Paediatric Type I Cartilage Tympanoplasty with or without Concomitant Adeno-tonsillectomy – An Institutional Experience

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ABSTRACT

Introduction

In the management of COM in paediatric age group, eradication of the septic foci in the tonsil and the adenoids while addressing the dysfunction of Eustachian tube play a key role This study aims to assess the success rate of type I tympanoplasty with cartilage graft in mucosal type of chronic otits media in paediatric age group and finally, whether concomitant adeno-tonsillectomy plays any role in outcome of surgery or curing the disease process.

Materials and Methods

A prospective clinical study was done over a period of one and half years amongst 59 patients, aged between 5 and 12 years, presenting with chronic otitis media with dry central perforation of ear-drum and pure conductive hearing loss. Patients were divided into two groups. Group 1 (n1= 22) underwent type I cartilage tympanoplasty with adenoidectomy/ tonsillectomy/ both in the same sitting and Group 2 (n2= 37) underwent type I cartilage tympanoplasty without any adeno-tonsillectomy.

Results

Graft uptake was 86.4% in Group 1 at 6 months post-operative follow up while that in Group 2 was found to be 86.5%. The mean hearing gain in two groups were found to be 15.91±6.54 dB and 17.02±8.96 dB respectively. No significant difference was found between graft uptakes and hearing gains in two groups at the end of the study.

Conclusion

Type I cartilage shield tympanoplasty, may be considered as an effective management strategy of paediatric chronic otitis media, mucosal disease. Type I tympanoplasty with concomitant adeno-tosillectomy did not prove to be better than type I tympanoplasty alone in terms of anatomic closure of tympanic perforation and hearing gain.

Keywords

Child; Adenoidectomy, Concomitant; Tympanoplasty

Tympanoplasty in children is a long-debated topic amongst Otolaryngologists and a controversial theme, though it is going through different modifications and alterations from time to time. Children usually suffer from recurrent upper respiratory tract infections. The disease usually begins in childhood as a spontaneous tympanic perforation due to acute otitis media, which occurs during the first 6 years of a child's life, with peak around 2 years.[1] The highest rate of perforation is seen in the 2 to 4 years old age group, at which stage, the rate of perforation is roughly 3 times the rate seen in adulthood.

There is always a possibility of failure of the conventional type I tympanoplasty operation in children

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due to recurrent attacks of otitis media. Cartilage has become a good alternative to temporalis fascia, as grafting material, in cases of type I tympanoplasty in both uncomplicated and revision cases, in adults; but more results are needed to establish its efficacy in paediatric population. In childhood, the spectrum of otitis media (AOM, OME and COM) is most commonly associated with Eustachian tube dysfunction secondary to various factors.[3,4,5] Hypertrophied adenoid and chronically inflamed tonsils act as a septic focus in upper respiratory tract in children; which not only cause mechanical obstruction to Eustachian tube, but also act as reservoir of micro-organisms to play a crucial role in pathogenesis of chronic otitis media in children. So, in the management of COM in paediatric age group, eradication of these septic foci and addressing the dysfunction of Eustachian tube play a key role.

In this study, an attempt is made to find out the effectiveness of cartilage in type I tympanoplasty, in terms of graft take rate and hearing results in inactive type of chronic otitis media in paediatric age group with or without concomittant adeno-tonsillectomy. At the same time, our aim is to assess whether concomitant adeno-tonsillectomy proves beneficial for management or alters the final outcome of paediatric type I tympanoplasty.

Materials and Methods

This study was carried out at Department of Otorhinolarryngology of a tertiary care hospital after getting proper approval from the ethical committee. 59 patients were selected for this study, all between 5 and 12 years of age (both the limits included), attended ENT OPD for chronic otitis media, mucosal disease, presenting with dry central perforation of ear drum and pure conductive deafness, over a period of one year. Patients with squamosal disease/cholesteatoma, patients with per-operative findings of ossicular fixity or discontinuity, h/o previous tympanoplasty or mastoid surgery, with sensori-neural or mixed hearing loss, with congenital anomalies of ear-nose-throat and medically unfit patients were excluded from this study.

