Intact Canal Wall Tympanomastoid Surgery: 10 Years Experience

Nishi Sonkhya · Payal Mittal · Dr. Divij Sonkhya

Received: 4 February 2011 / Accepted: 12 August 2011 / Published online: 22 September 2011
© Association of Otolaryngologists of India 2011

Abstract 310 cases of chronic middle ear disease were managed by Intact canal wall tympanomastoid surgery. Intact canal wall tympanomastoid surgery technique used in this study has been compared with the Jansen's classic ICW technique. A retrospective analysis of 310 cases of chronic middle ear pathology managed by Intact canal wall technique over a period of 10 years (January 1996 to December 2005) was conducted. Patients information was collected from the patients record. 310 patients, aged 5–60 years, were managed by Intact canal wall technique and followed for a minimum period of 5 years. The male:female ratio in our study was 1.25:1 (172 males:138 females). The ratio of adult to pediatric patients was 2.7:1 (226 adults:84 children). Out of 274 (88.4%) cases having a regular follow up, 196 (71.6%) were found to be stable. Postoperative retraction of the tympanic membrane was observed in 24 (8.8%) cases and was managed by the placement of ventilation tube. Secretory otitis media was seen in 14 (5%) cases and was managed by myringotomy and placement of ventilation tube. 17(12.4%) cases were revised including recurrent disease (10 cases), residual disease (6 cases), graft failure (12 cases), stenosis of the ear canal (4 cases), meatomastoid fistula (2 case). Our

technique of Intact canal wall tympanomastoid surgery takes less time than the classic Jansen's technique, is easily reproducible and taught, is a single stage procedure and can be universally applied to various chronic middle ear pathologies as the primary treatment with low recidivism rate.

Keywords Tympanomastoid surgery · Intact canal wall technique · Chronic middle ear pathology

Introduction

Otologist are still faced with the challenge of treating the effects of chronic inflammation of tympanum and mastoid. Tympanomastoid surgery is intended to eradicate the disease process and to help in the regression of middle ear cleft histopathological changes. Based on the principles of pathogenesis, surgery is aimed at interfering with the pathological process to stop the continuum of the disease and to establish the functions.

Prior to early 1950s, the only operations performed in chronic otitis media were radical and modified radical mastoidectomies. The purpose of these operations was to create a safe ear by exteriorizing the disease. Disadvantages included life long postoperative care to remove epithelial debris, recurrent discharge and poor hearing.

The treatment of chronic middle ear disease has undergone a series of technical advances within last 50 years, causing a shift in emphasis from extirpation of disease to preservation and reconstruction of middle ear structures.

The subject debated endlessly in the choice of surgical technique—open versus closed mastoidectomy. The arguments given by the supporters of the open cavity procedures are based on the conviction that there are higher

N. Sonkhya (✉)
Department of E.N.T., S.M.S. Medical College and Hospital,
7/251, Vidhyadhar Nagar, Jaipur, Rajasthan 302023, India
e-mail: drsonkhya@yahoo.co.in

P. Mittal
Department of E.N.T., S.M.S. Medical College and Hospital,
Jaipur, Rajasthan 302023, India

Dr. D. Sonkhya
Department of E.N.T., N.K.P. Salve Institute and Lata
Mangeshkar Hospital, Nagpur, Maharashtra, India

evidence of recurrent and residual disease after the closed procedures. However the proponents of the closed cavity procedures state the fact that the hearing results are disappointing with the change in the anatomy and physiology after creation of an open mastoid cavity.

Jansen [1] was the first to adopt a combined anterior and posterior tympanotomy approach to surgically treat cholesteatoma and chronic infection. Since the introduction of combined approach tympanoplasty (CAT), various modifications have been suggested by different otologists [2–9].

Materials and Methods

A retrospective review of the patients record at SMS hospital Jaipur was performed. During the 10 years period from January 1996 to December 2005, 310 cases of chronic otitis media (cholesteatomatous and non cholesteatomatous) were operated upon by the ICW technique. All cases have had a followup of a minimum period of 5 years.

All cases were approached with an intend of performing intact canal wall mastoid surgery, excluding those with intracranial complications, labyrinthine fistula, malignant disease, only hearing ear, extensive canal wall destruction and problematic follow up. Preoperative decision to remove the posterior canal wall was based on temporal bone anatomy like severely contracted mastoid, particularly with an ear canal slanting forwards and upwards, or unsuspected canal wall destruction.

