

## Survival of an eight-year-old child with a very severe high-tension electrical burn injury: a case report

Yüksek gerilime yakalanan elektrik yanıklı sekiz yaşındaki çocuğun sağkalımı: Olgu sunumu

Tülay S. YILDIZ,<sup>1</sup> Hakan AĞIR,<sup>2</sup> Didem KOYUNCU,<sup>1</sup> Mine SOLAK,<sup>1</sup> Kamil TOKER<sup>1</sup>

We present the management and survival of an eight-year-old boy with a severe high-tension electrical burn injury of 68% of total body surface area in a surgical intensive care unit, as a result of a well-planned and applied treatment strategy. Subsequent to escharotomy and fasciotomy operations under general anesthesia, the patient was taken into the surgical intensive care unit. In addition, patient underwent nine more operations including right femur disarticulation and split-thickness skin graftings with homografts from his brother and autografts. The patient was connected to mechanical ventilator for 59 days. By the time the patient was transferred to plastic and reconstructive surgery ward, he was fully conscious, cooperated and hemodynamically stable.

**Key Words:** Burns, electric/pathophysiology/therapy; child; high-tension electrical burn injury; reconstructive surgical procedures.

Bu yazıda, yüksek gerilime yakalanmaya bağlı toplam vücut yüzey alanının %68'i çok ağır elektrik yanıklı sekiz yaşındaki erkek hastanın cerrahi yoğun bakım ünitesinde iyi planlanmış ve uygulanmış bir tedavi stratejisi sonrası hayatta kalımı sunulmaktadır. İlk olarak genel anestezi altında eskaratomi ve fasiyotomi ameliyatları geçiren hasta hemen takiben cerrahi yoğun bakım ünitesine alındı. Bu ameliyatlara ek olarak, hasta sağ femur desartikülasyonu ve kardeşinden alınan homogreft ve kendisinden alınan otogreftlerle kısmi kalınlıkta deri greftlemelerini içeren dokuz ameliyat daha geçirdi. Hasta 59 gün mekanik ventilatöre bağlı kaldı. Hasta plastik ve rekonstrüktif cerrahi servisine devredildiğinde tam koopere, hemodinamik olarak stabil ve bilinci tamamen açık bir durumda idi.

**Anahtar Sözcükler:** Yanıklar, elektrik/fizyopatoloji/tedavi; çocuk; yüksek-gerilim elektrik yanık hasarı; rekonstrüktif cerrahi işlem.

Electrical burn injuries still remain to be an important cause of morbidity and mortality in children in developing countries. High-tension electrical injuries particularly have a characteristic clinical progress, which becomes more complicated and fatal with the increasing size and the depth of the burn.<sup>[1,2]</sup> This differential systemic feature necessitates a very aggressive fluid and electrolyte resuscitation in addition to immediate and serial surgical interventions.<sup>[3,4]</sup>

As a result, in hospitals, the whole management of such serious electrical burn injuries should be undertaken by specialized and experienced burn teams together with well established units.<sup>[5]</sup>

In this case report, we describe the management and survival of an eight-year-old boy with a very severe high-tension electrical burn injury of 68% of total body surface area (TBSA), in a surgical intensive care unit (SICU), as a result of a well-planned and applied treatment strategy.

### CASE REPORT

An eight-year-old boy was admitted to emergency department after a very high voltage electrical burn injury. At admission, the patient had a Glasgow Coma Scale (GCS) score of 9 to 10. In physical examination, both upper and lower extremities excluding distal parts, whole abdominal and tho-

Departments of <sup>1</sup>Anaesthesiology and Critical Care, <sup>2</sup>Plastic and Reconstructive Surgery, Medicine Faculty of Kocaeli University, Kocaeli, Turkey.

Kocaeli Üniversitesi Tıp Fakültesi, <sup>1</sup>Anesteziyoloji ve Yoğun Bakım Anabilim Dalı, <sup>2</sup>Plastik ve Rekonstrüktif Cerrahi Anabilim Dalı, Kocaeli.

Correspondence (İletişim): Tülay Şahin Yıldız, M.D. P.K.: 17, 41900 Derince, Kocaeli, Turkey.  
Tel: +90 - 262 - 303 10 00 / 8527 Fax (Faks): +90 - 262 - 325 73 63 e-mail (e-posta): tulaysahin00@yahoo.com

racic regions, total neck and lower face area, occipital scalp including ears had a full thickness deep burn injury. Right proximal lower extremity was severely charred. Total burn surface area was estimated as approximately 68% of the TBSA. Laboratory signs of severe dehydration and hemoconcentration were determined after the investigation of the blood samples. Initial medical treatment protocol for burns which has been well defined in the literature including fentanyl for analgesia was started immediately. Large amount of Lactated Ringer's solution was administered by IV infusion and urine output was monitored with the urinary catheter inserted. After the first management, it was decided to perform escharotomy and fasciotomy operations since the involved compartments of four extremities and thorax were already showing signs of remarkable compression.