These patients were placed into two groups, viz. Group 1: patients undergoing type I cartilage tympanoplasty with concomitant adeno-tonsillectomy (n1=22) and Group 2: patients undergoing type I cartilage tympanoplasty only (n2=37). Intactness of the graft, dryness of the ear, pre- and post-operative air-bone gap (in pure tone audiometry) were the parameters studied. Patients with Grade 3 & 4 tonsillar or adenoid enlargement underwent the additive operative procedures as needed along with tympanoplasty.

All the patients were subjected to thorough pre-operative assessment including detailed history and clinical examination (to rule out possible infective foci, if any), along with otoscopy and tuning fork tests. Examination under microscope, pure tone audiometry and Eustachian tube function tests including impedance audiometry were done in every case to select the children with dry central perforation and pure conductive hearing loss.

After proper counseling of patients and parents, written consent was signed regarding the procedures and after getting the fitness regarding general anaesthesia from the anaesthesiologists, patients were admitted for the surgery. Patients posted for surgery received a dose of intravenous antibiotic (preferably Amoxycillin+Clavulanic acid, dose adjusted as per body weight) before surgery.

All the surgical procedures were done under general anaesthesia with endotracheal intubation done by anaesthesiologists. Patients in Group 1 underwent adenoidectomy/ tonsillectomy/ both (by conventional technique) followed by type I tympanoplasty in the same sitting and those in Group 2 underwent type I tympanoplasty alone. No post-operative complication seen in any of adeno-tonsillectomy cases.

Tympanoplasty was done by post aural route (through Wilde's incision). Ossicular integrity and mobility, condition of middle ear mucosa and the opening of Eustachian tube were checked in all cases. Autologus tragal cartilage (without perichondrium on both sides) was harvested by giving a separate incision over the medial surface of the tragus and a piece of cartilage taken out leaving a rim of tragal cartilage on the lateral most part to maintain the contour of tragus. The harvested cartilage was sliced to 0.4 mm thickness using

cartilage slicer. The sliced cartilage was then cut in the shape of tympanic membrane and a 'V' shaped notch was made to incorporate the handle and lateral process of malleus. Graft was placed as underlay; shield and sometimes additional small pieces of cartilage were needed as architrave to support the graft or for proper fitting in the bony annulus. Middle ear was filled with antibiotic soaked gelfoam pieces before placing the graft to support the graft from within and after repositioning of the tympano-meatal flap, external canal also filled with antibiotic soaked pieces of gelfoam. Finally skin and soft tissues were closed in layers. Thereafter all the patients were followed up at 1, 3 and 6 months post-operative to note the anatomic and functional outcome of the surgery and complication, if any.

Pure tone audiometry was done in every case at 3 and 6 months post-operative follow up and hearing gain (Pre-op A-B gap minus Post-op A-B gap) was assessed by comparing it with pre-operative Air-Bone gap.

Results

The patients were selected between the age of 5 and 12 years, both the limits included and statistical analysis (Kolmogorov-Smirnov test with Lillifors significance correction) showed that the observations were not normally distributed. Pearson Chi-square test revealed no statistically significant difference in proportion of males and females in two groups. (Table I)

The graft uptake was compared between the two groups. (Table II) Statistical analysis (Fisher's Exact

Table I: Distribution of patients by their age and sex

GROUPS	AVERAGE AGE (IN YEARS)		SEX		TOTAL
	MEAN ± SD	STATISTICS, DF, P	MALE	FEMALE	
1. (n1=22) AT + CT	9.09± 2.11	0.16,22,0.115	14 (63.6%)	8 (36.4%)	22 (100%)
2. (n2=37) CT	9.30± 2.13	0.16,37,0.011	20 (54.1%)	17 (45.9%)	37 (100%)

[AT+CT=cartilage tympanoplasty with adeno-tonsillectomy, CT=cartilage tympanoplasty, df=degree of freedom, p=significance]

