



Evaluation of surgical outcome in chronic otitis media cases with cholesteatoma

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Abstract

Chronic suppurative otitis media owing to poor socio-economic status and poor environmental conditions account for morbidity in about 5 % of the total population. ENT surgeons by performing a corrective surgery for chronic otitis media can change the lifestyles of the patient profoundly. The medical line of management only can lessen the severity of the symptoms. Hence based on above findings the present study was planned for Evaluation of Surgical Outcome in Chronic Otitis Media Cases with Cholesteatoma.

The present study was planned in, Department of ENT, Nalanda Medical College and Hospital, Patna, Bihar, India. In the present study 20 cases of the patients of chronic otitis media with cholesteatoma of new cases, and previously operated cases with residual or recurrent disease were enrolled and evaluated. All patients underwent satisfactory removal of the disease (mastoidectomy) and hearing reconstruction (tympanoplasty) in a single stage surgery. Temporalis fascia graft was used for reconstruction of the tympanic membrane defect by underlay technique.

The data generated from the present study concludes that both procedures have their own advantages and disadvantages and when performed meticulously both serve the purpose of rendering the patient a safe ear. The ICW procedure leaves behind an anatomically normal appearing ear and when quality of life concerns needs to be addressed this should be the procedure of choice, with advancement in technology and availability of angled endoscopes which have marched well into otology.

Keywords: COM, cholesteatoma, hearing outcome, post-operative complications, etc

Introduction

A cholesteatoma consists of squamous epithelium that is trapped within the skull base and that can erode and destroy important structures within the temporal bone. Its potential for causing central nervous system (CNS) complications (eg, brain abscess, meningitis) makes it a potentially fatal lesion. The hallmark symptom of a cholesteatoma is a painless otorrhea, either unremitting or frequently recurrent. Other symptoms include the following: Conductive hearing loss & Dizziness: Relatively uncommon. Occasionally, cholesteatoma initially presents with symptoms of CNS complications, including the following: Sigmoid sinus thrombosis; Epidural abscess; & Meningitis, etc.

Unlike other cholesteatomas, the congenital type is usually identified behind an intact, normal-appearing tympanic membrane. The child often has no history of recurrent suppurative ear disease, previous otologic surgery, or tympanic membrane perforation [1, 2, 3, 4]. No laboratory tests or incisional biopsies are generally necessary for the diagnosis of cholesteatomas, because the diagnosis can be made based on physical examination and radiologic findings.

Computed tomography (CT) scanning is the diagnostic imaging modality of choice for these lesions, owing to its ability to detect subtle bony defects. Histologically, surgically removed cholesteatoma specimens demonstrate typical squamous epithelium. The histology is indistinguishable from that of sebaceous cysts or keratomas removed from any other portion of the body. Audiometry should be performed prior to surgery whenever possible. Air and bone conduction, the speech reception threshold, and speech discrimination scores should all be determined within a few weeks of the proposed operative procedure.

Magnetic resonance imaging (MRI) is used when very specific problems, such as the following, are suspected [5]:

Virtually all cholesteatomas should be excised. The only absolute contraindications to the surgical removal of cholesteatomas are medical in nature.

Canal wall-down tympanomastoidectomy: In the canal wall-down (open) procedure, the posterior canal wall is removed. A large meatoplasty is created to allow adequate air circulation into the cavity that arises from the operation. Canal wall-down operations have the highest probability of permanently ridding patients of cholesteatomas.

Canal wall-up tympanomastoidectomy: In the canal wall-up (closed) procedure, the canal wall is preserved. Canal wall-up procedures have the advantage of maintaining a normal appearance, but the risk of persistent or recurrent cholesteatomas is higher than in the canal wall-down operation.

A cholesteatoma consists of squamous epithelium that is trapped within the skull base that can erode and destroy important structures within the temporal bone. Its potential for causing central nervous system (CNS) complications (eg, brain abscess, meningitis) makes it a potentially fatal lesion (see the images below). Throughout the early half of the 20th century, cholesteatomas were managed by exteriorization. The mastoid air cells were exenterated, the posterior wall of the external auditory canal was removed, and the opening into the resulting cavity was enlarged to ensure adequate air exchange and to make visual inspection simple.

