Factors Associated with Occurrence of Amputation in Electrical Burns

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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. Mulativariate 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*

Latar Belakang: Luka bakar listrik dapat mengakibatkan kerusakan pembuluh darah pada ekstremitas yang mengenainya . Kerusakan ini dapat berujung pada terjadinya amputasi yang berdampak signifikan secara fisik maupun psikologis dan mempengaruhi kualitas hidup pasien. Penelitian ini bertujuan untuk mengetahui insiden dan faktor-faktor yang berhubungan dengan terjadinya amputasi pada luka bakar listrik.
Metode: Dilakukan studi case control pada pasien dengan luka bakar listrik yang datang ke RSHS periode 2011-2013. Analisis multivariate regresi logistik dilakukan pada faktor-faktor yang berhubungan dengan terjadinya amputasi pada luka bakar listrik.
Hasil: Sebagian besar luka bakar listrik dialami oleh laki-laki (93.5%), usia produktif (rerata 34,1 tahun; kisaran umur 10-60 tahun). Insiden amputasi pada luka bakar listrik sebesar 54.8 % dari 31 pasien. Terdapat hubungan bermakna antara penyebab luka bakar listrik tegangan tinggi >1000V dengan terjadinya amputasi (p=0.008) risiko relatif = 8,125, (95% CI=1,620 - 40,752) dan terdapat hubungan bermakna antara adanya derajat luka bakar berat grade III dengan terjadinya amputasi (p=0.011) risiko relatif= 16 (95%CI=1,643-155,76).Tidak terdapat hubungan bermakna antara luas luka bakar dan kadar laktat dengan terjadinya amputasi pada luka bakar listrik.
Kesimpulan: Amputasi pada luka bakar listrik memiliki insiden yang cukup tinggi. Tegangan listrik yang tinggi >1000V dan derajat luka bakar berat berhubungan dengan terjadinya amputasi.
Kata Kunci: *amputation, electrical burns, 1000 V, lactate, extensive burns, degree of burns*

Received: 4 September 2013, Revised: 12 November 2013, Accepted: 2 January 2014.
(Jurnal Plastik Rekonstruksi 2013;3:147-151)

Electrical burns are a type of trauma that can cause high morbidity and mortality. The incidence of electrical burns in Bandung and West Java is quite high which leads to amputation.1,2 Electrical burns have specificity because it can cause damage to the

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Presented in PIT Perapi 2014, Bogor, West Java, Indonesia.

Disclosure: *The authors have no financial interest to disclose.*

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.[3,4] 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. [2.4]

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.[5]

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. [6,7]

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. [8]

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.[4,5]

Lactate levels are an indicator of anaerobic metabolism in response to the

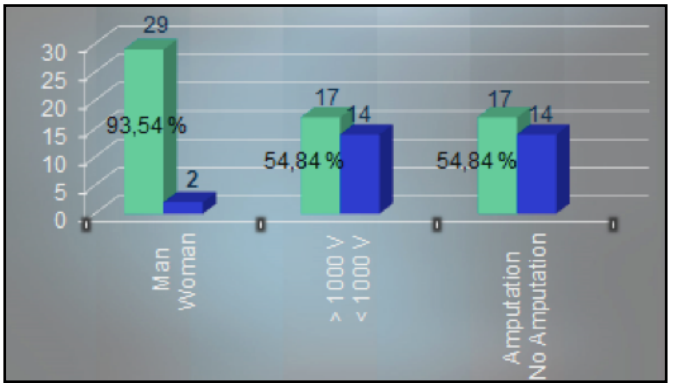

Figure 1. Distribution of sex, magnitude of electrical voltage, and occurrence of amputation.

	Minimum	Maximum	Mean	Std. Deviation	Kolmogorov smirnov	Distribution
Total Burn Area (%)	5	62	28.855	17.0241	0.153	Normal
Lactate level (mmol)	0	4.9	1.7833	1.21285	0.191	Normal
Age (year)	10	60	34.2258	11.63818	0.2	Normal
Length of Stay (days)	1	65	30,5	21.763	0.031	Not Normal

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).

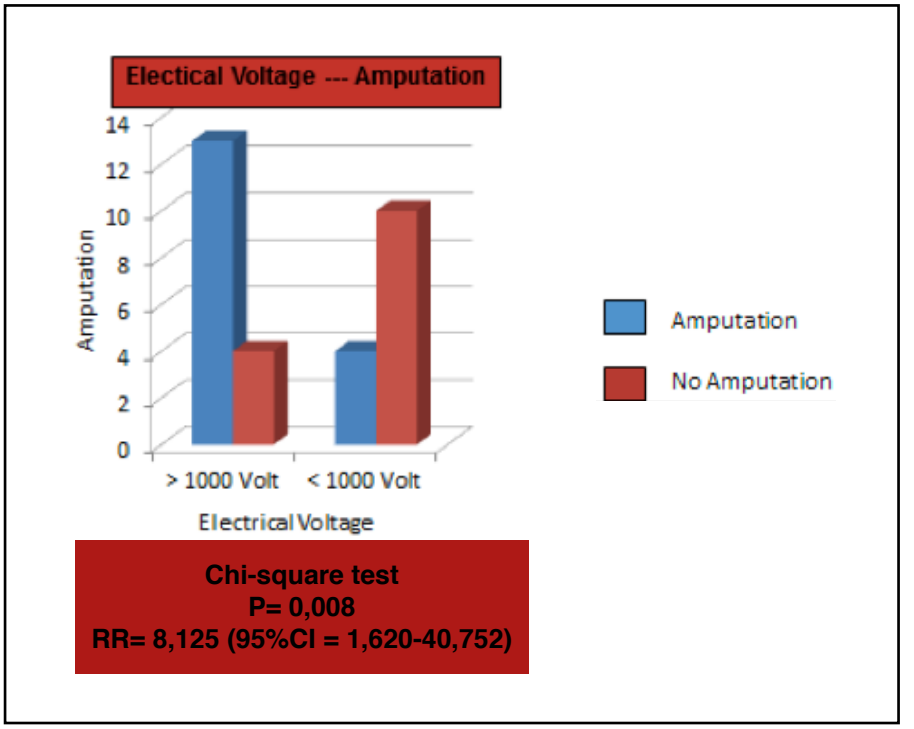

Figure 2. Relation between electrical voltage with incidence of amputation.