Out of 578 tympanomastoid surgeries performed by the key author over a period of 10 years, 310 cases underwent surgery by the ICW technique. Prerequisite for the surgical improvement of hearing in the tympanomastoid surgery are adequate tubal and inner ear functions. However, adequate tubal function is not a prerequisite for the eradication of the disease in tympanomastoid surgery and this is our primary aim.

Technique

The technique used is the modification of the modified intact canal wall technique given by Tos [4] and Morimitsu [7]. The key steps of the procedure are as follows;

Incision, Graft and Flap Elevation

All operations were performed under local anaesthesia (except children and uncooperative adults). Using a retroauricular approach, temporalis fascia was harvested and allowed to dehydrate for later use. A large tympanomeatal flap extending from 6 to 2 o'clock position was elevated to provide a good view of the mesotympanum,

hypotympanum and anterior tympanum. The extent of the disease in the middle ear was assessed and drum remnant was resected accordingly. If there was extensive mucosal disease involving the under surface of the drum remnant, the diseased portion of the drum remnant was resected leaving anterior and inferior rim of the tympanic membrane for placement of the graft.

Transcanal Posterior Tympanotomy and Anterior Atticotympanotomy

With small cutting burrs (1–2 mm) transcanal posterior tympanotomy was done to expose the entire posterior tympanic cavity. The disease was followed from before backwards focusing on the posterosuperior quadrant initially. A careful dissection was performed in the area of the oval window to identify the presence or absence of an intact incudostapedial joint and stapes suprastructure. The peristapedial region was meticulously dissected to remove granulation tissue and epithelium. The visualization of sinus tympani was improved by removing the posterosuperior bony annulus and pyramidal eminence. Having cleared the sinus tympani, finally disease was removed from the hypotympanum. Depending upon the extent of the disease partial removal of the scutum (anterior atticotomy) was done. If the disease was crossing neck of the malleus, it was followed anteriorly up to the epitympanic sinus with careful dissection to visualize the tensor tympani eminence and eustachian tube (ET) opening.

Transcortical Mastoidectomy

After clearance of all disease that was possible by the transmeatal route, transcortical mastoidectomy was performed. The entire mastoid was explored, exenterating as many air cells as required. The disease was followed anteriorly towards the fossa incudis. If cholesteatoma was seen extending medial to the incus, the incus was removed. Dissection was further carried forward to the malleus head. If disease was extending medial to the malleus head, the malleus head was removed to clear the disease.

Middle Ear Reconstructin—Ossiculoplasty, Scutumplasty and Grafting

Ossicular reconstruction was done either with autologous incus or malleus or cartilage depending on the type of ossicular defect. 0.5 mm silastic sheet was used to line the middle ear and ET. Reconstruction of the attic and posterosuperior defect was done by conchal cartilage. The middle ear was grafted with temporalis fascia using underlay technique. The tympanomeatal flap was repositioned back and kept in place by gel foam balls soaked in

antibiotic steroid drops. Finally, the canal was packed with merocoel ear pack. Wound was closed in layers and dressed with pad and bandage.

Follow Up

The patient was seen on the 7th day for removal of post auricular stitches and the pack. Then the patient was seen at 3 weeks after operation. Gel foam was removed if it was not absorbed. During subsequent visits at 6 weeks and 3rd months, condition of the tympanic membrane was assessed. Detection of any retraction, fluid behind the tympanic membrane and minimal or no movement on Valsalva manoeuvre was taken care of by myringotomy and placement of ventilation tube in the anterosuperior quadrant. The postoperative audiogram was taken 3 months of surgery. Each patient was followed quarterly in the 1st year and half yearly in subsequent years.

Results

The patients age ranged from 5 to 60 years. All cases were broadly divided into two groups pediatric age group (0–15 years) which constituted 27% of the study group and adult age group (16 years and above) which constituted 73% (Table 1). The ratio of adult:paediatric patients was 2.7:1 (226 adults:84 children). The male:female ratio in our study was 1.25:1 (172 males:138 females). Granulating pathology was found to be more common in both the age groups. Cholesteatomatous pathology, either alone or in combination with granulomatous pathology, was found in 54% of the cases (Table 2).