Table II: Comparison of graft uptake rate in cartilage tympanoplasty with or without adeno-tonsillectomy

GROUPS	FOLLOW UPS						TOTAL
	AT 1 MONTH		AT 3 MONTHS		AT 6 MONTHS		
	F	NF	F	NF	F	NF	
1. AT+CT	19 86.4%	3 13.6%	19 86.4%	3 13.6%	19 86.4%	3 13.6%	22 (100%)
2. CT	35 94.6%	2 5.4%	31 83.8%	6 16.2%	32 86.5%	5 13.5%	37 (100%)
TOTAL	54 91.5%	5 8.5%	50 84.7%	9 15.3%	51 86.4%	8 13.6%	59 (100%)

[AT+CT=cartilage tympanoplasty with adeno-tonsillectomy, CT=cartilage tympanoplasty; F=Favorable outcomes (Dry ear, Graft taken up/ Well epithelialized graft) NF=Not favorable/ Unfavorable outcomes (Discharging ear, Residual perforation/ Antero-inferior dehiscence, Graft failure)]

Table III: Hearing gain or improvements (in dB) obtained at 6 months follow up

GROUPS	MEAN±SD	ST. ERROR OF MEAN	MINIMUM, MAXIMUM, RANGE	TEST OF NORMALITY (SHAPIRO-WILK) STATISTIC/ DF/SIG
1. AT+CT	15.91±6.54	1.39	3 /35 /32	0.936/22/0.163
2. CT	17.02±8.96	1.47	3 /46 /43	0.898/37/0.003

[AT+CT= cartilage tympanoplasty with adeno-tonsillectomy, CT=cartilage tympanoplasty; all values in dB]

Test): At 1 month p=0.351 (>0.05), At 3 months p=1.000 (>0.05), At 6 months p=1.000 (>0.05). So, there was no significant differences between graft uptakes in two groups- cartilage tympanoplasty with or without adeno-tonsillectomy at 1, 3, 6 months follow ups.

We recorded the pre-operative A-B gap and post-operative A-B gap at 3 and 6 months follow ups in each of 59 patients irrespective of intervention underwent and calculated the hearing gain (Pre-op A-B gap minus Post-op A-B gap) in each case. Hearing gain at 3 months and 6 months showed negligible differences and we took the results at 6 months for comparison. (Table III).

Analysis showed that hearing gain data in Group 1 were normally distributed (p=0.163>0.05) and those in other group were not normally distributed (p=0.003<0.05). After log transformation of the data in two groups, the test of normality was again performed and the results are shown in Table IV.

As the hearing gain in these two groups are not normally distributed, so non-parametric Mann-Whitney Test was applied to get statistical analysis and the results are shown in Table V.

Table VI shows that there was no significant difference in Hearing gain among these two groups, i.e. Cartilage tympanoplasty with and without Adeno-tonsillectomy (p=0.919>0.05).

Discussion

Otits media is predominantly a disease of infancy and early childhood with peak age specific attack rate occurring between 6 and 18 months of age.[6] A functionally and structurally immature Eustachian tube system[3,4] and an immature immune system[7] are probably the most important factors related to the increased incidence of otitis media in infants and young children. Repeated episodes of acute upper respiratory tract infections (mostly viral, may be bacterial) lead to acute otitis media and otitis media with effusion; which with or without pre-existing pathophysiology of Eustachian tube,[8] result in chronic otitis media in children. Continued E. tube obstruction retards spontaneous closure of the

Table IV: Corrected analysis of data on hearing gain

GROUPS (LOG)	KOLMOGOROV-SMIRNOVA			SHAPIRO-WILK		
	STATISTIC	DF	SIG.	STAISTIC	DF	SIG.
1. AT+CT	0.15	22	0.18	0.88	22	0.01
2. CT	0.15	37	0.02	0.95	37	0.17

Lilliefors significance Correction [AT+CT=cartilage tympanoplasty with adeno-tonsillectomy, CT=cartilage tympanoplasty]

Table V: Results of Mann-Whitney test

	GROUPS	N	MEAN RANK	SUM OF RANKS
HEARING GAIN	1. AT+CT	22	29.7	653.5
	2. CT	37	30.18	1116.5
	TOTAL	59		

[AT+CT=cartilage tympanoplasty with adeno-tonsillectomy, CT=cartilage tympanoplasty]

perforation of eardrum. Chronic otitis media in children is multifactorial[2] which includes genetic, infection, immunologic, allergic, environmental and social factors.

