



**ORIGINAL RESEARCH PAPER**

**EVALUATION OF HEARING OUTCOME BY SINGLE STAGE INTACT CANAL WALL TYMPANOMASTOIDECTOMY IN PATIENTS WITH ACTIVE SQUAMOUS CHRONIC OTITIS MEDIA: A PROSPECTIVE OBSERVATIONAL STUDY**

**Otolaryngology**

**KEY WORDS:** cholesteatoma, intact canal wall tympanomastoidectomy, Hearing outcome and otosclerotic drilling.

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**ABSTRACT** This prospective study was undertaken to assess the postoperative hearing outcome following single stage modified canal wall up mastoidectomy in patients with cholesteatoma. 30 cases of cholesteatoma were selected and were operated by modified canal wall up tympanomastoidectomy. All these patients were regularly followed for 6 months. Hearing outcome was assessed at 3 and 6 months postoperatively by pure tone audiometry (A-B gap). Hearing improvement was seen in majority of patients by reduction in air-bone gap > 10dB. None of the patient had residual cholesteatoma in 6 months follow up. The single stage modified intact canal wall technique was found to result in complete and safe removal of disease from the middle ear and provided a durable and resistant reconstruction of the middle ear. However long term follow up is needed to assess for recurrence.

**INTRODUCTION**

Chronic Suppurative otitis media (CSOM) with cholesteatoma or granulations is a major cause of morbidity and deafness. In India the incidence of chronic suppurative otitis media with cholesteatoma or granulations and its complications are high<sup>1</sup>. Cholesteatoma almost invariably requires surgical management. Various surgical approaches are (i) Canal wall up mastoidectomy, (ii) Canal wall down mastoidectomy, (iii) CAT (combined approach tympanoplasty).

A single stage Canal wall down (CWD) mastoidectomy may be preferred to allow for better visualization, assurance of cholesteatoma eradication, decreased rates of recurrence, and decreased cumulative operative cost. While expectations associated with hearing were much lower among patients who had undergone canal wall down mastoidectomy as compared to canal wall up mastoidectomy. The classical intact canal wall (ICW) mastoidectomy with tympanoplasty (combined approach tympanoplasty)<sup>2,3</sup> has anatomic constraints for clearance of the disease from the anterior attic and sinus tympani leading to high recidivism. Ferrier (1969) had suggested his modification of anterior atticotomy with thinning of anterior canal wall. This was further modified by Tos (1982)<sup>4</sup> who described transmeatal atticotomy with drilling of postero-superior bony annulus (which he termed "**otosclerosis drilling**") combined with postauricular mastoidectomy with maximal thinning of posterior and superior bony canal walls. Modified intact canal wall mastoidectomy is an entirely different approach to critical areas in middle ear and anterior attic as compared to classical intact canal wall technique.

Sinus tympani and posterior tympanic sinus are difficult or even impossible to view via classical posterior tympanotomy facial recess approach and thus the classical technique becomes a blind technique when clearing disease in the area leading to risk of residual disease. Clearance of disease from anterior attic in classical intact canal wall technique requires extensive transmastoid epitympanotomy with narrow working space and inadequate visualization of supratubal recess especially its anterior end. While in modified intact canal wall mastoidectomy transmeatal atticotomy provides circumferential access to anterior attic with adequate working space and direct vision. Thus the chances of residual cholesteatoma decrease substantially and there is no need for second look surgery<sup>5</sup>. Besides, disease clearance this technique (canal wall up) results in maintenance of normal anatomy and formation of resonating close chamber which has better effects on hearing<sup>6</sup>. The extent of hearing impairment in chronic otitis media is dependent primarily on the degree of ossicular disruption. In the absence of cholesteatoma, a conductive loss of 20dB or less usually indicates the ossicular chain is intact. It is not unusual to find normal hearing in an ear with attic perforation and cholesteatoma. This may be an indication of an

intact ossicular chain. However this may indicate that sound transmission is accomplished through a mass of cholesteatoma that has replaced ossicular tissue ("cholesteatoma hearer" or "silent cholesteatoma")

A progressive hearing impairment in the absence of active disease suggests ossicular fixation. This may be due to tympanosclerosis or otosclerosis. Conductive losses greater than 30dB can suggest ossicular erosion.

