

# Spontaneous Healing of Traumatic Tympanic Membrane Perforation

Mohammed Radeef Dawood, FICMS

Date Submitted: 12/10/2014

Date Accepted: 7/12/2014

## Address for Correspondence:

Dr. Mohammed Radeef Dawood  
College of Medicine, Al-Mustansiriyah  
University, Baghdad, Iraq,  
Email mohmadradeef@yahoo.com

## Abstract

**Background:** The tympanic membrane is an important component of sound conduction system, as an ear trauma may lead to its rupture, so non healed perforation will result in impairment of its function.

**Aims:** To evaluate the factors those have influence on the spontaneous healing of the traumatic tympanic membrane perforations, and their relation, with various types of ear trauma.

**Patients and methods:** A descriptive study of 62 patients attended the Otolaryngology Department / Al-Yarmouk Teaching Hospital in Baghdad, from September 1st 2012 to September 1st 2013, with recent ear trauma, resulted in rupture of their tympanic membrane. The diagnosis was made by history of the ear trauma and otoscopy. The frequency of spontaneous healing was assessed by regular follow up, by the author.

**Results:** The most common type of the ear trauma was blast injury in 43.5%; and the most affected age group was 20-29 years 40.3%. In all types of ear trauma, male were mainly affected, except in slap injury. The smallest size perforation was 51.5%, and it is found in 93.8% of slap trauma. The most common site was posterior perforation 50%, and it is found in all types of ear trauma. The incidence of the spontaneous healing was 81.81%, and the highest frequency of healing was found in slap injury 100% as well as in small size tympanic membrane perforation was 94.1%.

**Conclusions:** The frequency of the spontaneous healing of traumatic tympanic membrane perforation is high, and the factors that affect its healing include the types of the ear trauma, the size of perforation, and the ear infection. The maximum incidence of spontaneous healing is found in slap trauma, in small sized perforation, and in the absence of ear infection.

**Keywords:** traumatic tympanic membrane perforation, spontaneous healing, ear trauma.

## INTRODUCTION

Traumatic Tympanic Membrane Perforation (TTMP) is commonly seen in ENT outpatient clinics. The Tympanic Membrane (TM) is an important component of sound conduction as its vibratory characteristic is necessary for sound transmission<sup>1</sup>.

Since the area of the tympanic membrane (60 mm<sup>2</sup>) achieve most of the impedance transformation, and it is larger than that of the stapes footplate (3.2 mm<sup>2</sup>), so the pressure on the stapes footplate is therefore increased by  $60/3.2=18.75$  <sup>2</sup>. While in the presence of TM perforation, the sound stimulus may be inadequately coupled to the tympanic membrane, and the impedance transformer action may be lost and the ability of the ossicles to move may be reduced<sup>3</sup>.

Various causes of traumatic rupture of the tympanic membrane have been studied and listed, including open-hand blows, injuries by cotton tipped swabs or foreign bodies, explosions as a result of blast overpressure, welding sparks, fracture injury to the temporal bone, and iatrogenic causes as such vigorous syringing of the ear or surgical intervention during insertion of ventilating tubes<sup>4</sup>. It was found that injury from overpressure (e.g., slap, fight, combat, clash, and more likely actions/activities that involve physical contacts) is the commonest mechanism of trauma to the tympanic membrane <sup>5, 6</sup>.

Due to the risk of introducing infection, the ear should not be cleaned out and be kept dry by preventing water from entering the ear canal. If the perforation fails to heal spontaneously by 3-6 months, with the absence of the secondary infection, surgical closure is considered<sup>7</sup>.

Surgical repair includes myringoplasty, and tympanoplasty, are indicated, in particular, when the traumatic perforation is associated with significant conductive hearing loss<sup>8</sup>.

The aim of this study: To evaluate the frequency of spontaneous healing of traumatic tympanic membrane perforation in relation with various types of ear trauma, and its relation with certain variables such as age group, gender, site and size of the perforation of the tympanic membrane according to specific etiology.

