Original Article

Aetiological factors and dimension of tympanic membrane perforation in Benin City, Nigeria

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Abstract

Background: Tympanic membrane (TM) perforation is a recognised cause of hearing loss in our environment. The integrity of the TM can be compromised by varying aetiological factors which are often preventable. TM perforation occurs in different dimensions which tend to influence the degree of hearing loss.

Aim: The aim of this study is to determine the aetiological factors and dimensions of TM perforation among adolescents and adults in Benin City.

Methods: This was a 1-year prospective study carried out from 1st July 2014 to 30th June 2015 at the Ear, Nose and Throat Clinic of University of Benin Teaching Hospital. Consecutive patients with TM perforation were examined using a hand-held otoscope as well as Firefly video otoscope and subsequently had an interviewer administered questionnaire. Data were analysed using Statistical Package for Social Sciences (SPSS) version 20 and ImageJ software.

Results: One hundred and forty-eight patients with TM perforation in either or both ears were studied. There were 67 (45.3%) males and 81 (54.7%) females; ratio of 1:1.2. Ages ranged from 10 to 64 years, with a mean age of 34.5 ± 15.7 years. Chronic suppurative otitis media (CSOM) was the major cause of TM perforation in this study, 148 (74.0%). The small perforation was predominant, 54 (55.1%) and 48 (47%) in the right and left ears, respectively while the central anterior perforation, 93 (46.5%) occurred commonly.

Conclusion: Central and small perforations were the predominant TM perforation while CSOM was the major cause of TM perforation.

Keywords: Aetiology, Benin City, perforation, tympanic membrane

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INTRODUCTION

Tympanic membrane (TM) is the transparent oval-shaped, pearly gray membrane, which lies obliquely inside the ear canal demarcating the external ear from the middle ear. It is divided into two parts: the pars tensa and pars flaccida. The pars tensa forms the larger part of the TM while the pars flaccida forms the superior part also called Shrapnel's membrane.[1,2] It is separated from the pars tensa by the anterior and posterior malleolar folds. An intact TM [Figure 1] plays a significant role in the conduction of sound waves across the middle ear and as well protects the middle ear cleft from infection.[3] TM perforation is a condition where the TM has a hole in it,[4] thereby establishing a

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direct communication between the external and middle ear. Perforation on the TM reduces the surface area available for sound pressure transmission on the one hand and allows sound waves to pass directly into the middle ear. As a result, the pressure gradient between the medial and lateral surfaces of the TM cancels out. This leads to impaired transmission of sound waves across the ossicular chain in the middle ear with a resultant reduction in hearing.[5]

TM perforation is the most common sequelae of middle ear infection. It is reported in approximately 10% of episodes where perforations tend to occur in the pars tensa;[6] other causes of TM perforation include trauma; direct trauma, acoustic trauma, barotrauma, iatrogenic causes and middle ear tumors. A perforated ear drum due to trauma may heal spontaneously usually within 10 weeks, especially if it is of small size, centrally located and the edges are not displaced.[7] However, ruptured ear drum due to chronic ear infection will often require treatment.[8]

TM perforation can be classified according to the size and location of perforation on the TM. Sub categories based on the size of perforation could be small, medium, large or subtotal perforation.[9,10] The locations vary from central, marginal or attic perforations. Central perforation could be anterior, posterior and inferior or subtotal while marginal perforation could be posterosuperior, anteroinferior or total. Anteroinferior perforations are the most common TM perforations.[11,12] Central perforation implies that the perforation is within the pars tensa or with the annulus intact. For marginal perforation, there is destruction of the annulus and encroachment into the sulcus tympanicus. Attic perforations usually involve the pars flaccida and it is a pointer to the presence of cholesteatoma; an unsafe ear.[13] A computer-based video otoscopy system is more appropriate in assessing TM perforation as it is more objective and provides a better view of the perforation which enhances better analysis of the size and location of perforation on the TM. The aim of this study was to determine the aetiological factors responsible for TM perforation as well as to categorize the various dimensions of TM perforation among adolescents and adults in Benin City.