During the 1950s and 1960s, the House Otologic Group developed a new approach. The group attempted to leave the basic underlying anatomic structure of the ear and temporal bone intact, principally by preserving the canal

wall. These aggressive attempts to conserve the normal anatomy of the ear created great controversy. Surgeons tended to align themselves with either the old "canal wall-down" (ie, open cavity) procedure^[6] or with the new "canal wall-up" (ie, closed cavity) method^[7].

Most otologic surgeons have now migrated to an intermediate position, with the majority of those in the United States now performing both techniques and basing the selection of the open or closed cavity procedure on the individual circumstances of each patient. A cholesteatoma consists of squamous epithelium that is trapped in the skull base^[8]. Squamous epithelium trapped within the temporal bone (ie, middle ear or mastoid) can expand only at the expense of the bone that surrounds and contains it. Consequently, a growing cholesteatoma can erode and destroy important structures within the temporal bone.

Cholesteatomas cause bony erosion by either of the following mechanisms:

Pressure effects produce bony remodeling, as occurs normally throughout the entire skeleton when pressure is applied consistently over time

Enzymatic activity at the margin of the cholesteatoma enhances osteoclastic activity, which greatly increases the speed of bone erosion; osteolytic enzymes appear to increase when a cholesteatoma becomes infected

A study by Rosito *et al* suggested that in patients with a posterior epitympanic cholesteatoma confined to the pars flaccida or a two-route cholesteatoma involving both the pars flaccida and pars tensa, the chance of having a labyrinthine fistula in the lateral semicircular canal is increased. In study patients with these cholesteatoma growth patterns, the prevalence of labyrinthine fistula in the lateral semicircular canal was 5.0%, while in patients with other growth patterns, the prevalence altogether was 0.6%^[9].

Occasionally, a cholesteatoma escapes the confines of the temporal bone and skull base. Extratemporal complications can occur in the neck, CNS, or both. When a cholesteatoma within the cranium grows large enough to produce mass effect, brain dysfunction can develop. Generally, the following 3 types of cholesteatoma are identified: congenital, primary acquired, and secondary acquired. Congenital cholesteatomas arise as a consequence of squamous epithelium trapped within the temporal bone during embryogenesis. The typical congenital cholesteatoma is found in the anterior mesotympanum or in the perieustachian tube area. They are identified most commonly in early childhood (6 mo to 5 y)^[10].

As they expand, congenital cholesteatomas can obstruct the Eustachian tube and produce chronic middle ear fluid and conductive hearing loss. They can also expand posteriorly to encase the ossicular chain and, by this mechanism, produce conductive hearing loss. Unlike other cholesteatomas, the congenital type is usually identified behind an intact, normal-appearing tympanic membrane. The child often has no history of recurrent suppurative ear disease, previous otologic surgery, or tympanic membrane perforation^[1, 2, 3, 4].

Bilateral congenital cholesteatoma is extremely rare, with a study by Lee *et al* finding that out of 604 children with congenital cholesteatoma, 1.8% had the bilateral form^[11]. A primary acquired cholesteatoma results from tympanic membrane retraction. The classic case develops from progressively deeper medial retraction of the pars flaccida into the epitympanum (attic). As this process continues, the lateral wall of the epitympanum (the scutum) is slowly

eroded, producing a defect in the lateral wall of the epitympanum that slowly expands^[12].

The tympanic membrane continues retracting medially until it passes over the heads of the ossicles and into the posterior epitympanum. Ossicular destruction is common. If the cholesteatoma pokes posteriorly into the aditus ad antrum and the mastoid itself, erosion of the tegmen mastoideum, with exposure of the dura and/or erosion of the lateral semicircular canal with deafness and vertigo, may result.^[13]

A second type of primary acquired cholesteatoma arises when the posterior quadrant of the tympanic membrane is retracted into the posterior middle ear. The drum initially adheres to the long process of the incus. As retraction continues medially and posteriorly, squamous epithelium envelops the superstructure of the stapes and retracts into the sinus tympani. Primary cholesteatomas arising from the posterior tympanic membrane are likely to produce facial nerve exposure (and occasionally paralysis) and destruction of the stapedia superstructure. Surgical removal from the sinus tympani may be extremely challenging.