Waldeyer's ring plays an important role in the pathophysiology of upper respiratory tract infection and allergy[7] in paediatric population. Adenoid hypertrophy can cause recurrent acute otitis media (RAOM), otitis media with effusion (OME), Obstructive sleep apnoea syndrome (OSAS) in children.[9] The size of the adenoid causing mechanical obstruction to E. tube, is not the main determinant factor in OME pathogenesis but the degree of bacterial colonization[10] is much more important in COM pathogenesis and a deciding factor whether adenoidectomy should be done in cases of COM or not. Saafan et al10 from Egypt in 2013 and Szalmas et al[9] from Hungary in 2013, have studied extent of surface biofilm of adenoid and evaluated its role in the pathogenesis of COM in children. Large tonsils, per se, have not been found to cause an ear infection to keep coming back; but chronic tonsillitis always acts as a reservoir of infection.

Though tymapnoplasty is considered as gold standard in the management of chronic otits media; when a child presents with a persistent perforation of ear drum, question arises whether early surgery to be attempted to correct the anatomical defect and thereby improving hearing; or the elective surgery is better to be deferred until the peak incidence of AOM has passed.[11,12] Jeffrey et al in 1999 have shown that otologic surgery in children is less successful and argued for tympanoplasty in older age groups.[13] Boronat Echeverria et al in 2012 favored paediatric tympanoplasty on the merit that children present greater risk of retraction, SOM, re-perforation with episodes of AOM and at the same time they coined that, it is technically difficult in doing surgery because of narrowness of external auditory canal and smaller size of ear drum.[14] They have presented arguments in favor of surgery at an earlier age (<5 yrs); though opinion differs in this regard in various studies like not before 7 years (MacDonald et al[15]), 8 years (Koch et al[16]), 10 years (Shih et al[17]) and 12 years (Raine and Singh[18]). On the other hand, long standing or permanent perforation of tympanic membrane can result in long-term irreversible damage to the inner ear in children and early intervention is always needed.[19] So, tympanoplasty in children not only cures the disease but also lessens the hearing handicap and helps in better school performance.

Though temporalis fascia is a time tested grafting material in tympanoplasty, various authors have used cartilage myringoplasty in different situations like E. tube dysfunction, retraction pockets, subtotal to total perforations, revision tympanoplasty, ear discharging at the time of surgery, myringoplasty in children etc.[20,21,22] Because of its thickness, rigidity and mechanical stability, cartilage can resist resorption and retraction; it is more resistant to infection and able to withstand adverse states of the graft bed as its vascular demands are less compared to other materials. Since tragal cartilage is yellow fibroelastic cartilage, formed mainly by type II collagen,[23] which is also the main type in lamina propria of tympanic membrane and it is easily available at operative field, a thin tragal cartilage graft would be a better option as grafting material. The rigidity of the cartilage that prevents re-perforation however has been questioned to interfere with sound conduction.[24] The cartilage slices <0.5 mm thick are similar to the tympanic

Table VI: Statistical analysis of the data on the hearing gain

	HEARING GAIN
Mann-Whitney U	**400.5**
Wilcoxon W	**653.5**
Z	**-0.102**
Asymp. Sig (2-tailed)	**0.919**

membrane in their acoustic properties.[25,26]

