EACC, and definitive treatment is by surgery with reconstruction as per the stage and degree of invasion of EACCs.

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