Secondary acquired cholesteatomas result directly from an injury to the tympanic membrane. This injury can be a perforation caused by acute otitis media or trauma, or it may be due to surgical manipulation of the drum. A procedure as simple as the insertion of tympanostomy tubes could implant squamous epithelium into the middle ear, ultimately producing a cholesteatoma. Posterior marginal perforations are the most likely to result in cholesteatoma formation. Although central perforations are considered unlikely to produce cholesteatomas, they do so occasionally. Any deep retraction pocket can lead to cholesteatoma formation if the retraction pocket becomes deep enough to trap desquamated epithelium^[14, 15].

The incidence of cholesteatomas in the United States is unknown, but they are a relatively common reason for otologic surgery (approximately weekly in tertiary otologic practices). Death from intracranial complications of cholesteatoma is now uncommon, with the change being attributable to earlier recognition, timely surgical intervention, and supportive antibiotic therapy. Cholesteatomas remain a relatively common cause of permanent, moderate conductive hearing loss in children and adults.

Eliminating a cholesteatoma is almost always possible; however, multiple operations may be required. Because surgery is generally successful, complications from uncontrolled cholesteatoma growth are now relatively uncommon. Canal wall-down (open cavity) tympanomastoidectomy offers a very low rate of recurrence or persistence of cholesteatomas. Reoperation for cholesteatomas occurs in 5% of patients or less. This compares quite favorably to the 20-40% recurrence rates associated with closed-cavity techniques (canal wall-up)^[6]. Nonetheless, because the ossicular chain and/or tympanic membrane cannot always be completely restored to normal, cholesteatomas remain a relatively common cause of permanent, moderate conductive hearing loss.

A literature review by van der Toom *et al* reported that canal wall-up and canal wall-down tympanoplasty with mastoid obliteration had recurrent and residual cholesteatoma rates that were similar to or better than those for nonobliterative surgery. In canal wall-up tympanoplasty with mastoid obliteration, the recurrent and residual

cholesteatoma rates were 0.28% and 4.2%, respectively, while for the canal wall-down procedure with mastoid obliteration, the rates were 5.9% and 5.8%, respectively [16].

A study by Rosito *et al* linked cholesteatoma with sensorineural hearing loss. In an analysis of 115 patients with middle ear cholesteatoma on one side, greater bone-conduction thresholds were found in the affected ear than in the contralateral ear at various frequencies. It was also found that the larger the air-bone gap in the affected ear, the greater the damage to the inner ear [17].

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Methodology

The present study was planned in, Department of ENT, Nalanda Medical College and Hospital, Patna, Bihar, India. In the present study 20 cases of the patients of chronic otitis media with cholesteatoma of new cases, and previously operated cases with residual or recurrent disease were enrolled and evaluated. All patients underwent satisfactory removal of the disease (mastoidectomy) and hearing reconstruction (tympanoplasty) in a single stage surgery. Temporalis fascia graft was used for reconstruction of the tympanic membrane defect by underlay technique.

All the patients were informed consents. The aim and the objective of the present study were conveyed to them. Approval of the institutional ethical committee was taken prior to conduct of this study.

Results & Discussion

It is widely accepted that CSOM with atticointral disease invariably requires surgical management. Generally, two surgical approaches canal wall up and canal wall down mastoidectomy have been performed in CSOM with atticointral disease. Otological symptoms, clinical findings, audiometric evaluation, operative procedures and results were evaluated in this study of management of unsafe type of CSOM. Air and bone conduction thresholds were analysed. The air-bone gaps of the diseased ears were analysed pre and postoperatively. Canal wall down mastoidectomy allows for better visualisation, greater assurance of cholesteatoma eradication and a lower recurrence rate than canal wall up mastoidectomy. On the other hand, canal wall up mastoidectomy is not associated with mastoid bowl problems and allows for good hearing outcomes. However, it is associated with higher recurrence rate than canal wall down mastoidectomy owing to poor visualisation and an increased likelihood of the postoperative formation of a retraction pocket. Retrograde tympanomastoidectomy combines the virtues of both canal wall down and canal wall up procedures by the partial or entire removal of the posterior bony canal wall depending on disease extent.

The term Tympanoplasty was first used in 1953 by Wullstein [18] to describe surgical techniques for

Reconstruction of middle ear hearing mechanisms that had been destroyed by chronic ear disease [19]. A number of histopathological changes can develop in the middle ear and mastoid in chronic suppurative otitis media determining the success or failure of tympanomastoid surgery. Studies have shown that obstructed aditus and antrum can potentially lead to the development of the pathological tissue in the middle ear cavity, the prevalence of which was found to be as high as 97% in 144 temporal bones studied [19]. Tympanoplasty is defined as an procedure to eradicate the disease in the middle ear and to reconstruct the hearing mechanism with or without tympanic membrane grafting [20].