The goals of surgical treatment of chronic otitis media include removal of inflammation and creation of sound conducting mechanism in the well-aerated, mucosa lined middle ear cleft<sup>7</sup>. The primary goals of cholesteatoma surgery are disease eradication and achievement of dry, trouble free ear. Secondary goals include a maintenance-free ear and hearing preservation or restoration<sup>8</sup> Hearing thresholds were improved in 30% of CWU procedures and 12% of CWD procedures in the national comparative audit of mastoid surgery – a statistically significant difference<sup>9</sup>. Thresholds were worse in 13% of CWD and 8% of CWU procedures (not significant). Once again however, hearing outcomes were unknown in 40% of cases, so these results do not necessarily give us a clear picture. Hearing is generally thought to be worse following CWD than CWU surgery due to: 1. Changes in the resonance of the middle and external ear due to the mastoid cavity and 2. A shallower middle ear cleft and therefore reduced middle ear volume.<sup>10</sup> In addition the external auditory canal and mastoid cavity are made into one large cavity in canal wall down mastoidectomy than that with canal wall up mastoidectomy. Other disadvantages of canal wall down procedure: enlarged meatus, difficult fitting of hearing aid, annual, semiannual canal cleaning needed, problems with water exposure (dizziness may develop after water exposure and cold air restoration)

The aims of study were: 1. To assess the degree of hearing loss in patients with chronic otitis media with active squamous disease. 2. To periodically assess the post-operative hearing gain after single stage intact canal wall tympanomastoidectomy in patients of chronic otitis media with active squamous disease.

**MATERIAL AND METHODS**

The study entitled as "Evaluation of hearing outcome by single stage intact canal wall tympanomastoidectomy in chronic otitis media with active squamous disease: A prospective study of 30 cases" was conducted on the patients of chronic otitis media with active squamous disease admitted in the Department of Otorhinolaryngology, S.M.H.S. Hospital an associated hospital of Govt. Medical College Srinagar, from January 2016 to August 2017 to identify the success of this technique in eliminating diseases including cholesteatoma, granulations and to assess the degree of postoperative hearing improvement. All Patients with **active squamous chronic otitis media [cholesteatoma]**

admitted in the dept. who fulfilled the inclusion criteria were admitted in the department and underwent modified Canal wall up tympanomastoidectomy to evaluate the hearing outcome postoperatively. Following patients were excluded from the study:

1. Patients below 15yrs of age
2. Patient with only hearing ear.
3. Revision case.
4. Patients with SNHL
5. Complicated COM.
6. Posterior canal wall defect.
7. Patients with co-morbidities.
8. Patients in whom proper follow up is questionable
9. Low lying dura
10. Anteriorly placed sigmoid sinus

A detailed history was taken from all the patients regarding the presenting illness. History with regard to the any underlying illness was also taken from the patients. Detailed ENT examination of the patients was done with focus on:

- Otoscope examination
- Pure tone audiometry to calculate the type and degree of hearing loss
- X-ray mastoid with Townes view to see pneumatisation of mastoids
- HRCT Temporal bone

All the patients then underwent intact canal wall tympanomastoidectomy under general/local anaesthesia as under.

**TECHNIQUE:**

This technique approaches the pathology through postaural approach, using transmeatal tympanotomy, anterior atticotomy and a simple transcortical mastoidectomy. This technique has given excellent exposure of the posterior mesotympanum, including sinus tympani, anterior epitympanum, transmeatally and of antrum, aditus and attic transcortically. clearance of the disease from all these sites was achieved after raising a large tympanomeatal flap and performing otosclerosis drilling to remove posterior bony annulus and posterosuperior canal wall overhang. Transmeatal anterior atticotomy was performed by partial removal of the scutum and disease cleared from the epitympanic sinus. The disease extending posterior to stapes and medial to facial that cannot be removed through facial recess approach because of the intervening vertical facial nerve requires 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 posterior tympanic recess (**otosclerotic drilling**). Removal of disease from the tympanic sinus is safer and easier via transcanal route after otosclerosis drilling of posterosuperior bony annulus. The purpose of otosclerosis drilling is also to ascertain the condition of ossicular chain and to tailor tympanoplasty as per the status of the ossicular chain. The surgery was performed in single stage to avoid unnecessary planned 2<sup>nd</sup> and 3<sup>rd</sup> stage procedure with their attendant cost, discomfort and inconvenience to the patient. The patient was best served by a single operation rationally selected and meticulously executed. Intraoperative oto-endoscopic examination to visualize the difficult areas was done to achieve complete clearance of the disease in selected cases wherever found necessary (difficult areas). Patients who had extensive disease not amenable to complete clearance with Canal wall up (CWU) procedure after otoendoscopic examination were converted into Canal wall down (CWD) procedure and excluded from the study. Routine postoperative ear examination was done on first, second and fourth postoperative week and also at 3<sup>rd</sup> and 6<sup>th</sup> months of surgery to assess hearing. Audiological examination after 3<sup>rd</sup> and 6<sup>th</sup> months of surgery was done to assess hearing outcome by pure tone audiogram in terms of change in Air-Bone (AB) gap post operatively as compared to pre-op Air-Bone (AB) gap.

