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Original Article

Hearing Injuries in the Frontline during the 2011 Conflict of Braiga, Libya

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Abstract

Introduction: Noise exposure causes different insults on hearing ranging from mild to severe damages. **Objectives:** We assessed the effects of acute auditory trauma on hearing at the front line of Braiga, near Benghazi, Libya, from February to November 2011. **Patients and Methods:** A total of 236 acoustic injury cases referred to audiology department, Hawari ENT Center, Benghazi, were studied. These cases were either seen directly after injury or referred from other hospitals after treatment of associated injuries. History, examination, and audiological assessment in the form of pure tone audiogram were done using Ad629 interacoustic. **Results:** A total of 236 cases were studied; aged 21–30 years. All were not using measures to protect ear and hearing. The majority of these cases (96.6%) complained of hearing loss and tinnitus. Most of the hearing loss (75.0%) was of the sensorineural hearing loss (SNHL) type. More than 32% had moderate to severe hearing loss. Treatment was given according to type and degree of hearing loss. Patients who was diagnosed as hearing loss (H.L) of S.N type, treatment plan was either hyperbaric oxygenation, hearing aids or cochlear implants according to degree of H.L and availability of treatment. **Conclusions:** Explosions cause hearing insult of different types and different degrees. The most commonly noted type is sever to profound SNHL. Therapies needed included hearing aids in SNHL or tympanomastoidectomy in conductive hearing loss. Lack of use of hearing protective measures does increase the number of hearing problems in individuals at high risk.

Keywords: Armed conflict, auditory trauma, hearing loss, mastoid exploration, myringotomy, noise, tinnitus, tympanoplasty

Introduction

Noise exposure causes various insults on hearing. It has to be loud enough and of sufficient duration to cause injury. Damage to different parts of the ear depends on various factors such as sound loudness level, the intensity of noise in decibel, and length of exposure; all are of critical importance. Exposure to both single intense and repetitive sound leads to inner ear damage and hence to sensorineural hearing loss (SNHL).[1-4] Noise-induced hearing loss is caused either by intense impulse noise at the level of 100–150 dB sound pressure level called acoustic trauma or by continuous exposure to loud sound at or above 85 dB sound pressure level over long periods of time.[5-8]

Blast injuries cause different types of hearing loss ranging from mild to profound, external, middle, and inner ear; all are affected by this injury.[9] In outer ear, both auricle and external canals are injured by an explosion in the form of edema, hematoma, and wounds. The middle is affected by the ruptured tympanic membrane which may be small, multiple, or total perforations.[10] Fragment of destructive keratinous epithelial debris may reach middle ear and mastoid cavity after blast exposure causing cholesteatoma.[11] The ossicles are exposed to disruption and damage by blast injury as well. The most affected part of the inner ear is the basilar membrane of the cochlea.[12] According to American Academy of Audiology, noise causes damage to hair cells in the inner ear which is the sensory cells that convert sound energy into electrical signals that travel to the brain. Once damaged, hair cell cannot grow back and get replaced by supporting cells as a scar that is the permanent damage. This type of damage caused by noise is seen as the significant threshold shift SNHL in the audiogram.[1]

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The louder the noise, the shorter the time it will take to damage hearing. Other factors such as hearing protection are only partly effective and useful if it is properly used. On exposure to high sound intensity such as firearms which is in the range of 140–165 dB, there will be a great possibility of immediate damage. Recent workers have shown that noise exposure causes cochlear neuronal degeneration which presents as hearing loss, hyperacusis, and tinnitus.[2]

Explosions cause temporary or permanent cochlear damage which is recorded on audiogram as temporary or permanent threshold shift. Threshold shift may be recovered after cessation of noise exposure, but threshold recovery does not mean hearing recovery as every time this happens there will be a loss of few neurons. In military services, military grade weapons are often louder and more damaging to the ear than standard sportsmen type of weapons.[2] According to military audiology reports, 60% of the United States personnel exposed to blast injury suffer from permanent hearing loss and 49% of them suffer from tinnitus.[3] Here, we will focus on acute acoustic trauma in which there may also be damage to middle ear as tympanic membrane and ossicular injury with a variable degree of injury to the inner ear, that is, the cochlea. Examples of acute acoustic trauma are explosions and single loud sound. We have therefore evaluated the effects of acute auditory trauma at the front line of Braiga, near Benghazi, Libya, during the recent armed conflict of 2011.

Patients and Methods

This is case series of all injured cases referred to audiology department at Hawari ENT Center, Benghazi, Libya, between February and November 2011. This period represents the initial armed conflict that ensued after the 2011 popular uprising in Libya. These cases were either seen directly after injury or referred from other hospitals after treatment of associated injuries. For all these cases, history was taken; ear examination and audiological assessment in the form of pure tone audiogram were done using Ad629 interacoustic to assess hearing. Hearing loss was classified according to American Speech-Language-Hearing Association as follows: mild hearing loss from 20 to 40 dB; moderate hearing loss from >40 to 60 dB; severe hearing loss from >60 to 90 dB; and profound hearing loss from >90 dB. Approval of the ENT Center was obtained for the study and an informed verbal consent from each patient was obtained. Cases that need surgery such as tympanoplasty, mastoidectomy, and myringotomy were referred to main hospital's ENT Department for the operation.

