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Hearing Outcome In Type III Tympanoplasty With Or Without Cartilage Augmentation: A Cross-Sectional Study

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Abstract
Background: *The objective of this study is to assess the hearing status in pre- and post-operative canal wall down mastoidectomy with type III tympanoplasty with or without cartilage augmentation in patients with squamosal variety of chronic otitis media.*
Methods:*This study included 32 patients. The patients were divided into two groups (Group A and Group B). In group A (16 patients) canal wall down mastoidectomy with cartilage augmented type III tympanoplasty and in group B (16 patients) type III tympanoplasty with temporalis fascia without cartilage augmentation was done.The pre-operative and post-operative Air Bone Gap (ABG) was calculated by taking differences between air conduction and bone conduction threshold.*
Results:*In our study, group-A patients average PTA ABG was 38.72 dB pre-operatively and 30.85 dB post-operatively with a net gain of 7.87 dB. In group-B patients average PTA-ABG was 38.12 dB pre-operatively and 35.15 dB post-operatively with a net gain of 2.97 dB.*
Conclusions:*Hearing results after cartilage augmentation type III Tympanoplasty showed improvement at individual and mean post-operative PTA-ABG and also improvement in ABG closure.*
Keywords: *Chronic otitis media, Canal wall down mastoidectomy, Type III tympanoplasty, Cartilage augmentation.*

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I. Introduction

Chronic Otitis Media (COM) is a chronic inflammatory disease of the middle ear cavity and mastoid air cells that results in long term, or more often, permanent change in the tympanic membrane including atelectasis, dimer formation, perforation. tympanosclerosis, retraction pocket development or cholesteatoma. There is variable involvement of the ossicular chain. COM results from long term eustachian tube dysfunction with poorly aerated middle ear space, multiple bouts of acute otitis media, persistent middle ear infection or other chronic inflammatory stimulus[1]. It is typically a persistent disease, insidious in onset, often capable of causing severe destruction and irreversible sequelae, and clinically manifests as deafness and aural discharge.

COM can be characterized histopathologically by middle ear pathology such as granulation tissue, cholesterol granulomas or cholesteatoma formation[2]. Active COM is chronic inflammation of the middle ear and mastoid mucosa, with recurrent discharge (> 6 weeks) through a perforation of the tympanic membrane. The World Health Organization (WHO) estimated that 65-330 million people worldwide are affected by COM, of whom 50% suffer from hearing impairment and approximately 28000 deaths per annum are attributable to the complications of COM[3]. The incidence of COM is higher in developing countries because of malnutrition, poor hygiene, overcrowding, poor housing quality, recurrent upper respiratory tract infection, inadequate healthcare facilities that are associated with a higher incidence of middle ear infections [4].

COM is the commonest cause of persistent mild to moderate hearing impairment in children and young adults in developing countries. Central perforation with intact ossicular chain shows hearing loss approx. 10-30dB. In postero-superior marginal perforation with disruption of ossicular chain hearing loss is 40-60dB and in total or subtotal perforation with loss of malleus and incus, the stapes remaining mobile, hearing loss is 60-80dB [5]. The predominant hearing loss in chronic otitis media is conductive in nature, but a few cases of sensorineural hearing loss is also found [6].

Chronic Otitis Media is broadly divided into two varieties: mucosal variety and squamosal variety. More recently COM has been classified into: (1) Healed chronic otitis media, (2) Inactive mucosal, (3) Active mucosal, (4) Inactive squamous, (5) Active squamous COM. Squamous variety of COM most commonly involves the epitympanum and usually associated with cholesteatoma. Cholesteatoma is a benign keratinizing epithelial lined cystic structure found in the middle ear and mastoid. It can cause destruction of the local structures - ossicular chain and otic capsule, thereby leading to complications such as hearing loss, vestibular dysfunction, facial paralysis and intracranial disease [7].

