SJIF Impact Factor: 6.711

WORLD JOURNAL OF ADVANCE HEALTHCARE RESEARCH

ISSN: 2457-0400
Volume: 9
Issue: 8
Page N. 146-152
Year: 2025

Original Article

www.wjahr.com

OUTCOMES OF MYRINGOPLASTY IN AL-JAMHORY TEACHING HOSPITAL, MOSUL, IRAQ BETWEEN 2010-2012

[1]*Ayad Shakir Ibrahim, [2]Hmed Saad Allah Ahmed and [3]Awf. A. Abdulmaged

[1]F.I.B.M.S (ENT), AL-Jamhory Teaching Hospital.
[2,3]C.A..B.M. S (ENT), AL-Jamhory Teaching Hospital.

Article Received date: 03 June 2025 **Article Revised date**: 24 June 2025 **Article Accepted date:** 14 July 2025

***Corresponding Author: Ayad Shakir Ibrahim**
F.I.B.M.S (ENT), AL-Jamhory Teaching Hospital.

ABSTRACT

Objectives: To evaluate the success rate and hearing improvement after myringoplasty. Study design: Nonrandomized clinical trial study. **Background:** Myringoplasty is a surgical procedure used to repair a perforation in the tympanic membrane. Various surgical techniques and graft materials are in practice. Most common indications are to prevent further infection of the ear and to improve hearing. **Methods:** Nonrandomized clinical trial study was carried out on 61 ears with chronic tympanic membrane perforations, who underwent myringoplasty for the period from September 2010 to July 2012. Post aural approach was performed, using autologous temporalis fascia or conchal cartilage grafts by underlay technique. **Results:** The study was performed on 61 ears of 59 patients with chronic tympanic membrane perforations, 31(52.54%) were males and 28(47.45%) were females. The mean age of the patients was 27.18 years. Overall surgical success rate was 86.89 % (53 out of 61 ears). The surgical success rate of cartilage grafts myringoplasty was 93.88% and it was 58.33% for fascia grafts myringoplasty. The surgical success rate was 100%, for medium size perforations, and it was 80%. for large size perforations. The significant hearing gain after myringoplasty (more than 10dB) was noticed in 44 out of 53 (83%) of surgical success cases. The mean preoperative air bone gap was 35.28 dB, and it was 15dB for mean postoperative air bone gap of the surgical success cases. Conclusion: Myringoplasty carries high surgical success rate. Cartilage myringoplasty has better surgical success rate than temporalis fascia. The size of tympanic membrane perforation can affect surgical outcome. Hearing gain was significant for both cartilage and temporalis fascia myringoplasty. There was significant difference in relation to hearing gain between conchal cartilage and temporalis fascia myringoplasty in favoring the late.

KEYWORDS: Myringoplasty, surgical success rate, hearing gain.

INTRODUCTION

Surgery of the tympanic membrane dates back as far as the 17th century when Banzer in (1640) described the first attempt at repair of a tympanic membrane perforation with a pig's bladder.[1] Wullstein and Zollner are given credit for ushering in the modern era of tympanoplasty in the 1950s.[2] Otologic management is dictated by the patient's symptoms and findings. The status of the tympanic membrane and eustachian tube function greatly influences the alternatives for otologic care. Patients with conductive hearing loss and a clean dry perforation have three options: (1) periodic observation and monitoring of hearing status, (2) surgical reconstruction of the tympanic membrane, and (3) amplification with a hearing aid. Electing no further treatment with a dry tympanic membrane perforation incurs the risk of recurrent otorrhea after an upper respiratory tract infection or contamination with water.[3]

AIMS OF THE STUDY

The present study is aiming to

1. To study the surgical success rate and hearing gain after myringoplasty in our center.
2. Comparison between conchal cartilage and temporalis fascia myringoplasty in relation to surgical success rate and hearing gain.