**OBSERVATIONS AND RESULTS:**

Majority of patients belonged to 16-25 age group 14 (46.6%) mean age at the presentation was 29.5 years. The youngest patient was 16year old and the eldest was 54 year.

- In this study majority of patients were females 53.3% (16/30) and males were 46.6% (14/30)
- Majority of patients belongs to rural population 26 (86.6%) and 4 (13.3%) belongs to urban.
- Ear discharge was present in 30 patients (100%), decreased hearing in 26 (86.6), tinnitus in 16 (53.3%) and otalgia in 2 patients (6.6%). PSRP+cholesteatoma was seen in 17 patients (54.8%), attic cholesteatoma in 14 (45.16%), polyp in 5 (16.12%), TM perforation+cholesteatoma in 4(12.9), Tympanosclerosis+cholesteatomas 5 (16.12%)

**Table – 1: Type of surgery performed.**

PROCEDURE	NO. OF EARS.	%AGE
Canal wall up mastoidectomy+ type 1 tp.	1	3.2
Canal wall up mastoidectomy+ type 2 tp	12	38.7
Canal wall up mastoidectomy+ type 3tp ( major columella)	8	25.8
Canal wall up mastoidectomy+ type 3tp ( minor columella)	10	32.2

Hearing reconstruction by CWUM+type 1 in 1(3.2%),CWUM +type 2 tp in 12 patients (38.7%) and by CWUM+type 3 majorcolumella in 8 patients(25.8%), CWUM+type 3 minor columella in 10(32.2%).

**Table 2.interaoperative ossicular status (n-31)**

1.MALLEUS	NO. OF EARS.	%age
Present	18	58
Necrosed	5	16
Absent	8	26
2.INCUS		
Present	9	29
Necrosed	10	32
Absent	12	39
3.STAPES		
Present	23	74.1
Suprastructure absent	8	25.8

Intraoperatively malleus was present in 18 (58%) of patients, partly necrosed in 5 (16%) and completely absent in 8 (26%). Incus was present in 9 (29%), necrosed in 10 (32%) and completely absent in 12 patients (39%). Stapes was present in 23 (74.1%), suprastructure absent in 8 (25.8%).

**Table - 3: Otoscopic findings during follow up period**

Finding	1 month		% age		3 months		% age		6 months		% Age	
	dry	Wet			dry	Wet			dry	wet		
EAC	29	2	93.5/6.4.		31	0	100/0		31	0	100/0	
Graft in place	31	100	100		31	100	100		31	100	100	
Retracted TM	NIL		NIL		3	9.6			2	6.4		
Residual perforation	NIL		NIL		2	6.4			Nil			
Residual cholesteatoma.	NIL				Nil				NIL			

Graft was in place in all the patients, wet ear observed only in 2 patients at 1 month after the surgery which resolved after some time, tympanic membrane retraction seen in 3 patients,

residual perforation seen in 2 patients at 3 months, which resolved over time. No residual cholesteatoma seen till the end of 6 months followup.