Austin DF *et al* reported that rate of recurrence of cholesteatoma was 4% for the Canal wall down technique and 39% in intact canal wall technique [21]. Dodson EE *et al*. reported patients who undergone intact canal wall technique for treatment of cholesteatoma shows better hearing results post operatively compared to canal wall down technique [22]. The choice of technique is controversial and it is dependent on several factors, including extent of disease. Sheeley *et al* proposed two-stagesurgery as the first stage was disease eradication and membrane repair with silastic elastomer and the second stage of tympanic exploration and ossicular reconstruction, 6-1 2months later [23]. Prior to the mid-1950s, the treatment for unsafe ear was accomplished by removal of the posterior external auditory canal wall, resulting in a radical or modified radical mastoidectomy cavity. The past 50 years have witnessed a trend away from mandatory canal wall removal.

Many otologic surgeons now prefer intact canal wall mastoidectomy with tympanoplasty except when canal wall removal is required because of extensive disease, inadequate access for cholesteatoma excision, operation on an "only hearing ear," or uncertainty of adequate followup. Portmann *et al*, cut the posterior canal wall bone of the external canal after skeletonization of the mastoid and repositioned the bone after complete resection of the disease [24].

Tarabichi M *et al* stated that the endoscopic technique allows for transcanal, minimally invasive, eradication of limited cholesteatoma. Preservation of the ossicles coupled with complete removal of disease is more likely with the endoscope. Continuous post-operative office based endoscopic surveillance is critical to the success of this approach [25].

The popularity of intact canal wall mastoidectomy stems from the benefits of maintaining a canal wall, which include freedom from the need for frequent mastoid bowl cleanings, freedom from water intolerance and calorically induced vertigo, and less difficulty in fitting and use of hearing aids. Kim JH *et al* (2009) reported in attic cholesteatoma, if the mass is removed by attico-antrotomy and the attic is obliterated or reconstructed with cartilage, the rates of recurrence can be decreased. Attic reconstruction with cartilage could improve the hearing post-operatively, while attic obliteration could not. Thus attico-antrotomy is a relatively effective procedures that can be used in the management of cholesteatoma extending from the attic [26].

Kapur TR *et al* detected 26.5% failures (recurrence), 47.5% of which were due to attic retraction pocket, and 10% of which are due to residual cholesteatoma. The cholesteatoma recurrence rate in their patients with less than 10 years of follow up was 8.8%, significantly lower than the rate in patients with more than 10 years of follow up [27].

Table 1: Demographic Details

Parameters	No. of Cases
Age	
0 – 10 years	1
11 – 20 years	6
21 – 30 years	6
31 – 40 years	4
41 & above years	3
Sex	
Males	9
Females	11
Total	20

Table 2: Air Bone Gap (ABG) Comparison

Air Bone Gap in Mastoidectomy	No. of Cases	Net improvement in ABG (mm)
Intact Canal Wall (ICW)	12	15.9 ± 6.8
Canal wall-down (CWD)	8	12.3 ± 7.6
Total	20	
Air Bone Gap in Tympanoplasty		
Myringoplastinopexy	11	13.2 ± 5.9
Myringostapediopexy	9	15.1 ± 7.9
Total	20	

Table 3: Post-operative complications– ICW vs. CWD surgery

Post-operative complication	Intact Canal Wall (ICW)	Canal wall-down (CWD)
No. of Cases	12	8
Significant external auditory canal stenosis	1	0
Post-aural wound dehiscence	0	1
Significant medialization of pinna	0	6

In a study conducted by Mutoh *et al* comparing the results efficacy of mastoidectomy in methicillin resistant staph aureus and methicillin susceptible staph aureus infected otitis media, mastoidectomy had significantly better results concerning post-operative complications in discharging ears with MRSA infected chronic otitis media [28]. In a separate study by Rickers J, Petersen CG comparing the long term follow up evaluation of mastoidectomy in children with non-cholesteatoma chronic otitis media they concluded that mastoidectomy in these patients should be kept as a last resort when intensive conservative treatment and myringoplasty [29]. In another similar study Balyan FR *et al* compared the graft success rate and the final functional hearing outcome and found tympanoplasty without mastoidectomy as preferable treatment modality in non-cholesteatoma ears ($p > 0.05$) [30]. Vijayendra *et al.* advocated the opening of the antrum to prevent the graft failure in 2-3 % of patients [31].

