Impact of tympanoplasty on tinnitus using tinnitogram

Original Article

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ABSTRACT

Introduction: Chronic Suppurative otitis Media (CSOM) and tympanic membrane perforation are leading causes of mild to moderate conductive acquired hearing loss worldwide that may lead to tinnitus.

Aim: This study is designed to evaluate the postoperative various potential effects of tympanoplasty on tinnitus in patients with central tympanic membrane perforation using different methods of testing including tinnitogram.

Methods: This study was carried out in: Oto-rhinolaryngology department – El Azhar University Hospitals and Oto-rhinolaryngology department Hearing and Speech institute in Giza (from March 2016 to March 2018). One hundred ears with central tympanic membrane perforation of one hundred patients were included in this study and it was designed as a prospective randomized study. Typmpanoplasty was done for all the ears with preoperative and postoperative audiological assessment and tinnitogram and Tinnitus Handicap Inventory.

Results: Overall improvement by comparing pre-operative and post-operative results revealed that Tinnitus Handicap Inventory score improvement mean was (67.25), loudness threshold decrease mean was (35.71) and average Air Bone Gap improvement mean was (44.13).

Conclusion: Patients with tinnitus and hearing loss are excellent candidates to undergo tympanoplasty in order to control tinnitus by hearing improvement. Our study results proved that Repair of tympanic membrane perforation will improve hearing outcome and decrease burden of tinnitus complaint on patient's life.

Key Words: Tinnitus, tympanoplasty, tinnitus handicap inventory tinnitogram

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INTRODUCTION

Tympanoplasty is a common operation used to reconstruct the eardrum and ossicles, the main goals of treatment for CSOM are to relieve symptoms, rehabilitate hearing, and minimize complications and drainage[1]. Some patients, however, do not tolerate tinnitus and ask physicians about the results of surgery in relation to tinnitus[2]. Conventionally, tympanoplasty is performed under an operative microscope. Recently, endoscopic ear surgery is done all over the world[3]. The post-operative results of patients after surgical intervention of chronic suppurative otitis media are assessed by clinical examination and audiological evaluation[4]. However, the criteria for the post-tympanoplasty clinical improvement may not reflect the satisfaction expressed by the patient[5]. Although its association with exclusively conductive hearing loss is very little studied, it is full of relevance because the conductive component is more commonly reverted with treatment, when compared with its sensori-neural counterpart[6].

AIM

This study is designed to evaluate the postoperative various potential effects of tympanoplasty on tinnitus in patients with central tympanic membrane perforation using different methods of testing including tinnitogram.

METHODS

This study was carried out in: Oto-rhinolaryngology department – El Azhar University Hospitals and Oto-rhinolaryngology department Hearing and Speech institute in Giza (from March 2016 to March 2018). One hundred ears with central tympanic membrane perforation of one hundred patients were included in this study and it was designed as a prospective randomized study. Typmpanoplasty was done for all the ears with preoperative and postoperative audiological assessment and tinnitogram and Tinnitus Handicap Inventory. The following factors were considered in this work: Site and

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Size of tympanic membrane perforation, Integrity of the ossicular chain, Presence or absence of middle ear adhesions or fibrotic bands, Exposure of the round window or Eustachian tube orifice through perforation, Type of graft used for tympanoplasty either [fascia or thinned chondro-perichondrium from tragal or conchal cartilage], Recorded unexpected middle ear pathology during surgery. Inclusion criteria: All patient aged 18-45 years old undergone tympanoplasty were included and we excluded patients with SNHL and medically unfit for surgery.

Ethical committee

This study followed all principles of declaration of Helsiniki and approved by El-Azhar ethical committee.