In general, studies support no single conclusion about the usefulness of previous adenoidectomy/tonsillectomy for major ear surgery. While Gianoli et al[27] and Charlett et al[28] favored adenoidectomy and showed that success rate of tympanoplasty depends on it; Ophir et al[29] concluded that adenoidectomy is not related to the success of paediatric myringoplasty. Vartiainen et al found that all failure cases of paediatric tympanoplasties occurred in those who underwent previous adeno-tonsillectomy.[30]

Many authors consider that a 4 to 6 weeks interval is needed between adeno-tonsillectomy and tympanoplasty to resolve post-operative mucosal oedema that may block E. tube function.[31] Although large studies regarding paediatric cartilage tympanoplasty (seven such in PubMed listed below) and its relation with previous adeno-tonsillectomy (two such in PubMed listed below) are available in contemporary literature, paediatric tympanoplasty with or without concomitant adeno-tonsillectomy study has not been done in recent times (no study found in pub med). (Table VII)

In the present study, type I tympanoplasty and adeno-tonsillectomy were done in the same sitting in one of the study groups in view of the facts that- i) it prevents the child from repeated exposure to general anaesthesia and related hazards, ii) parents counseling is also easier, iii) more easy to follow up in our set up, iv) if adenoidectomy or tonsillectomy or both be done in expert hands and in precise way with modern instruments, it does not cause any E.tube injury or local oedema to hamper E.tube function so as to be the reason behind tympanoplasty failure.

So, the anatomic and functional results of this study are comparable with the available series in the literature

Conclusion

From this study, we can see that tympanoplasty is still the gold-standard in the management of inactive mucosal type of chronic otitis media in paediatric age group and can be well advocated in the patients of age 5 years and above. Type I cartilage shield tympanoplasty, using sliced (<0.5 mm thickness) tragal cartilage in post-aural route is a good solution to paediatric COM, inactive type, where it can effectively tackle the issues like E.tube dysfunction, recurrent URTI, retraction of ear drum, re-perforation and different anatomic and physiologic variations of middle ear cleft in paediatric age group. Graft uptake and hearing results of Type I cartilage shield tympanoplasty were satisfactory (>86% and >15 dB hearing gain respectively) in this study and hence cartilage may be used more liberally in paediatric type I tympanoplasty as grafting material. And Removal of septic focus (adenoidectomy/ tonsillectomy/ both) plays a vital role in the management of mucosal disease, however, type I tympanoplasty with adeno-tonsillectomy in the same sitting did not prove to be better or beneficial than type I tympanoplasty alone in terms of anatomic closure and hearing gain.

Table VII: Comparison of Graft Uptake and Hearing Results among Different Studies

STUDY/ AUTHOR	ANATOMIC SUCCESS RATE	HEARING RESULTS
Paediatric Cartilage Tympanoplasty		
Diaa M El-Hennawi, 2001, Egypt.[32]	86.60%	Excellent post-operative hearing gain, though delayed up to 6 months
Couloigner Vincent et al, 2005, France.[33]	71%, may be increased up to 81%	Hearing levels were not different from those obtained with underlay temporalis fascia tympanoplasty
Gaslin M et al, 2007, USA.[34]	85.70%	93.8% patients achieved post-op A-B gap< 20 dB; Mean improvement in A-B gap 10.7 dB
Albirmawy OA, 2010, Egypt.[35]	95%	Trends towards better post-operative results in cartilage 'ring' graft compared to temporalis fascia
Nevoux J et al, 2011, France.[36]	87.30%	Closure of the average A-B gap within 20 dB achieved in 62.2% at 1 year; Mean pre-op ABG 25±11.8 dB, post-op ABG 18.9±10.3 dB
Adva B Friedman MD et al, 2012, USA.[37]	95%	Improvement in PTA post-operatively – 10.23(<7yr), 12.5(7-10yr), 3.95(10-13yr) dB
Yilmaz MS et al, 2013, Turkey.[38]	41 out of 45 i.e. 91.1%	Mean pre-op PTA 30.6±7.7 dB and post-op PTA 17.8±7.8 dB
Paediatric Cartilage Tympanoplasty + Adenoidectomy/ Tonsillectomy		
Gianoli G et al, 199527	75%	
Charlett SD et al, 200928	79.10%	
Present study		
Cartilage tympanoplasty + Adenotonsillectomy	86.40%	Mean hearing gain/improvement 15.91±6.54 dB at 6 months
Cartilage tympanoplasty	86.50%	Mean hearing gain/improvement 17.02±8.96 dB at 6 months