Results

The total number of ear injury cases was 236 cases. All of them were not using protective measures to protect the ear and hearing. Over half of the patients aged 21–30 years, nearly one-third (30.0%) of them aged 31–40 years, and lower percentage of cases (2.11% and 0.4%) aged <10 and 51–60 years, respectively, as seen in Table 1.

Table 1: Age distribution of acute acoustic trauma in the case series

Patient age (years)	Number of cases (%)
<10	1 (0.4)
11-20	26 (11)
21-30	121 (51.3)
30-40	71 (30)
41-50	12 (5)
51-60	5 (2.1)
Total	236 (100)

Table 2: Types of ear injuries among acute acoustic trauma cases

Types of ear injuries	*n* (%)
SNHL	170 (72.0)
Conductive hearing loss	40 (17.0)
Mixed hearing loss	18 (7.6)
Soft tissue injury*	6 (2.5)
Seventh nerve injury*	2 (0.9)
Total ear injuries	236 (100)

*No hearing loss. SNHL: Sensorineural hearing loss

The majority of these cases (96.6%) (72.0 + 17.0 + 7.6 = 96.6%) complained of hearing loss and tinnitus as shown in Table 2.

Pure tune audiogram was done to all cases complaining of hearing loss and tinnitus. Most of the hearing loss (75.0%) was SNHL type, and it was pure SNHL (75%) or mixed hearing loss (18.0%). Regarding the degree of hearing loss, more than 32% had moderate to severe hearing loss as shown in Table 3. The frequency mostly affected is 4000 Hz. Treatment was given according to type and degree of hearing loss.

Hearing aids, cochlear implants, and hyperbaric oxygen therapy all as a treatment for different degrees of SNHL as needed, whereas conductive hearing loss was treated by surgical intervention as simple myringotomy, mastoid exploration, or tympanoplasty according to diagnosis. Most of the ear drum perforation healed spontaneously, unless they got infected. Some cases refused treatment either because they got accommodated to mild hearing loss or they deny the presence of hearing disability, as shown in Table 4.

Discussion

The middle ear muscles, tensor tympani, and stapedius muscle protect the inner ear structures from damage effect of noise. However, sudden exposure to noise may not allow time for the muscles to act, that is why, the damaging effect of sudden noise is more. The outer hair cells are the mostly affected part, specifically the inner row which is more susceptible to damage than the outer one. The first change due to noise is stiffening of the cilia, followed by shortening, and finally, fracture of their basal rootlet due to excessive exposure to noise, which means permanent damage.

Table 3: The spectrum of therapies needed in the study

Type of treatment	*n* (%)
Hearing aids	91 (39)
Myringotomy	7 (3)
Cochlear implant	2 (0.9)
Hyperbaric oxygen therapy	19 (8.3)
Medical treatment	26 (11.4)
Mastoid exploration with or without tympanoplasty	38 (16.6)
No treatment	45 (19.7)
Total	228 (100)

Table 4: The different methods of treatment of hearing loss needed in our cohort

Degree of hearing loss	*n* (%)
Mild SNHL hearing loss	22 (12.9)
Moderate SNHL	20 (11.8)
Mild to moderate SNHL	24 (14.1)
Severe SNHL	24 (14.1)

SNHL: Sensorineural hearing loss

Serving in the military is associated with increased risk of hearing loss,[13] so they should be protected both during training and war. Direct trauma to the ear is usually associated with head injury, that is why these cases are missed from our study. Hearing loss due to acute noise trauma manifests as a dip in the audiogram at higher frequencies. Other frequencies get affected with continuous noise exposure.

The study population was young soldiers. In our study, hearing loss and tinnitus were the most common disability noticed at the front line. Similar findings were reported by others.[2,14] Blast-related injuries commonly involve middle and inner ear structures resulting in a conductive, sensorineural, or mixed-type hearing loss.

The pure SNHL is the predominant type occurring in blast-related traumatic brain injury. In the present study, 75% of the cases had SNHL, which was higher than the results of the Veterans Affairs Rehabilitation Unit (60%). This may be attributable to the fact that our patients were not using protective measures.[15] These observations were also noticed recently as an increasing number of US service members have hearing loss as a result of being in the proximity to the detonation of explosive devices in the Iraq and Afghanistan operations.[14] Nearly, similar percentage of soldiers (71%) returning from Iraq and Afghanistan, reported exposure to loud noise and more than 15% of returnees reporting ringing in their ears.

SNHL is mostly treated by hearing aids. For many cases, it can take years before they become aware of hearing loss; they may go to a period of 5–7 years denial period. This may explain why a large number of cases (19.7%) do not receive any treatment.

The other type of deafness is conductive type, which results from perforated tympanic membrane, ossicular discontinuity, or hemotympanum; surgical treatment is needed in these cases in the form of tympanoplasty, mastoid exploration, or tympanostomy, respectively.

Conclusions

This study revealed high rates of noise-induced auditory injury in this particular conflict exemplifying many of the recent conflicts in the Middle East. There is a need to enforce the proper use of hearing protective measures such as ear plugs and muffles. There are sophisticated hearing apparatus developed in the military to hear sounds of potential danger while avoiding the dangers posed by the nearby explosive devices.

Disclosures

The authors are responsible for the conduct of the study, data collection, and analysis. They drafted and revised the manuscript and approved its final version.

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Nil.

Conflicts of interest

There are no conflicts of interest.

Compliance with ethical principles

Approval for the study was granted by the faculty of medicine and verbal informed consent was obtained from all participants prior to the study.

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