### PATIENTS AND METHODS

A descriptive study of 62 patients with ear trauma resulted in traumatic tympanic membrane perforations (TTMPs) are conducted on the patients who attended the Otolaryngology Department/ Al-Yarmouk Teaching Hospital in Baghdad, from September 1<sup>st</sup> 2012 to September 1<sup>st</sup> 2013.

58 patients were with unilateral TM perforation, and 4 patients were with bilateral TM perforation, and therefore, there were 66 affected ears. At the initial assessment, certain information was collected, including age, gender, and the types of the trauma. It is important to mention here that all patients received a thorough ENT examination using otoscopy and binocular X6-10 microscope, the assessment, the status of the tympanic membrane, including the accurate size and the site of the perforation were evaluated. The measurement of the size of tympanic membrane perforation was done by using zero degree Hopkins rod telescope and a digital camera to capture the image of the tympanic membrane and perforation. The size of perforation was calculated as a percentage of the whole tympanic membrane size by using the computer and special software package (AutoCAD classic 2013). This program calculates the total area of TM in square millimeter, and then, the area of perforation. By using Eq. (1), the percent of perforation was calculated and categorized as small (i.e., when its size involved less than 25% of the entire tympanic membrane), medium (i.e., when its size involved 25% - 50% of the entire tympanic membrane), and large (i.e., when its size involved 50% - 75% of the entire tympanic membrane).

$$\% \text{ of the Perforation} = \frac{\text{Area of Perforation}}{\text{Total Area of TM}} \times 100 \quad (1)$$

The assessment of the site of the perforations in the pars-tensa was performed using a method that includes drawing of an imaginary vertical line through the handle of the malleus. If the perforation lies anterior to this line, it was labeled as anterior perforation, and if it lies posterior to this line, it was labeled as posterior perforation. While in the case where two halves are

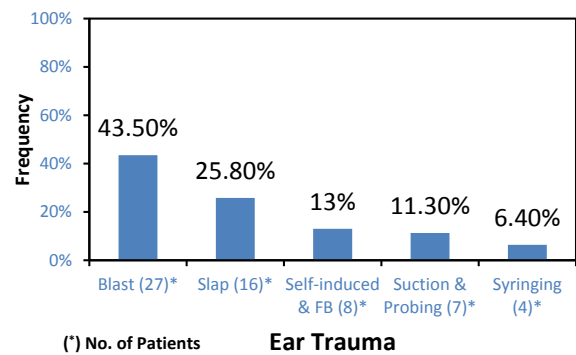
involved, then it was labeled as inferior or central perforation.

The selection criteria are ear trauma, within 2 days of the presentation, with no history of ear diseases or surgery prior to injury. The audiological assessment was out of the scope of this study. The treatment includes systemic antibiotics, instructions provided to keep the ear dry, with no surgical intervention. The follow up visits (done by the author of this study) were scheduled at 2, 4, 8, then 12 weeks, to assess the spontaneous healing rate of the perforations.

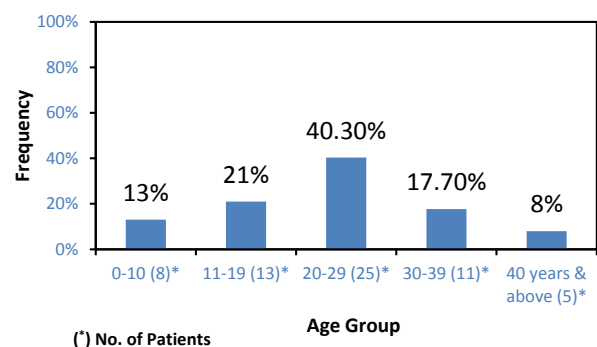
### RESULT

Sixty two patients were diagnosed with traumatic tympanic membrane perforation enrolled in this study. They were classified in accordance to different criteria: patients' age, gender, the size/site of the perforation, and the type of ear trauma.

Figures 1 and 2 depict the overall distribution of patients according to types of the ear trauma, and their age group respectively.