References

1. Charles D. Bluestone; Epidemiology; Eustachian Tube: structure, function, role in otitis media. Vol 2, BC Decker 2005; 11-12
2. Hamilton J. Chronic otitis media in childhood; Scott Brown's Otorhinolaryngology, Head and Neck Surgery, 7th ed, 2008; volume 1; Hodder Arnold; 933
3. Bluestone CD. Anatomy; Eustachian Tube: structure, function, role in otitis media; Vol 2, Hamilton BC Decker, 2005; 25-32
4. Bluestone CD. Physiology; Eustachian Tube: structure, function, role in otitis media; Vol.2, Hamilton BC Decker, 2005; 51-66
5. Bluestone CD, Eustachian Tube: Structure, Function, Role in Otitis Media; Vol. 2; Ch. 5, Ed. Bluestone MB; 2005, BC Decker 2005; 67-91
6. Darrow D H, Derkay CS. Otitis Media; Complications in Pediatric Otolaryngology; Ed. Josephson GD, Wohl DL. Broken Sound Parkway NW, Taylor & Francis 2005; 445
7. Bluestone CD. Eustachian tube function: physiology, pathophysiology and role of allergy in pathogenesis of otitis media. J Allergy Clin Immunol. 1983; 72(3): 242-51
8. Bluestone CD. Conquering Otitis Media, An illustrated guide to understanding, treating and preventing ear infections; Ed. Bluestone MB; Ch.5, BC Decker 1999; 16-24
9. Szalmás A, Papp Z, Csomor P, et al. Microbiological profile of adenoid hypertrophy correlates to clinical diagnosis in children. Biomed Res Int. 2013;2013:629607. doi:10.1155/2013/629607
10. Saafan ME, Ibrahim WS, Tomoum MO. Role of adenoid biofilm in chronic otitis media with effusion in children. Eur Arch Otorhinolaryngol. 2013 Sep; 270(9): 2417- 25
11. Dornhoffer JL. Cartilage tympanoplasty. Otolaryngol Clin N Am. 2006; 39: 1161-76
12. Buchwach KA, Birck HG. Serous otitis media and type 1 tympanoplasties in children. A retrospective study. Ann Otol Rhinol Laryngol Suppl. 1980; 89(3 Pt 2):324-5
13. Vrabec JT, Deskin RW, Grady JJ; Metaanalysis of Pediatric Tympanoplasty; Arch Otolaryngol Head Neck Surg.1999; 125(5):530-4
14. Boronat-Echeverría NE, Reyes-García E, Sevilla-Delgado Y et al. Prognostic factors of successful tympanoplasty in pediatric patients: a cohort study. BMC Pediatrics 2012, 12:67. https://doi.org/10.1186/1471-2431-12-67
15. MacDonald RR 3rd, Lusk RP, Muntz HR. Fasciaform myringoplasty in children. Arch Otolaryngol Head Neck Surg. 1994; 120(2):138-43. doi:10.1001/archotol.1994.01880260010003
16. Koch WM, Friedman EM, McGill TJ, Healy GB. Tympanoplasty in children. The Boston Children's Hospital experience. Arch Otolaryngol Head Neck Surg. 1990;116(1):35-40. doi:10.1001/archotol.1990.01870010039013
17. Shih L, de Tar T, Crabtree JA. Myringoplasty in children. Otolaryngol Head Neck Surg. 1991; 105: 74-7
18. Raine CH, Singh SD. Tympanoplasty in children: A review of 114 cases. J Laryngol Otol. 1983; 97(3):217-21
19. Knapik M, Saliba I. Pediatric Myringoplasty: a study of factors affecting outcome. Int J Pediatr Otorhinolaryngol. 2011; 75(6): 818-23
20. Milewski C. Composite graft tympanoplasty in the treatment of ears with advanced middle ear pathology. Laryngoscope 1993; 103:1352-1356
21. Amedee RG, Mann WJ, Riechelmann H. Cartilage palisade tympanoplasty. Am J Otol. 1989; 10(6):447-50
22. Duckert LG, Muller J, Makielski KH, et al. Composite autograft "shield" reconstruction of remnant tympanic membranes. Am J Otol. 1995; 16(1):21-6
23. Ross MH, Romrell LJ. Connective tissue. In: Histology: a text and atlas, vol. 89, 2nd ed. Baltimore, Williams and Wilkins 1989.
24. Singh I. editor. Textbook of human histology. New Delhi Jaypee Brothers Medical Publishers 2004; 89-93
25. Zahnert T, Huttenbrink KB, Murbe D, Bornitz M. Experimental investigations of the use of cartilage in tympanic membrane reconstruction. Am J Otol. 2000; 21:322-8 26. Mürbe D, Zahnert T, Bornitz M, Hüttenbrink KB. Acoustic properties of different cartilage reconstruction techniques of the tympanic membrane. Laryngoscope 2002; 112(10):1769-76. doi:10.1097/00005537-200210000-00012
26. Gianoli GJ, Worley NK, Guarisco JL; Pediatric Tympanoplasty: the role of adenoidectomy; Otolaryngol Head neck Surg. 1995;113(4): 380-6
27. Charlett SD, Knight LC. Pediatric myringoplasty: does previous adenoidectomy improve the likelihood of perforation closure? Otol Neurotol. 2009; 30(7):939-42
28. Ophir D, Porat M, Marshak G. Myringoplasty in the pediatric population; Arch Otolaryngol Head Neck Surg. 1987; 113(12): 1288-90
29. Vartiainen E, Vartiainen J. Tympanoplasty in young patients: the role of adenoidectomy; Otolaryngol Head neck Surg. 1997; 117(6): 583-5
30. Wohl DL, Belenkay WM. Otologic Surgery; Complications in Pediatric Otolaryngology. Eds. Josephson GD, Wohl DL. Broken Sound Parkway NW, Taylor & Francis 2005; 480
31. El-Hennawi DM. Cartilage perichondrium composite graft (CPCG) in pediatric tympanoplasty. Int J Ped Otorhinolaryngol.