The choice of treatment for cholesteatoma is surgery for which the goal is total clearance of the disease, to obtain a safe, dry ear, restoration or maintaining the functional capacity if possible. There are different surgical modalities of treatment according to the extent of cholesteatoma and amount of destruction such as:

- Suction clearance.
- Intact canal wall procedures (Simple mastoidectomy, Cortical mastoidectomy, Classic intact canal wall mastoidectomy, Combined approach tympanoplasty).
- Canal wall down procedures (Atticotomy, Bondy's operation, Atticoantrostomy, Radical mastoidectomy, Modified radical mastoidectomy).

In intact canal wall procedure, there is good preservation of hearing but more chance of incomplete clearance or recurrence of disease. Canal wall down procedure causes disease clearance properly but the disadvantage of poor preservation of hearing which can be overcome by reconstructive surgery such as type III Tympanoplasty under magnification is a modern advancement in otology. In canal wall down mastoidectomy without reconstruction, if there is loss of ossicles and/or tympanic membrane for complete clearance of disease, the post operative audiometric evaluation shows further hearing loss. On the other hand, canal wall down mastoidectomy with reconstruction i.e. type III Tympanoplasty, cartilage augmentation, ossiculoplasty, improves hearing in variable amount [8].

The goal of Tympanoplasty is to restore sound pressure transformation at the oval window by coupling an intact tympanic membrane with a mobile stapes footplate via an intact or reconstructed ossicular chain and to provide sound protection for the round window membrane by a closed, air containing, mucosa lined middle ear.

In classical type III tympanoplasty or myringostapediopexy, disease is removed from tympanomastoid compartment and advancement of the tympanic membrane or placement of tissue graft is done on top of the stapes head. After this procedure, air bone gap (ABG) range is around 10-60dB. For augmented type III tympanoplasty, either cartilage or sculptured cortical bone or sculptured ossicles can be kept between the intact stapes and the fascial graft. Cartilage disc was hypothesized to improve the "effective" vibrating area of the graft that was coupled to the stapes head [9]. Cartilage also offers the advantage of higher mechanical stability compared with membranous transplants, thus preventing retraction of tympanic membrane in the long run. It also increases the depth of the middle ear cavity. As there is chance of improvement of hearing status and quality of life by doing reconstruction of hearing mechanism during Canal Wall Down Mastoidectomy, this procedure is gaining popularity worldwide.

II. Objectives

- To compare the hearing outcome of type - III tympanoplasty with cartilage augmentation and without cartilage augmentation.
- To determine post-operative complication associated with this surgical procedure.

III. Materials And Methods

This prospective cross-sectional observational studywas conducted in the Department of Otorhinolaryngology and Head &Neck surgery, Agartala Government Medical College and Govind Ballabh Pant Hospital. The study period wasfrom January 2023 to May 2024. The study participants consist of 32 patient of chronic otitis media (squamous type) who underwent canal wall down mastoidectomy with type III tympanoplasty with or without cartilage augmentation.

Inclusion criteria:

- Patients with COM of squamosal variety with only conductive hearing loss.
- Patients of age between 11-55 years irrespective of any sex.

- Patients, who gave consent.

Exclusion criteria:

- Patients who refused to give consent.
- Patients of COM with intracranial complication.
- Patient with associated sensorineural hearing loss.

IV. Methodology

All the patients attended to Department of ENT with history of ear discharge and diminished hearing, comprehensive history, clinical, and local examinations was done by otoscope and under microscope, pus was sent for culture and sensitivity test. Tuning fork tests was done for hearing assessment. After that patient was subjected to do pure tone audiometry with a digital audiometer calibrated to ANSI standards. Air conduction and Bone conduction thresholds were recorded for the same frequencies. X-ray of mastoid and HRCT of temporal bone was done. All routine blood investigations, ECG, Chest X-ray was done as per clinical proforma.

After diagnosing the case as Chronic Otitis Media (squamous variety) and those who fulfilled the selection criteria were included in the study once their informed consent has been taken. Pre anaesthetic checkup and details of both the procedure were explained. In all consented patient with COM (squamous variety), canal wall down mastoidectomy with type-III tympanoplasty with or without cartilage augmentation was done under general anaesthesia and under microscope through post auricular approach.

