Ear damage by high voltage electrification in a mexican worker

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ABSTRACT

Introduction: Altered hearing has been reported in persons who received electrical discharge by lightning. Case report: The case of a Mexican worker electrified by a high voltage (23 kV) electrical current is described as having hearing loss, absent otoacoustic emissions, and increased latency of all waves and interwave intervals of auditory evoked potentials of the brainstem. The worker showed permanent hearing loss post high voltage electrocution (23 kV), with progressive sensorineural hearing loss and perturbed neural conduction of the auditory nerve, and disturbed neuroconduction of the auditory nerve following to a high voltage electrical discharge. Conclusion: Given the implications in rehabilitation and the social and legal consequences patients should be fully evaluated, including a complete hearing study.

Keywords: Hearing loss, Electrification, High voltage, Work accident

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INTRODUCTION

Electricity generation has increased the risk of occupational accidents due to high voltage electrical discharge (HVED) ≥1000 volts (electrification) [1]. In the United States there have been reports of low voltage electrification <1000 volts in 20% and with high voltage electrification in 38% of the general population. Half of these cases are of occupational origin [1, 2]. Due to the seriousness of the injuries, medical care focuses on the patient’s survival. However, in the HVED survivors have been reported osteomuscular, cardiovascular, neurological, renal, visual, and other types of damage [2, 3]. Hearing loss and tinnitus were reported in one case of HVED, but were reversible [4]. Experimentally, alterations in the posterior cochlea following HVED in guinea pigs have also been reported [5].

Moreover, these alterations were observed in patients who received an atmospheric electric discharge (lightning) [6–9]. These cases included perforation of the tympanic membrane, conductive hearing loss,
sensorineural hearing loss, ossicular disruption, and perilymphatic fistula in the oval window with mixed type hearing loss [6–9]. The present report describes the case of a worker who underwent HVED (23 kV) and survived; however, hearing damage was irreversible.

CASE REPORT

A 38-year-old male working at an electrical supply company installing and repairing electrical service (ISCO-088-7245) who dealt with 6, 13.2, and 23 kV electricity supply wires [10] and had been held the workplace for 12 years with no significant personal or family background of auditory symptoms and no previous exposure to organic solvents. He underwent fluctuating exposure to environmental noise due to urban vehicle traffic. On 11 September 2006, he suffered a HVED with direct 23 kV current in both hands, while working. He lost the alert status and was hospitalized. Four reconstructive surgeries were required due to the deep second degree burns. Five weeks after the accident he regained consciousness although failed to remember events prior to, during, or after the work accident. Once discharged from the hospital, the worker reported hearing loss and tinnitus, and thus was evaluated at the audiology ward of the Specialty Hospital Siglo XXI at National Medical Center of the Mexican Social Security Institute (IMSS).

Since discharge from the hospital, patient underwent five audiological evaluations: at three, six, twelve, eighteen, and twenty months so as to identify a specific pattern of cochlear damage as well as any fluctuation in the hearing threshold. The first three hearing evaluations were performed using a Beltone 2000 audiometer; in the fourth and fifth evaluations a Madsen Orbiter audiometer was used.

The fifth evaluation assessed otoacoustic emissions (OAE) with a Madsen Capella analyzer, in the modes of distortion product (DPOAE), transient (TOAE), and spontaneous (SOAE). Auditory brainstem response (ABR) were also obtained using multimodal evoked potentials equipment (Nicolet Viking Quest).

Otoscopy showed normal tympanic membranes and tuning forks with symmetrical decrease in the hearing acuity. Pure Tone Average (PTA) was determined for each ear. Audiometry evidenced right superficial sensorial hearing loss which evolved to severe sensorial hearing loss, while the left ear had superficial sensorial hearing loss that evolved into moderate sensorial hearing loss (Figure 1). Phonemic discrimination also showed progressive bilateral degeneration at the same period. Otoacoustic emissions by distortion products were absent in both the ears.