PATIENTS AND METHOD

This nonrandomized clinical trial study was conducted to analyze 61 myringoplasties which were performed to treat patients with chronic tympanic membrane perforations, for the period from September 2010 to July

2012 at Otolaryngology Department, Al-Jamhory Teaching Hospital in Mosul, Iraq. Patients Inclusion between 13-55 years of age presented with chronic tympanic membrane perforations as result of recurrent middle ear infection, traumatic perforations and those with idiopathic perforation incidentally found during investigations for hearing impairment. All patients' ears were dry at least 4 weeks prior to surgery. Patients with cholesteatoma, active ear discharge, otitis externa, possible causes of Eustachian tube dysfunction especially those patients with allergic rhinitis and septal deviations, patients with ossicular disconnection, patients with moderate to severe conductive deafness, sensorineural deafness (SNHL), extensive myringosclerosis, patients who cannot attend for follow up, children less than or equal to 12 years the policy of our center does not operate below this age, patients with moderately to sever conductive hearing loss are excluded from this study. Sixty-one myringoplasties was performed for 31 males (52.54%), and 28 females (47.45%), were two cases had bilateral myringoplasties 6 months intervals. Age of the patients ranged from 13 up to 55 years with a mean of 27.18 years. Preoperative evaluation was done regarding site and size of tympanic membrane perforations, the size of external auditory canal in addition to the state of ossicular chain. The size of the perforations was quantified according to surface area of tympanic membrane involved, (26%-50%) regarded as medium sized perforations. while (51%-100%) regarded as large size perforation. For statistical requirement and for simplicity, the subtotal and total perforation were regarded as large size perforations. The site of tympanic membrane perforation will be assessed in future study. All patients had dry ears at least one month prior to surgery. Hearing level was assessed by the Tuning fork composed of 128, 256, 512 and 1024 Tuning fork Hz were used depending mainly on 512 Hz, for each patient Rinne and Weber tests were performed.

Pure tone audiometry to measure both air and bone conduction thresholds. Four frequencies were used (500, 1000, 2000, 4000 Hz), recorded to calculate the mean air bone gap (ABG) of each ear. Preoperative audiogram was done, and the patients with mild to moderate conductive hearing loss were included in this study. The mean preoperative air-bone gap was 35.28 dB. Regarding the graft used in our procedures, our center used either conchal (tragal) cartilage or temporalis fascia grafts. All cases operated under general anesthesia and postauricular approach. Tympan meatal flap and graft placement performed with aid of microscope; patients discharge at same day of surgery. Postoperative assessment to evaluate graft taken for 4 weeks.

Postoperative audiogram was usually done 3-6 months after surgery, for surgical success cases and compared with preoperative one. Follow up period was 15 months. The outcome was graded as Successful myringoplasty, the graft was still in situ with absence of residual perforation during follow up. Failure myringoplasty, complete graft failure like graft rejection or presence of residual perforation in T.M during follow up. Effective hearing gain of at least more than 10 dB by comparing mean preoperative and postoperative ABG.

RESULTS

This study included 61ears of 59 patients with chronic tympanic membrane perforations, were 2 cases had bilateral myringoplasty.

Age and sex distribution the age of our patients was 13-55 years with a mean of 27.18 years. Thirty-one patients 52.54% were males and 28 patients 47.45% were females. (Figure 1) and (figure 2)

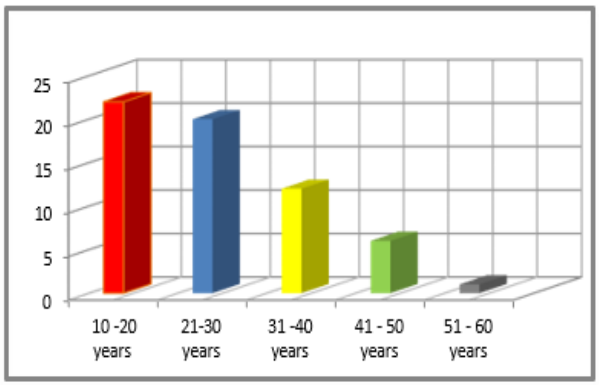

Figure 1 Age distribution of patients.