The evaluation of each patient was conducted pre-operatively and three months post operatively. The following was performed: Taking a thorough full medical history, Complete general and local examination including fairly comprehensive otologic examination. Completion of Tinnitus Handicap inventory (THI), Otoscopic examination and microscopic examination of the ear canal and tympanic membrane with detailed description of the findings. All patients under study were subjected to routine audiologic testing which provides an assessment of the patient′s hearing and a basis for subsequent tinnitus measurement, using the following equipments: Sound treated room, (Amplisilence Model E), Two-channel pure tone audiometer: Interacoustics AC 40, caliberated according to the ISO standards, TDH 39 headphones and bone vibrator radio ear B71. Pure tone audiometry: Air conduction in the frequency range of 250-8000Hz., Bone conduction in the frequency range of 500-4000Hz.

Speech audiometry; including: Speech reception threshold (SRT), using Arabic (Soliman, *et al* 1985)[7] spondaic words, Word discrimination score (WDS), using Arabic phoetically balanced (PB) words (Soliman 1976)[8]. Immittancemetry using Immittance meter: Interacoustics AZ 26 with single-cmponent, single-frequency probe tone 226 Hz, calibrated according to the ISO standards.

Acoustic reflexes were presented contralaterally using headphones TDH 39 to test frequencies in frequency range (500-4000) in octave intervals. Specific tinnitus measurements (Tinnitogram) using same audiometer were applied to the contralateral ear (ear contralateral to perforated tympanic membrane with tinnitus): Tinnitus pitch match (TPM);We started at 1000 Hz and moved up and down in frequency, sometimes we used narrow band noise for pitch matching, Tinnitus loudness match (TLM); Patient threshold was determined at frequency of pitch matching, sound level was then increased in small steps (1 or 2 dB increments) until patient reported that specific tone was just equal in loudness to his tinnitus. The dB level of loudness match was in dB sensation level (dB SL) i.e. dB above threshold. Repetition was sometimes necessary to confirm reliability of measurements. Surgical intervention techniques: The patients were operated upon under supervision of the first two senior authors at El-Azhar university hospitals and senior staff of hearing and speech institute. All procedures were performed under general anesthesia, through a post auricular approach. In (66) ears of (66) patients, temporalis fascia including both superficial and deep layers was harvested through the retro-auricular incision. (25) ears of (25) patients underwent harvesting tragal cartilage together with perichondrium on both sides through medial surface incision in tragus and subcutaneous inferior cut was made as low as possible to gain most of tragal cartilage.

The perichondrium was peeled at the convex side, The cartilage perichondrium graft was prepared by dissecting perichondrium off one side only, keeping the attachment of other side and the surface covered with perichondrium was directed laterally. Conchal chondro-perichondrium was harvested in (9) ears of (9) patients through same post auricular incision.

The choice of conchal cartilage was the surgeon's choice in (6) as this is his ordinary technique, one patient had deformed tragus, one patient had old trauma that resulted in tragus fracture and the latter patient had very thin tragal cartilage.

Statistical analysis

Data analysis was performed using the software SPSS (Statistical Package for the Social Sciences) version 20. Quantitative variables were described using their means and standard deviations. Categorical variables were described using their absolute frequencies.

Kolmogor¬ov-Smirnov (distribution-type) and Levene (homogeneity of variances) tests were used to verify assumptions for use in parametric tests. To compare means of two groups, independent sample t test was used when appropriate

RESULTS

In the present study, 100 ears of 100 patients were included with no bilateral cases at same patient, patients age ranged from 18 to 40 years, they were 52 males and 48 females, 51 of them live in urban areas, majority of them(69) were non-smokers and 23 of them smoke cigarette and 8 smoke Goza. All patients included in this study had central tympanic membrane perforation and complaining of tinnitus as one of their main complaints, besides 57 of them complained mainly from hearing loss, 39 from otalgia and 4 of them complained mainly from intermittent ear discharge. Overall improvement by comparing pre-operative and post-operative results revealed that THI score improvement mean was (67.25), loudness threshold decrease mean was (35.71) and average ABG improvement mean was (44.13)

(Tables 1,2,4). There is statistically significant difference between percent change in THI and size of perforation and large perforation group of patients were the main cause of this result (Table 3). There is significant difference between presence of exposed round window, site of perforation and percent change in ABG (Tables 5,6). There are statistically significant differences between THI scores and loudness threshold pre-operatively and post-operatively within and between both groups (Table 7) (Figures 1,2).