The earliest mastoid surgery was reportedly performed in 1772. Despite this, more than two centuries later, debate continues to exist regarding the choice of surgery, closed or open cavity mastoidectomy for the treatment of COM with cholesteatoma. In addition, numerous methods are described to tackle the cavity problems ensuing after the open cavity or canal wall down (CWD) procedures with equivocal results [32, 33].

An understanding of the interrelationship between the disease and its location dictates the need for a surgical procedure that allows flexibility in the intraoperative setting to expose and remove the disease as it is tracked through various anatomic locations within the ear. Such an approach

has been termed as the “flexible approach to tympanomastoidectomy.” First described by Paparella and Jung, this approach consists of a series of tailor-made surgical steps based upon the aggressiveness of the disease determined intraoperatively. Such customization helped correct the problems and prevent future sequel, leading to good long-term results [34].

Conclusion

The data generated from the present study concludes that both procedures have their own advantages and disadvantages and when performed meticulously both serve the purpose of rendering the patient a safe ear. The ICW procedure leaves behind an anatomically normal appearing ear and when quality of life concerns needs to be addressed this should be the procedure of choice, with advancement in technology and availability of angled endoscopes which have marched well into otology.

References

- De la Cruz A, Fayad JN. Detection and management of childhood cholesteatoma. *Pediatr Ann.* 1999; 28(6):370-3.
- Janet CL, CSL JA, A GK, C PB. Congenital cholesteatoma and cochlear implantation: Implications for management. *Cochlear Implants Int*, 2012.
- Lim HW, Yoon TH, Kang WS. Congenital cholesteatoma: clinical features and growth patterns. *Am J Otolaryngol*, 2012.
- Stapleton AL, Egloff AM, Yellon RF. Congenital cholesteatoma: predictors for residual disease and hearing outcomes. *Arch Otolaryngol Head Neck Surg.* 2012; 138(3):280-5.
- Joel Swartz H. Harnsberger. *Imaging of the Temporal Bone.* 3 Sub edition. New York: George Thieme Verlag; Oct 1, 1997.
- Roland PS, Meyerhoff WL. Open-cavity tympanomastoidectomy. *Otolaryngol Clin North Am.* 1999; 32(3):525-46.
- Graham MD, Delap TG, Goldsmith MM. Closed tympanomastoidectomy. *Otolaryngol Clin North Am.* 1999; 32(3):547-54.
- Koizumi H, Suzuki H, Ohbuchi T, Kitamura T, Hashida K, Nakamura M. Increased permeability of the epithelium of middle ear cholesteatoma. *Clin Otolaryngol.* 2015; 40(2):106-14.
- Rosito LPS, Canali I, Teixeira A, Silva MN, Selaimen F, Costa SSD. Cholesteatoma labyrinthine fistula: prevalence and impact. *Braz J Otorhinolaryngol*, 2018.
- Potsic WP, Korman SB, Samadi DS, Wetmore RF. Congenital cholesteatoma: 20 years' experience at The Children's Hospital of Philadelphia. *Otolaryngol Head Neck Surg.* 2002; 126(4):409-14.
- Lee CH, Kim MK, Kim HM, Won C, Shin TH, Kim SY. Bilateral Congenital Cholesteatoma. *Otol Neurotol*, 2018.
- Morita Y, Yamamoto Y, Oshima S, Takahashi K, Takahashi S. Pediatric middle ear cholesteatoma: the comparative study of congenital cholesteatoma and acquired cholesteatoma. *Eur Arch Otorhinolaryngol.* 2016; 273(5):1155-60.
- Kemppainen HO, Puhakka HJ, Laippala PJ, *et al.* Epidemiology and aetiology of middle ear cholesteatoma. *Acta Otolaryngol.* 1999; 119(5):568-72.