METHODS

This was a 1-year prospective study (1st July 2014–30th June 2015) conducted at the Ear, Nose and Throat Clinic of University of Benin Teaching Hospital (UBTH), Benin City, Nigeria. Ethical clearance was obtained from the Ethics and Research Committee, UBTH, before commencement of the study. Consecutive patients (10–64 years) presenting at the clinic during the study had their ears examined for TM perforation by ENT surgeons using head lights and battery-powered otoscope. Those eligible for the study gave informed consent and data were obtained from them through interviewer-administered questionnaire. The content of the questionnaire included serial number, information on personal data; age, sex, occupation, ear symptoms; hearing loss, tinnitus, ear pain, vertigo, ear discharge, duration of symptoms, past illness, use of ototoxic drugs, history of ear trauma and ear surgery. The ear of each patient with TM perforation was assessed using a Firefly DE 550 hand-held USB video otoscope, and images saved on the computer for the determination of the size of the TM perforation and location of the perforation on the TM.[14] Saved images were analysed using the ImageJ (version 1.35 of Wayne Rasband, National Institute of Health, USA) geometrical analysis software package. The perforation margin was first outlined using a mouse, and thereafter, the boundary of the entire TM was identified and marked likewise [Figure 2a]. The area of the TM perforation (P) and the area of entire TM (T) were calculated, and the percentage of perforation ($P/T \times 100/1$) was obtained [Figure 2b].

Data collected was analysed using Statistical Package for Social Sciences (SPSS) version 20 (SPSS version 20.0 Armonk, NY:IBM Corp) and results presented in tables and figure.

RESULTS

A total of 200 ears from 148 patients out of the 162 patients with TM perforation in either or both ears were studied. Ages ranged from 10 to 64 years, with a mean age of 34.5 ± 15.7 years. A high proportion of the participants, 98 (66.3%), were within the younger age group of 10–39 years. There were 67 (45.3%) males and 81 (54.7%) females; ratio of 1:1.2. Students accounted for up to one-third, 49 (33.1%), of the study population [Table 1]. Unilateral TM perforation was more than the bilateral perforation; 96 (64.9%) for the former and 52 (35.1%) for the latter, respectively [Table 2]. The left ear recorded the higher number of TM perforation among the study ears, 102 (51.0%) [Table 3]. Tinnitus was the most common symptom reported by patients, 112 (75.7%) while ear pain was the least reported symptom, 52 (35.1%) [Table 4]. Chronic suppurative otitis media (CSOM) was the most common cause of TM perforation, 148 (74.0%) while trauma, 22 (11%) was the least cause of perforation on the TM [Figure 3]. The small perforation was predominant; 54 (55.1%) and 48 (47%) in the right and left ears, respectively while the central anterior perforation, 93 (46.5%) and central perforation, 83 (41.5%) occurred commonly [Table 5].

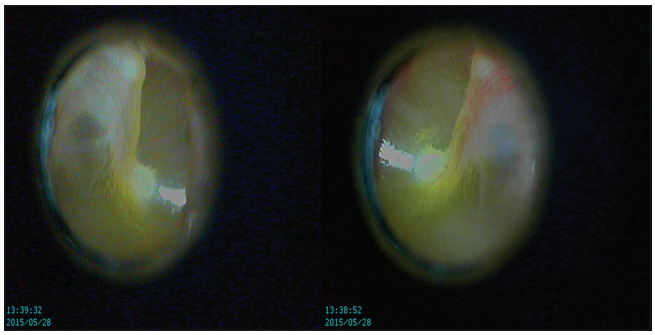

Figure 1: Video otoscopy images of the right and left intact tympanic membrane

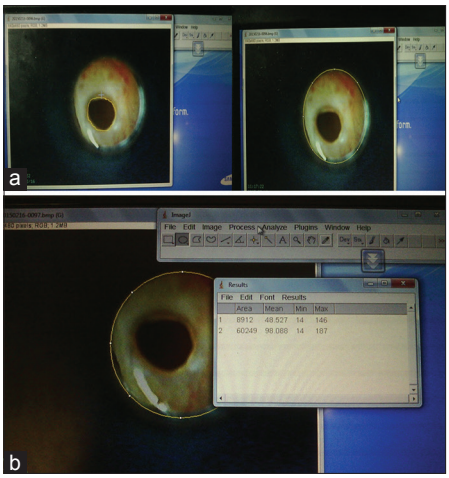

Figure 2: (a) Outline of area of tympanic membrane perforation and the entire tympanic membrane. (b) Area measurement of tympanic membrane perforation and the entire tympanic membrane: P = 89.1 mm^2, T = 602.5 mm^2. Size of perforation (% area) = 89.1/602.5 × 100 = 14.9%