**Table 4: Hearing outcomes in all patients following cwum+tympanoplasty:**

S. No.		Mean air conduction on in db.	Meanbone conduction in db.	Mean A-Bgap in db.	Standard deviation .	P value.
1.	Preoperative	43.9	9.6	34.37	10.29	

2.	Postoperative at 3 months	34.5	10	24.57	7.018	<0.05
3.	Postoperative at 6 months	34.7	9.8	24.9	6.326	<0.05

Mean air conduction threshold preoperatively is 43.9db, bone conduction threshold is 9.6db and A-B gap is 34.37db with standard deviation 10.29db Postoperative air conduction threshold at 3 months is 34.5db, bone conduction threshold 10db and A-Bgap is 24.5 db with standard deviation 7.018. At 6 months postoperatively air conduction threshold is 34.7db, bone conduction 9.8db and A-B gap is 24.9db with standard deviation 6.326. The pre-operative mean air conduction was 43.9dB which at 3 months post-operatively was reduced to 34.5dB. Further at 6 months air conduction levels to 34.7dB. Thus there was a gain in air conduction threshold by 21.4% and 22.09% at 3rd month and 6th months respectively. Reduction in air bone gap was recorded during the postoperative period. Pre-operative air-bone gap was 43.9 dB which was decreased to 34.5 dB and 34.7 dB post-operatively at 3rd month and 6th months respectively.

**DISCUSSION**

Chronic otitis media (COM) is a chronic inflammatory disease of the middle ear and mastoid that often results in partial or total loss of the tympanic membrane (TM) and ossicles, leading to conductive hearing loss that can range in severity up to 60-70dB. Chronic otitis media (COM) is a common condition, affecting 0.5–30% of any community. Therefore, a conservative estimate of the number of people in the world suffering from COM is over 20 million. Chronic otitis media with cholesteatoma and granulations is major cause of morbidity and deafness. The extent of hearing impairment in chronic otitis is dependent primarily on the degree of ossicular disruption. In this prospective observational study, a total no. of 30 patients of chronic otitis media with active squamous disease were included.

All the patients underwent canal wall up mastoidectomy with tympanoplasty and were followed up for a period of 6 months. The demographic and clinical data were collected which included age, sex, diagnosis, (chronic otitis media with active squamous disease) details of surgical technique, intraoperative findings (middle ear mucosa status, ossicular chain status, and reconstruction), postoperative findings (graft incorporation), hearing and duration of follow up. The main outcome measures were both anatomical and functional in form of graft incorporation, normal anatomy preservation and postoperative hearing function. Our technique approaches the pathology through postaural approach using transmeatal anterior atticotomy, a simple transcortical mastoidectomy and otosclerotic drilling. We have found that this technique gives excellent exposure of the posterior mesotympanum, including sinus tympani, facial recess, anterior epitympanum transmeatally with thinning of posterior canal wall and of antrum, aditus, and attic transcortically. 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. 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. Since 1970, Tos has used a modification of CAT which is based on a new philosophy. The Tos technique consists of transcanal and transmastoid 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 postero-superior 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