**Figure 1. The Distribution of Patients with TM Perforation for Different Etiologies (62 Patients)**



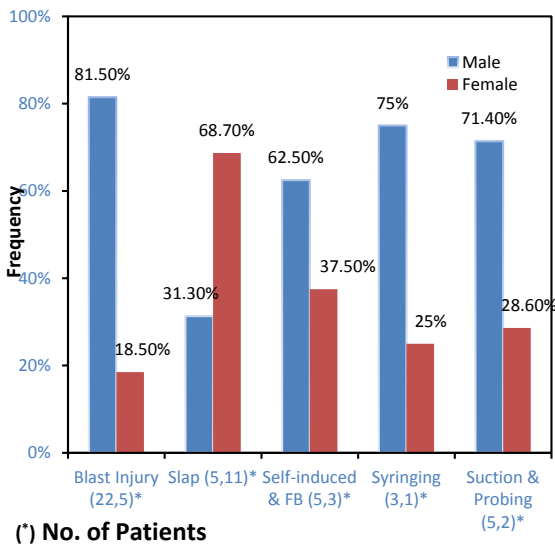
**Figure 2. The Age Distribution of Patients with Traumatic TM Perforation (62 Patients)**

For the Etiologies, Table 1 provide the association of the type of various ear trauma with in different age group, it shown that, the most common type of injury in age group between 20-29 years is blast (19 ears), and in age less than 10 years the most common type of trauma is self –induced & FB (5 ears).

**Table 1. The Relation between Different Etiologies & the Age Group (n = 66 Ears)**

Age Group	Etiology					
	No. of Ears	Suction & Probing	Syringing	Self-induced & FB	Slap	Blast
0-10	8	2	0	5	1	0
11-19	13	3	0	2	5	3
20-29	28	0	1	1	7	19
30-39	12	2	1	0	3	6
40 & Above	5	0	2	0	0	3
Total	66	7	4	8	16	31

The relationship between the gender and the types of ear trauma is shown in figure 3, which revealed that blast injury is found more in males than females in all types of ear trauma, with the percentages of 81.5%, and 18.5% respectively, with exception of slap trauma, were females affected more than males with the percentages of 68.7%, and 31, 3% respectively.



**Figure 3. The Distribution of Different Etiologies with Gender (62 Patients)**

Table 2 demonstrate the size of TTMPs in different etiologies, where most common size of traumatic tympanic membrane perforation was the small size perforation and it was found in 34 ears (51.5%), followed by the medium size perforation in 26 ears (39.4%), and then the large size perforation in 6 ears (9.1%).

**Table 2. The Etiology Distribution of Patients with TM Perforation (Different Size of Perforation) (n = 66 Ears)**

Etiology	Size of Perforation			Total
	Small	Medium	Large	
Blast Injury	2 (6.5%)	2 (77.4%)	5 (16.1%)	3 (100%)
Slap	1 (93.8%)	1 (6.2%)	-	1 (100%)
Self-induced & FB	8 (100%)	-	-	8 (100%)
Syringing	2 (50%)	1 (25%)	1 (25%)	4 (100%)
Suction & Probing	7 (100%)	-	-	7 (100%)
Total	34	26	6	66

As regards the sites of tympanic membrane perforations in the various types of ear trauma, it found that, the most common site was the posterior perforation in 33 ears (50%), followed by the central perforation in 20 ears (30.3%), and the least one was the anterior perforation in 13 ears (19.7%), (See Table 3).

**Table 3. The Distribution of Different Etiologies with Site of Perforation (n = 66 Ears)**

Etiology	Site of Perforation*				Total (Ears)
	Anterior	Posterior	Central	Total (%)	
Blast Injury	5 (38.46%)	14 (42.42%)	12 (60%)	31	46.96%
Slap	3 (23.07%)	9 (27.27%)	4 (20%)	16	24.24%
Self-induced & FB	3 (23.07%)	4 (12.12%)	1 (5%)	8	12.12%
Syringing	1 (7.69%)	2 (6.06%)	1 (5%)	4	6.06%
Suction & Probing	1 (7.69%)	4 (12.12%)	2 (10%)	7	10.60%
Total	13	33	20	66	

\* No attic or marginal perforations

The effect of these variables on the spontaneous healing of tympanic membrane perforation, were demonstrated in Table 4. The results were shown for 54 cases out of a total of 66 patients (81.81 %), who have spontaneous healing.