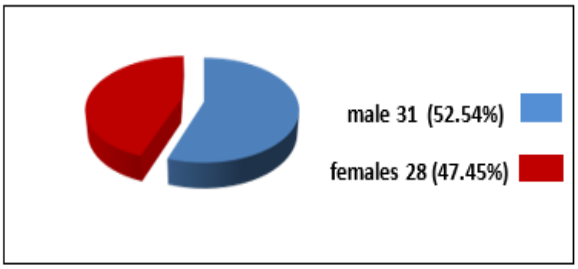

Figure 2 Sex distribution of patients.

Size of tympanic membrane perforation Nineteen ears 31.147% had medium size perforations whereas forty-two ears 68.85% had large size perforations as in (Table 1).

Table 1: Size of tympanic membrane perforations distribution.

size of perforation	No.	%
medium size	19	31.147%
large size	42	68.85%
Total ears	61	100%

Temporalis fascia grafts were used in 12 ears 19.67% whereas 49 ears 80.33% were treated by conchal

cartilage grafts. (Table 2) Type of graft used in procedure.

Table 2: (Graft materials distribution).

Type of graft	No.	Percentage
Temporalis fascia	12	19.67%
Conchal cartilage	49	80.33 %
Total	61	100%

Graft success rate overall, surgical success rate in this series was 86.89%, fifty-three ears out of 61 ears. Whereas the failure rate was 13.11% eight ears out of 61 ears (Table 3).

Table 3: Graft success rate distribution.

Graft success rate	No.	Percentage
Surgical success	53	86.89 %
Surgical failure	8	13.11 %
Total	61	100 %

Relationship between type of graft and success rate, the success rate of fascia group was 58.33%, seven out of 12 ears. On the contrary it was 93.88% for the cartilage group, forty six out of 49 ears. The difference in success rate between two groups was statistically significant (P-value = 0.015) 95% C.I for difference(6.8%; 64.2%)

Table 4: Success Rate In Relation To The Type Of The Graft.

Type of graft	No.	%	success rate No.	%	P_ value
Fascia	12	19.67	7	58.33	0.015*
Cartilage	49	80.33	46	93.88	
Total	61	100	53		

* Z-two proportion was used

Relationship between size of perforation and surgical success.

Nineteen ears with medium size perforations, surgical success rate was 100%. Whereas 42 ears with large size perforations, 34(80.95%) of them succeeded to take graft and 8 (19.04%) were failed (table 5)

Table 5: Surgical Success Rate In Relation To The Size of Perforations.

Size of perforation	Total No	Graft success rat No %	Graft failure rate No %
medium	19	19 (100%)	0
large	42	34 (80,95%)	8 (19.04%)
total	61	53 (86.88%)	8 (13.11 %)

(Table 7): Hearing improvement in surgical success cases.

Hearing gain	No .	Percentage
Significant(>10 dB)	44	83.01%
Not significant(< or = 10 dB)	9	16.98%
total success cases	53	100%

Overall improvement in ABG after myringoplasty from table(8), we can conclude that the overall improvement rate in ABG in surgical success ears was 57.48%.

(Table 8) Difference between mean preoperative and postoperative ABG of surgical success cases

Surgical success rate in relation to size of perforation and graft materials. Nineteen ears with medium size perforations, five of them were treated with temporalis fascia, and fourteen were treated with conchal cartilage, all of them succeeded to take graft. Moreover, forty-two ears had large size perforations, thirty five of them were treated with conchal cartilage and the remainder were treated with temporalis fascia grafts.

The surgical success rate was 91.42% and 28.57% respectively (Table 6)

Statistical analysis revealed that there was no significant association between size of perforation and surgical success rate when cartilage graft was used. (P = 0.548). However, when temporalis fascia used the difference was statistically significant. (P = 0.013) in favoring for medium size perforation.