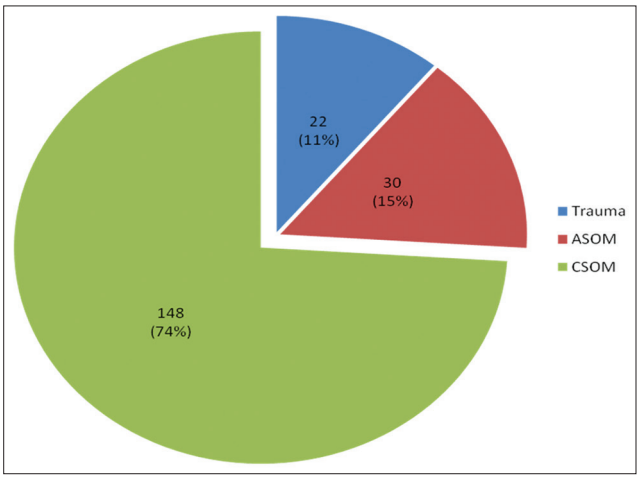

Figure 3: Aetiology of tympanic membrane perforation

Table 1: Sociodemographic characteristics (*n*=148)

Variable	Frequency (%)
Age (years)	
10-19	22 (14.9)
20-29	47 (31.8)
30-39	29 (19.6)
40-49	25 (16.9)
50-59	16 (10.8)
60-69	9 (6.0)
Sex	
Male	67 (45.3)
Female	81 (54.7)
Occupation	
Students	49 (33.1)
Traders	36 (24.3)
Civil servant	21 (14.2)
Farmer	10 (6.8)
Artisans*	8 (5.4)
Unemployed	8 (5.4)
Teacher	6 (4.1)
Others**	10 (6.7)

Mean age=35.4±16.8 years. *Artisans included electricians, painters, carpenters and welders, **Others included retirees, soldier, security man, journalist, house help and cleaner

Table 2: Laterality of tympanic membrane perforation among study participants (*n*=148)

	Frequency (%)
Unilateral	
Right	46 (31.1)
Left	50 (33.8)
Bilateral	52 (35.1)
Total	148 (100.0)

Table 3: Side of tympanic membrane perforation

Side	Study ear (*n*=200), frequency (%)
Right ear	98 (49.0)
Left ear	102 (51.0)
Total	200 (100.0)

Table 4: Symptoms of tympanic membrane perforation (*n*=148)

Symptom	Frequency (%)
Tinnitus	112 (75.7)
Hearing loss	97 (65.5)
Ear discharge	88 (59.5)
Ear pain	52 (35.1)

DISCUSSION

TM perforation is an identifiable cause of hearing loss. The incidence is on the increase in the developing countries[15] due to malnutrition, overcrowding, frequent upper respiratory tract infections[15,16] encouraged by poverty and ignorance. The predominant age group was mainly the young population (10–39 years) [Table 1]. Similar studies in Nigeria were in agreement with the above finding.[17,18] There was a female preponderance (54.7%), probably following the speculation that the health-seeking behaviour of females are better than males in the developing countries.[19] The reasons behind this notion though not fully substantiated may be due to their peculiar health needs. Other studies[18,20] also showed a similar trend. The predominant students population is a reflection of the population distribution of Nigeria (60% youths) and may

Table 5: Size and site of tympanic membrane perforation (*n*=200)

Variable	Side of ear		Total, *n* (%)
	Right, *n* (%)	Left, *n* (%)	
Size (percentage area)			
Small (1-25)	54 (55.1)	48 (47.0)	102 (51.0)
Medium			
26-50	21 (21.4)	31 (30.4)	52 (26.0)
51-75	17 (17.4)	18 (17.6)	35 (17.5)
Subtotal (76-100)	6 (6.1)	5 (4.9)	11 (5.5)
Total	98 (100.0)	102 (100.0)	200 (100.0)
Site			
Central	43 (43.9)	40 (39.2)	83 (41.5)
Central anterior	42 (42.9)	51 (50.0)	93 (46.5)
Central posterior	2 (2.0)	4 (3.9)	6 (3.0)
Subtotal	9 (9.2)	7 (6.9)	16 (8.0)
Marginal	2 (2.0)	0 (0.0)	2 (1.0)
Total	98 (100.0)	102 (100.0)	200 (100.0)

also be attributable to involvement in active and daring activities associated with trauma.[21]

