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Case Series
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Electrification of the ENT Area: Report of Three Cases with Literature Review

Fokouo Fogha JV[1,2], Minka Ngom EGS[2,3,4], Choffor Nchinda E[2,5,6], Evehe Vokwely JE[2,7], Njifou Njimah Amadou[4] and Njock Lr[4]*

[1]ORL Unit of Bertoua Regional Hospital, Cameroon

[2]COCHLEES Technical Group, Cameroon

[3]ORL Unit of Douala General Hospital, Cameroon

[4]Department of Medicine and Pharmaceutical Sciences, Douala University, Cameroon

[5]Department of Surgery and Specialties, University of Buea, Cameroon

[6]ENT Unit, Buea Regional Hospital, Cameroon

[7]ORL Unit of Essos-Yaounde Hospital Center, Cameroon

Abstract

Electric power is an indispensable utility nowadays. Nevertheless, electricity, either natural or artificial, is very dangerous. When not lethal, electric accidents can cause a lot of damage. We report the case of a 39-year-old male, shocked as he inadvertently stepped on a wet electric cable and subsequently sustained right hearing loss. The second case is that of a 5-year-old boy who was electrified on the head by a bare electric cable and sustained focal necrosis of the scalp and the third case is that of a 26-year-old man who became deaf after lightning struck his shelter while wearing earphones.

Keywords: Electricity; Electrification; Burn; Perceptive deafness

Case Series

Case 1

Mr. AH, a 39-year-old farmer from Yaounde was rushed unconscious to the emergency room after allegedly being shocked by electricity while heading home in rainy weather. According to his family, he stepped on an electric cable that had fallen during the rain, wearing only light and worn slippers. He was propelled about two meters away. He was found unconscious and brought to our hospital. He recovered consciousness about an hour after the incident and immediately realized that he could hear nothing but tinnitus with the right ear. He also had a complete amnesia of the accident. He had neither vertigo nor facial palsy.

His vital signs were normal but the patient was confused on initial physical examination. There were bruises and swelling of the right forearm. He also presented a right hemiparesis with muscle strength of 3/5 on right limbs. There was no burn but hyperesthesia of the right side and right foot sole pain. Tendon reflexes were present and otoscopy was normal.

A chest X-ray of the right upper limb showed a non-displaced fracture of the radius at the union of upper and middle thirds. A brain CT scan was done but showed no relevant finding. Auditory brainstem response revealed an absence of the characteristic waves on the right ear (Figure 1). Cardiology and neurology advices were asked, but were irrelevant.

A right upper limb casting was done by the orthopedist. The patient was placed on Trimetazidine (35 mg every 12 h) for 2 months, Betamethasone (40 mg once per day) for 10 days, Vitamin B (3 tablets per day) and Pentoxyfyllin (400 mg per day) for 10 days. He also underwent 6-week physiotherapy.

The evolution was characterized by a substantial reduction of tinnitus which was no more debilitating and a consolidation of the radius fracture. At mid and end of treatment, we did a control pure tone audiometry that showed no improvement of the hearing on right side. Today, after 2-year follow up, the patient has recovered from all injuries related to the accident except right deafness.

Correspondence:
Fokouo Fogha JV, ORL Unit of Bertoua Regional Hospital, Cameroon, Tel: 677559034;
E-mail: valentin.fokouo@gmail.com

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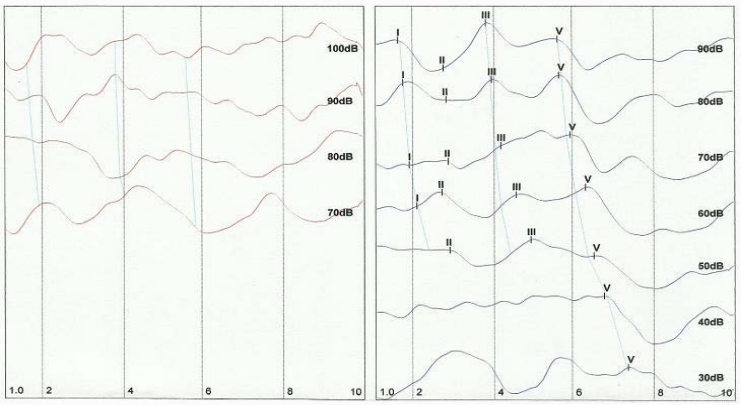

Figure 1: Patient 1's result of the Brainstem evoked response audiometry showing an absence of waves on right ear.

