Long term outcome and follow up of electrical injury

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1. Introduction

Electrical burns in our country are more prevalent than in developed countries, and have severe complications with socio-economic impact. Passage of high voltage (>1000 V) through the body and specially muscles will result in severe necrosis in the entry points in skin and in the deep tissue near the bone. Other soft tissues such as nerve, vessels and tendons may develop necrosis too[1].

The incidence of electrical burns is about 2%–3% in developed world and about 10% or more in our country among burn patients, but it has high morbidity, impaired function, needs reconstructive surgeries and sometimes will lead to death[2].

The objective of this study was to identify the epidemiologic features of electrical injury, to evaluate the outcome of electrical burn on a patient’s life performance and the disability induced by this type of injury.

Methods: This study is a prospective 6 years descriptive study. The injured patients admitted to our center between 2006 and 2008 were followed for 6 years to estimate the ability of their life and job performance after the injury.

Results: In the patients, 96.8% were male. The mean age of patients was 27.9 years. 73.9% of those injuries were occupational injuries. 86.5% were pure electrical injuries. 81% of patients went back to their previous job within a 5–6 year period. Only 5% had the ability to perform their usual daily activities; these patients needed financial support from family, insurance companies and government. Unfortunately 6.3% were totally disabled and needed complete help even for their minor natural needs. These patients are young and probably have a long-term life expectancy and would have a huge financial impact on the government and society. The mean length of hospital stay was 17.7 d. The mean total body surface area burned was 13.3±11.5%. We could see an association between high voltage burns and falling down (P=0.005). High voltage burns needed longer periods away from work (197 d) in comparison with low voltage injuries (145.8 d) (P=0.003).

Conclusions: High voltage electrical burns are severe, needing more flap repairs and/or amputations and cause longer periods away from work.
basis for developing targeted preventive programs to prevent electrical injuries.

2. Materials and methods

This study is a prospective descriptive study of all electrical injuries. The out patients were excluded. The data has been retrieved from our burn registry program. The patients were all electrically injured and admitted to our center between 2006 and 2008. The following data has been included in the study: age, sex, total body surface area burned, mortality, length of hospital stay, accompanying trauma, falling, high or low voltage, need for an intervention (debridement, flap, graft, amputation), severity of burn, severity of disability and length of disability.

The patients were observed over a period of 6 years to identify the severity of disability after complete recovery. We retrieved data about the patient’s performance in life according to their job at present and before the injury. SPSS 19 was used for data analysis. P value less than 5% was considered significant.

3. Results

Among the patients studied, some could handle their previous occupation, some had to change their job, some could not go back to work, and a group of them did not even perform their personal activities. A total of 96 patients with electrical injuries were admitted in a 2–year period from 2006 to 2008.

96.8% were male. The mean age of patients was 27.9 years. 73.9% of those injured were occupational injuries (Table 1). The mean age and cause of injury in high and low voltage cases is shown in Figure 1. 75% were high voltage injuries.

<table>
<thead>
<tr>
<th>Causes</th>
<th>Number</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupational accidents</td>
<td>71</td>
<td>73.9</td>
</tr>
<tr>
<td>Other accidents</td>
<td>20</td>
<td>21.0</td>
</tr>
<tr>
<td>Cable stealing</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>Others</td>
<td>1</td>
<td>1.0</td>
</tr>
<tr>
<td>Missing</td>
<td>3</td>
<td>3.1</td>
</tr>
<tr>
<td>Total</td>
<td>96</td>
<td>100.0</td>
</tr>
</tbody>
</table>

86.5% were pure electrical injuries while in 4.8% the patients had simultaneous orthopedic fractures. 6% had head trauma and in 2.4% there were other types of trauma accompanying electrical injuries.

67.7% of patients needed skin graft. 20.4% had a kind of limb amputation. 21.6% needed flap repair.

The mean length of hospital stay was 17.7 d. The mean total body surface area burned was 13.3%±11.5% (Mean±SD). The mean time away from work for each patient was (183.4±171.9) d. 81% could perform their previous job in a 5–6 year follow up period.

About 8% of patients had to find another alternative job for a living and need further training for the new job. But 5% had only ability to perform their usual and daily activities and could not work. 6.3% of them were disabled and did not even return to their personal activities.

The severity of disability was categorized into three grades: mild, moderate and severe. 12.7% were severely disabled. 21.5% were moderately disabled and 65.8% were mildly disabled.

Majority of high voltage burns were job related but it was not statistically significant (Table 2). The demographic distribution of all groups showed a predominance of young male adults.