neosteogenesis and adhesion formation postoperatively. Clearance of disease from anterior attic in classical intact canal wall technique requires extensive transmastoid epitympanotomy with narrow working space and inadequate visualization of supratubal recess especially its anterior end. While in modified intact canal wall mastoidectomy transmeatal atticotomy provides circumferential access to anterior attic with adequate working space and direct vision. Thus the chances of residual cholesteatoma decrease substantially and there is no need for second look surgery. All ears were dry. All the patients had an intact eardrum except two with a small, central hole, which had been seen since the early post-operative period. There was no sign of residual or recurrent cholesteatoma in any patient during the follow-up period or at the final examination. The hearing assessment was done using pure tone audiometry. Hearing threshold at 500, 1000 and 2000 hz was considered for calculation of hearing threshold. Average air conduction threshold preoperatively is maximum in b/w 41-50dbs in 11 patients (35.4%), 31-40db in 10 (32.2%), 21-30db in 7 (22.5%) and 51-60db in 1 (3.2%) of patients. Average bone conduction threshold preoperatively is <10db in 23 (74.19%), 11-20db in 7 (22.53%), 21-30db in 1 patient (3.2%). Average air-bone gap preoperatively is between 31-40dbs in 12 (38.7%), 41-50db in 10 (32.2%), 21-30db in 5 (16.12%) and 51-60db in 1 (3.2%) patient. Average air conduction threshold postoperatively at 3 months, 31-40db in 13 (41.9%), 41-50db in 9 (29.03%), 21-30 in 8 (25.8%) and 11-20 in 1 (3.2%). Average bone conduction threshold postoperatively at 3 months <10db in 24 (77.4%), 11-20db in 6 (19.9%) and 21-30 in 1 (3.2%). Average A-B gap at 3 months is 21-30db in 14 (45.1%), 31-40 in 8 (25.8%), <20 db in 6 (19.3%) and 41-50db in 3 (9.6%) patients. Average air conduction threshold postoperatively at 6 months is 31-40 db in 11 (35.4%), 21-30db in 8 (25.8%), 41-50db in 6 (19.3%) and 11-20db in 5 (16.1%). Average bone conduction threshold postoperatively at 6 months is <10db in 25 (80.6%), 11-20 db in 5 (16.1%) and 21-30db in 1 (3.2%). Average A-B gap at 6 months is 21-30db in 15 (48.3%), <20db in 9 (29.03%), 31-40db in 5 (16.1%) and 41-50db in 2 (6.4%). Mean air conduction threshold preoperatively is 43.9db, bone conduction threshold is 9.6db and A-B gap is 34.37db with standard deviation 10.29. Postoperative air conduction threshold at 3 months is 34.5db, bone conduction threshold 10db and A-B gap is 24.9 db with standard deviation 7.018. At 6 months postoperatively air conduction threshold is 34.7db, bone conduction 9.8db and A-B gap is 24.9db with standard deviation 6.326. This study is comparable to the study conducted by **Dr. Anantchouhan (2014)**<sup>1</sup> modified ICWM technique in chronic suppurative otitis media: a prospective study of 50 cases. Of 50 studied cases, In this study most of the patients had air-bone gap between 31 to 40 dB. 18 patients had air bone gap between 21-30 dB followed by 7 patients had >40 dB and 4 patients ≤20dB.

The pre-operative mean air conduction was 52.1 dB which at 3 months post-operatively was reduced to 42 dB. Further at 6 months there was more reduction in the preoperative A-B gap was 33.85db which was decreased to 23.4db and 21.1db postoperatively at 3<sup>rd</sup> and 6<sup>th</sup> months respectively. Other studies having similar post operative hearing outcomes following CWUM +tympanoplasties are: **Liansheng Zhang (2016)**<sup>11</sup>. Therapeutic outcomes of canal wall up mastoidectomy in combination with Type I tympanoplasty in otitis media. **Mahadevaiah et al. (2008)**<sup>5</sup> study revealed that postoperative mean air conduction was 41.5 dB and mean air-bone gap was 21.1 dB. **Stankovic**<sup>12</sup> observed mean air-bone gap of 14.6 dB. **Tos and Lau<sup>4</sup> et al.(2007)** achieved significantly better postoperative hearing results with CWU than CWD surgery but the preoperative thresholds were also significantly better in the CWU group, demonstrating that disease severity and other confounding factors also affect hearing outcomes independent of the surgical procedure. **Dodson EE (1998)**<sup>13</sup> studied the ICWM with tympanoplasty mastoidectomy canal wall up procedure and had better hearing outcome. **S.C. Prasad (2014)**<sup>14</sup>. Long-term surgical and functional outcomes of the intact canal wall technique for middle ear cholesteatoma. The mean AC improved from 34 dB before surgery to 28 dB at 6 months. **Ji Heui Kim, MD (2009)** conducted the study on Clinical Results of Atticoantrotomy with Attic Reconstruction or Attic