Unilateral TM perforation recorded a higher prevalence of 64.9% among the study participants [Table 2].This was similar to the findings among adults in Nigeria-West Africa[15] where unilateral TM perforation accounted for 80% of cases in the study population. The left ears were marginally more perforated (51.0%), compared to the right ear [Table 3]. Although the reason for this could not be clearly defined, it appears that handedness may be a factor. Since most people are right handed, most hand slaps land on the left side of the face. In this study, tinnitus was the most prevalent symptoms (75%) [Table 4]. This is, however, comparable with the previous studies.[21,22] With perforations on the TM, sound waves tend to strike the oval and round windows simultaneously, which tends to negate the middle ear baffle effect resulting in tinnitus and hearing loss.

The cause of TM perforation was predominantly due to CSOM (74%) [Figure 3]. In a study on the pattern of TM perforation in Ibadan,[18] CSOM was the most common cause of TM perforation in about 91% of cases. This may be likely due to poorly treated acute suppurative otitis media (ASOM) in early childhood, with associated late presentation and low-socioeconomic status.[16,23,24] In another study,[25] trauma was found to be the major aetiological factor for TM perforation. Here, the population studied was, however, predisposed to trauma. Worrisome is the prevalence of trauma from hand slaps to the face, occasioned by domestic violence and assault with associated TM perforation. Documentations suggest that this has been on the increase in Nigeria.[21,26]

ASOM occurred more during the wet season, probably due to the high incidence of viral infections such as coryza, which if not well-treated could be complicated by ASOM. Although the scope of this study was not audiometric analysis, however, it has been observed that there is association between aetiological factors of TM perforation and severity of hearing loss among adults in Nigeria-West Africa.[15] The severity of hearing loss was more common among patients with CSOM compared to those with other causes of TM perforation. This is probably due to the fact that patients with other causes of TM perforation such as ASOM and ear trauma seek medical care earlier than those with CSOM.

Video otoscopy assessment of the size of TM perforation showed that the sizes of perforation ranged from 2.0% to 92.0%, with a mean size of 31.7% ±21.4%. In an earlier study correlating TM perforation and hearing loss,[27] the sizes of TM perforation ranged from 1.5%–89.0%. This computer-based measurement of size of TM perforation is precise, compared to the conventional battery-powered clinic otoscopy which is highly subjective.[28,29]

The small perforation (1%–25%) was more common in the right than the left ear; 55.1% and 47.0% respectively, while the larger perforations were more common in the left ear [Table 5]. We cannot presently hypothesise the reasons for this. In another study in Bengaluru,[25] small-sized perforations were more common in a study done only on perforations resulting from ear trauma. This was contrary to what was obtained in a similar study[30] where the larger perforations predominated in both ears. This may be due to the classification adopted in the study where sizes of TM perforations of 40% and above were considered to be large perforation.

Most perforations were in the central anterior and central portions of the TM in both the right and left ears; 46.5% and 41.5%, respectively [Table 5]. The central portion of the pars tensa is the most dependent part of the TM;[1,31] hence, it is more predisposed to rupture. This may also be in keeping with the phenomenon of safe ear[20] (tubo tympanic disease) as it relates to CSOM. Earlier studies[18,20,27] showed the central TM perforations to be more common. The marginal perforation was the least common. Marginal perforation is usually located in the posterior and superior segments of the TM and often associated with the unsafe type of CSOM with the presence of cholesteatoma (attico antral disease). Its occurrence is rare with the advent of antibiotics.

Evaluation of the audiometric thresholds of the various dimensions of TM perforation would have made this study more encompassing. This is an arrear to consider in the future research.

CONCLUSION

The causes of TM perforation in this study were middle ear infections and trauma, with varying dimensions in sizes and location on the TM; the small and central perforations being predominant. Early presentation of patients to the ENT surgeon at the wake of unexplained ear symptoms could enhance prompt treatment to avert TM perforation complicating hearing loss.

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Conflicts of interest
There are no conflicts of interest.

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