Table 1 Age wise distribution of the cases and associated pathology

Pediatric 0–15 years			Adults 16–60 years		
84 (27%)			226 (73%)		
Ch.	Gr.	Both	Ch.	Gr.	Both
24	42	18	78	102	46
28.5%	50%	21.5%	34.5%	45%	20.5%

Ch. Cholesteatoma, Gr. granulation

Table 2 Type of pathology (310 cases)

Type of pathology	No.	%
Cholesteatoma	102	33
Granulations	144	46
Both	64	21

Table 3 Site of perforation and associate pathology

Site of perforation	Total no.	Ch.	Gr.	Both
Attic	50 (16%)	40 (80%)	–	1 (20%)
Posterosuperior	80 (26%)	16 (20%)	38 (47.5%)	26 (32.5%)
Attic and postero superior	34 (11%)	18 (53%)	4 (12%)	12 (35%)
Total	34 (11%)	4 (12%)	16 (47%)	14 (41%)
Subtotal	60 (19%)	6 (10%)	36 (60%)	18 (30%)
Central	52 (17%)	4 (8%)	42 (81%)	6 (11%)

Table 4 Extent of Disease

Site	No.	%
E, ME and M	128	41
E and ME	82	26.5
E and M	26	8.5
E only	24	8.0
ME only	50	16.0

E Epitympanum, ME middle ear, M mastoid

The most common site of perforation was posterosuperior region comprising 26% of the cases. 80% of the attic perforations were associated with cholesteatoma while only 8% of central perforation cases presented with cholesteatoma (Table 3). When considering the extent of disease, only 24 (8%) cases were limited to epitympanum, 50 (16%) were limited to middle ear only and pathology extended to mastoid in 128 (41%) of the cases in this series (Table 4).

At 3–6 weeks follow up well vascularized graft was observed. 36 (11.6%) cases were lost to follow up. Out of 274 (88.4%) cases having a regular follow up, 196 (71.6%) cases were found to be stable. Retraction of tympanic membrane was observed in 24 (8.8%) cases because of ET dysfunction and which was taken care of by placement of ventilation tube. Serous otitis media was observed in 14 (5%) cases which was managed by myringotomy and placement of ventilation tube. Failure of cartilage support was present in 2.2% cases with posterosuperior retraction but with stable ear (Table 5).

Persistent discharge was present in 28 (10.2%) cases due to residual central perforation with persistent infection in 12 cases and due to residual or recurrent disease in 16 cases. Cases with residual central perforation were taken care of by adequate antibiotic therapy followed by grafting and cases with residual and recurrent disease were managed by a CWD procedure (Table 6). All 6 cases of residual disease involved middle ear and epitympanum while 80% of the recurrent disease involved middle ear and epitympanum. Recurrence was seen in the mastoid in 2 cases only (Table 7).

Table 5 Follow up results

	Examination	No.	%
1	Healed or stable ear	196	71.6
2	Persistent discharge	28	10.2%
3	Retraction of tympanic membrane	24	8.8
4	Secretory otitis media	14	5.0
5	Failure of cartilage support	6	2.2
6	Stenosis of ear canal	4	1.5
7	Meatomastoid fistula	2	0.7
36 (11.6%) cases lost to follow up			
274 (88.4%) cases with regular follow up			

Table 6 Reasons for revision in 17 (12.4%) cases

Residual and recurrent disease		Graft failure	Stenosis of ear canal	Meatomastoid fistula
Res	Rec			
6	10	12	4	2
CWD mastoidectomy	Myringoplasty	Meatoplasty	Covered with cartilage and skin graft	

Table 7 Site of residual and recurrent disease

Residual (6)		Recurrent (10)	
Mastoid	ME and Epitympanum	Mastoid	ME and Epitympanum
–	6	2	8

In 80% of the cases, air-bone gas was 30 dB or less. Among them 68% of the ears achieved air-bone gap of 20 dB or less, while in 45% of the cases it was 10 dB or less.

Discussion

Our technique approaches the pathology through postaural approach, using transmeatal posterior tympanotomy, transmeatal anterior atticotomy and a simple transcortical mastoidectomy. We have found that this technique gives excellent exposure of the posterior mesotympanum, including sinus tympani, anterior epitympanum transmeatally and of antrum, aditus, and attic transcortically. Reconstruction of the posterosuperior and scutum defect is done with conchal cartilage which is easily harvested because of post-auricular incision. Reaeration of the aditus and antrum is achieved and the anatomical configuration of the middle ear is brought back to normal as nearly as possible.