The patients were divided into two groups (Group A and Group B). In group A canal wall down mastoidectomy with cartilage augmented type III tympanoplasty and in group B type III tympanoplasty with temporalis fascia without cartilage augmentation was done. For cartilage augmentation, thin disc of conchal cartilage of partial thickness of 4-6 mm in diameter was interposed between the stapes head and temporalis fascia graft. Small hole was made on conchal cartilage by 1 mm diamond burr and placed on stapes head. Selection of the cases were done as per randomized chart.

Air and bone conduction thresholds were calculated by taking the averages of 500, 1000, 2000 and 4000 Hz frequencies. The Air Bone Gap (ABG) was calculated by taking differences between air conduction and bone conduction threshold. Postoperative ABG closure was calculated by taking the difference between preoperative and postoperative ABG of the average frequencies of 500, 1000, 2000 and 4000 Hz.

Patient would be followed up in post operative periods for minimum 6 months at 15days, 30days, 45days, 60days, 90 days and 6 months respectively for aural discharge, condition of the graft, assessment of hearing improvement and any complication developed or not.

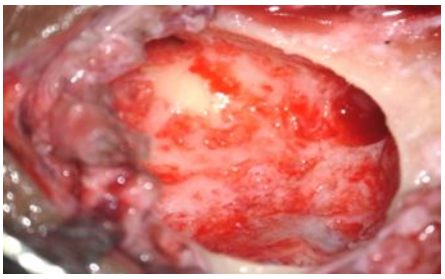

Fig 1: Showing Intraoperative Open Mastoid Cavity With Low Facial Ridge.

Fig 2: Showing Placement Of Conchal Cartilage Between Mobile Stapes Head And Temporalis Fascia Graft.

Data processing and analysis:

Data were recorded, entered and analysed using SPSS version 29.0 statistical software. Categorical values have been expressed as proportion, independent samples test (unpaired ‘t’ test) was used for statistical

analysis and presented in appropriate table, bar and pie diagram. P value was calculated using the independent samples test and P value of 0.05 was taken as significant.

Institutional ethical clearance:

Ethical approval was granted (F.4(6-13) / AGMC / Medical Education / IEC approval / 2022 / 21850) from the Institutional Ethics Committee of Agartala Government Medical College and Govind Ballabh Pant Hospital, Agartala and all the ethical principles were adhered during the whole study period.

V. ResultsAnd Observations

32 cases of chronic otitis media (squamous variety) were studied. The patients were randomly divided into two groups of 16 each. One group (Group A) underwent type III tympanoplasty with cartilage augmentation and other group (Group B) underwent type III tympanoplasty without cartilage augmentation.

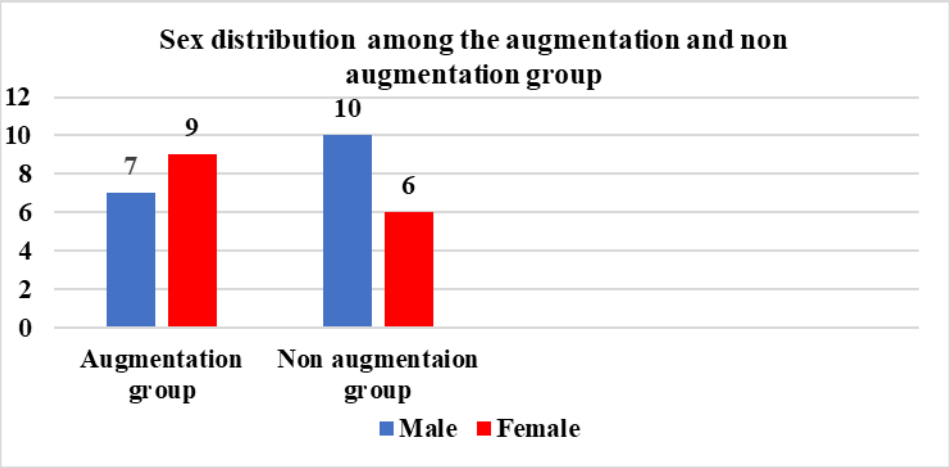

Fig 3: Bar chart showing sex distribution in both groups.