Table 6: Surgical success rate in relation to the size of perforation and graft materials.

variable		Medium size No. %	Large size No.%	Total No.%	P value
Fascia group	No.	5	7	12	
	success	5(100 %)	2(28.57%)	7 (58.33%)	0.013*
	failure	0	5(71.42%)	5 (41.42%)	
Cartilage group	No.	14	35	49	
	success	14(100 %)	32 (91.42%)	46(93.88%)	0.548**
	failure	0	3(8.57%)	3(8.57%)	
Total No.		19	42	61	

* Fisher Exact's Test

** Z Test for two proportion.

Hearing improvement in surgical success cases Table (7) showed that the hearing gain expressed as reduction in mean postoperative ABG more than 10dB (significant hearing gain) observed in 44(83.01%) out of 53 surgically success ears. Whereas less than or equal to 10dB (non-significant hearing gain) observed in 9(16.98%) ears.

Table 7.

variable	Total No.	Mean	StDev	Min.	Max.	P-value*
Pre. ABG dB	53	35.28	5.99	20	50	0.001
Post. ABG dB	53	15.00	7.27	5	35	

* Paired T- test

Statistical analysis revealed that there was significant improvement in ABG after myringoplasty (P-value = 0.001).Paired T test used for mean preoperative and postoperative ABG : Difference is 20.28 dB. 95% C.I from mean difference (18.74; 22.02) Hearing gain in temporalis fascia group the improvement in ABG of surgical success ears using temporalis fascia was 71.71%, and mean ABG difference was 23.57dB. This difference was statistically significant P- value = 0.001 (Table 9).

Table 9: Mean preoperative ABG and postoperative ABG for fascia group of surgical success cases.

Fascia group	No.	Mean	StDev	SE mean	P-value*
Pre. ABG dB	7	32.85	2.67	1.0360	0.001
Post. ABG dB	7	9.29	3.45	1.30	
Difference		23.57	2.43	0.922	

* Paired T- test. 95% CI for mean difference (21.13; 25.83).

Hearing gain in conchal cartilage group, the improvement in ABG of surgical success ears using conchal cartilage was 55.48% and mean ABG difference was 19.78dB. This difference was statistically significant. P- value = 0.000 (Table 10).

Table 10: Mean Preoperative Abg And Postoperative Abg For Cartilage Group.

Cartilage group	No	Mean	StDev	SE mean	P-value
Pre. ABG dB	46	35.65	6.29	0.8703	0.000 *
Post. ABG dB	46	15.87	7.32	1.08	
Difference		19.78	7.81	1.15	

* Paired T- test. 95% CI for mean difference (17.46 ; 22.10)

Comparison between fascia and cartilage groups in relation to hearing improvement Statistical analysis revealed that there was significant difference between cartilage and fascia groups in relation to hearing improvement P = 0.024.

Table 11: Postoperative ABG of fascia and cartilage groups.

variable	Total No.	Mean	StDev	SE Mean	P- value*
Post. ABG_ Cartilage	46	15.87 dB	7.33	1.1	0.024
Post. ABG_ Fascia	7	9.29 dB	3.43	1.3	

* Two sample T test. Estimated fore difference

95% CI for difference (- 0.0896 ;12.27).

DISCUSSION

Myringoplasty is the operation in which the reconstructive process is limited to repairing a tympanic membrane perforation. The key objectives in the indication of a myringoplasty are two: restoring the integrity of the tympanic membrane and improving hearing in the damaged ear.[5] In this study, two types of autologous grafts namely, temporalis fascia or conchal cartilage have been used to repair tympanic membrane by underlay technique. The characteristics of both graft types, their availability in the operative field and their ease of handling have made them the most commonly used materials in the repair of tympanic membrane defects to date.[6] The criteria to choose the type of grafts in our patients depend on many factors includes; size and site of the tympanic membrane perforations, frequent middle ear discharge or short discharge free periods, preference of surgeons, and patients' needs mastoidectomy in addition to myringoplasty to eradicate hidden mastoid air cells infections. Surgical success rates Black J. H. and Wormald P.J mention factors that implicated in graft take rate like grade of surgeon, size of perforation, infection at time of surgery, Eustachian tube patency, presence of tympanosclerosis, age of patient, previous surgery to that ear, per meatal / postauricular approach and use of middle-ear gel foam.[7]

