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Intensity and localization of trauma in non-fatal electrical injuries

Ölümcül olmayan elektrik yaralanmalarında travmanın şiddeti ve yerleşimi

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BACKGROUND
Electrical injuries currently remain a worldwide problem. In Turkey, burns are relatively small in number among injuries overall, but they continue to be a major public health problem. Electrical injuries may occur due to high- or low-voltage contact. Injuries due to low voltage usually occur at home. High-voltage injuries are usually work-related and result from a shorter contact, but may cause serious tissue destruction and secondary injuries.

METHODS
The objective of this study was to review a medical institution's experience with electrical injuries between 1997–2005. The institution admitted 55 electrical injury cases throughout this period. A computerized burns registry was used for data collection and analysis.

RESULTS
The burn causes differed among age groups and between the sexes, with males constituting 89.1% of the electrical burn patients. Forty-one of the injuries were due to high voltage whereas 14 injuries were due to low voltage. Complications were most common in the high-voltage group. Mean length of stay was longest in this group, at 33.69±21.13 days, and the patients in this group also required the most operations.

CONCLUSION
Work-related activity was responsible for the majority of these high-voltage injuries, with the most common occupations being linemen and electricians. These patients tended to be younger men in the prime of their working lives. Our study underlines the need for stronger efforts aimed at prevention, such as better public education and strict regulations regarding the distribution and use of electricity.

Key Words: Electrical injuries; forensic medicine; trauma.

AMAÇ
Elektrik yaralanmaları günümüzde dünya çapında artış gösteren bir sorundur. Türkiye'de yanıklar göreceli olarak yaralanmaların küçük bir kısmını oluştursa da önemli bir halk sağlığı sorunu olmaya devam etmektedir. Elektrik yaralanmaları yüksek ya da düşük voltajla temasla ortaya çıkar. Düşük voltaj yaralanmaları genellikle evde olmaktadır. Yüksek voltaj yaralanmaları işle ilgili bir ortamda kısa süreli temas sonucunda, ciddi doku hasarına ve ikincil yaralanmalara sebep olabilir.

GEREÇ VE YÖNTEM
1997-2005 yılları arasında elektrik yaralanması nedeniyle sağlık kurumumuza başvuran 55 olgu değerlendirildi. Elektrik yaralanması olarak tanı alan 55 kişinin dosya kayıtları araştırma verisini oluşturdu. Dijital ortamdaki yanık kayıtları analizlerde kullanıldı.

BULGULAR
Yanıklar farklı yaş gruplarında ve her iki cinste de görülebilmektedir. Olgulardan %89,1'i erkek idi. Yaralanmaların 41'inde yüksek 14'ünde düşük voltaj nedeniyle hasarlanmalar oluşmuştur. Komplikasyonların en yaygın olduğu grup yüksek voltajın neden olduğu yaralanmalardır. Erkeklerin hastanede en uzun kalma süresi (33,69±21,13) gündür. Bu gruptaki hastaların çoğu ameliyat edilmiştir.

SONUÇ
İşle ilgili faaliyetler yüksek voltaj yaralanmalarının çoğunluğundan sorumludur. En yaygın olarak elektrik hatları üzerinde çalışan elektrikçiler bu tip kazalara maruz kalmaktadır. Bu gruptaki hastalar genç insanlardır, iş yaşamlarının da başlangıcındadırlar. Araştırmamız daha iyi toplumsal eğitim, kazaları önlemeye yönelik güçlü çabalar, elektriğin kullanım ve dağıtımında katı düzenlemeler gerektiğinin altını çizmektedir.

Anahtar Sözcükler: Elektrik yaralanmaları; adli tıp; travma.

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Electrical accidents have been increasing in number due to the diversification in the fields of use of electrical energy. The lesions that emerge due to electrical injuries require a multidimensional examination since they are related with all systems in the body. The treatment of cases should be carried out in experienced burn centers. The injuries and deaths that occur as a result of occupational accidents are of legal significance.

The objective of this study was to review a medical institution's experience with electrical injuries occurring between 1997-2005. The institution admitted 55 electrical injury cases throughout this period.

MATERIALS AND METHODS

A computerized burns registry was used for data collection and analysis. Of these injuries, 41 were due to high-voltage (≥1000 V), and 14 were due to low-voltage (220 V). The medical records of 55 patients who were treated during the nine-year period were retrospectively analyzed with respect to age, gender, cause of burn, the month in which the burn occurred, admission date, duration of hospital stay, and area of burns.

RESULTS

Of the cases that form our research universe, 49 (89.1%) were male and the remaining six (10.9%) were female. Patient ages ranged from 4-55 years. Of 40 adult cases, 36 (90%) were male and four (10%) were female (age range: 19-55 years; average: 31.33±10.56). Of 15 pediatric cases (27.28%), two (13.34%) were female and 13 (86.66%) were male (age range: 4-17 years; average: 13±3.65).