Twenty months after the accident, ABR were performed under physiological sleep, using 2000 clicks of alternate polarity at an intensity of 100 dB SPL and with mask at 80 dB SPL, at a stimulation rate of 33.1 clicks/second and 10 ms analysis duration. The ABR showed adequate of I–III and V waves, prolonged absolute latency of I, III and V waves, and bilateral elongation of absolute latency waves (I, III, and V). Moreover, interwave elongation of latencies was observed (I–III, III–V, and I–V) with respect to the equipment’s reference parameters (Table 1).

DISCUSSION

Audiological evaluation of the case revealed the presence of bilateral sensorineural progressive hearing loss; this finding suggests irreversible hearing damage. Jindal et al. [4] published a similar HVED case, in which they have also observed normal tympanic membranes and bilateral sensorineural hearing loss. However, this case was reversible.

Otoacoustic emissions were absent in the present case due to detriment of the hearing threshold, a difference with Jindal’s [4] case, where the emissions were also absent in both the ears, but they were recovered in a month. As regards ABR, absolute latencies of components I, III, and V and interwave latencies (I–III, III–V, I–V) were prolonged compared to reference parameters (Table 1). In the study by Jindal et al. [4], prolonged absolute latencies were documented but came back to normal one month after the event, where the interwave intervals were normal.

Despite similar results between this study and that of Jindal et al. [4], the present case report displayed progressive hearing loss, absence of otoacoustic emissions, and prolonged absolute latencies as well as interwave intervals.

A probable explanation for the differences between this and report of Jindal et al. [4] could be the severity of electriification, due to the difference in electrical tension, or the type of electrical current. In the present study the damage was caused by a direct current, whereas Jindal have not mentioned the type of current. This is an important piece of information because experimentally in guinea pigs [5] caused a decrease in otoacoustic emissions by administering alternate and direct current stimuli throughout ten days. To explain hearing damage, Jindal et al. proposed that the HVED causes functional
Table 1: Comparison of PEATC latencies of the case with reference values in milliseconds (ms)

<table>
<thead>
<tr>
<th></th>
<th>Wave I</th>
<th>Wave III</th>
<th>Wave V</th>
<th>Interwave I – III</th>
<th>Interwave III – V</th>
<th>Interwave I – V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference value</td>
<td>1.65</td>
<td>3.79</td>
<td>5.82</td>
<td>2.14</td>
<td>2.02</td>
<td>4.16</td>
</tr>
<tr>
<td>Right ear</td>
<td>1.74</td>
<td>4.24</td>
<td>6.42</td>
<td>2.50</td>
<td>2.18</td>
<td>4.68</td>
</tr>
<tr>
<td>Left ear</td>
<td>1.78</td>
<td>4.28</td>
<td>6.56</td>
<td>2.50</td>
<td>2.28</td>
<td>4.78</td>
</tr>
<tr>
<td>Differential Right ear</td>
<td>0.09</td>
<td>0.45</td>
<td>0.6</td>
<td>0.36</td>
<td>0.16</td>
<td>0.52</td>
</tr>
<tr>
<td>Differential Left ear</td>
<td>0.13</td>
<td>0.49</td>
<td>0.74</td>
<td>0.36</td>
<td>0.26</td>
<td>0.62</td>
</tr>
</tbody>
</table>

Abbreviations: ms= milliseconds

CONCLUSION

Our results show permanent hearing alterations including progressive neurosensory hearing loss, disturbed neuroconduction of the auditory nerve following HVED. The most relevant aspect in this type of accident is prevention. But when such accidents do occur, it is vital to attain ensure survival. Nevertheless, given the implications in rehabilitation and the social and legal consequences patients should be fully evaluated, including a complete hearing study.

The results of the present study pave the way for further research in larger groups of workers who suffered HVED; therefore future research should elucidate the mechanism and physiopathology of hearing damage and its relationship with the nature, gravity, type of current (DC or AC), voltage, resistance, path, and contact mechanism (direct, arch or ignition) [1].

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Guarantor
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Conflict of Interest
Authors declare no conflict of interest.

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REFERENCES