**Table 4. Healing Time Frequency of TM Perforation with Different Variables**

Variables		Healing Time (in weeks)						
		2wks	4wks	8wks	12wks	Healing Rate (%)	Healed Ears	(Non-healed)
<b>Age Group</b>	0-10	2	4	1	-	87.50	7	1
	10-19	1	7	2	1	84.60	11	2
	20-29	5	9	7	2	82.10	23	5
	30-39	-	4	4	1	75.00	9	3
	40 & Above	-	1	2	1	80.00	4	1
<b>Gender</b>	Male	3	15	14	3	81.00	35	8
	Female	5	10	2	2	82.60	19	4
<b>Site of Perforation</b>	Anterior	2	5	2	1	83.30	10	3
	Posterior	5	15	6	2	82.40	28	5
	Central	1	5	8	2	80.00	16	4
<b>Size of Perforation</b>	Small	8	20	4	-	94.10	32	2
	Medium	-	5	12	3	77.00	20	6
	Large	-	-	-	2	33.30	2	4
<b>Etiology</b>	Blast	-	8	10	4	71.00	22	9
	Slap	3	10	3	-	100.00	16	-
	Self-induced & FB	2	4	1	-	87.50	7	1
	Syringing	1	1	1	-	75.00	3	1
	Suction & Probing	2	2	1	1	85.70	6	1

The non-healing tympanic membrane perforations were 12 ears of the total 66 ears (18.18%). The most common cause of non healed TTMPs was infection 8 ears (12.12%), and it occurred mainly in the medium size perforation (62.5%), and in blast injury (75%), and the second cause of non healed TTMPs was the dry persistent perforation 4 ears (6.06%), which was found mainly in the large size perforation (75%), and in blast injury in (75%).

## DISCUSSION

Trauma to the tympanic membrane and middle ear can be caused by blunt or penetrating injuries such as slap, road traffic accidents, instrumentations, and barotraumas<sup>9</sup>. In the present study males were found to be affected more than females (i.e., 64.5% and 35.5%, respectively) with a male to female ratio of 1.8:1. Moreover, it was noticed that the most common affected age group is between 20-29 years, which represents 40.3 % of the patients, it is also noted that in blast injury which was the most common etiology (43.5%), and male were affected more than female with 81.5% and 18.5%, respectively, and in the slap trauma which come the next common etiology (25.8%), females were more affected than males with 68.7% and 31.3%, respectively. The obtained results were in match and similar to the study conducted by Salm.H.<sup>10</sup> who found that the commonest affected age group, was 21-30 years (i.e., represents 49%), the males were found more affected than females with a male-female ratio of 2.6:1, while Zheng.C. Lou et al.<sup>11</sup> found that the common age group affected was 31-40 years (35%). The study done by Afolabi O.A et al.<sup>12</sup> concluded that the most common affected age group was 35-64 years with a male-female ratio of 2.5:1. The explanation of reporting a high incidence in men was probably because they

usually were involved in hard physical jobs such as outside door activities in the community, and this resulted that men were more prone to the trauma, while in slap trauma, women were usually affected due to domestic violence.

As the regard the etiology of traumatic TM perforation the results in this study were in line to other studies<sup>10, 11, 13</sup>. To this extend, another study that was done by. Afolabi O.A et al.<sup>12</sup> found that the commonest cause of TM perforation was slap, which represents 35.9% and was mainly in males (i.e., with 65%), and also a study done by Salim. H.<sup>10</sup> showed that in slap trauma males were more affected than females.

According to this study, there was some variability in frequency from the aforementioned studies. This may rely on the urban location where which the study has been performed and/or due to the cultural characteristics, the general community status, and the probability that derived from the instability and the insecurity conditions in Iraq, with rise in violence and explosions.

In this study, the frequency of the size of TM perforations was observed and a conclusion was drawn out of the results indicating that the small size perforation was the commonest with 51.5%, followed by the medium size of 39.4%. Compared to the study conducted by Zheng.C. Lou et al.<sup>11</sup> the small size perforation was 80% and the large size tympanic membrane perforation was 20%. While the results of another research done by Lou Z.C. et al.<sup>13</sup> showed that the small size perforation was 52.4%, followed by the medium size of 29.4%. To further analyzing the results of this study, the results obtained by Orji F.T. et al.<sup>14</sup> were compared, which indicated that the small size was the most frequent with 83% and the large size with 17%.