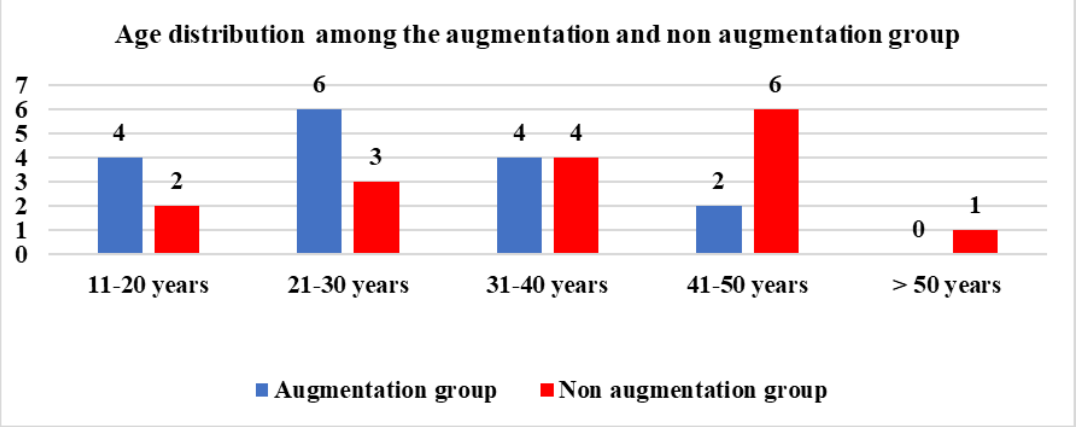

Fig 4: Bar charts showing age distribution in both groups.

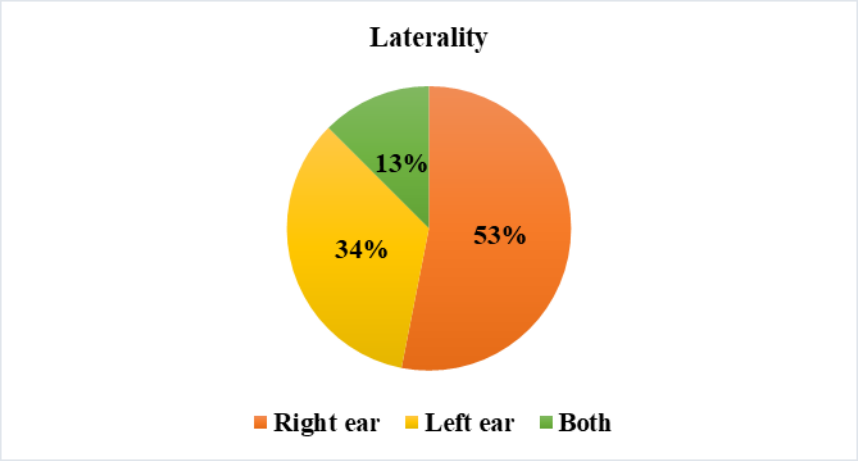

Fig 5: Pie chart showing proportion of involvement of right and left ear.

Table 1: Preoperative clinical presentations of the patients (n=32)

Symptoms	Number of patients	Parentage (%)
Aural discharge	32	100
Hearing impairment	32	100
Headache	02	6.2
Vertigo	01	3.1
Tinnitus	01	3.1
Pain in the ear	02	6.2
Facial weakness	01	3.1

Table 2: Pre operative findings of the physical examination of the patients (n=32)

Aural discharge	Odour	Odourless	03 (9.4%)
		Malodourous	29 (90.6%)
	Amount of discharge	Scanty	27 (84.4%)
		Profuse	05 (15.6%)
	Nature of discharge	Mucopurulent	05 (15.6%)
		Purulent	26 (81.3%)
		Blood stained	01 (3.1%)
TM perforation	Attic		26 (81.3%)
	Posterior marginal		05 (15.6%)
	Central		01 (3.1%)
Cholesteatoma			25 (78.2%)
Aural polyp			02 (6.2%)
Granulation tissue			05 (15.6%)