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Occupational injuries</th>
<th>Casual injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td>High voltage</td>
<td>63 (87.5%)</td>
<td>9 (12.5%)</td>
</tr>
<tr>
<td>Low voltage</td>
<td>8 (36.3%)</td>
<td>13 (59.0%)</td>
</tr>
<tr>
<td>Total</td>
<td>71 (73.9%)</td>
<td>22 (23.0%)</td>
</tr>
</tbody>
</table>

In our study there was only one death due to high voltage occupational injury. The mortality rate and high voltage burns had a strong correlation (P=0.05). We could see an association between high voltage burns and falling dawn (P=0.005). High voltage burns needed more amputations (not statistically significant) (Figure 2). They had longer periods away from work (197 d) in comparison with low voltage
injuries (145.8 d) (P=0.003).

Figure 2. Frequency of amputations in high and low voltage electrical injury.
H=high voltage; L=low voltage; tbsa=total body surface area.

The mean total body surface area in occupational injuries is 13.2% while in casual group it is 10.3% (P=0.04). The mean age in occupational electrical burn is 30.4 years however casual electrical burns it is 21.2 years (P=0.01).

There was a significant correlation between occupational electrical burns and need for a flap repair (P=0.03) (Table 3). Table 4 shows the outcome, number of amputations and length of hospital stay in high and low voltage injuries.

Table 3
Type of injury and need for flap repair.

<table>
<thead>
<tr>
<th>Type of injury</th>
<th>Flap repair needed</th>
<th>No need for a flap repair</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occupational electrical</td>
<td>16 (22.5%)</td>
<td>55 (77.5%)</td>
</tr>
<tr>
<td>Casual burns</td>
<td>5 (22.7%)</td>
<td>17 (77.3%)</td>
</tr>
</tbody>
</table>

We did not find any association between total body surface area burned causes, accompanying trauma with going back to activities.

As we can see high voltage electrical burns are more severe, needing more flap repairs, amputations and cause longer periods away from work. Some of them induce disabilities that make it impossible for the victims to do their previous job (Table 4). The injured patients are mostly young males at work. The injuries are usually causing falling dawn and accompany other types of trauma.

Table 4
Statistical comparison of outcomes after high voltage and low voltage injury.

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>High voltage</th>
<th>Low voltage</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>1</td>
<td>0</td>
<td>0.05</td>
</tr>
<tr>
<td>Delay to return to work</td>
<td>31</td>
<td>33</td>
<td>0.02</td>
</tr>
<tr>
<td>Falling dawn</td>
<td>21</td>
<td>7</td>
<td>0.05</td>
</tr>
<tr>
<td>Mean length of hospital stay</td>
<td>17</td>
<td>10</td>
<td>NS</td>
</tr>
<tr>
<td>Amputation</td>
<td>17</td>
<td>3</td>
<td>NS</td>
</tr>
<tr>
<td>Graft</td>
<td>54</td>
<td>11</td>
<td>NS</td>
</tr>
</tbody>
</table>

NS: Not significant.

4. Discussion

Electrical burns are relatively uncommon, and are associated with significant morbidity and mortality and long-term (or life time) disability[3,4].

Electrical injuries are categorized according to voltage: high voltage injury is defined as voltage over 1000 V; lightening is the most rare type of high voltage electrical injury with a high mortality.

Clinical features of electrical injury include 3rd or 4th degree burn in entry and exit points (surface of entry point is usually bigger than exit point), myoglobinuria, acute tubular necrosis of kidneys, compartment syndrome in extremities and usually vessels, nerve, tendon and muscle loss, vertebral (specially cervical) fracture due to severe muscular contractures of paravertebral muscles, fall and long bone fractures, different kind of mummification of the limbs that lead to amputations of extremities, acalculus cholecystitis bowed perforation and peritonitis, intra-abdominal bleeding, neurological symptoms and paralysis, and cataract.

The tissue loss depends on the voltage of the electricity and the resistance of the specific tissue, the pathway of current through the victim’s body, and the duration of the contact[5].

The death usually is due to ventricular arrhythmia or arrest or respiratory apnea[5].

Severe tissue necrosis in limbs and body, renal failure, and the secondary multiple system organ failure determines morbidity and long-term prognosis[5].

Loss of school days in children electrical burn is reported and result in serious and significant health and financial burden for the their families[6].

The amputations and long term unemployment lead to choosing of alternating job due to disability, and often need of new job training and rehabilitation for amputation limbs and need for prosthesis[7-9]. The majority of electrical burn injuries were work–related[10-13].