For the frequency of the site of perforations in the tympanic membrane, it was found that the most common location was posterior perforation with 50%, followed by the central perforation of 30.3%. Comparing to the study done by Salm.H.10 the results were in match with what have been reported in this study, as the commonest site of perforation was posterior with 54%, followed by the central perforation of 24%.

Regarding the size and the site of TTMP in relation to various types of the ear trauma was also considered in this study. It was found that in blast injury, the commonest size was the medium perforation with 77.4%. While in slap trauma, the commonest size perforations was the small size perforation with 93.8%. The results of Zheng.C Lou et al.11 study showed that the blast injury caused large perforation in 67% of cases, while slap caused small perforation in 84%. While in other study done by the by Lou Z.C. et al.13 the small perforation was commonly associated with slap which constituted 57% and the blast injury caused medium perforation in 66.7%.

The clinical outcome of the spontaneous healing of acute tympanic membrane perforations was generally associated with perforation size, etiology, and with/without the presence of a serosanguenous discharge13. Most tympanic membrane heals more effectively if the local environment is free of infection and/or there is a rich blood supply and oxygen level7.

In the current study, the frequency of the healing of TTMP was 81.81 %. This result almost agreed with results of other studies10, 11, 13, 15, 16, 17. Most of ears healed within first 4weeks, and the healing may be delayed to 8 weeks or 12 weeks, as it found in males (17 ears), in large size perforation (2 ears), in central site perforation (10 ears),and in blast injury (14 ears).

In the present study, the important factors that affect the frequency of the healing rate were the size of the perforation and the type of the ear trauma. For the size of the perforation, the current study found that 94.1% of small size perforations were healed spontaneously. These findings were in agreement with the results obtained by other studies10, 11, 13, 14, 15, 18.

The other factor that considered in this study was the type of specific etiology. It was found that highest healing rate was in perforations caused by slap injury 100%. These results are in agreement with the results obtained by Salm.H.10, and Orji F.T. et al.14 who showed that the maximum healing rate in perforation caused by slap injury was 88%, and 98% respectively.

In this study the results showed that, the site of the perforation has no influence on the healing process,

which constituted nearly the same frequencies within the period of 12 weeks, (without considering the size of the perforation, and the type of ear trauma), and this agreed with study done by Orji F.T. et al.14 who showed that, perforations in the anterior versus posterior quadrants showed no significant difference in the healing rate.

With the absence of ear infection, most of TTMP healed spontaneously. Persistent perforation was usually a manifestation of tubotympanitis, inflammation of Eustachian tube, and tympanic cavity19. The histological examination of permanent perforation showed that stratified squamous epithelium grows medially over the edge of the perforation, which appears to arrest the subsequent closure of the perforation20.

This study indicated that the causes of the 12 non-healed ears (18.18%) were infection (12.12%), and dry perforation (6.06%). While the study done by Salm.H.10 showed that the sequelae of CSOM were (8%) and of dry perforations were (17%). So the factors that reduce spontaneous healing rate are large size perforation, infection, and foreign bodies21.

#### Conclusions

1-A high frequency of the spontaneous healing of traumatic tympanic membrane perforation.

2- The factors that affect the healing process are the size of the perforation, the type of the ear trauma, and the presence of ear infection, so the maximum incidence of healing rate was found in slap trauma, in small sized perforation, and in patients with no ear infection.

3-The other parameters such as the age, the gender, and the site of the perforation have no influence on the healing process.

4- The incidence of traumatic tympanic membrane perforation was found higher in male patients, in blast injury, in small size perforation, and in posterior site perforation.