Overall, the surgical success rate in our study was 86.89%. Our results are comparable to Gersdor VS[8], Karkanevatos et al[9] they reported that the overall success rates were 87.7% and 83.3% respectively. Surgical success rates in relation to the type of grafts. In our study, we found that conchal cartilage myringoplasty had higher surgical success rate (93.88%) than temporalis fascia myringoplasty (58.33%). On comparison, Zulkifal A.et al.[10] reported that the surgical success rate of tragal cartilage was 85% and it was 75% for temporalis fascia. Similarly, Saeed B.M.[11] reported that the success rate of conchal cartilage with perichondrium was 85.71%.Dornhoffer J.L showed that the rigid quality of the cartilage, made it not to lateralize, and particularly applicable for all revision cases as well as certain high-risk primary tympanoplasties, which include a subtotal perforations or perforation in a previously repaired cleft palate, In addition to discharging ears at the time of surgery. Use of cartilage-perichondral graft is well established in treatment of posterior and attic retraction pockets, in recurrent perforation and atelectatic TMs.[12] Harvinder et al.[13] studied 50 cases, with a mean age of 32.08 years, who underwent myringoplasty using temporal fascia in 30 cases using underlay technique. The mean follow-up of the patients was 3 months. the successful closure was achieved in 17(57%) of cases which comparable to our study. It can be concluded that cartilage graft carries higher success rate because it more stable and can resist the negative middle ear pressure, even in cases with chronic Eustachian tube dysfunction. as well as it is well tolerated by the middle ear and shows long-term survival.[14] Surgical success rate in relation to the size of perforations. In our study we found that medium size perforations had highest surgical success rates 100%, whereas the success rate in large size perforations was 80%. Our results are comparable to Mani L.A.[15] reported that the surgical success rate was 87.09% and 75% for medium size and subtotal perforations respectively. On the contrary Lee et al.[16] showed that the success rate for small perforations was 74.1% and 56% for large perforations. It can be conclusion that medium size tympanic perforations have better surgical success rate than large perforations. Large perforations have less margins to support the graft for survive and less tension to resist the tympanic retraction postoperatively.[17],[18] Hearing improvement in successful cases. Myringoplasty improves hearing by two mechanisms, first, closure of the tympanic membrane perforation will restore the vibratory area of the membrane and second, it affords round window protection. It can be concluded that myringoplasty can benefit a large number of patients by improving hearing. This is a simple, cost effective, and less time-consuming surgical procedure with minimal complications.[19] Sheehy and Anderson stated that in most cases of chronic otitis media, even though the ossicular chain may appear normal, there is some factor of scar tissue that prevents total restoration of hearing.[20] In our study significant hearing improvement (more than 10dB) was noticed in 44 out of 53 (83%) of surgical success cases, whereas in the remainder 9 patients (17%) the gain was equal or less than 10dB.However Karela et al[40], 211 patients who underwent myringoplasties were included in his study. All were performed by a post aural approach using autologous temporalis fascia and underlay technique. overall hearing improvement was achieved in 91.5% of cases. On the contrary Yadav et al.[21] performed Myringoplasties in 129 patients, and only those who had graft uptake i.e., 105, were selected for the study, temporalis fascia graft, used with underlay technique. He showed that 74% had hearing improvement of more than 10 dB and 9% had hearing improvement of less than 10 dB. In our study, the overall improvement rate in ABG of surgical success cases was 57.48% and mean closure in ABG was 20.28dB which is comparable with Labatut et al.[22] who showed that the mean ABG improvement was 19 dB. Contrary to a study carried out in China by She et al[44] shows that the mean ABG improvement was 4.9 dB. Whereas Sudhangshu[23], reported that the mean ABG improvement was 11dB.

Hearing gain in temporalis fascia group, two main reasons why many otologists prefer fascia than cartilage are the compliance of operation and the postoperative hearing improvement.[24]

In Our study the improvement rate in ABG in surgical success cases using temporalis fascia was 71.71%, and mean ABG difference was 23.57dB. This difference was statistically significant. Mani L. et al[36], he studied 100 patients of tubo tympanic variety of CSOM. underlay

myringoplasty technique with temporalis fascia as a graft in all cases. Closure in air bone gap was 12.04dB.

