

BOMB BLAST INJURIES TO THE EAR: THE PESHAWAR EXPERIENCE

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ABSTRACT

Objective: To evaluate the symptoms, mechanism and types of injuries to the ear in bomb blast and its effects on hearing and balance.

Material & Methods: A total of 30 patients were included in the study. These patients presented to the Accident and Emergency Department at Hayatabad Medical Complex, Lady Reading Hospital, Peshawar and Khyber Teaching Hospital, Peshawar following three separate bomb explosions on crowded bazaars in Peshawar. The patients were referred to ENT for having ear symptoms due to bomb blast. The victims who presented to ENT within 24 hours, of either sex or any age, having otological symptoms were included in the study. All patients underwent a thorough otological history and examination, including tuning fork tests. Audiometry was advised for all the patients and, where appropriate, microscopic suction clearance was performed. Victims having history of ear pathology in the past were excluded from the study.

Results: Majority of the patients were males and majority were in their forties and fifties. The presenting otological features were hearing loss or tinnitus. None of the patients had vestibular symptoms or complaint of earache. Examination of the tympanic membrane in these patients showed perforations in only 11 cases and the rest had normal looking drum. Majority of the patients were treated conservatively. Surgical treatment was offered to three patients in whom one refused and the other two underwent myringoplasty. The patients were followed up as out-patients in the Otolaryngology Department for a period of minimum six months. Two patients dropped out after initial assessment. The symptoms resolved completely within 48h in three patients, and within 4 weeks in 17 others, but in seven patients symptoms remained persistent even after passage of six months.

Conclusion: Although the ear is extremely sensitive to the effects of blast, spontaneous recovery from acquired sensorineural hearing loss, tinnitus and tympanic membrane perforations can be expected in the majority of cases.

Key Words: Bomb Blast, Terrorist, Blast injury, Sensorineural, Hearing Loss.

INTRODUCTION

The incidence of bomb blast injuries are on the rise throughout the world. Pakistan being involved against the so-called war on terrorism is the victim of frequent acts of terroristic bomb blasts. People of Khyber Pakhtunkhwa province of the country are the victims in particular. Peshawar being the capital of the province is suffering most of the attacks.

The bomb blast wave has a characteristic pattern. In a typical explosion, the explosive material is changed, suddenly, from a solid to a gaseous state with a massive increase in volume and consequently in pressure. The pressure wave spreads out from the site of the explosion, initially faster than the speed of sound, and has

three components: (1) an irregular shock front (2) an abruptly rising but short lived positive pressure wave which lasts for 5-10ms and reaches an amplitude of hundreds to thousands of kilograms per square cm and (3) a long negative phase which lasts for approximately 30ms and is never greater than atmospheric pressure. Friedlander curve shows the characteristic blast wave pattern.

Head and neck is affected more frequently by the bomb blast than any other organ in the body. Ear is the most sensitive organ in the body to the effects of blast. The effects of the blast on the ear are due to sudden changes in pressure and volume. The first case of deafness due to blast injury was reported by Green in 1872.¹

The inner ear is more frequently affected than the middle ear. A temporary threshold shift of hearing acuity is common, often quite severe initially, but usually only transient. Tinnitus is the most frequently reported ear symptom, and its recovery tends to parallel that of hearing loss. Balance problems are rare. Tympanic

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membrane perforations are common in those near to the explosion. These tend to close spontaneously in more than 80% of cases.²⁻⁴ The classification of airborne stimulation deafness, as was accepted by International Audiological Society in 1958 is as follows.⁵

- a. Noise-induced deafness, as a result of long term exposure to elevated sound intensities, resulting in cochlear damage only, and it is most marked around 4 kHz.
- b. Report trauma, occurring in gunners where the stimulus duration is less than 1.5m and the middle ear damage is unusual.
- c. Blast trauma a single stimulus having duration of more than 1.5ms where middle ear damage is not uncommon and cochlear damage is most marked in the higher tones.