Case 2

A 5-year-old boy was brought to the emergency room after being electrified by a stripped electric cable hanging over him while climbing a small wall. The child was unconscious but his vital signs were normal. An IV line was placed and he received Mannitol (25 ml every 6 h), Prednisolone (20 mg IV per day) and citicoline (500 mg IV every 1 h). His airways were intermittently and properly suctioned as required. He recovered consciousness at day 5 and was sent to the ENT department for an Eschar-like lesion on the top of his head. On physical examination, there was dried blood in the hair surrounding the lesion. The skin was swollen and insensitive on a round area of about six square cm. The lesion was cleaned and dressed with Povidone-iodine. The child was prescribed IV Amoxicillin and clavulanic acid. On the subsequent dressings, the Eschar fell, leaving the skull bone exposed (Figure 2). Four weeks after the accident, we had to close the gap surgically under local anesthesia with two bilateral releasing incisions and advancement flaps. We shaved the surroundings of the defect and scrubbed with Povidone-iodine. Then, we infiltrated xylocaine with 0.1% adrenaline. The next steps were excision of the edges, lateral releasing longitudinal incisions at about 2 cm away from the defect edge, undermining of the flaps and advancement and finally suture with 2-0 Synthetic suture. The scarring process went uneventfully with good cosmetic results, as the hair growth hid the scar. A neurological evaluation and Brain CT-scan were done and found no damage. After 6 months of follow up, the child has no complaint and behaves normally.

Case 3

A 26-year-old soldier with no relevant past medical history was watching a movie on his laptop charging on AC power socket during a light rain with earphones plugged on both ears. After a loud thunder and lightning, he felt pain in his ears and heard a high pitch sound for a few minutes and then totally lost the hearing. The house was not damaged. Brought to our consultation 4 days after the incident, there was no injury of any kind all over the body on physical examination. Ear drums looked normal on otoscopy. We performed a pure tone audiometry and auditory evoked potential which revealed a bilateral total deafness and no characteristic wave. The patient was put on trimetazidine (35 mg PO 12 hourly for 3 months), Prednisolone (60 mg PO at once per day for 10 days), and piracetam (800 mg PO 8 hourly for a month). After the treatment, a control pure tone audiometry was done and showed no improvement. The patient was sent to a neurologist who asked a brain MRI which was normal. Until now, 6 months after the accident, the patient has not improved at all and is left without solution to restore his hearing. He communicates by lip reading and speaking.

Discussion

Home electricity is a useful accommodation that has become indispensable in our modern society. However, it is potentially very dangerous [1,2]. The first recorded accidental death from electric current occurred in 1879 in Lyon, France [1,2]. However, by respecting basic security measures it can be exploited quite safely. In 1954, Silversides reported a weak and constant incidence of lethal accidents due to electricity of approximately 0.8% to 1% of accidental deaths while non-lethal incidents were 7 times as many [1].

The pathophysiology of the electric lesion is still not fully elucidated because of the numerous contributive factors. Kouvenhoven described the six variables that determine the severity of electrical injury: Type

Figure 2: Patient 2 initial picture and evolution.
A= Initial picture showing the skin defect and skull bone. B= Intraoperative view. C= 3-week postop view

of electric circuit, resistance, amperage, contact duration, voltage and the pathway of the current in the body [2-6].

Body lesions due to electricity are the same whatever the source of the electricity (lightning or artificial). They comprise but are not limited to burns, fractures, neurological damage [2,7]. Deafness as sequela of electrification is also reported by few authors [5,7]. Its mechanism is complex and linked to the properties of the electric current.