14. Golz A, Goldenberg D, Netzer A, *et al.* Cholesteatomas associated with ventilation tube insertion. *Arch Otolaryngol Head Neck Surg.* 1999; 125(7):754-7.
15. Drahy A, De Barros A, Lerosey Y, Choussy O, Dehesdin D, Marie JP, *et al.* Acquired cholesteatoma in children: Strategies and medium-term results. *Eur Ann Otorhinolaryngol Head Neck Dis,* 2012.
16. van der Toom HFE, van der Schroeff MP, Pauw RJ. Single-Stage Mastoid Obliteration in Cholesteatoma Surgery and Recurrent and Residual Disease Rates: A Systematic Review. *JAMA Otolaryngol Head Neck Surgm,* 2018.
17. Rosito LS, Netto LS, Teixeira AR, Costa SS. Sensorineural Hearing Loss in Cholesteatoma. *Otol Neurotol.* 2016; 37(3):214-7.
18. Wullstein H. (Technic and early results of tympanoplasty *Monatsschr Ohrenheilkcl Laryngorhinol.* 1953; 87:308-11.
19. Chouhard CH. Wriesberg intermediary nerve. In: Fisch U(ed). *Facial nerve surgery.* Birmingham, AL: Aesculapius Pub Co, 1977, 24-39.
20. Committee on conservation of hearing American Academy of Ophthalmology and Otolaryngology. Standard classification for surgery of chronic ear diseases. *Arch Otol,* 1965, 81:204.
21. Austin DF. Single-stage surgery for cholesteatoma: an actuarial analysis. *Am J Otol.* 1989; 10(6):419-25.
22. Dodson EE, Hashisaki GT, Hobgood TC, *et al.* Intact canal wall mastoidectomy with tympanoplasty for cholesteatoma in children. *Laryngoscope.* 1998; 108(7):977-83.
23. Sheehy JL, Shelton C. Tympanoplasty: to stage or not to stage. *Otolaryngol Head Neck Surg.* 1991; 104(3):399-407. DOI: 10.1177/019459989110400320.
24. Portmann M, Portmann D. Tympanoplasty and other operations for combined indications, In: Portmann M, Portmann D, eds. *Otologic surgery: manual of otosurgical techniques.* London: Singular Publishing Groups, Inc, 1998, 136-139.
25. Tarabichi M. Endoscopic management of cholesteatoma: long-term results. *Otolaryngol Head Neck Surg.* 2000; 122(6):874-81. DOI:10.1016/S0194-59980070017-9.
26. Ji Heui Kim, SeungHyo Choi, Jong Woo Chung. Clinical results of Atticoantrostomy with attic reconstruction or attic obliteration for patients with an attic cholesteatoma. *Clinical and Experimental Otorhinolaryngology.* 2009; 2(1):39-43.
27. Kapur TR, Jayarmachandran S. Management of acquired cholesteatoma of the middle ear and mastoid by combined approach tympanoplasty: a long-term view. *Clin Otolaryngol.* 1997; 22:57-61.
28. Mutoh T, Adachi O, Tsuji K. Efficacy of mastoidectomy on MRSA infected chronic otitis media with tympanic membrane perforation *Auris nasus larynx.* 2007; 34:9-13.
29. Rickers J, Petersen CG Long term follow up evaluation of mastoidectomy in children with non cholesteatomatous chronic otitis media. *Int J Paediatr Otorhino Laryngol.* 2006; 70:711-5.
30. Balyan FR, Aslan A. Mastoidectomy in non cholesteatomatous chronic otitis media: is it necessary? *Otolaryngol head neck surg.* 1997; 117:592-5.
31. Vijayendra H, Mahadeviah A, Surendran K, Sangeetha R. Micro ear surger – its purpose and procedure for a tubo tympanic pathology. *Indian J Otolaryngol Head Neck Surg.* 2005; 57:360-363.
32. Baek MK, Choi SH, Kim DY, Cho CH, Kim YW, Moon KH, *et al.* Efficacy of Posterior Canal Wall Reconstruction Using Autologous Auricular Cartilage and Bone Pâté in Chronic Otitis Media with Cholesteatoma. *J Int Adv Otol.* 2016; 12:247-51.
33. Sun J, Sun J, Hu Y, Lv Q, Wang Y, Li X, *et al.* Canal wall-down mastoidectomy with mastoid obliteration for pediatric cholesteatoma. *Acta Otolaryngol.* 2010; 130:259-62.
34. Paparella MM, Morris MS, da Costa SS. Flexible methodology in the surgical approach to otologic disease. Presented at the Middle Section Meeting of the Triological Society, 1988.