Intra-operative observations:

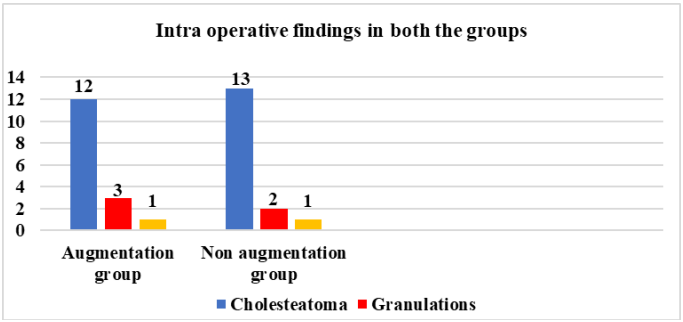

Fig 6: Bar chart showing intra operative findings in both the groups.

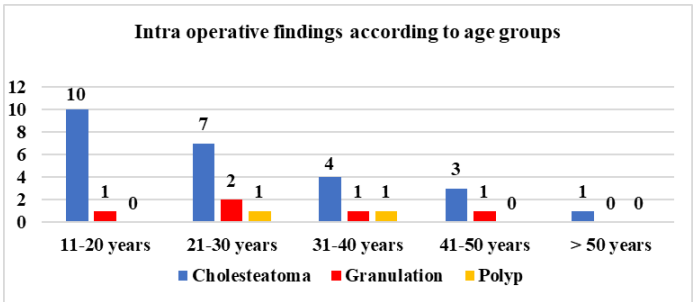

Fig 7: Bar chart showing intra-operative findings among the age groups.

Post-operative outcome:

Table 3: Post-operative follow-up of the patients (n=32).

Findings	Post-operative days 15	Post-operative days 30	Post-operative days 60	Post-operative days 90	Post-operative 6 months
Pain	4 (12.5%)	2 (6.2%)	0	0	0
Dry ear	4 (12.5%)	15 (46.8%)	23 (71.8%)	28 (87.5%)	31 (96.8%)
Aural discharge	18 (56.2%)	11 (34.3%)	5 (15.6%)	2 (6.2%)	1 (3.1%)
Giddiness	3 (9.3%)	0	0	0	0
Facial weakness	0	0	0	0	0
Graft taken	13 (40.6%)	23 (71.8)	28 (87.5%)	31 (93.7%)	31 (96.8%)
Graft failure	5 (15.6%)	3 (9.3%)	1 (3.1%)	1 (3.1%)	1 (3.1%)
Dead ear	0	0	0	0	0
Recurrence	0	0	0	0	0

Audiological outcome:

Table 4: Comparison of pre- and post-operative AC Threshold in both the groups.

		AC Threshold		P value
		Mean	Std Deviation	
Group A	Pre op	54.43	14.84	**< 0.001**
	Post op	39.93	11.52	
Group B	Pre op	55.25	14.52	**< 0.001**
	Post op	43.50	10.67	

Table 5: Comparison of pre- and post-operative PTA-ABG (dB) in group A (n=16).

Parameter	Frequency	Mean	Std Deviation	Min	Max	P value
Preop ABG	500Hz	45.93	11.67	26	62	<0.001
Postop ABG		35.87	10.51	15	48	
Preop ABG	1000Hz	43.68	10.01	26	60	<0.001
Postop ABG		34.12	9.64	15	43	
Preop ABG	2000Hz	32.62	8.92	22	56	<0.001
Postop ABG		23.31	7.83	09	40	
Preop ABG	4000Hz	32.68	8.27	26	62	<0.001
Postop ABG		30.12	9.03	13	42	
Preop ABG	Average	**38.72**	**7.07**	32.62	45.93	**<0.001**
Postop ABG		**30.85**	**5.57**	23.31	35.87	

Table 6: Comparison of pre- and post-operative PTA-ABG (dB) in group B (n=16).