In Cameroon, the current supplied by the national electricity company ENEO is produced from three main hydroelectric plants and various smaller size thermal plants. It is an Alternative Current (AC) of frequency 50 Hz. The original high voltage current is transformed into low that is used by homes and most of industries. The carried by domestic cables oscillates between 220 and 380 V.

Nerve tissue, blood and muscles have the lowest resistance to the propagation of electric current while bones, tendons and fat have the highest resistance [2]. Other tissues have an intermediate resistance. High resistance tissues convert most of their electricity into heat that causes burns. It is not easy to determine the resistance of the body during the electrification since its variable. The wetting of the cable by rain contributed to lowering the resistance. Resistance of the human body is maximum on dry skin over the palms and soles and is estimated at 100,000 ohms. This resistance drops to 2,500 ohms when moist [7]. It can be further lowered by immersion in water (1,500 ohms) [7].

The amperage is the amount of energy transported by the current. It is difficult to determine this because it varies according to the tissue resistance. Above 10 mA, muscle tetany occurs, making the victim to grasp even more firmly the electric source [1]. This tetanic contraction can be so powerful that it can provoke a muscle tear or a bone fracture [1]. In the first case, the fracture may be due to the fall since a tetanic contraction would have caused other thermic lesions. In this case, there were only some bruises on the right forearm. From 75 mA, death can occur [8]. The voltage transported by the cable is 380 V and the minimal resistance of the body being 1,000 Ω, we can deduct from the formula U=RI that the intensity of the current that passed through our patient 1 is about 38 mA.

The contact duration with the cable; though short, was long enough to create skin lesions at the entry points: The foot sole in the first patient and the head in the second.

Voltage is the measure of a potential difference between two distinct points. It depends on the electric source. Electric accidents are classified into two types: Low voltage accidents (<500 V) and accidents of high voltage (>1000 V) [1]. The two types are deadly but mostly the latter. As from 25 V, a voltage is dangerous. Lethal accidents have been reported at 46 and 60 V [1]. In low voltage accidents, the current is multiplied by grounding [1]. At the same voltage, alternative current is three times as dangerous as direct current because of the possibility of tetanic contraction in case of prolonged contact [2]. However, the main cause of body lesions is the amount of current that passes through the body [2].

Ear lesions comprise but are not limited to tympanic membrane rupture, ossicular fracture, mastoid fracture, ear cerebrospinal fluid leak, hemotympanum and permanent deafness [7]. The hearing loss is typically conductive, rarely sensorineural [2-5]. Facial nerve damage, vertigo, tinnitus and nystagmus can also occur [9]. The mechanism of deafness is complex. The post mortem examination of electrocution casualties shows some lesions: Blood or pus collection of the middle ear and/or the mastoid, tear of Reissner's membrane, degeneration of the stria vascularis and Corti's organ, micro fractures of the otic capsule and hemorrhage of inner ear [3-5]. The hearing loss and tinnitus may be due to microlesions of the inner ear. Not knowing the prior audiological status of the patient could make us doubt electrification as the cause of hearing loss, suspecting malingering since such patients receive compensation from the electricity company. However, the dramatic scene of the patient complaining of hearing loss upon recovery from coma and interrogations from his relatives made us believe otherwise. In the 3rd patient, the lightnings stroke a nearby location and the current was channeled through the ground to his house and entered his ears *via* earphones. In addition, the change of vasculature in the inner ear after the lightning strike has been advanced as a possible cause of cochlear injury [4].

Nervous system involvement comprises brain injury, spinal cord and peripheral nerve lesions and neuropsychological sequela [10]. Loss of consciousness is frequent, generally followed by total recovery as we witnessed in the first 2 cases [11].

The management of patient 1 was that of sudden hearing loss in a resource limited setting. It was successful on tinnitus. Our hypothesis is that some minor cochlear cells lesions healed, relieving the tinnitus, but those cells were already too damaged to function well.

Conclusion

Electrical accidents are relatively frequent nowadays, due to natural and artificial current. Lesions of the head and neck are common, comprising burns and hearing loss. The ENT specialist should be involved in multidisciplinary teams that deal with such patients.

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