Obliteration for Patients with an Attic Cholesteatoma A-B gap reduced from 29.2db to 25db postoperatively. **Kim et al**<sup>16</sup> found no significant difference in post-operative air-bone gap (ABG) between CWU and CWD (10.9 vs13.5dB) or in the proportion of patients with an ABG <20dB (58.6% vs 68.4%) 3 months after ossiculoplasty. This study is notable for the fact that the authors have tried to exclude confounding factors by comparing CWU and CWD outcomes in patients with an intact tympanic cavity and stapes who had a staged ossiculoplasty at least 6 months after mastoidectomy. Nevertheless their follow up period is short.<sup>17</sup> published their comparison of patients who had CWU, CWD with **Toner and Smyth** reconstruction and CWD surgery with follow up of between 8 and 12 years. 17 They found that the hearing benefit at one year (pure tone average (PTA) air conduction (AC) threshold) was greater in the CWU group, but that this benefit was lost over a longer period of follow up of between 7 and 11 years such that the average long-term AC gain was the same in all 3 groups. Studies in children show great variability. **Murphy & Wallis**<sup>18</sup> had similar hearing outcomes following CWU and CWD surgery in children. **Osborn et al**<sup>19</sup> found hearing to be significantly better following CWU surgery (mean PTA 30dB) than CWD surgery (mean PTA 45dB) in their retrospective review of 420 children, independent of preoperative hearing levels and of the condition of the stapes. The main aim of our study is hearing preservation in addition to the eradication of disease without compromising the normal anatomy. The intact canal wall mastoidectomy preserves the posterior canal and maintains the a natural external auditory canal, reduces postoperative convalescence, rarely requires in office debridement and avoids restriction on water exposure especially in swimmers. Several studies have demonstrated improved hearing outcomes with ICWM compared to CWD. Hearing outcome depends on the preoperative ossicular status, as per the Austin Kartush criteria. Our results indicate that hearing improved when stapes suprastructure (minor columella type 3TP) is present. The improved hearing outcomes from the presence of the malleus handle were also observed. This is similar to the studies conducted by **Kevin Wilson (2013)**<sup>20</sup> on Hearing after Chronic Otitis Media and Cholesteatoma Surgery, **Erik F. Blom, Bsc et al (2015)**<sup>21</sup> influence of Ossicular Chain Damage: A Systematic Review and . Improvement in hearing with Meta-analysis and **Ghodrat Mohammadi et al (2012)**<sup>22</sup> preservation of normal anatomy and decreased symptomatic profile (dry ear) achieved in majority of our patient. Only three patients had postoperative complications, one had facial palsy which recovered after 3 months. Two had residual perforation, which also resolved of its own over a period of time and there was no residual perforation at 6 months. Reduction in air bone gap was recorded during the post-operative period. Preoperative air-bone gap was 34.37 dB which was decreased to 24.57dB and 24.9dB postoperatively at 3rd month and 6th months respectively. On analysing the audiometric parameter of air-bone gap by the same paired 't' test there was again significant improvement in air-bone gap after surgery (*P* value < 0.05 at 3 months and 6 months post-operatively).

## CONCLUSION

The modified intact canal wall technique was found to result in complete and safe removal of disease from the middle ear and provided a durable and resistant reconstruction of the middle ear as a single stage procedure. This technique also resulted in significantly improved hearing outcomes in majority of the patients. Residual cholesteatoma was not evident in any case after 6 months of surgery. Thus a longer follow up period will be required to definitely establish the efficacy of CWUM in complete eradication of disease from middle ear. Improvement in hearing was clearly evident post-operatively even after 3 and 6 months. There was marked improvement in air conduction thresholds with consequent reduction in air-bone gaps. Majority of the patients have a significant reduction in air-bone gaps of >10 dB, at 3 and 6th months post operatively. Although intact canal wall procedures limit the need for post-operative care, they do not eliminate the need for follow up. This must be emphasized to the asymptomatic postoperative patient. When deciding to perform an intact canal wall tympanoplasty with mastoidectomy for cholesteatoma, the decrease in post-operative care and good

hearing results must be weighed against the risk of recurrent post-operative cholesteatoma. These factors must be considered by the otologist and the patients post-operatively.

