The Otological Manifestations of a Scud Missile

M. E. Baraka, L. A. Bohliga


In the worst Scud missile attack of the Gulf war, a surface to surface missile demolished a barracks housing American soldiers in Dahran, Saudi Arabia. Twenty-eight soldiers were killed; 98 were wounded — 60 of whom were admitted to King Fahad Hospital of the University (KFHU) in Al-Khobar, with a variety of injuries. Of these 60 wounded, 20 were seen by the ENT surgeon; 15 (25%) had otological injuries and the other five had shrapnel injuries to the head and neck. After receiving the primary treatment all patients were later transferred to a military hospital. This paper analyses injuries to the ears, and suggests that ear protection should be part of preventive measures to be taken during the alarm phase of such attacks.

Acoustic trauma has been known since the eighteenth century when following the firing of 80 broadsides from his ship, HMS Formidable, in 1782, Admiral Rodney was almost entirely deaf for a fortnight, and an officer is said to have been made permanently deaf by the nearby discharge of Cannon at the battle of Copenhagen in 1801.1

High frequency sounds above 2 kHz are found to be more damaging than low frequency sound. Coles2 found automatic gun intensity to reach 174 dB at the firer’s head, and noise from a firearm might attain 180 dB.3 Salmivalli4 recorded impulse noise attaining 188 dB from field cannons and 185.6 dB from anti-tank guns. Tympanic membranes are considered to rupture at 160 dB intensity.5 The maximum permissible level which the ear can tolerate without sustaining permanent damage is dependent on the exposure time. It was considered that 160 dB intensity is permissible for 0.003 s/day, but for 0.3 s only 145 dB can be tolerated.6

Despite the fact that there are many conflicts around the world, involving both civilians and military establishments, in which the use of explosives is very frequent, the number of ear injuries is under-reported. This prompted us to document the otological manifestations of a Scud attack.

Materials

In the worst Scud attack of the Gulf war, an Iraqi surface to surface missile, demolished a unit of barracks 80 × 33 m, in Dahran, Saudi Arabia, on 25 February 1991. The occupants were American soldiers. The explosion could be heard several miles away and the blast shattered the windows of a housing complex about 500 m away from the site of impact.

Urgent medical evacuation carried the wounded to nearby hospitals. Being the largest hospital close to the

Department of ENT, King Fahad Hospital of the University, Al-Khobar, Saudi Arabia

MOHAMED ELFATIH BARaka FRCSI, Associate Professor and Consultant ENT Surgeon

LAMIA ABDELWAHAB BOHLIGA MB BS, Third Year Resident, King Faisal University Fellowship Training Programme in ENT

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Figure 1. The pure tone audiogram of the patient with a right moderate sensorineural hearing loss and a left dead ear.

Figure 2. Plain X-rays showing a Scud missile shrapnel lodged posterior to the parotid gland.

site of the blast, KFHU received 60 of the 98 wounded soldiers. Of these, 20 were seen by the ENT specialist; 19 were males and one female. (Circumstances did not allow the same ENT specialist to see all the 60 wounded soldiers at KFHU.) Their ages ranged from 19 to 47 years. Fifteen of them had otological injuries; six had traumatic perforation of the tympanic membrane (five unilateral and one bilateral = seven ear drums), resulting in
Table 1
The otological manifestations of the Scud missile attack

<table>
<thead>
<tr>
<th>Symptoms/signs</th>
<th>No. of patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tympanic membrane perforations</td>
<td>6</td>
</tr>
<tr>
<td>SNHL</td>
<td>3</td>
</tr>
<tr>
<td>Tinnitus</td>
<td>3</td>
</tr>
<tr>
<td>Fullness in ears</td>
<td>2</td>
</tr>
<tr>
<td>Dead ear</td>
<td>1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>15</td>
</tr>
</tbody>
</table>

SNHL: Sensori-neural hearing loss.

Conductive hearing loss of mild to moderate degree. Three soldiers (including the only female) had mild unilateral sensorineural hearing loss. Figure 1 shows pure tone audiogram of the only patient with a dead left ear and a moderate sensorineural hearing loss in the right ear. Other otological manifestations of the loud sound are listed in the table. No patient complained of vertigo. One patient had a fractured temporal bone.

The remaining five patients had shrapnel injuries to the head and neck. Three of them had superficial injuries of no serious nature. Of the other two, one had shrapnel lodged in the maxillary antrum, and in the second, the shrapnel pierced the anterior wall of the cartilaginous external auditory meatus and was embedded in the sulcus posterior to the parotid gland (Fig. 2). This patient was found to have incomplete facial palsy the following morning before the shrapnel was removed. His tympanic membrane and cochlear functions were intact.

Discussion

Loud sound, from both military and industrial sources, remains a common cause of hearing loss in the world. Auditory and vestibular faculties are essential to the quality of life. Their disturbance can vary from a mere nuisance to total incapacity. Loss of hearing is probably one of the worst disabilities which can affect people, especially the young.

If the Scud were carrying 300 kg of TNT, the estimated noise intensity at zero metres (the impact site) would have been 226.82 dB. This is calculated according to the formula: $B = 187 - 20 \log R + 8 \log W$. (In which, B is the blast noise in dB, R is the distance in metres and W is the weight of the TNT in kg.) If the explosive material Pantolite is used, the noise induced is 1.27 times louder than that of TNT (personal communications).

Based on these figures and the information from the survivors, including the description of the explosion site, the analysis of impact is depicted in Fig. 3: the central zone being the zone of fatalities. Using the same formula, a distance of 218 metres away from the Scud’s impact site is needed to bring the noise down to the maximum permissible level of 160 dB, which can be called a safe zone. All patients who sustained otological trauma were located in the serious otological injury zone.

Figure 3. The zonal manifestations of the Scud missile explosion.

Noise-induced hearing loss is an entirely preventable disability, but totally incurable. Methods of protection against chemical attacks are well established. The impact on the ear has not received appropriate attention in the design of protective devices. This is, undoubtedly, because the loss of life is the main concern. However, hearing protection ought to be an essential part of the precautionary measures that the general public is advised to follow in such circumstances. The otological sequelae of the loud noise of the Scud explosion in Dhahran, were hearing loss, tinnitus and tympanic membrane perforations. The injuries that took place in the otological damage zone (Fig. 3) would have been reduced if personal aural protective devices had been used.

Conclusion

In conclusion, when the dangers of a loud noise are being considered, the aim of the otologist is indeed the preservation of hearing.

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References
