

TREATMENT AND REHABILITATION OF CHILDREN WITH ELECTROTHERMAL INJURY

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Electrothermal lesions are most often seen in pediatric injuries. This type of injury is uncommon, but is one of the leading causes of death and disability in children. Using medical records, we analyzed the outcomes of the treatment and rehabilitation of children with electrothermal lesions ($n = 51$) admitted to Pediatric Burn Center, Children's City Clinical Hospital No. 9 (Yekaterinburg, Russia) over the period from 2010 to 2015. The patients were divided into two groups: Group 1 (39 children) had injuries from electrical household appliances and Group 2 (12 children) sustained high-voltage injuries. Primary surgical debridement was performed on all children; the extent and depth of the burns were established. The next step of surgical treatment for Group 1 included necrectomy and single-stage dermatoplasty; in Group 2 necrectomy and the first stage of skin grafting (formation of a skin flap) were performed. Subsequently, all patients in Group 2 received skin grafts for final closure of the skin defect. The duration of treatment in Group 2 was 2 times longer than in Group 1, due to larger burn areas (an average of 12 % vs. >5 %), longer burn shock (>24 h vs. 10 h), higher complication rate, and multiple stages of surgical treatment. Six patients from Group 2 received surgical amputation. However, the division into groups according to the physical properties of the electric current can be beneficial for the development of more effective treatment algorithms.

Keywords: electrical current, electrothermal lesion, electrical injury, combustiology, children, pediatric injuries

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ОСОБЕННОСТИ ЛЕЧЕНИЯ И РЕАБИЛИТАЦИИ ДЕТЕЙ С ЭЛЕКТРОТЕРМИЧЕСКОЙ ТРАВМОЙ

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Электротермические поражения характерны для детского травматизма. Этот вид травмы встречается редко, но занимает одно из первых мест в структуре причин летальных исходов и инвалидности у детей. В статье по истории болезни проанализированы результаты лечения и реабилитации детей с электротермическими поражениями ($n = 51$), находившихся в 2010–2015 гг. на лечении в Детском ожоговом центре Детской городской клинической больницы № 9 (Екатеринбург). Сформировали две группы: в первой 39 детей получили травмы при контакте с бытовыми электроприборами, во второй 12 детей пострадали от высоковольтного тока. Первичную хирургическую обработку проводили всем детям, устанавливали степень и глубину ожогов. На следующем этапе в первой группе проводили некрэктомию и одноэтапную пластику, а во второй — некрэктомию и первый этап пластики (формирование лоскута). В последующем во второй группе выполняли второй этап пластики кожными лоскутами разных видов для окончательного закрытия дефекта кожи. Выяснили, что продолжительность лечения детей во второй группе была в 2 раза больше, чем в первой, вследствие большей площади ожогов (в среднем 12 % против менее 5 % в первой группе), большей продолжительности ожогового шока (более 24 ч по сравнению с 10 ч в среднем в первой группе), развитием осложнений, многоэтапностью лечения. Во второй группе у 6 пациентов применили ампутацию. Тем не менее лечение детей с разделением на группы с учетом физических характеристик тока перспективно для создания более эффективных алгоритмов помощи.

Ключевые слова: электрический ток, электротермическое поражение, электротравма, комбустиология, дети, детский травматизм

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Electrothermal injury is considered a specific burn injury type because of the nature of the damaging factor, the electric current. It causes both local and systemic injury. The type of pediatric electrothermal injury depends on the age and social activity of the child. Young children are more likely to be injured by electrical household appliances, whereas teenagers are more likely to sustain high-voltage shock.

It is not possible to assess the total or regional incidence of electrothermal injury in children, since a large number of patients do not seek medical attention, and in rare cases death occurs at the scene of an accident before first aid can be provided [1–3]. In the overall structure of hospital admissions, electrothermal injuries account for 1–8 %, according to the data from a number of burn centers [4].

Children admitted to a hospital after sustaining an electrothermal injury need surgical treatment aimed at restoring skin integrity and eliminating functional disorders. Due to a low incidence of electrothermal injuries and the severity of the sequelae, the physicians should be particularly careful when dealing with young patients and strictly adhere to the algorithms of medical treatment considering the dependence of the severity of a patient's condition on the physical characteristics of the electric current [4–5]. Typical of this type of burns are deep and spreading lesions of subcutaneous tissue, neurovascular structures or muscles, through which the electric current travels faster than through the skin surface, as resistance in these body areas is different [6–8].

Current literature, both Russian and international, does not provide sufficient data on how the characteristics of the electric current influence treatment decisions. There are single case reports, descriptions of shock treatment principles, intensive care and skin repair techniques. But there is no standardized approach to the management of patients who sustained injuries from different types of electric current [9–11]. The aim of this study was statistical analysis of the treatment and rehabilitation outcomes in children with different electrothermal injuries admitted to the Pediatric Burn Center, Pediatric City Clinical Hospital No. 9 (Yekaterinburg).