## REFERENCES

1. Dr. Anant Chouhan, Dr. Suman Saini, Dr. Digvijay Singh, Dr. B.K. Singh, Dr. P.C Verma. Modified intact canal wall mastoidectomy technique in chronic suppurative otitis media: A prospective study of 50 cases. Indian Journal of Basic and Applied Medical Research September 2014; Vol. 3, Issue 4: P.332-340. 13
2. Sheehy JL, Patterson ME. Intact canal wall tympanoplasty with mastoidectomy. Laryngoscope 1967; 77: 1502-1542.
3. Jansen C. The combined approach for tympanoplasty. J Laryngol Otol 1968; 82: 779-793.
4. Tos M. Modification of combined approach tympanoplasty in attic cholesteatoma. Arch of Otolaryngol Head Neck Surg 1982; 108: 772-778. 24
5. Mahadevaiah A. Modified intact canal wall mastoidectomy – long term results in hearing and healing. Indian J Otolaryngol Head Neck Surg 2008; 60: 317-323. 6.
6. Evans RA, Day GA, Browning GG. Open-cavity mastoid surgery: its effect on the acoustics of the external ear canal. Clin Otolaryngol Allied Sci. 1989 Aug; 14(4): 317-21.
7. Viktor Chrobok, Arnost Pellant, Milan Meloun, Karel Pokorny, Eva Simáková, Petra Mandysová. Prognostic factors for hearing preservation in surgery of chronic otitis media. Int. Adv. Otol. 2009; 5(3): 310-317.
8. Chada N, Jardine A, Owens D, Gillette S, Robinson P, Maw A. A multivariate analysis of the factors predicting hearing outcome after surgery for cholesteatoma in children. J Laryngol Otol 2006; 120: 908-913.
9. Harkness P, Brown P, Fowler S, et al. Mastoidectomy audit: results of the Royal College of Surgeons of England comparative audit of ENT surgery. Clin Otolaryngol 1995; 20: 89-94.
10. Rebecca L Heywood Antony A Narula. The pros and cons of canal wall up versus canal wall down mastoidectomy for cholesteatoma. The Otorhinolaryngologist 2013; 6(3): 140-143.
11. Liansheng Zhang. Therapeutic outcomes of canal wall up mastoidectomy in combination with Type I tympanoplasty in otitis media. Pak J Med Sci 2016; Vol. 32, No. 3.
12. Stankovic M. Follow-up of cholesteatoma surgery: open versus closed tympanoplasty. ORL J Otorhinolaryngol Relat Spec 2007; 69: 299-305.
13. Dodson E, Hashisaki G, Hobgood T, Lambert P. Intact canal wall mastoidectomy with tympanoplasty for cholesteatoma in children. Laryngoscope 1998; 108: 977-983.
14. S.C. Prasad, C. La Melia, M. Medina, V. Vincenti, A. Bacciu, S. Bacciu, E. Pasanisi. Long-term surgical and functional outcomes of the intact canal wall technique for middle ear cholesteatoma in the paediatric population. ACTA Otorhinolaryngologica Italica 2014; 34: 354-361.
15. Ji Heui Kim, Seung Hyo Choi, Jong Woo Chung. Clinical Results of atticotomy 16with attic reconstruction or attic obliteration for patients with an attic cholesteatoma. Clinical and Experimental Otorhinolaryngology 2009; Vol. 2, No. 1: 39-43.
16. Min-Beom Kim, Jeeseun Choi, Jae Kwon Lee, Ju-Yeon Park, Hosuk Chu, Yang-Sun Cho, Sung Hwa Hong, Won-Ho Chung. Hearing outcomes according to the types of mastoidectomy: a comparison between canal wall up and canal wall down mastoidectomy. Clinical and Experimental Otorhinolaryngology 2010 Dec; Vol. 3, No. 4: 203-206.
17. Toner JG, Smyth GD. Surgical treatment of cholesteatoma: a comparison of three techniques. Am J Otol 1990; 11(4): 247-9.
18. Murphy TP, Wallis DL. Hearing results in pediatric patients after canal wall-up and canal-wall-down mastoid surgery. Otolaryngol Head Neck Surg 1998; 119(5): 439-43.
19. Osborn AJ, Papsin BC, James AL. Clinical indications for canal wall-down mastoidectomy in a pediatric population. Otolaryngol Head Neck Surg 2012 May 7.
20. Wilson KF, London NR, Shelton C. Tympanoplasty with intact canal wall mastoidectomy for cholesteatoma: long-term hearing outcomes. Laryngoscope 2013 Dec; 123(12): 3168-71.
21. Erik F. Blom, Marlise N. Gunning, Nienke J. Kleinrensink, Alexander S.H.J. Lokin, Hanneke Bruijnzeel, Adriana L. Smit, Wilko Grolman. Influence of ossicular chain damage on hearing after chronic otitis media and cholesteatoma.
22. Ghodrat Mohammadi, Masoud Naderpour, Mehrnoosh Mousaviagdas. Ossicular Erosion in Patients Requiring Surgery for Cholesteatoma. Iranian. Journal of 55 Otorhinolaryngology 2012; Vol. Vol.24.