Middle ear damage is more frequently sustained after blast trauma than after report trauma, but cochlear damage prevails in both. Disturbances of balance are uncommon, regardless of the type of airborne stimulation deafness. The state of the eardrum is also important. Healed perforations are sites of potential weakness whereas tympanosclerosis and thickening are comparatively strong. The tympanic membranes of young people seem to be more resistant to blast injury than those of the elderly.⁴

Many other factors determine the degree of damage sustained by the ears, the lungs or any other organ in the body include the rise time, i.e. the speed with which the positive pressure wave builds up, the amplitude of the positive pressure wave and its duration.^{6,7} All of these variables are directly related to the nature and amount of the explosive. The distance of the ear from the explosion, the presence of obstructing objects and the proximity of surrounding structures are also significant.⁴

The commonest effect of blast on the middle ear is a perforated eardrum. The perforation is usually located in the antero-inferior part of the pars tens, may be punched out, ragged, linear or multiple, and is produced by the positive pressure wave. It has been estimated that the minimum pressure needed to cause a perforation is 25 cm Hg, whereas considerably less is required to cause cochlear damage (7 cm Hg.).⁸ Ossicular discontinuities are rare in the presence of intact ear drum and have only been reported in the presence of a perforated eardrum.¹ There is no association between middle ear and inner ear damage, and no evidence to suggest that dissipation of energy by a perforation of the eardrum protects the inner ear. Debris from the blast may be driven into the external or middle ear and consequently introduce infection. Similarly, squamous epithelium can be implanted in the middle ear cleft and later form cholesteatoma.⁹

Though ear is very susceptible to bomb blast injury but there is a high rate of spontaneous closure

of drum perforations and improvement of sensorineural hearing loss and tinnitus.²

MATERIAL AND METHODS

A total of 30 patients were included in the study. These patients were having ear symptoms and presented to the Accident and Emergency Department at Hayatabad Medical Complex and Lady Reading Hospital, Peshawar and Khyber Teaching Hospital following three separate bomb explosions on crowded bazaars in Peshawar. Those patients who were referred to the ENT department within 24 hours were included in the study. All patients underwent a thorough otological history and examination, including tuning fork tests. Audiometry

Table 1: Age and Sex Distribution

Age Range	Male	Female	Total percent
11 – 20	—	02	02(06.67%)
21 – 30	04	01	05(16.67%)
31 – 40	07	—	07(23.33%)
41 – 50	10	—	10(33.33%)
51 & above	05	01	06(20.00%)
Total	26	04	30(100%)

Table 2: Otological Symptoms

Symptoms	No. of patients & percentage
Bilateral hearing loss with bilateral tinnitus	07(23.33)
Right hearing loss with right tinnitus	08(26.67)
Left hearing loss with left tinnitus	06(20.00)
Bilateral tinnitus	05(16.67)
Right tinnitus	03(10.00)
Left tinnitus	01(03.33)
Total	30(100)

Table 3: Status of clinical features at Follow up

Features	No.
Symptoms Resolved by 48 hours	02
Symptoms Resolved by 04 weeks	18
Persistent symptoms	07
Bilateral hearing loss with tinnitus	03
Rt. hearing loss, right tinnitus	02
Left hearing loss, left tinnitus	01
Only Tinnitus	01
Persistent Drum perforation by 04 weeks	03
Dropped out	02

Table 4: Audiological threshold data

Threshold (dB)	Initial PTA				Final PTA			
	Ear with Air-Bone Gap		Air Conduction at 8 KHz		Ear with Air-Bone gap		Air conduction at 8 KHz	
	R	L	R	L	R	L	R	L
00 – 10	14	14	3	7	20	17	13	15
11 – 20	06	06	3	3	0	3	1	1
21 – 30			4	3			2	1
31 – 40			3	3			0	1
41 – 50			7	4			4	2

was advised for all the patients and, where appropriate, microscopic suction clearance was performed. Any patient with history of ear problem in the past was not included in the study.