Table 1: Comparison between preoperative and postoperative tinnitus handicap inventory (THI) findings of study patients

	Preop.	Postop.	Wilcoxon Test	*P value*
Score :				
Median	68	22	-8.694	<0.001**
Range	28 - 94	6 - 52		
Grade:				
Median	4	2	-8.841	<0.001**
Range	2 - 5	1 - 3		

***p*≤0.001 is highly significant

Table 2: Relations between preoperative data and improvement in THI

	THI % change Mean ± SD	t	*p*
Exposed round window:			
Noise exposure	68.1 ± 7.48	0.759	0.348
No noise exposure	65.69 ± 17.92		
Exposed Eustachian tube:			
Absent	67.56 ± 11.51	0.400	0.690
Present	66.47 ± 13.86		
Site of perforation:			
Antro-superior portion	69.29 ± 9.93		
Antro-inferior portion	64.98 ± 15.92	F=1.379	0.254
Postro-inferior portion	67.27 ± 8.87		
Postro-superior portion	71.53 ± 4.71		
Size of perforation:			
Small	69.38 ± 6.96	F=7.592	0.001**
Medium sized	69.81 ± 8.18		
Large	58.95 ± 12.15∞		

∞Group responsible for statistical significant difference (large perforation)
***p*≤0.001 is highly significant

Table 3: Relations between intra-operative data and improvement in THI

	THI % change Mean ± SD	t	*p*
Adhesion fibrotic band:			
Absent (78)	67.01 ± 13.01	-1.339	0.184
Present (2)	68.92 ± 1.16		
Double perforation:			
Absent (77)	66.87 ± 12.26	-1.559	0.122
Present (3)	76.47 ± 0		
Edematous mucosa:			
Absent (77)	68.95 ± 6.28	1.44	0.156
Present (3)	65.18 ± 16.61		
Severely retracted handle:			
Absent (66)	66.64 ± 13.15	-2.049	0.039*
Present (14)	70.28 ± 4		
Ossicular chain erosion:			
Absent (71)	64.99 ± 12.05	-3.074	0.003*
Present (9)	77.45 ± 7.5		
Cortical mastoidectomy:			
Not done (75)	74.51 ± 5.13	8.36	<0.001**
Done (5)	58.02 ± 12.27		
Graft taken:			
Tragal chondro perichondrium (20)	51.61 ± 19.41∞	F=16.629	<0.001**
Conchal chondro-perichondrium (7)	68.18± 0		
Temporalis fascia (53)	71.78 ± 7.63		

∞ Group responsible for statistical significant difference
* *p*<0.05 is statistically significant **p≤0.001 is highly significant

Table 4: Correlation between various parameters and improvement in THI

Percent change in THI	r	*p*
Age	0.029	0.744
Pre-operative Loudness threshold	0.02	0.845
Pre-operative Average air bone gap	-0.414	<0.001**
Post-operative Loudness threshold	-0.194	0.053
Post-operative Average air bone gap	-0.711	<0.001**
Percent change in loudness threshold	0.198	0.048*

**p* <0.05 is statistically significant
***p*≤0.001 is highly significant

Table 5: Pre-operative data and improvement in average air bone gap

	improvement in ABG		*p*
	Mean ± SD	t	
Exposed round window:			
Absent (52)	41.18 ± 15.37	-2.905	0.005*
Present(28)	49.6 ± 10.32		
Exposed Eustachian tube:			
Absent (58)	44.64 ± 15.45	0.570	0.570
Present (22)	42.81 ± 11.09		
Site of perforation:			
Antro-superior (6)	31.25 ± 6.68∞		
Antro-inferior (35)	42.22 ± 15.82	F=3.657	0.015*
Postro-inferior (24)	47.35± 10.74		
Postro-superior (15)	48.27 ± 15.09		
Size of perforation:			
Small (11)	42.25 ± 13.16	F=0.907	0.407
Medium sized (51)	43.26 ± 14.72		
Large (18)	47.61 ± 13.91		