The classic combined approach tympanoplasty comprises a large mastoidectomy with thin and intact bony canal wall and posterior tympanotomy [10–12]. Removal of disease from the anterior attic through the cortical mastoidectomy and from the tympanic sinus through the posterior tympanotomy is complicated, especially under narrow anatomical conditions and the large frequency of residual cholesteatoma is therefore not surprising [10–18].

Since 1970, Tos [4] has used a modification of CAT which is based on a new philosophy. The Tos [4] technique consists of transcanal and transmatoid approach that includes the simple cortical mastoidectomy and transcanal atticotomy, sparing a bridge of bone between the attic and mesotympanum, together with a limited posterior tympanotomy by performing otosclerosis drilling of the posterior bony annulus and posterosuperior canal wall overhang. The technique is no doubt simple but nothing much is gained by preserving the thin bridge of bone of the scutum which could easily be absorbed and eroded away making reconstruction unstable. There could be neoosteogenesis and adhesion formation postoperatively.

Our technique approaches the clearance of disease from mesotympanum including posterior tympanic sinus and sinus tympani, hypotympanum, and antero tympanum, transmeatally after raising a large tympanomeatal flap and performing otosclerosis drilling to remove posterior bony annulus and posterosuperior canal wall overhang. Transmeatal anterior atticotomy is performed by partial removal of the scutum and disease is cleared from the epitympanic sinus. While considering classic ICW procedure, there are definite disadvantages of posterior tympanotomy like risk of damage of facial nerve through medial route, the drill can touch the incudostapedial joint causing sensorineural hearing loss, long term hearing results are poor if intact ossicular chain is disrupted before proceeding with the drilling, view of the tympanic sinus is hampered if posterior buttress is preserved to prevent the contact of the burr with the incudostapedial joint.

The disease extending posterior to the stapes and medial to facial nerve cannot be removed through the facial recess approach because of the intervening vertical facial nerve and required anterior transcanal approach with thinning of the posterior canal wall to the anterior surface of the pyramidal and vertical segment of the facial nerve and into the posterior tympanic recess. Smyth reported a high percentage of residual cholesteatoma in the posterior tympanic sinus which could not be properly removed through posterior tympanotomy. A high percentage of residual cholesteatoma has been reported in the anterior attic because of insufficient exposure of the anterior attic through the posterior tympanotomy approach [19].

Findings of recurrent cholesteatoma, tympanic atelectasis and tympanic effusion were observed with significantly

($P < 0.03$) high incidence in ears with no re-aerated space in their reconstructed mastoid cavities [20].

In our series, the frequency of residual and recurrent disease in 16 cases (5.8%) and thus considerably lower than the frequency observed in the classic CAT [12–17]. Removal of the disease from tympanic sinus is safer and easier via transcanal route after otosclerosis drilling of posterosuperior bony annulus. The interposed ossicle between stapes and the drum will prevent the posterior retraction of the pars tensa. The purpose of otosclerosis drilling is also to ascertain the condition of the ossicular chain at the beginning of the surgery.

In classic ICW technique, regardless of the surgeon's skill, maintenance of the most medial part of the canal wall prevents adequate access to disease and will lead to an unacceptable incidence of residual disease. It is interesting to note that residual disease in middle ear and epitympanum was detected in essentially the same percentage of cases regardless of the technique used [10, 12, 21]. Taking down the canal does not ensure success in cholesteatoma surgery. There are many pitfalls in canal wall down surgeries as in canal wall up surgeries [22]. Residual disease is found twice as often in the tympanic cavity as in attic [23]. This is one of the reasons why residual disease is also a problem in radical or modified radical operations in which it is found in 6–17% of the cases [23, 24].

The incidence and localization of residual cholesteatoma in CWD tympanoplasty with soft wall reconstruction was found to be 21% (18/85 cases). 6 cholesteatoma were located in epitympanum (33%), 3 in sinus tympani (17%), 3 in the antrum (17%), 2 on stapes (11%) 2 in tympanic membrane (11%), 1 one tympanic portion of facial canal (6%) and 1 just under the skin of exterior auditory canal.

The main cause of residual cholesteatoma in epitympanum and sinus tympani was incomplete removal of matrix under an indirect surgical view because of insufficient drilling [25]. The middle ear cholesteatoma recurrence rate was 12.8% in patients operated using closed tympanoplasty technique and among those who underwent MRM, recurrent disease occurred in 9.7% of the cases. The cholesteatoma recurrence rate after closed tympanoplasty is relatively high [26].