The overview of cases with respect to their occupation showed that 19 cases (34.5%) were workers, 11 (20.0%) were students, eight (14.6%) were electricians, three (5.5%) were housewives, two (3.6%) were teachers and two (3.6%) were retired; the employment of four cases could not be defined.

Twenty-two cases (40.0%) applied to the hospital from our province and the remaining 33 (60.0%) were from neighboring provinces. The abundance of applications from neighboring provinces can be attributed to the fact that the only burn center in the region is in our hospital.

Sixteen cases (29.2%) occurred in spring, 19 (34.5%) in summer, 13 (23.6) in autumn and seven (12%) in winter. It was determined that electrical injuries occurred most frequently in June (9 cases, 16.4%) and least often in January (1 case, 1.8%), and that the evaluation with respect to months is compatible with that concerning seasons. Regarding the distribution of electrical injuries by day of the week, it was concluded that injuries occurred most frequently on Thursday (17 cases, 30.9%) followed by weekend days (5 cases, 27.3%).

The exact time of the accident could not be determined in 17 cases (30.9%). In the cases in which time of occurrence was determined, 12 (21.8%) were exposed to trauma between 06:00-12:00, 19 (34.5%) between 13:00-18:00, and 17 (12.7%) between 19:00-24:00. The hours between 13:00-18:00 are presumed to be significant in terms of electrical injuries.

Forty-one cases (74.5%) were exposed to high voltage whereas the remaining 14 (25.4%) were exposed to low voltage. Twelve of the cases (21.8%) exposed to high voltage suffered from a fall from a high place as well as electric shock.

In the cases that suffered from both electrical and mechanical trauma, the traumatic findings on the body or on clothes should not be determined to be signs of coercion - violence immediately. It should be taken into consideration that these findings may result from a strike due to losing one's balance or from a fall from an extreme height.

As for the areas of burns on the body, it was determined that 12 burns (21.4%) were on the head, seven (12.5%) on the face, 14 (25.0%) on the throat, 21 (37.5%) on the thorax, eight (14.3%) on the abdomen-pelvis, seven (12.5%) on the spinal cord, 54 (80.4%) on the upper extremity, and 34 (60.7%) on the lower extremity. The parts of the body mostly affected by burns were the upper extremities. The distribution of electrical burns on the upper extremities was as follows: right hand in 18 cases (32.7%), left hand in 11 cases (20.0%), and both hands in 11 cases (20.0%); in 15 cases (27.3%), burns were on the upper extremities; however, the exact area of the burns could not be determined.

Twenty-four cases (43.6%) suffered from second-to-third-degree burns, 21 cases (38.2%) from second-degree burns and 10 cases (18.2%) from third-degree burns.

It was observed that the cases had burn surface areas of: min. 1%, max. 50% and average 16.23±14.45. Surgical treatment was applied in 42 cases, whereas medical treatment was applied in 13 cases. Eight (19.0%) of 42 cases who received surgical treatment required inpatient treatment at our hospital a second time.

The duration of the hospital stay for patients who underwent surgical treatment was as follows: for their first stay in the hospital, min. 1, max. 96 (average 33.69 ±21.13 days); and for their second stay in the hospital, min. 2, max. 77 (average 12.75±26 days). Those who received only medical treatment stayed min. 1, max. 16 (average ±4.20) days in the hospital.

Six patients (10.9%) were discharged from the hospital on their own accord before their treatment was completed, and three cases (5.5%) died during their treatment process. In the cases of the exitus patients, one of the most significant problems was determining the relation between the trauma and death. In cases where determining this relation is problematic, it is important to take account of clinical symptoms and late complications of electrical trauma. Two cases (3.6%) were transferred to other hospitals.

The judicial reports showed that the trauma was life-threatening in 41 cases (74.5%), and non-life-threatening in 14 cases (25.5%).

It was observed that 52 cases (94.5%) had not recovered with simple medical attention, while three cases (5.5%) did.

The trauma caused organ damage in six cases (10.9%) and functional loss in nine cases (16.4%). The types and numbers of surgical interventions are given below:

Debridement 58; Grafting 36; Escharotomy and fasciotomy 19; Tangential excision 9; Major amputation 9; Minor amputation 9; Local flap 6; Distant flap 4; Free tissue transfer 2; Primary repair 3; Stump revision 3; Embolectomy 2; Tracheotomy 1; Artery repair 1; Open reduction and internal fixation 1 (a mandibular fracture); Open reduction and internal fixation 1 (a significant bone fracture).

DISCUSSION

In Nursal et al.'s study on electrical burns in our country, 95.5% of the patients were male; the percentage of male patients was the same in Tredget et al.'s study. Our findings are compatible with the results of these studies.[1,2] As mentioned in the literature, children are rarely exposed to burns resulting from high voltage.

