Factors Associated with Occurrence of Amputation in Electrical Burns

Steven Narmada, Lisa Y. Hasibuan

Background: Electrical burns can cause damage to blood vessels in the burning extremities. This damage can lead to amputation that significantly impacts both physically and psychologically that affects the quality of life. This study aimed to determine the incidence and factors associated with the occurrence of amputation in electrical burns.

Method: A retrospective cohort study was done to patients with electrical burns that came to RSHS from 2011 to 2013. Multivariate analysis, logistic regression, was performed on the factors associated with the occurrence of amputation in electrical burns.

Result: Most of the electrical burns were suffered by men (93.5%) at reproductive age (mean 34.1 years; range 10-60 years of age). The incidence of amputation in electrical burns is 54.8% from 31 patients. There is a significant relationship between the causes of high-voltage electrical burns> 1000V with the occurrence of amputation (p = 0.008; Relative risk ratio 8,125 ; 95% CI= 1,62-40,752) and there is a significant relationship between the presence of third degree of burns with amputation (p = 0.011; Relative risk ratio 16; 95 % CI=1,643-155,76). There is no significant relationship between the extent of burns and lactate levels with the amputation on electrical burns.

Conclusion: Amputation in electrical burns have a fairly high incidence. High electrical voltage> 1000V and presence of third degree of burns are associated with the occurrence of amputation.

Keywords: amputation, electrical burns, 1000 V, lactate, extensive burns, degree of burns

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The damaged could include nervous system, blood vessels, muscles, skin, fat and bones. The greater voltage which is accepted by patient, the greater degree of tissue damage happened. Electrical burns injury can significantly damage blood vessels. This damage is progressive and proportional to the magnitude of the electrical voltage. It can also lead to amputation that significantly impacts both physically-psychologically and affects the patients quality of life.

The damage caused to the skin is proportional to the magnitude of the electrical voltage. The epidermis of the skin is relatively dry and acts as a resistor that is influenced by the thickness and moisture levels.

Lactate levels in the blood of patients had a positive correlation with the amount of tissue damage experienced by the patient. When tissue damage occurs, the anaerobic metabolism that occurs is reflected by elevated lactate level in patients blood.

This study aimed to determine the incidence and factors associated with the occurrence of amputation in electrical burns. By knowing the risk factors, health workers are expected to recognize the possibility of amputation in patients with electrical burns.

METHODS

The design used in this study is a cohort retrospective with multivariate logistic regression analysis of the factors associated with the occurrence of amputation in patients with electrical burns who came for treatment to RSHS period January 2011 to December 2013. This research information is obtained through medical record. The data collected were age, gender, length of stay, the magnitude of the electrical voltage, total burns area, degree of burns, lactate levels at admission, and the presence or absence of amputation as patient outcomes. The collected data which is included had a complete variables to be observed.

The Magnitude of electrical voltage were divided into high voltage ( > 1000 volts ) and low voltage ( < 1000 Volts). It divided by source of electric current, whether derived from household electricity, power poles or high voltage electricity.

Total burns area are expressed in percent and divided into burns area below 10 %, between 10-25 %, and above 25 %. The depth of burns as a damage caused by the magnitude of the voltage is divided into superficial degree burns ( IIA and IIB ) and deep degree burns ( IIB and III ). The deep degree of burns as severe tissue damage increasing the likelihood of amputation.

Lactate levels are an indicator of anaerobic metabolism in response to the
<table>
<thead>
<tr>
<th></th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Kolmogorov Smirnov</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Burn Area (%)</td>
<td>5</td>
<td>62</td>
<td>28.855</td>
<td>17.0241</td>
<td>0.153</td>
<td>Normal</td>
</tr>
<tr>
<td>Lactate level (mmol)</td>
<td>0</td>
<td>4.9</td>
<td>1.7833</td>
<td>1.21285</td>
<td>0.191</td>
<td>Normal</td>
</tr>
<tr>
<td>Age (year)</td>
<td>10</td>
<td>60</td>
<td>34.2258</td>
<td>11.63818</td>
<td>0.2</td>
<td>Normal</td>
</tr>
<tr>
<td>Length of Stay (days)</td>
<td>1</td>
<td>65</td>
<td>30.5</td>
<td>21.763</td>
<td>0.031</td>
<td>Not Normal</td>
</tr>
</tbody>
</table>

The mean burn area is 28.55% with lactate level was 1.78 mmol/L. The mean length of stay in hospital was 30.5 days, most of them ending the treatment by force discharge (table 1).