Hearing gain in conchal cartilage group It has been shown, both in experimental and clinical studies, that cartilage is well tolerated by the middle ear and shows long-term survival. However, acceptance of routine reconstruction of the tympanic membrane with cartilage has been hampered by its reputation of sacrificing maximum hearing improvement, although various authors have shown that the hearing results are good, regardless of the thickness of the grafts.[25] Reducing cartilage thickness leads to an improvement into acoustic transfer qualities. From an acoustic point of view, 0.1-0.2 mm thick cartilage plate seems to give the best results in term of tympanic membrane vibration.[26] In our study improvement rate in ABG of surgical success cases using conchal cartilage myringoplasty was 55.48% and mean ABG closure was 19.78dB, this difference was also statistically significant. Chen X.W et al.[17] studied 102 patients aged from 13 to 67 years with large tympanic membrane perforations, who had underlay tympanoplasty using a tragal or conchal perichondrium/cartilage graft. showed that the preoperative ABG was 41.66 dB and postoperative ABG of 20 dB achieved in 57 of the 102 patients (55.88%), and cartilage graft with perichondrium at thickness of 0.5mm achieved TM closure in more than 96% of patients and provided satisfying hearing improvement in 85.8% patients, suggesting cartilage/ perichondrium composite graft is efficient in restoring both the integrity of TM and hearing Comparison between temporalis fascia and conchal cartilage in relation to hearing improvement. In our Study mean postoperative ABG with conchal cartilage myringoplasty was 15.87dB, whereas in temporalis fascia myringoplasty was 9.29dB, this difference is significant statistically(P-value =0.024). Gerber et al, studied 11patients with cartilage–perichondrium graft and 11patients with temporalis fascia tympanoplasty underlay technique, showed that the hearing results after cartilage tympanoplasty are comparable to those after temporalis fascia tympanoplasty. There were no statistically significant differences in speech reception threshold improvement or air–bone gap closures between the two groups. Therefore, when indicated, a cartilage–perichondrium graft can be used for prevention of disease recurrence or progression without fear of impairing hearing.[25] On contrary Sunil et al.[4] studied 50 patients with CSOM, in 25 of them used partial tragal cartilage myringoplasty and in other 25 patients used temporalis fascia. Showed that the ABG closure was better in cartilage myringoplasty when compared to temporalis fascia myringoplasty.

CONCLUSIONS

1. Myringoplasty carries high surgical success rates.
2. In our study cartilage myringoplasty carries better surgical success rate than temporalis fascia especially in large perforations.
3. Medium size perforations have better surgical success rates than large perforations.
4. Hearing gain was significant for both cartilage and temporalis fascia myringoplasty.
5. There was significant difference in hearing gain between conchal cartilage and temporalis fascia myringoplasty and in favoring the late.
6. Complications of myringoplasty were infrequent apart from injury to chorda tympani nerve.

Recommendations

1. Myringoplasty is valid treatment modality for chronic tympanic membrane perforations.
2. We believe in using cartilage graft in large size perforations.
3. Site of perforations need to be evaluated in future studies.
4. Children need to be included in further studies to clarify the effects of the age on myringoplasty.
5. More number of fascia myringoplasty cases need to assess in next study.
6. Longer follow up periods need to be studied, to clarify the effect of prolonged follow up on the end result.
7. More number of mastoidectomy with myringoplasty cases in regarding the graft used need to evaluated in further studies.

