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. 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.
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.\textsuperscript{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 concomitant adenotonsilllectomy. At the same time, our aim is to assess whether concomitant adenotonsilllectomy 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 Otorhinolaryngology 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 (n=22) and Group 2: patients undergoing type I cartilage tympanoplasty only (n=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 adenoidealctomy/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). Oscillar 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

| GROUPS | AVERAGE AGE (IN YEARS) | SEX |
|--------|------------------------|-----|
|        | MEAN ± SD | STATISTICS, DF, p | MALE | FEMALE | TOTAL |
| 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]

| GROUPS | FOLLOW UPS |
|--------|------------|
|        | 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)]
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

Otitis media is predominantly a disease of infancy and early childhood with peak age specific attack rate occurring between 6 and 18 months of age. A functionally and structurally immature Eustachian tube system and an immature immune system 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, result in chronic otitis media in children. Continued E. tube obstruction retards spontaneous closure of the

### 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]

### Table IV: Corrected analysis of data on hearing gain

| GROUPS (LOG) | KOLMOGOROV-SMIRNOVA | SHAPIRO-WILK |
|--------------|---------------------|--------------|
|              | STATISTIC | DF  | SIG. | STATISTIC | 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]
perforation of eardrum. Chronic otitis media in children is multifactorial 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 in paediatric population. Adenoid hypertrophy can cause recurrent acute otitis media (RAOM), otitis media with effusion (OME), Obstructive sleep apnoea syndrome (OSAS) in children. 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 is much more important in COM pathogenesis and a deciding factor whether adenoidectomy should be done in cases of COM or not. Saafan et al from Egypt in 2013 and Szalmas et al 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 tympanoplasty is considered as gold standard in the management of chronic otitis 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. Jeffery et al in 1999 have shown that otologic surgery in children is less successful and argued for tympanoplasty in older age groups. 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. 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), 8 years (Koch et al), 10 years (Shih et al) and 12 years (Raine and Singh). 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. So, tympanoplasty in children not only cures the disease but also lessens the hearing handicap and helps in better school performance.

Table V: Results of Mann-Whitney test

| GROUPS  | N  | MEAN RANK | SUM OF RANKS |
|---------|----|-----------|--------------|
| 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]
membrane in their acoustic properties.\textsuperscript{25,26}

In general, studies support no single conclusion about the usefulness of previous adenoidectomy/tonsillectomy for major ear surgery. While Gianoli et al\textsuperscript{27} and Charlett et al\textsuperscript{28} favored adenoidectomy and showed that success rate of tympanoplasty depends on it; Ophir et al\textsuperscript{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.\textsuperscript{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.\textsuperscript{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

\textbf{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.

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