Cholesteatoma is considered a more aggressive disease in children than in adults. Patients undergoing ICW mastoidectomy with tympanoplasty 19% had residual disease at a planned second stage surgery and 22% developed recurrent cholesteatoma, for a total recidivism rate of 41%. A SRT of less than 30 dB HL was achieved in 75% of the patients. The patients who underwent CWD mastoidectomy with tympanoplasty, 2 patients (12%) had residual cholesteatoma in 2nd stage procedure and no recurrent cholesteatoma was found, supporting the use of ICW mastoidectomy with tympanoplasty for pediatric cholesteatoma [27].

Cholesteatoma in the mastoid can easily be removed at the primary surgery while cholesteatoma in the middle ear recesses and around the tendons and ossicles is at times difficult to remove regardless of the technique of the surgery, be it open or closed. Middle ear residual disease is more easily recognized and is more common than the residual disease in the mastoid. The incidence of residual disease is same in CWD and ICW procedures [10, 28].

In our technique, a separate cortical mastoidectomy is performed and as many cells as needed to remove the disease are exenterated. Creation of a large transcortical mastoid cavity is avoided by this technique as required in the classic ICW technique to open up the facial recess. A large cortical mastoidectomy creates unfavourable conditions with the possibility of retraction pocket formation [4]. When classic ICW fails, it is never too late for a radical or a modified radical operation to be performed but the final size of the mastoid bowl is large [29]. Moreover, thinning of the posterior canal wall in the classic ICW technique compromises its blood supply and may cause atrophy of the posterior canal wall [23].

We have been performing surgery in one stage avoiding unnecessary planned 2nd and 3rd stage procedures with their attendant cost, discomfort and inconvenience to the patient. The patient is best served by a single operation rationally selected and meticulously executed. The canal up technique (Classic CAT) has met with considerable criticism because of the need for second look and two stage operation [14, 15]. The planned two stage operations and 2nd look operations are a strain on the patient and give no guarantee that the late deterioration of the hearing will not occur [4].

Paparella and Kim [30] recommended one stage tympanomastoidectomy with careful surgery and proper application of technique. Planned multiple procedures are not usually necessary and should be avoided to reduce unnecessary hospitalisation and expenses. In their series minor revision operations were more common following open cavity procedures (35.5%) than in closed cavity procedures (23.4%). Incidence of revision was higher in cases with granulation tissue Farrior [2], Jansen [11] and many others advocate a single stage procedure—reserving the second stage for cases in which first operation failed or when stapedectomy was required for hearing improvement. Staging of the procedure is indicated in cases with extensive destruction of middle ear mucosa, absence of ossicular tissue, stapes fixation or question of uncertainty of removal of middle ear or mastoid disease (cases of lateral canal fistula, where matrix enveloped the stapes crura tightly attached to the mobile foot plate) [31]. Staged or a second look procedure can deal with the early residual disease but late recurrence may be due to dormant residual disease or a new foci because the original etiological cause is still

present [32]. Post operative formation of the attic and posterosuperior retraction pocket following modified ICW tympanomastoid surgery is avoided by the use of conchal cartilage for attic and posterosuperior support in our technique. Conchal cartilage is easily available from the operative site and its curvature adapts well to the defect. The attic and postero superior support by cartilage is a beneficial technique for obtaining a healthy aerated ear, preserving the bony canal and supporting the tympanic membrane in a normal anatomical position. In 2.2% of our cases, failure of cartilage support was due to migration of cartilage.

Pappas et al. [33] used homograft nasal septal cartilage for attic support with a success rate of 84%. Kinney [34] reported that the number of recurrences are reduced with attic obliteration by cartilage and perichondrium. Recurrent disease has occurred more frequently in classic ICW cases either due to retraction of tympanic membrane into the epitympanum and facial recess or due to reperforation of the tympanic membrane) [17]. Smyth [14] concluded that lack of support for the tympanic membrane graft, especially in its superior and postero superior parts, and the nearby meatal skin, predisposed to its collapse into the tympanum. He suggested two modifications to prevent the collapse of graft into the tympanum: (i) lining the tympanum with inert material such as silastic sheeting (ii) repair of sulcus defect with cartilage. Large areas of diseased or absent mucosa in chronic infected middle ear are frequently present. Ground work must be laid to promote growth of normal mucosa. We use silastic sheet (0.5 mm) all over the denuded bone surface to avoid formation of scar tissue and adhesions, to promote good mucosal regeneration and to improve the drainage of middle ear spaces towards the tubal orifice. Key technical manoeuvres suggested to reduce the incidence of recurrence of disease in ICW technique include use of thick silastic sheeting to cover the medial wall of the ear, repair of the bony sulcus defect with cartilage, preplanned re-exploration of the mastoid, epitympanum and middle ear and transtympanic ventilation tube insertion in cases of refractory tubal insufficiency [35].