REFERENCES

1. Glassock M.E. Surgery of the Ear. 4th edition. Philadelphia. WB Saunders, 1990; 334-48.
2. Mudry A. History of myringoplasty and tympanoplasty type I / Otolaryngology Head and Neck Surgery, 2008; 139: 613-614.
3. Barry E.H: Myringoplasty and Tympanoplasty. In: Myers E.N, editors. Operative Otolaryngology Head and Neck Surgery. 2nd Edition Saunders, 2008; 1133-1135.
4. Sunil S Nichlani et al. Reconstruction of the Tympanic Membrane with Partial Tragal cartilage Graft Versus Temporalis Fascia Graft. Bombay Hospital Journal, 2010; 52(2).
5. Crovetto M, Fiz ML, Escobar MA. Myringoplasty in chronic simple otitis media: Comparative analysis of underlay and overlay techniques. Acta otorhinolaringol Esp., 2000; 51: 101-4.
6. Milewski C. Composite graft tympanoplasty in the treatment of ears with advanced middle ear pathology. Laryngoscope, 1993; 103: 1352-6.
7. Black J. H., Wormald P. J. Myringoplasty - effects on hearing and contributing factors. S Afr. Med J., Jan. 1995; 85(1): 41-3.
8. Gersdor V.S Myringoplasty: long term results in adults and children. Am J Otol., 1995; 16(4): 532. Retrieved from www.ivsl.org. accessed in 15/8/2012.
9. Karkanevatos S. De, Srinivasam V.R, et al. Day care myringoplasty: five years experience. J. Laryngol Otol., 2003; 117: 763-5.

10. Zulkifal A, Hussain A, Bashir H. Myringoplasty: A Comparative Study of Different Graft Materials and Various Surgical Techniques. Ann. Pak. Inst. Med. Sci., 2008; 4(4): 209-211.
11. Saeed B.M. Cartilage Tympanoplasty. The Outcome in 35 Patients. JMJ, 2012; 46C1: 45–51.
12. Dornhoffer J.L. Hearing Results With Cartilage Tympanoplasty. Laryngoscope, Aug. 1997; 107(8): 1094-9.
13. Harvinder S, et al. Underlay myringoplasty: comparison of human amniotic membrane to temporalis fascia graft. Med J Malaysia, 2005; 60: 585-9.
14. Duckert LG, Muller J, Makielski KH, Helms J. Composite autograft "shield" reconstruction of remnant tympanic membranes. Am J Otol., 1995; 16: 21-6.
15. Mani L, Khorshed A, Debesh C.T et al. Outcome of myringoplasty Bangladesh J Otorhinolaryngol, October 2009; 15(2): 40-44.
16. Lee P., Kelly G., Mills. R.P. Myringoplasty. Does the size of the perforation matter Clinical otolaryngology and allied sciences, 2002; 27(5): 331-4.
17. Chen X.W, Yang H, Gao R, Rong Y and Gaoz. Perichondrium/cartilage composite graft for repairing large tympanic membrane perforations and hearing improvement. Chinese Medical Journal, 2010; 123(3): 301-304
18. Vrabec JT. Deskin RW, Graby JJ. Meta analysis of pediatric tympanoplasty. Arch Otolaryngol Head Neck Surgery, 1999; 125: 530-4.
19. Karela M, Berry S, Watkins A, Phillipps JJ. Myringoplasty: surgical outcomes and hearing improvement; Eur Arch Otorhinolaryngol, Sep. 2008; 265(9): 1039-42. www.ivsl.org. accessed in 15/8/2012.
20. Sheehy JJ, Anderson RG. Myringoplasty: Areview of 472 Cases. Ann Otol Rhinol Laryngol, 1990; 89: 331-334.
21. Yadav L.K, Shrestha D, Pradhananga J. Hearing improvement after myringoplasties in Bir Hospital, Kathmandu. Journal of College of Medical Sciences-Nepal, 2010; 6(4): 31-35.
22. Labatut P.T, Sierra G.C, Mora R.E. et al. Primary myringoplasties. Results after 2 year follow up period. Acta Otorhinolaryngologica Espanola, 2009; 60(2): 79-83.
23. Sudhangshu S.B. Hearing evaluation after myringoplasty. Bangladesh J Otorhinolaryngol, 2010; 16(1): 23-28.
24. Austin D. F, Glassock M.E. Mechanics of hearing, Surgery of the Ear, 4th edition. Philadelphia. Saunders, 1990; 297-319.
25. Gerber M J, John C.M, Paul R.L. Hearing Results After Primary Cartilage Tympanoplasty. Laryngoscope, 2000; 110: 1994–1999.
26. Wen Y.H, Hsu LP, Peir R.C, Chen F.L et al. Design Optimization of Cartilage Myringoplasty using Finite Element. Tzu Chi Med J., 2006; 18: 5.