We estimated our patient's TBSA as 0.94 m<sup>2</sup>. Fluid requirement for the first 24 hours was calculated as (according to Carvajal's fluid replacement program): (burn related losses) 5000 mL/m<sup>2</sup> burned TBSA plus (maintenance fluids) 2000 mL/m<sup>2</sup> TBSA.<sup>[6]</sup> Consequently, 24 hours fluid allowance was calculated as  $5000 \times 0.63 + 2000 \times 0.94 = 5030$  mL. Half of the calculated amount was administered during first 8 hours and the other half was given in next 16 hours. In 3 hours of surgery, a blood loss of 500 mL and a urinary output of 650 mL were recorded and the patient received 3500 mL crystalloids and 500 mL colloids. The patient as in intubated state was admitted to SICU where the following managements would be held afterwards (Fig. 1).

He was connected to the mechanical ventilator and left under continuous monitor control. Fluid replacement was adjusted so that urine output was kept above 1 to 1.5 mL.kg-1.hr-1. Precautions were taken to keep the patient warm because of developed hypothermia. Meanwhile, midazolam infusion (0.08 mg.kg-1.hr-1) for sedation and IV bolus doses of fentanyl, then morphine infusion (1 to 2 mg/hr) for pain control were administered. Propofol infusion or IV bolus doses of diazepam was administered whenever midazolam infusion was believed to be inadequate. Insulin infusion therapy was commenced after the blood glucose measurements above 500 mg/dL. Daily necessary protein intake was estimated as 2 gr.kg-1.day-1 and

energy requirement as 70 kcal.kg-1. Patient failed to tolerate enteral feeding for several times. We could begin enteral feeding on 28th day. Total parenteral nutrition (TPN) was started with 6% trophamine, 10% dextrose and trace elements. In following days, 10% intralipid was added to TPN and 10% dextrose was replaced with 20% dextrose. Whilst TPN was maintained, diarrhea occurred and lasted 20 days. Tracheostomy needed to be performed on the fourth day due to severe edema. A temporary rectal tube was used for prevention of infection in the perianal region due to feces contamination. Various metabolic and hematological problems were seen such as severe anemia and thrombocytopenia, hyperglycemia, hypokalemia, metabolic acidosis, hypo/hyponatremia and hyperbilirubinemia. All of these particular disorders were managed accordingly. Erythrocyte suspension, Fresh Frozen Plasma and vitamin K were



**Fig. 1.** Appearance of the patient early after his admission to SICU (Surgical Intensive Care Unit).

administered. Following very low total protein, albumin and globulin values (2.8 g/dL, 1.4 g/dL and 1.4 g/dL, respectively), Human Albumin and Human Immune Globulin was added to therapy after 2 days and 5 days, respectively and maintained for 20 days.

Burn wounds were infected with *P. aeruginosa* on sixth day post burn injury. *P. aeruginosa* and *S. aureus* were grown in tracheal aspirate cultures on nineteenth day in addition to *P. aeruginosa*, *S. aureus* and *C. albicans* growth in blood cultures on sixteenth day. Antibiotic regimen was changed with appropriate one according to the antibiotic sensitivity results.

Amniotic membrane as a biological dressing was applied on wounds to reduce fluid and heat loss and to prevent bacterial growth. Eventually, it was found to be effective. In addition to that,



**Fig. 2.** Post-burn one-year appearance of the patient with the right total lower limb prosthetic device in-situ.

patient had nine more operations including right femur disarticulation, radical debridements and split-thickness skin graftings with homografts from his brother and autografts.

On 7-day post admission, the patient has responded verbal impulse with opening his eyes and spontaneous movements. The patient was connected to mechanical ventilator for 59 days. Finally, on his 65th day of ICU stay, he was left to breathe room air. By the time the patient was transferred to plastic and reconstructive surgery ward on 72nd day, he was fully conscious, easily cooperated and hemodynamically stable. He has still been in the plastic surgery ward and receiving his surgical treatments and physiotherapies (Fig. 2).