Parameter	Frequency	Mean	Std Deviation	Min	Max	P value
Preop ABG	500Hz	41.50	8.59	28	62	<0.001

Postop ABG		40.37	9.09	20	56	
Preop ABG	1000Hz	43.25	9.98	28	62	<0.001
Postop ABG		38.37	10.15	22	54	
Preop ABG	2000Hz	32.12	9.45	18	52	<0.001
Postop ABG		28.12	9.78	12	42	
Preop ABG	4000Hz	35.62	8.36	22	50	<0.001
Postop ABG		33.75	9.90	10	46	
Preop ABG	Average	**38.12**	**5.16**	32.12	43.25	**0.001**
Postop ABG		**35.15**	**5.44**	28.12	40.37	

Table 7: Postoperative ABG closure in different categories.

Groups	0-5 dB	6-10 dB	11-15 dB	16-30 dB	>30 dB
Group A (n=16) (CWD mastoidectomy with cartilage augmented type III tympanoplasty)	2 (12.5%)	4 (25%)	6 (37.5%)	3 (18.7%)	1 (6.3%)
Group B (n=16) (CWD mastoidectomy without cartilage augmented type III tympanoplasty)	5 (31.2%)	4 (25%)	2 (12.5%)	1 (6.3%)	4 (25%)

VI. Discussion

The objectives of surgical management of cholesteatoma include the eradication of disease, restoration of hearing and normal anatomical configuration [10]. Conventionally Squamous type of COM (Cholesteatoma) was being managed by Radical Mastoid surgery or Modified Radical Mastoid surgery where eradication of disease is the main aim. As a result, disease clearance was done at the expense of hearing. Due to advancement of micro surgical techniques of ear, repair of hearing mechanism is gaining popularity. Ensuring total clearance of the disease if repair is done properly, satisfactory hearing gain can be achieved. This study was performed to compare the pre and postoperative hearing results in terms of average ABG and ABG closure. In the present study, 32 patients in the age group of 11-55 years of either sex were selected. The mean age was 32.15 years with maximum number of patients 9(28.1%) being between the age group of 21-30 years followed by 8(25%) patients between age group of 31-40 years and 41-50 years in each. 6(18.7%) patients between the age group of 11-20 years and 1(3.2%) patient in >50 years. Similar studies done by Kyrodimos et al and Shrestha et al, the mean age of presentation was also 32.4 and 24.8 years respectively [10,11].

In present study there was male preponderance as compared to female patients. Overall, 17(53.2%) were males while rest 15(46.8%) patients was females. The right ear involvement was seen in 17(53.1%) cases. The left ear was seen to be involved in 11(34.4%) cases. Both the ear was involved in 4 (12.5%) cases.

Rural people (70%) were affected more than urban (30%) people and it is well explained by inadequate health care facilities, lack of awareness. The majority of the patients (65.5%) were having poor socio-economic condition. This is because of overcrowding, poor hygiene, poor sanitation, malnutrition, upper respiratory tract infection etc. This study is similar to other study [11,12]. Higher incidence of COM in illiterate (35%) and primary educated (30%) group were also reported in many studies. This reflects that people, lack of health education and awareness about their problem were more affected [13].

Study showed cholesteatoma was present in 78.2%, granulation tissue in 15.6% and aural polyp in 6.2% patients, that is also similar to other study.

The commonest presentation of the patients was otorrhoea (100%) and hearing impairment (100%) which was supported by Goyal et al. [14]. The duration of ear discharge ranged from 2 years to 12 years. Maximum number of patients, that were 17(53.1%) cases, had duration of ear discharge of 3-6 years fallowed by 10 (31.2%) patients gave history of ear discharge for a duration of < 3 year and 5(15.6 %) had a history of ear discharge of >6 years.

In this study 81.3% had attic perforation, 15.6% had posterosuperior marginal perforation and 3.1% had central perforation. These findings are more or less similar to other series where attic perforation was more

[15]. Present study shows pain (12.5%) and giddiness (9.3%) within first two-week, Graft taken in 96.8% cases and dry ear was 98.6% of patient after 6 months of operation which is similar to other study [14].