#### REFERENCES

1. Gacek R R, Gacek M R. Anatomy of the Auditory and Vestibular Systems. In: James B Snow Jr, John Jacob Ballenger, editors. Ballenger's Otorhinolaryngology. Head and Neck Surgery. 16th ed. Ontario: DC Becker; 2003.p.1-5.
2. James O Pickles. Physiology of hearing. In: Michael Gleeson, George G B, Martin J B, Ray C, John H, Nicholas S J, et al editors. Scott-browns Otolaryngology.7thed. London: Hodder Arnold; 2008.p.3181.
3. Peake WT, Rosowski JJ, Lynch TJ Middle-ear transmission: acoustic versus ossicular coupling in cat and human. James O Pickles. Hearing Research 1992; 57: 245-68.

4. Ott MC, Lundy LB. Tympanic membrane perforation in adults. How to manage, when to refer. *Postgrad Med J*. 2001; 110:81–84.
5. Sakata T, Esaki Y, Yamano T. Air pressure sensing ability of the middle ear. Investigation of sensing regions and appropriate measurement conditions. *Auris Nasus Larynx* 2009; 36: 393-99.
6. Da Lilly-Tariah OB, Somefun AO. Traumatic perforation of the tympanic membrane in University of Port Harcourt Teaching Hospital, Port Harcourt. Nigeria. *Niger Postgrad Med J*. 2007; 14: 121-24.
7. Toner JG, Kerr AG. Ear Trauma. In: Booth JB, Kerr, Advisory AG, Groves J, editors. *Scott-Brown's Otolaryngology*. Otolology 6th ed. London: Butterworths Meinemann; 1997.p. 711-13.
8. Michael C. Ott, Larry B. Lundy. Tympanic membrane perforation in adults. *Postgrad Med J*. 2001; 11: 1049.
9. Schwaber Mitchell K .Trauma to the Middle Ear, Inner Ear, and Temporal Bone. In: James B Snow Jr, John Jacob Ballenger, editors. *Ballenger's Otorhinolaryngology Head and Neck Surgery*. 16th ed. Ontario: DC Becker; 2003. p. 345-56.
10. Salim H. Al-Obiedi .Spontaneous healing of traumatic perforations of the tympanic membrane. *Ann. Coll. Med. Mosul* 2009; 35: 26-32.
11. Zheng-Cai Lou, Zi-Han Lou, Qing-Ping Zhang. Traumatic tympanic membrane perforations: a study of etiology and factors affecting outcome. *Am J of Otolaryngol* 2012; 3: 549–55.
12. Afolabi OA, Aremu SK, Alabi BS, S Segun-Busari. Traumatic tympanic membrane perforation: an aetiological profile. *BMC Res Notes* 2009; 2: 232.
13. Lou, Z.-C., Tang, Y.-M. & Yang, J. A prospective study evaluating spontaneous healing of aetiology, size and type-different groups of traumatic tympanic membrane perforation. *Clin Otolaryngol* 2011; 36: 450–60.
14. Orji F.T. & Agu C.C. Determinants of spontaneous healing in traumatic perforations of the tympanic membrane. *Clin Otolaryngol* 2008; 33: 420–26.
15. Griffin WL. A retrospective study of traumatic tympanic membrane perforations in a clinical practice. *Laryngoscope*1979; 89: 261-82.
16. Kristensen S. Spontaneous healing of traumatic TMP in man. Century of experience. *J Laryngol Otol* 1992; 106: 1037-50.
17. Chun SH, Lee DW, Shin JK. A clinical study of traumatic tympanic membrane perforations. *Korean J Otolaryngol* 1999; 42: 437-41.
18. Ritenour A.E., Wickley A., Ritenour J.S, et al. Tympanic membrane perforation and hearing loss from blast overpressure in operation enduring freedom and operation Iraqi freedom wounded. *J. Trauma* 2008; 64: 174–78.
19. Paparella M.Shumrick D, Gluckman J and Meyerhoff W."Diseases of the Tympanic Membrane in Otolaryngology," *Otology and Neuro-Otology*,1991; 1: 1271-88.
20. Somers T. Growth factors in tympanic membrane perforation. *Am J Otol* 1998; 19: 428-34.
21. Bhat NA; Retrospective Analysis of surgical outcome, symptom changes and hearing improvement following Myringoplasty. *J Otolaryngol* 2000