## DISCUSSION

Full thickness burns involving more than 20% of TBSA (>10% in children younger than 10 years) and all kinds of electrical burn injuries are defined as major burns.<sup>[7,8]</sup> Morbidity and mortality rates increase with the size and the depth of the major burns as well as with the decreasing age of the victim. Survival rate appears to be lower in children below thirteen years old.<sup>[9]</sup> In “true” high-tension electrical burn injuries, prognosis is particularly poor due to extensive tissue damage.<sup>[1,2]</sup> In our patient, burned TBSA was estimated according to Lund and Browder’s surface area ratios age adjusted chart.<sup>[10]</sup> It was calculated as 68% TBSA which could be accepted as a fatal ratio.

Major burns of thorax, abdomen, head and neck area can cause severe edema and circumferential scar tissue formation, which may lead to obstruction and restriction of the respiratory system. To prevent deterioration in respiratory functions, full thickness escharotomy should be performed without any hesitation. In our patient, escharotomy was done immediately and respiratory functions were observed to improve subsequently.

Plasma volume loss is greatest in the first 4 to 6 hours after the injury and decreases substantially by 18 to 24 hours if adequate perfusion is maintained. Increased microvascular permeability, impaired cell membrane function and increased tissue osmotic pressure all lead to interstitial fluid accumulation.<sup>[11,12]</sup> Protein loss is greatest during the first 8 hours but continues unless the wounds are completely closed. Uncontrolled aggressive

attempts to restore blood volume should be avoided at this early stage, which can worsen the status. The goal of fluid resuscitation should be to restore and to maintain both perfusion and tissue oxygen delivery at optimal levels to protect the zone of ischemia in burned tissue.<sup>[11]</sup> Adequacy of replacement therapy can be assessed by some clinical parameters such as adequate urinary output (1 to 1.5 mL.kg-1.hr-1) and urinary density.<sup>[5]</sup> Fluid replacement is advised to begin with isotonic fluids such as Lactated Ringer solution. IV replacement with other solutions (hypo or hypertonic) or colloids has been controversial. In our case we began fluid resuscitation with Lactated Ringer solution and added human albumin to IV therapy after the first 24 hours.

To minimize infection risk and to decrease blood loss associated with customary serial debridements, amputation of mummified electrically burned limbs at more proximal levels, including marginally viable muscle cannot be avoided sometimes.<sup>[13,14]</sup> Our patient was first grafted with the skin grafts harvested from his brother and himself. Besides, amniotic membrane was applied over the wounds as described in the literature. In our patient a right femur disarticulation operation was performed which we suggest that made a great contribution to patient's recovery and survival.

During his stay in the ICU, our patient had PT and aPTT values constantly above normal. It is well known that factors like malabsorption, decreased enteral feeding, use of antibiotics and serial surgical procedures contribute to vitamin K deficiency in burned patients.<sup>[15]</sup> In our management daily vitamin K was given 5 mg IV besides FFP transfusions.

As a developing country, we still have a lack of correlation between the number of the burn injuries per year and the number of specialized burn centers established per year. Actually, a very severely burned patient by 68% TBSA had to be referred and treated in one of the pediatric ICUs, specialized in major burn injuries. However, no vacant room was available for the patient in any of these institutions in time of admission and during following weeks so we had to take over the responsibility of treatment.

The results of our management may be taken into consideration that such severe major burn

patients have the chance of survival in an ICU without a specified team and equipment. We suppose that several surgical factors played a major role in our success like properly performed surgical fasciotomies, serial radical debridements, use of allografts and homografts as temporary wound dressings, amputation of the charred limb in the early period. We think these surgical measures contributed greatly to prevention of the difficult and resistant fluid and electrolyte imbalances, acute renal failure as well serious infections and septic shock. Surgical removal of all necrotic tissues including life threatening charred extremities decrease the risk of acute tubular necrosis with lowering the load of renal system. Surprisingly, in our patient skin allografts taken from patient's brother remained viable for more than one month that was well beyond the limits expected. That might be due to the immunosuppression caused by severe major burn injury. In addition, we assume that a very vigorous fluid and electrolyte replacement including acid base haemostasis, close monitoring for infection and administering proper IV antibiotics, adequate treatment of anxiety and pain for minimizing stress response, high calorie and high protein intake which promotes wound healing contributed a lot to our patients survival during his follow up for 72 days in the ICU.

In conclusion, it can be said that if proper and meticulous fluid and electrolyte replacement is done, necessary surgical interventions are performed and all other management protocol is provided by SICU, severe electrical burns such as 68% of TBSA will have a chance of survival.

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