The success of hearing results after a closed tympano mastoidectomy depends on both effective closure of perforated tympanic membrane and the specific technique of ossicular reconstruction. Brown [32] achieved better hearing results with ICW than with modified radical mastoidectomies. Hearing results are dependent on normal anatomical configuration and attention to details of the reconstruction.

Lesinskas' found hearing improvement in 15 cases (38.46%) after closed tympanoplasty, while there was no hearing improvement after MRM. Closed t'plasty method permits to preserve adequate hearing level and releases

from post operative cavity care problems as compared to MRM [26]. In our study hearing results of airborne gap of 30 dB or less was seen in 80% of the cases while 45% of the patients had air bone gap of 10 dB or less.

Residual disease may appear long after the initial surgery. The accumulated sum of residual recurrence increases with years after surgery until it stabilizes at 6–8 years post operatively. Therefore long term follow up is important after surgery [21]. Late recurrences may be due to dormant residual disease or new foci because original etiological cause is still present. Brown [32] suggested long term follow up rather than staged or second look operation.

In our study we have followed the cases for a period of 5–10 years with a minimum follow up of at least 5 years in every case; therefore we can conclude that our results of residual or recurrent disease are consistent.

Conclusions

1. Our technique of intact canal wall surgery takes less time than the classic ICW procedure, is reproducible, easily taught and can be universally applied to chronic middle ear pathology as primary treatment.
2. Retraction pocket formation is an unavoidable complication of ICW procedure which can be prevented by the use of silastic sheet, ventilation tube and reconstruction of the attic and posterosuperior canal wall defects with scutumplasty using conchal cartilage. Reaeration of the aditus and antrum is established and the middle ear configuration is brought back as nearly as possible to normal, both anatomically and functionally.
3. It is the intention of the authors that this group of patients will be followed up further, as they realize that the long term results of tympanomastoid surgery for chronic middle ear pathology are important. In our study we have followed patients for 5–10 years with a minimum period of 5 years.

References

1. Jansen C (1958) *Über Radikaloperation und Tympanoplastik*. Ber Fortbild Ärztekammer Ob
2. Farrior JB (1969) The canal wall in tympanoplasty and mastoidectomy. *Arch Otolaryngol* 90:706–714
3. Bellucci RJ (1973) Preservation of the posterior canal wall: the wide external auditory canal technique. *Arch Otolaryngol* 97: 198–200
4. Tos M (1982) Modification of combined approach tympanoplasty in attic cholesteatoma. *Arch Otolaryngol* 108:772–778
5. Paparella MM, Jung TTK (1983) Intact bridge tympanomastoidectomy (IBM) combined essential features of open vs. closed procedures. *J Laryngol Otol* 97:575–585