∞ Group responsible for statistical significant difference
*p<0.05 is statistically significant
**p≤0.001 is highly significant

Table 6: Intraoperative data and improvement in average bone gap

	improvement in ABG		*p*
	Mean ± SD	t	
Adhesion fibrotic band:			
Absent (78)	42.46 ± 14.67	-8.098	<0.001**
Present (2)	55.24 ± 0.49		
Double perforation:			
Absent (77)	43.4 ± 14.17	-12.538	<0.001**
Present (3)	61.54 ± 0		
Edematous mucosa:			
Absent (77)	40.67 ± 15.79	-2.748	0.005*
Present (3)	48.34 ± 11.11		
Severely retracted handle:			
Absent (66)	41.14 ± 13.82	-9.039	<0.001**
Present (14)	58.72 ± 4.65		
Ossicular chain erosion:			
Absent (71)	43.05 ± 14.79	-4.967	<0.001**
Present (9)	52.87± 3.98		
Cortical mastoidectomy:			
Not done (75)	45.61 ± 16.84	1.234	0.122
Done (5)	42.24 ± 10.21		
Graft taken:			
Tragal chondro-perichondrium (20)	40.41 ± 11.25	F=3.158	0.028*
Conchal chondro-perichondrium (7)	55.56 ± 0∞		
Temporalis fascia (53)	44.42 ± 14.34		

∞ Group responsible for statistical significant difference
*p<0.05 is statistically significant
**p≤0.001 is highly significant

Table 7: Intraoperative data and improvement in average bone gap

	Pre-op. Average air bone gap		t	*p*
	Group 1 (<15db)	Group 2 (≥15 db)		
	Mean±SD	Mean±SD		
Pre-operative THI	40 ± 12.83	70.52 ± 12.04	-6.843	<0.001**
Post-operative THI	9 ± 3.21	23.63 ± 9.72	-4.211	<0.001**
Paired sample t test	9.113	36.001		
p	<0.001**	<0.001**		
Pre-operative loudness threshold	25 ± 5.35	46.7 ± 9.41	-6.411	<0.001**
Post-operative loudness threshold	18 ± 5.35	29.68 ± 10.61	-3.071	0.003*
Paired sample t test		14.798		
p		<0.001**		

t independent sample t test
*p<0.05 is significant
**p≤0.001 is highly significant

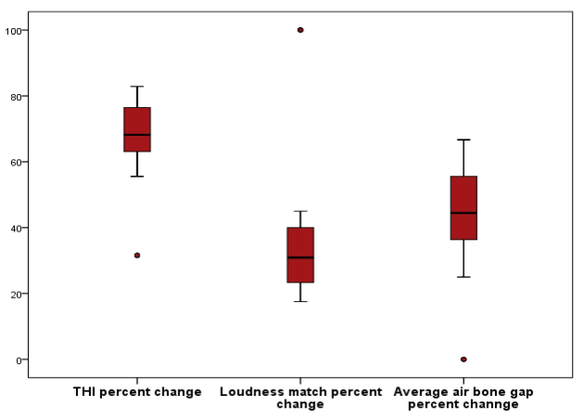

Fig. 1: Boxplot showing percent change in THI, loudness match and average air bone gap