Patients who survive high voltage electrical injury may have some complications, such as limb amputation and disability, neurologic sequelae, chronic renal failure, loss of muscles and tendons, inability to perform fine works, blindness, psychological and physical symptoms[3-5,7-9].

Xie et al. in 2003 reported that the intensity of brain injury was related to intensity and site of electrical damage and
that whether it was high voltage or not. This electrical injury was related to the direct effect of electrical current on the brain tissue, to mechanical injury, to the cardio–pulmonary injury, or to massive skin necrosis[16].

The long–term complications of the electrical injury may appear after 1 to 5 or more years after the electrical injury. Therefore we decided to follow our patients for about 6 years to evaluate the long–term sequela of electrical injuries[1,2].

High voltage injuries will have larger body mass necrosis than low voltage with longer length of stay in ICU and in hospital. And it needs reconstruction due to large tissue necrosis and higher rates of amputation[16].

Chudasama et al. reported that the rate of disability in the high and low voltage groups were 17.5% and 5.3%, respectively. Electrical injuries is usually accompanied by severe morbidity and small burn size[16].

On the other hand, Cancio et al. reported that high voltage injury leads to high rate of amputation and a low risk of mortality. He stated that gross myoglobinuria is the predicting sign of higher rate of fasciotomy and/or amputation[17].

Prevention modalities for these complications are escharotomy and fasciotomy, early flap coverage, hyperbaric oxygen and infection prevention[3,4,18]. Neurological, psychological, occupational therapy, reconstructive surgery and rehabilitation are the mainstay of treatment[19].

Chang et al. in 2001 suggested that rehabilitation professionals can assist amputee patients to perform better function, through modalities like orthotics, prosthetics, and assistive devices[19].

Neurological impairments, either immediated or delayed, temporary, permanent or progressive, can occur such as peripheral neuropathies, chronic pain syndromes, brain injury and severe paralytic syndromes[20]. All of above complications can prevent patients to go back and perform their work and would result in financial problems and poor quality of life[21,22].

Noble et al. in 2006 showed that significant emotional distress and anxiety are more common in high voltage injuries. He stated that electrical burn patients may have a limited ability to return to previous work resulting in long–term emotional distress[22].

To our knowledge there are few reports about long–term outcome of electrical injury, so we decided to perform the present study. Our data showed that 73.8% of electrical injuries were occupational and 20.4% had a kind of limb amputation. Most of the patients were young male adults, and some other reports also mentioned young male adults with some degree of amputation. So majority of the patients were good, capable labor force for society, and one fifth of them had amputation and lost their ability to work properly for their family and society as general. The political and economic consequences for society are enormous, since most of the patients were in the prime of their working lives[10–13].

The mean time away from work was more than 6 months and this would have a high impact on insurance companies, health and governmental facilities.

Fortunately 81% of patient went back to their previous job, about 8% of patients had to find another alternative job for a living and need further training for new job. But 5% had only ability to perform their usual and daily activities and could not work; these patients need financial support from family, insurance companies and government.

Sadly 6.3% were totally disabled and need complete help for their living and even for their minor natural needs. These patients are young and probably have a long–term life expectancy and would have a huge financial impact on the government and the country.

It seems that about 8% need partial support from government and insurance companies. But unfortunately about 11% need complete support and would have a huge economical burden over governmental budget.

We have seen that 66% of disabilities were mild and 21% moderate; these patients could manage to go back to work and have a better outcome.

As we all know prevention is the major factor in all types of burn and high voltage injuries had a much worse outcome than low voltage, so preventive programs should focus more on these groups of patients.

The regional burn centers and industry should work together to prevent occupational electrical burn injuries and potentially life–threatening electrical accidents[8]. It is difficult to prevent most of high voltage electrical injuries, since accidental contact with high voltage lines may occur in different classes of workers; training programs may have variable results among workers and it might be cost–effective[1,16,23–25].

It is suggested that proper training of personnel for handling the electrical devices, better training and better warning signals will reduce the incidence of electrical burns significantly[8,25–27].

There are few numbers of electrical injury, and larger studies that may be with higher number of cases would better help us to understand several features of electrical injuries.

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job. About 8% of patients had to find another alternative job for a living and need further training for new job. But 5% had only ability to perform their usual and daily activities and could not go back work, and unfortunately 6.3% were totally disabled and need complete help for their living. Therefore about 11% of patients would have a huge financial impact on the government and society. Prevention of high voltage electrical injuries could reduce these financial losses.

Conflict of interest statement

The authors report no conflict of interest.

References