From chi square test, there are closed relation between electrical voltage with incidence of amputation in electrical burn injury, patient with electrical voltage > 1000 volt have higher incidence of amputation. P value 0.008, Relative Risk 8.125 (95% CI from 1.620 - 40.752).

Figure 2. Relation between electrical voltage with incidence of amputation.
There are no relation between lactate level (p=0.436) nor total burns area (p=0.3) with occurrence of amputation.

From Fischer exact test, there are closed relation between degree of burns with incidence of amputation. Patients with degree of Burns IIB & III have higher incidence of amputation. P value 0.011 Relative risk ratio 16 (95 % CI= 1.643 – 155.76).
Table 2. Multivariate analysis on factors associated for amputation

<table>
<thead>
<tr>
<th>Factors associated for amputation</th>
<th>Constanta</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnitude of electrical voltage</td>
<td>1.768</td>
<td>0.05</td>
</tr>
<tr>
<td>Degree of burns</td>
<td>2.423</td>
<td>0.048</td>
</tr>
<tr>
<td>Total burn area</td>
<td></td>
<td>0.309</td>
</tr>
<tr>
<td>Constant</td>
<td>-2.626</td>
<td>0.031</td>
</tr>
</tbody>
</table>

Based on the results of logistic regression, the significant factors for the occurrence of amputation in electric burns are degree of burns and magnitude of the electrical voltage.

Multivariate Analysis

Multivariate analyzes were performed with logistic regression on risk factors of amputation which p value below 0.25 through bivariate analysis. Factors included in the multivariate analysis, among others, the magnitude of the electrical voltage, degree of burns, and total burns area. Regression with backward stepwise logistic was performed (Table 2).

From table 2, there is formula to calculate the probability for amputation.

\[ Y = -2.626 + 1.768 \text{ Electrical Voltage} + 2.423 \text{ Degree of Burns} \]

\[ P = \frac{1}{(1+e^{-Y})} \]

Note:

- If degree of burns IIA & IIB \( x \) 0
- If degree of burns IIB & III \( x \) 1
- If electrical voltage \( < 1000 \text{ V} \) \( x \) 0
- If electrical voltage \( > 1000 \text{ V} \) \( x \) 1

P is probability for amputation.

DISCUSSION

Most electrical burns are suffered by men (93.5%) with a mean age of 34.1 years old. This is possible because most of them were work related to electrical installations without safety procedure. The mean length of stay in RSHS is 30.5 days, including healed patient, died patient and forced discharge.

There is a significant relationship between the magnitude of the voltage experienced by patients (above 1,000 volts) with the number of amputations \( P = 0.008 \). This is due to the greater power supply voltage of the patient, the greater the tissue damaged were caused. This damage can be caused by heat diffusion through the intima resulting in vascular endothelial damage and progresif thrombus formation, lead to ischemia and necrotic tissue following with amputation.

The depth of burns also determine the likelihood of amputation in patients with electrical burns, \( P = 0.011 \) (fischer exact test). It showed that grade III burns has severe enough damage. The electrical energy through the skin is converted into thermal energy and the thermal effects resulted. Meanwhile, the wet skin will be a good conductor and just little energy is absorbed and forwarded to the underlying tissues, so the damage is not as deep as dry skin.

There was no significant association between extensive of burns area with amputation incidence, \( P = 0.200 \) (chi square test). Extensive of burns area not reflect the local severity of damage to the burnt tissue. Lactate levels also were unable to determine the likelihood of amputation in electrical burns \( P = 0.436 \) (chis square test). Lactate levels > 2 mmol/L showed the presence of tissue damage that leads to anaerobic metabolism, but lactate levels reflect the degree of damage to the body systematically, not locally on a particular organ or tissue. In addition, lactate levels easily changed by adequate resusistation.
On the basis of multivariate logistic regression analysis, the variables included were those that P value below 0.25, i.e. magnitude of electrical voltage, degree of burns, and total burns area. Retrieved end result, a significant factor for incidence of amputation is the degree of electrical burns (P = 0.048) and the magnitude of the electrical voltage (P = 0.05). Patients with deep degree of burns has 16 times risk for amputation (95%CI = 1.643 to 155.76) and patients exposed to high voltage electrical above 1000V has 8,125 times risk for amputation (95 % CI = 1.620 to 40.752).

When next electrical burns patient come to our emergency department, we could predict the probability for amputation by use this equation Y = -2.626 + 1.768 + 2.423 Voltage Degree Burns.

**CONCLUSION**

Incidence of Amputation in electrical burn injury is quite high (54.84 %). There are closed relation between electrical voltage and degree of burns with occurrence of amputation.

**REFERENCES**