The findings of our study showed that the average age of children exposed to electrical injury is 13.26±3.65. Rai et al. evaluated a period of 30 years and determined that the burns resulting from electrical accidents are seen among male children from 11-15 years of age. Our finding is compatible with that of Rai et al.[3,4]

The study of Hanumadass et al., which covered a period of 10 years, revealed that electrical injuries occurred at home and were preventable. However, our findings showed that only three children (17.6%) were injured at home and the remaining (82.4%) were exposed to electrical injury outside the home because of high voltage. Our findings concerning the place of the accident among children do not agree with the findings of Hanumadass et al. and Koumbourlis.[5,6]

An evaluation with respect to the occupation of the patients showed that almost half suffered the accident at their workplace (workers 34.5% and electricians 14.6%). This finding is compatible with the results of Koumbourlis and Arnoldo et al. The burns resulting from electrical accidents can be regarded as a public problem that causes a significant loss in the labor force among the young population.[6,7]

Approximately 56% of electrical accidents occurred from 06:00-18:00. Our findings concerning the times of the accidents are compatible with the findings of Chien et al.[8]

Considering that most of the people who are exposed to accidents are young, male and among the working population, it is inevitable that the accidents would occur during working hours.

Accidents due to high voltage were seen in 74.5% of the cases. In most studies about electrical accidents, injuries resulting from high voltage were predominant, and our finding is compatible with these studies.[9-11]

In their study on 55 cases exposed to accidents between 1995-2001, Liand et al. determined that burns caused injuries most frequently in the upper extremities. Our finding is also parallel to this result. Since most of the cases were male and workers (19, 43.5%) and/or electricians (8, 14.6%), it is not surprising that a majority of the burns would be seen on the hands. Proper management of early complications and repair of injured hands are of great importance in cases of electrical surgery.

When it is taken into consideration that the cases had burn surface areas of: min. 1, max. 50 and average 16.23±14.45, it is seen that these areas are larger than those reported by Tredget et al.: 9.9±12.9 total burn surface area, range 1-65.[12]

An evaluation of the duration of the hospital stay among cases who were exposed to electrical injury revealed that the average stay was 26.2 days in Nursal et al.'s study, 18.9 days in Arnoldo et al.'s study, and 18.6±7.3 days in Tredget et al.'s study. Our cases who underwent surgical treatment stayed an average of 33.69±21.3 days (range: 1-96 days) in their first hospitalization and an average of 12.75±26 days (range: 2-77 days) in their second hospitalization. These periods are longer than the periods identified in the other studies on electrical injuries in our country.[1,2,7]

Three cases (5.5%) died due to electrical injury. According to Edlich et al., the rate of mortality caused by electrical burns was 3-15%, and Cheng et al. reported a mortality rate of 6%. The rate of mortality defined in our study is compatible with the findings of these researchers.[7,12]

On the condition that a person is considered a physical or mental patient due to intentional, deliberate and conscious acts of another person or other persons, or a person loses his/her health due to imprudent, careless or negligent acts of another person or other persons, this situation has a judicial aspect within the context of laws. Electrical injuries are within the scope of judicial cases as well. Hence, all cases exposed to electric current were regarded as judicial cases.

In accidents caused by high tension or arc currents, strong and large thermal (heat, flame) burn areas emerge, and these areas may hide traces of currents. In such a situation, the traces of currents, known as entry wound of the electrical current, should be searched carefully in areas of thermal burns.

Working people lose some of their working force due to damages to their body as a result of accidents at their workplace. These weaknesses or losses are defined as disability (loss of working force). Since these losses are related with the person's occupation, some problems arise that concern the employer, the employee and the state.

Disability is not adequately incorporated into the social security system in our country or it may have different connotations. These differences may cause inequality in the workers' compensation.

Today, burns are among the serious health problems that threaten life despite the developments in medicine and technology. Electrical burns are significant injuries that require advanced treatment in the hospital. Though household devices may result in hazardous burns, serious burns generally occur among those who work on high tension lines where there is high voltage or who live in houses close to high tension lines and come into contact with these lines.

The degree of injury varies according to the amount of voltage and the duration of exposure. Bearing in mind that the cases require intensive rehabilitation and psychiatric support, the treatment process should include both of these medical disciplines.

One of the fundamental human rights is to resolve the problems and compensate the losses of individuals who suffer from electrical injury due to occupational accidents. "Belated justice is not a justice" is a saying that emphasizes one of the most important problems in our legal system. The disability scale that is currently used in our country should be updated.

Preventive measures taken before electrical injuries occur are regarded throughout the world as the cheapest and most effective method of reducing the number of such injuries.

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