The preoperative mean AC threshold was (54.4±14.84 dB) and the postoperative mean AC threshold was (39.93±11.52 dB) in patients who had undergone cartilage augmented type III tympanoplasty (group A). Whereas the mean pre and postoperative AC threshold was (55.25±14.52 dB) and (43.50±10.67 dB) respectively in patients who had without cartilage augmented type III tympanoplasty (group B).

In our study, group-A patients average PTA ABG was 38.72 dB pre-operatively and 30.85 dB post-operatively with a net gain of 7.87 dB. The post-operative PTA-ABG ranged from 23.31-35.87 dB. The difference between the pre- and post-operative PTA-ABG results was statistically significant (<0.001). Hearing improved in 93.7% cases and most of the cases (37.5%) gain ABG closure of 11-15 dB.

In group-B patients average PTA-ABG was 38.12 dB pre-operatively and 35.15 dB post-operatively with a net gain of 2.97 dB. The post-operative PTA-ABG ranged from 28.12-40.37 dB. The difference between the pre- and post-operative PTA-ABG results was statistically insignificant (0.001). Hearing improved in 75% cases and most cases (31.2%) gain ABG closure of 0-5 dB.

This result is consistent with the study done by Kyrodimos et al [11] where pre- and post-operative PTA-ABG were 35.41 dB and 24.33 dB respectively. Merchant et al [9] was found the mean ABG of 10-25 dB in aerated middle ear with variable ABG in non-aerated ear. In the study, conducted by Shrestha et al [10] the hearing gain in patients underwent cartilage augmented type III Tympanoplasty was 7.7 dB.

A comparative study, conducted by Cheang et al. [16] between myringolenticulopexy and myringostapediopexy, the mean post-operative air-bone gaps in the two groups were 17.5 and 24.7 dB, respectively. Similarly, Moustafa and Khalifa [17] in their tympano-cartilago stapediopexy were performed in the other 95 cases, achieved ABG of less than 20 dB. Malafronte G et al [18] in cases of double-cartilage block ossiculoplasty, one year after surgery, a postoperative ABG of 20 dB or less occurred in 80% (n = 20) of patients of Group 1 and in 84.3% (n = 27) of patients of Group 2. After a mean follow-up of 7 years, a postoperative ABG of 20 dB or less occurred in 48% (n = 12) of patients in the first group and in 81% (n = 26) of patients in the second group the ABG of 20 dB or less achieved. In our study the overall AB gap gain was 7.87 dB in group A and 2.97 dB in group B.

Table 8: Comparison of hearing outcome with other studies.

Study	Pre-op AB gap	Post-op AB gap	Net gain
Present study	38.72 dB	30.85 dB	7.87 dB
Kyrodimos et al	35.41 dB	24.33 dB	11.09 dB
Shrestha et al	37.4 dB	29.7 dB	07.7 dB

VII. Conclusion

The results concluded that the mean pre- and post-operative air bone gap were 38.72 dB and 30.85 dB respectively with a net gain of 7.87 dB in canal wall down mastoidectomy with cartilage augmented type III Tympanoplasty which is statistically significant. The post-operative PTA-ABG ranged from 23.31-35.87 dB, the ABG closure was 11-15 dB in 37.5% case. Whereas mean pre- and post-operative air bone gap were 38.12 dB and 35.15 dB respectively with a net gain of 2.97 dB in Canal wall down mastoidectomy without cartilage augmented type III Tympanoplasty which is statistically insignificant. The post-operative PTA-ABG ranged from 28.12-40.37 dB, the ABG closure was 0-5 dB in 31.2% case. Thus, hearing results after cartilage augmentation type III Tympanoplasty showed improvement at individual and mean post-operative PTA-ABG and also improvement in ABG closure suggesting thin cartilage disc increased the effective vibrating area of tympanic membrane graft.

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Conflict of Interest: No conflict of interest.