2001; 59(1):1-5

32. Couloigner V, Baculard F, El Bakkouri W, Viala P, et al. Inlay Butterfly Cartilage Tympanoplasty in Children. Pediatric Otology and Neurology 2005; 26(2):247-5
33. Gaslin M, O'Reilly RC, Morlet T, McCormick M. Pediatric cartilage
34. interleave tympanoplasty. Otolaryngol Head Neck Surg. 2007; 137(2):284-8
35. Albirmawy OA. Comparison between cartilage-perichondrium composite "ring" graft and temporalis fascia in type one tympanoplasty in children. J Laryngol Otol. 2010; 124(9); 967-74
36. Nevoux J, Roger G, Chauvin P, Denoyelle F, Garabedian EN. Cartilage shield tympanoplasty in children: review of 268 consecutive cases; Arch Otolaryngol Head Neck Surg. 2011; 137 (1): 24-9
37. Friedman AB, Dornhoffer JL. Outcomes of cartilage tympanoplasty in pediatric patients. Otolaryngol Head Neck Surg. 2012; 147(2 suppl):102
38. Yilmaz MS, Guven M, Kayabasoglu G, Varli AF. Comparison of the anatomic and hearing outcomes of cartilage type 1 tympanoplasty in pediatric and adult patients. Eur Arch Otorhinolaryngol. 2015; 272(3):557-62. doi:10.1007/s00405-013-2869-2.