METHODS

We performed a retrospective analysis of medical records of children with electrical injury treated in the Pediatric Burn Center over the period of 2010–2015. The study included 51 children

(39 boys, 12 girls). About half of the children were 3-years old or younger (24 patients), 10 patients were 13–15 years old (adolescents), 9 patients were 8–12 years old (primary school age), 8 patients were 4–7 years old (preschool children). The patients were divided into two groups according to the source of the electric current: group 1 included 39 (76 %) children with electrothermal lesions from electrical household appliances; group 2 included 12 (24 %) children with high-voltage shock.

The choice of surgical treatment depended on the characteristics of the electric current. Primary surgical debridement was performed in all children; the extent and depth of the burns were established. The next step was different for both groups: necrectomy and single-stage dermatoplasty was performed in group 1, while necrectomy and the first stage of skin grafting with the formation of a skin flap were performed in group 2. Subsequently, the patients from group 2 underwent the second stage of dermatoplasty with various skin grafts for final closure of the skin defect. Enzyme therapy and scar dermatoplasty were also performed for better cosmetic effect in group 2.

The localization of lesions, burn areas, burn shock duration, overall treatment time, and the level of disability were evaluated.

RESULTS

The incidence of electrothermal injuries in the Pediatric Burn Center, Children's City Clinical Hospital No. 9, was <5 % of the total number of children admitted to the Center over the period of 2010–2015. No deaths were observed. The results of treatment and rehabilitation of patients are shown in table. In group 1, an electrical injury of a hand with limited area grade IIIB–IV burns was most often seen at the site of direct contact with the current, and the lesion area was less than 5 %. The duration of burn shock was less than 24 h (10 h in average). In group 2, burn location was different and involved the head, neck, back, and upper limbs; burn areas were larger (from 5 to 15 %, an average of 12 %), burn shock was longer (over 24 h) and neurological symptoms were observed.

The children from group 1 were closely monitored until the formation of the demarcation line. This allowed for sparing surgical debridement followed by skin grafting. In group 2, aggressive surgical treatment was chosen to rescue the damaged segment of the body. Here, treatment duration was 2 times longer compared to group 1. The disability rate in

Results of treatment and rehabilitation of children with electrothermal lesions based on the characteristics of the electric current

Parameter	Group 1 (n = 39)	Group 2 (n = 12)
Current characteristics	220 B / 5 A	>1000 B / 100 A
Burn area	<5 % of the body	5–15 % of the body
Burn grade	II–IIIA. (n = 14) IIIB–IV. (n = 25)	IIIB–IV. (n = 12)
Duration of burn shock	Less than 24 h, not always manifested	More than 24 h
Combined injury	–	12 cases
Treatment	1) Primary surgical revision 2) Debridement 3) Single-staged skin grafting 4) Dressings	1) Primary surgical revision 2) Debridement (primary and secondary), including amputation 3) Multi-staged skin grafting 4) Dressings 5) Rehabilitation
Number of cases of disability	–	6 cases
Time of treatment, bed-days	3–34	9–75

group 2 was 50 %. In 6 cases, amputation was performed due to inability to preserve the integrity of tissues. Also, in group 2 patients, heart pathology (ectopics), neurological disorders (paresthesia, paresis, and other disorders of the peripheral innervation) were observed. These children were referred to cardiologists and neurologists in a primary care facility for further rehabilitation.

Electrothermal injuries were most common in children under the age of 3. In all studied cases, they were caused by home appliances and resulted from the lack of parental control. The second largest group with regard to the incidence of injuries was constituted by adolescents with high-voltage injuries resulting from the lack of age-appropriate activities during leisure time: children were unsupervised by adults. Eighty three percent of children resided not in Yekaterinburg but in other populated areas of the Sverdlovsk region.

DISCUSSION

Treatment and rehabilitation of children with high-voltage electrothermal lesions required more time, which was due to the combined nature of the injuries, a larger burn area, prolonged burn shock, disorders of the cardiovascular, nervous and respiratory systems, and multi-staged treatment in both in-patient and out-patient care facilities. Distributing patients into groups allowed us to develop algorithms of care based on the characteristics of the electric current and the severity of injury that directly influenced the strategy of surgical treatment and

rehabilitation. Aggressive surgical intervention at an early stage provided for maximum possible preservation of damaged tissues. Methods proposed previously did not include early skin grafting [12–14].

Interestingly, we observed a decreased incidence of household electric injuries in preschool children; we also registered high-voltage injuries in this group of patients for the first time. The same tendency was observed in primary school children. In general, over the past 6 years there has been a decrease in the incidence of electric injuries in both age groups, while from 2014 to 2015 no cases of high-voltage injuries were registered. Apparently, it is the result of the public campaign in the media and in schools to properly handle electrical appliances. Inspections of industrial enterprises and railroads aimed at timely prevention of injuries in children also had their effect.

CONCLUSIONS

The prognosis of organ preservation in electrothermal injuries depends on the physical characteristics of the electric current, the location of burns, and the degree of trophical and neurological disorders in the affected area. The treatment of high-voltage injuries with the burn area of >5% should include early surgical debridement and skin grafting (formation of a skin flap), followed by close wound monitoring, and, if necessary, extension of the debridement area and different types of dermatoplasty.

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