References

[1] Browning GG, Chapter 8. Etiopathology Of Inflammatory Conditions Of The External And Middle Ear. In: Kerr AG (Ed.). Scott-Brown's Otolaryngology, 6th Edn. Vol 3. London: Arnold. 1997;6/8/5-25.
[2] Glasscock-Shambaugh, Surgery Of The Ear, 6th Edn. Ch 31. P. 515-27.
[3] Acuin J. World Health Organization. Chronic Suppurative Otitis Media: Burden Of Illness And Management Options. Geneva, Switzerland: World Health Organization; 2004.
[4] Godinho RN Goncalves T M Nunes F B Et Al. Prevalence And Impact Of Chronic Otitis Media In School Age Children In Brazil. First Epidemiologic Study Concerning Chronic Otitis Media In Latin America Int J Pediatr Otorhinolaryngol 2001. Dec;613223-32.

[5] Gray RF, Hawthorne M. In Synthesis Of Otolaryngology, 5th Edn. London: Butterworth Heinmann,1992:113-117.
[6] Hanif M, Alam MZ, Tarafder KH, Haque MR, Arafat MS, Rahaman MM. Evaluation Of Hearing Status In Pre And Post Operative Canal Wall Down Mastoidectomy With Type III Tympanoplasty With Or Without Cartilage Augmentation. Bangladesh J Otorhinolaryngol 2020;26(2):86-94.
[7] Scott-Brown's Otorhinolaryngology Head &Neck Surgery, 8th Edn. Vol 2, Ch 83. P. 977-1013.
[8] Ahmed M. Pre And Post Audiometric Evaluation Of Canal Wall Down Mastoidectomy. Dept Of Otolaryngology. Bsmmu 2005:70.
[9] Merchant SN, Mckenna MJ, Mehta RP, Et Al. Middle Ear Mechanics Of Type III Tympanoplasty (Stapes Columella): II Clinical Studies. Otol Neurotol. 2003; 24(2):186-94.
[10] Shreshtha BL, Bhattarai H, Bhusal CL. Comparison Of Pre And Post Operative Hearing Status After Cartilage Augmentation Type III Tympanoplasty, Society Of Otolaryngologists Of Nepal,2010; Vol 1 No. 2 Issue: 3-5.
[11] Kyrodimos E, Sismanis A, Santos D. Type III Cartilage Shield Tympanoplasty: An Effective Procedure For Hearing Improvement. Otolaryngol Head Neck Surg 2007; 136: 982-5.
[12] Hussain MM, Hundu SC, Haque MR, Shamsuzzaman AKM, Khan MK, Halder KK. Extracranial Complications Of Chronic Suppurative Otitis Media Study On 100 Cases MMCJ 2006; 15:4-9.
[13] Merchant SN, Mckenna MJ, Mehta RP, Et Al. Middle Ear Mechanics Of Type Lll Tympanoplasty (Stapes Columella): Ll. Clinical Studies Otol Neurotol 2003;24:186-94.
[14] Goyal R, Mourya A, Qureshi S, Sharma S. Modified Radical Mastoidectomy With Type III Tympanoplasty. Indian J Otolaryngol Head Neck Surg 2016;68(1):52-55.
[15] Chowdhury MA, Alauddin M. Comparative Study Between Tubotympanic And Atticoantral Types Of Chronic Suppurative Otitis Media. Bangladesh Med Res Counc Bull. 2002; 28:36-44.
[16] Cheang PP, Kim D, Rockley TJ. Myringostapediopexy And Myringolenticulopexy In Mastoid Surgery. J Laryngol Otol 2008;122: 1042-6.
[17] Moustafa HM, Khalifa MA. Tympano-Cartilago-Stapediopexy: A Method To Improve Hearing In Open Technique Tympanoplasty. J Laryngol Otol 1990; 104: 942-4.
[18] Malafronte G, Filosa B, Mercone F. A New Double-Cartilage Block Ossiculoplasty: Long-Term Results. Otol Neurotol 2008; 29: 531-3.