6. Morimitsu T, Nagai T, Nagai M et al (1989) Pathogenesis of cholesteatoma based on clinical results of anterior tympanotomy. *Auris Nasus Larynx* 16(suppl 1):9–14
7. Morimitsu I (1991) Illustrated ear surgery. Tokyo Medical Illustration, p 114
8. Dornhoffer JL (2000) Retrograde mastoidectomy with canal wall reconstruction: a single stage technique for cholesteatoma removal. *Ann Otol Rhinol Laryngol* 109(11):1033–1039
9. Reddy TN, Dutt SN, Shetty A, Maini S (2001) Transcanal atticotomy and transcortical mastoidectomy for cholesteatoma: the Farrior-Olaizola technique revisited. *Ann Otol Rhinol Laryngol* 110(8):739–745
10. Sheehy JL, Patterson ME (1967) Intact canal wall tympanoplasty with mastoidectomy. A review of 8 years experience. *Laryngoscope* 77:1502–1542
11. Jansen C (1968) The combined approach for tympanoplasty. *J Laryngol Otol* 82:779–793
12. Sheehy JL (1970) Intact canal wall technique in management of aural cholesteatoma. *Laryngoscope* 84:1–31
13. Glasscock ME, Miller GW (1976) Intact canal wall tympanoplasty in the management of cholesteatoma. *Laryngoscope* 86:1639–1657
14. Smyth GDL (1976) Postoperative cholesteatoma in combined approach tympanoplasty: fifteen years report on tympanoplasty, part 1. *J Laryngol Otol* 90:597–621
15. Cody DTR, Taylor W (1977) Mastoidectomy for acquired cholesteatoma: long-term results. In: McCabe BF, Sade J, Abramson M (eds) Cholesteatoma: First International Conference. Aesculapius Publishers Birmingham, pp 337–351
16. Sade J (1977) Postoperative cholesteatoma recurrence. In: McCabe BF, Sade J, Abramson M (eds) Cholesteatoma: first international conference. Aesculapius Publishers, Birmingham, pp 284–289
17. Sheehy JL, Brackmann DE, Graham MD (1977) Cholesteatoma surgery: residual and recurrent disease: a review of 1,024 cases. *Ann Otol Rhinol Laryngol* 86:451–462
18. Dodson EE, Hashisaki GT, Hobgood TC et al (1998) Intact canal wall mastoidectomy with tympanoplasty for cholesteatoma in children. *Laryngoscope* 108:977–983
19. Graham MD, Delap TG, Goldsmith MM (1999) Closed tympanomastoidectomy. *Otolaryngol Clin North Am* 32(3):547–554
20. Ikeda M, Yoshinda S, Ikui A, Shigihara S (2003) CWD tympanoplasty with canal reconstruction for middle ear cholesteatoma; postoperative hearing, cholesteatoma recurrence and status of recreation of reconstituted middle ear cavity. *J Laryngol Otol* 117(4):249–255
21. Gristwood RE, Venables WN (1990) Factors influencing the probability of residual cholesteatoma. *Ann Otol Rhino Laryngol* 99:120–124
22. Jackson CG, Glasscock ME, Schwaber MK et al (1985) Open mastoid procedures: contemporary indications and surgical techniques. *Laryngoscope* 95:1037–1043
23. Sade J, Berco E, Brown M (1981) Results of mastoid operations in various chronic ear diseases. *Am J Otol* 3(1):11–20
24. Gristwood RE (1976) Chronic otitis media with epidermoid cholesteatoma—a discussion on some points of controversy concerning surgical management. *Clin Otolaryngol* 1:337–342
25. Haginomori S, Takamaki A, Nonaka R, Takenaka H (2008) Residual cholesteatoma: incidence and localization in CWD tympanoplasty with soft wall reconstruction. *Arch Otolaryngol Head Neck Surg* 134(6):652–657
26. Lesinskas E, Vainutine V (2004) Closed tympanoplasty in middle ear cholesteatoma surgery. *Medicina (Kaunas)* 40(9):856–859
27. Dodson EE, Hashisaki GT, Hobgood TC, Lambert PR (1998) Intact canal wall mastoidectomy with tympanoplasty for cholesteatoma in children. *Laryngoscope* 108(7):972–983
28. Sheehy JL (1988) Cholesteatoma surgery: canal wall down procedures. *Ann Otol Rhino Laryngol* 97:30–35
29. Sade J (1982) Treatment of retraction pockets and cholesteatoma. *J Laryngol Otol* 96:685–704
30. Paparella MM, Kim CS (1977) Mastoidectomy update. *Laryngoscope* 87(12):1977–1988
31. Sheehy JL, Crabtree JA (1973) Tympanoplasty: staging the operation. *Laryngoscope* 83(10):1594–1621
32. Brown JS (1982) A ten year statistical follow up of 1142 consecutive cases of cholesteatoma. The closed vs. the open technique. *Laryngoscope* 92:390–396
33. Pappas JJ, Bailey HAT, McGrew RN, Graham SS (1981) Homograft septal cartilage for attic support in intact canal wall tympanomastoidectomy and tympanoplasty. *Laryngoscope* 91:1457–1462
34. Kinney SE (1982) Five years experience using the intact canal wall tympanoplasty with mastoidectomy for cholesteatoma: preliminary report. *Laryngoscope* 92:1395–1400
35. Sanna M, Zini C, Gamoletti R et al (1987) Prevention of recurrent cholesteatoma in closed tympanoplasty. *Ann Otol Rhinol Laryngol* 96:273–275