RESULTS

Majority of the patient were males and majority were in their forties and fifties, the details of which are summarized in Table 1. The presenting ontological features were hearing loss or tinnitus. None of the patients had vestibular symptoms or complaint of earache (Table 2). Examination of the tympanic membrane in these patients showed perforations in only 11 cases and the rest had normal looking drum.

Majority of the patients were treated conservatively. Avoidance of water was advised to patients with drum perforation. Topical antibiotics were not required, as there were no cases of infection. Surgical treatment was offered to three patients in whom one refused surgical treatment and the other two underwent myringoplasty. The patients were followed up as out-patients in the Otolaryngology Department for a period of minimum six months. Two patients never turned up after initial assessment. The symptoms resolved completely within 48 hours in three patients, and within 4 weeks in 17 others, but in seven patients symptoms remained persistent. In three patients persistent drum perforation was present out of whom two were treated with myringoplasty and one refused the surgery (Table 3).

The pure tone audiometry findings are given in Table 4. The air conduction (AC) threshold at 8 KHz is used to illustrate those patients with a high frequency sensorineural element to their hearing loss. The difference between the air conduction and bone conduction thresholds (AB) indicates those patients with a conductive element to their hearing loss. Ten patients failed to attend clinic for PTA.

DISCUSSION

Majority of our patients were males and majority were young. Kerr and Byrne² reported that 100% of people in their series had some degree of temporary

hearing loss and/ or tinnitus, the same happened in this study. Recovery is often rapid (occurring within hours to days), with a higher rate for the middle than the high frequencies, and it is complete in a large proportion of patients. Similarly in our series, all patients had some degree of initial hearing loss and/or tinnitus, 10% became asymptomatic in 48 hours and 58% had reverted to normal within 4 weeks.

In our study spontaneous healing of ear drum rate was 72%. Kerr & Byrne² had reported 83% rate of spontaneous healing. In their series, six out of seven myringoplasties were successful, and no ossicular damage was reported. There was no ossicular damage and two out of two myringoplasties were successful in our study.

In some experimental work tears in Reissner's membrane and the basilar membrane in the basal coil, with hair cell damage over long stretches of the organ of Corti had also been found which may be the cause of permanent sensorineural hearing loss in some cases.⁵ Such observations were beyond the scope of our study

Tinnitus is the commonest ear symptom after a bomb blast reported in other series and recovery parallels the restoration of hearing. Balance disorders are exceptionally uncommon. If present, they are probably secondary to an associated head injury. However, a few cases of benign positional paroxysmal vertigo have been described in the absence of a history of head injury.⁴ In the current study tinnitus occurred in 100% of cases and no case of balance impairment found.

The management of these patients is relatively straightforward. Sensorineural hearing loss and tinnitus undergo rapid early spontaneous resolution, and therefore reassurance is appropriate. It is unlikely that any treatment influences the course of sensorineural deafness, but Kerr prescribes corticosteroids to those with severe airborne stimulation deafness on an empirical basis.⁴ We did not prescribe any steroid to our patients. In view of the high spontaneous closure rate of perforated eardrums, immediate surgery is not recommended, and patients should be reassured of this fact. A minimum wait of six week is required before making

any decision for surgery.

Prophylaxis should always be considered when bomb blast exposure is expected. Ear muffs and plugs afford protection but restrict communication. A Gun defender ear plugs offer considerable protection and at the same time maintains almost normal hearing. This is effected by a small perforation in a metal disc embedded in rubber which allows the passage of speech sounds but impedes the blast wave. This sort of prophylaxis may not be possible in terroristic bomb blasts.

CONCLUSION

Although the ear is exquisitely sensitive to the effects of blast, spontaneous recovery from acquired sensorineural hearing loss, tinnitus and tympanic membrane perforations can be expected in the majority of cases.

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