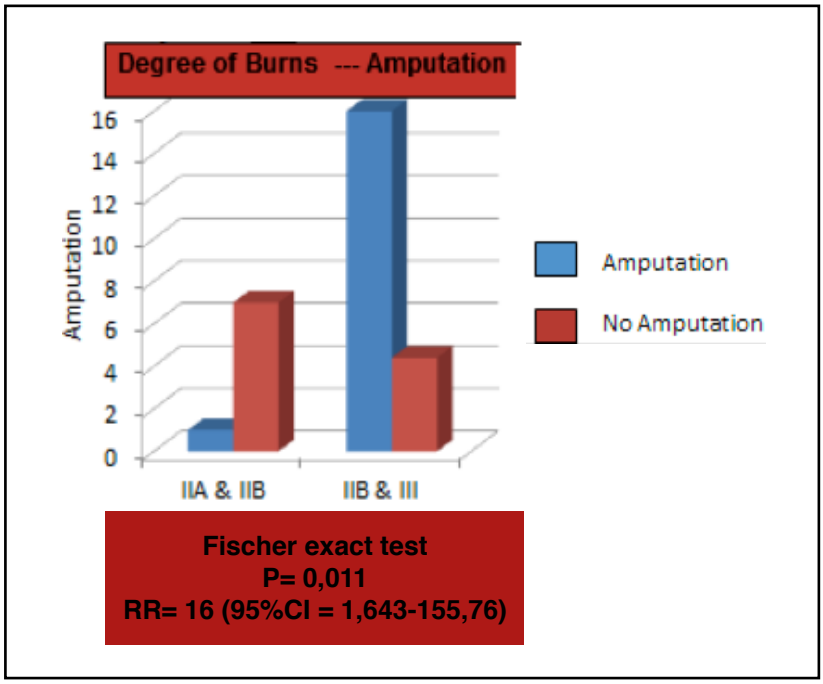

Figure 3. Relation degree of burns with incidence of amputation.

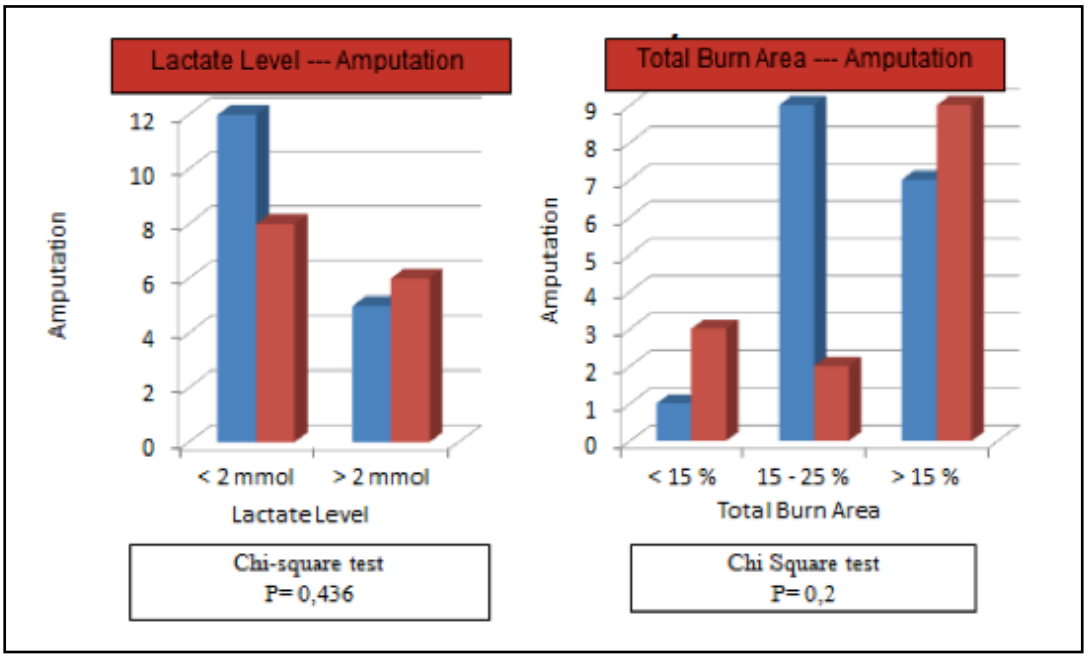

Figure 4 and 5. Relation between lactate level and total burn area with occurrence of amputation.

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

Factors associated for amputation	Constanta	P Value
Magnitude of electrical voltage	1.768	0.05
Degree of burns	2.423	0.048
Total burn area		0.309
Constant	-2.626	0.031

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 perfomed 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. Regeression 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 Electrical Voltage + 2,423 Degree of Burns

$P=1/(1+e^{-y})$

Note :

If degree of burns IIA & IIB x 0

If degree of burns IIB & III x 1

If electrical voltage < 1000 V x 0

If electrical voltage > 1000 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.[9]

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 progersif thrombus formation, lead to ischemia and necrotic tissue following with amputation. [8,10,11]

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.[5,12]

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 systemically, not locally on a particular organ or tissue In addition, lactate levels easily changed by adequate resusistation. [6.7]

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.

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