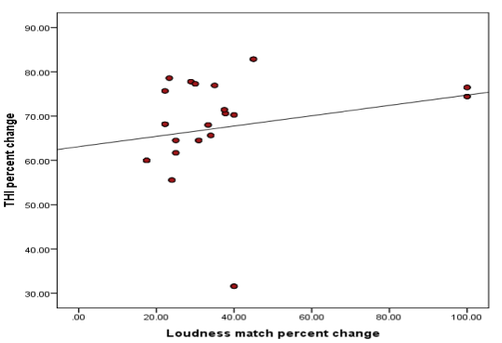

Fig. 2: scatter graph showing insignificant positive correlation between percent change in loudness match and percent change in THI

DISCUSSION

Tinnitus is considered as an abnormal activity of the auditory pathway, usually interpreted as a sound by the central nervous system. The association between tinnitus and hearing loss happens in 85 to 96% of the cases[6]. Tympanoplasty usually improve tonal thresholds and the favorable tinnitus results are very likely a consequence of this improvement, since the proper vibration of middle ear fluids re-establishes both afferent and efferent stimuli.

We planned our study to exclude patients who have or developed sensori-neural or mixed hearing loss preoperatively and in the postoperative follow up period in order to exclude tinnitus that is caused by this component. We think that patients with milder hearing loss and concomitant tinnitus mostly will have significant hearing gain and tinnitus improvement.

Saito *et al*. (1999)[9] reported tinnitus improvement in 50% of the patients by different middle ear diseases; of those, 22 are cases of chronic otitis media, five of chronic cholesteatomatous otitis media, two of ossicular chain malformations and one of otospongiosis. Differently from this, Helms (1981)[10] reported tinnitus remission after surgery in 1/3 of the patients, also remaining unaltered and getting worse in 1/3, respectively. Hearing loss, even with a primary conductive characteristic, causes a reduction in afferent stimuli of the central auditory pathways. Since the efferent pathways have modulating properties, hearing loss reduces its suppressive action because it is no longer necessary. The efferent pathways dysfunction is one of the possible mechanisms causing tinnitus.

CONCLUSION

Patients with tinnitus and hearing loss are excellent candidates to undergo tympanoplasty in order to control tinnitus by hearing improvement (Figures 3,4). We recommend Tinnitus Handicap Inventory as a self-report measure that can be used in a busy clinical practice to quantify the impact of tinnitus on daily living. Also, Tinnitogram is a reliable accurate technique for tinnitus accurate testing.

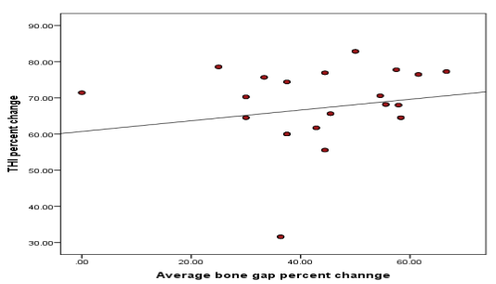

Fig. 3: scatter-dot showing insignificant positive correlation between percent change in ABG and percent change in THI

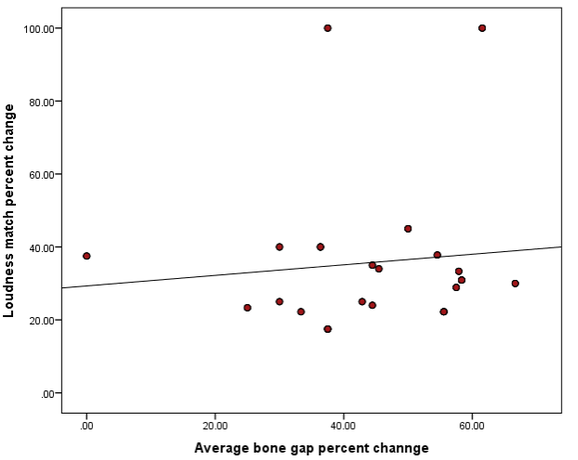

Fig. 4: scatter dot showing insignificant positive correlation between percent change in ABG and percent change in loudness match

CONFLICT OF INTERESTS

There are no conflict of interest

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