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Combined rectus abdominis muscle/paraumbilical flap and lower abdominal flap for the treatment of type III circumferential electrical burns of the wrist

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ABSTRACT

Background: Type III circumferential electrical burns of the wrist are one of the most severe electrical injuries, involving rather extensive necrosis, progressive blood circulatory embarrassment and a high amputation rate. This injury poses a challenge for vascular reconstruction and wound coverage. The purpose of this study was to evaluate the effectiveness of the combined rectus abdominis muscle/paraumbilical flap and lower abdominal flap for the treatment of type III circumferential electrical burns of the wrist.

Methods: Six men (age, 19–32 years; average, 21 years) with type III circumferential electrical burns of the wrist were included. After thorough debridement, the volar wound was repaired with a partial rectus abdominis muscle/paraumbilical flap and the dorsal wound was repaired with a lower abdominal flap.

Results: Flap survival was complete in all six patients. During a follow-up of 6–12 months, the flaps showed good texture and shape. No abdominal hernia occurred in any patients. The scar on the abdominal wall was acceptable.

Conclusion: The combined rectus abdominis muscle/paraumbilical flap and lower abdominal flap has large wound coverage potential and offers a new, easy, safe option for the treatment of type III circumferential electrical burns of wrist.

High-voltage electrical injuries of the wrist have a devastating effect because of the involvement of deep structures [1,2]. Exposure and degeneration of profound vital structures such as tendons, nerves, blood vessels, bones and joints can result in permanent disability and limb amputation if satisfactory wound coverage is not provided [3]. Early coverage of open wounds of the wrist is a generally accepted concept to achieve a better functional result. The treatment strategy involves early wound debridement and primary resurfacing of functionally important tissues with well-vascularised tissue.

Our previous report indicated that type III circumferential electrical burns of the wrist are one of the most severe electrical injuries, involving rather extensive necrosis, progressive blood circulatory embarrassment and a high amputation rate. This injury poses a real challenge for vascular reconstruction and wound coverage [1]. Complicated and time-consuming procedures, such as multiple-flap transfer or chimeric flaps, may be necessary for limb salvage in patients with more severe burns and large defects [1,4,5].

Based on the very well known vascular anatomy of the rectus abdominis muscle and paraumbilical and lower abdominal areas, we designed a rectus abdominis muscle/paraumbilical flap and lower abdominal flap to reconstruct circumferential wounds of the wrist. The volar wound was repaired with a partial rectus abdominis muscle and paraumbilical flap, and the dorsal wound was repaired with a lower

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abdominal flap. We herein discuss the effectiveness of the combined rectus abdominis muscle/paraumbilical flap and lower abdominal flap for the treatment of type III circumferential electrical burns of the wrist.

1. Methods

1.1. Patients

This study was approved by our hospital's Ethics committee. The selection criteria included: (1) patients suffering from electrical injuries resulting from a voltage >1000 V, (2) patients with a massive wound on the volar and dorsal aspects of the wrist and (3) patients with an open wound with exposure of underlying vital structures such as tendons devoid of paratenon, bone without periosteum and major nutrient arteries of the upper extremity, all of which threaten limb function or survival. Six men hospitalised in our institution met the inclusion criteria (age, 19–32 years; average, 21 years) and were thus selected as the participants. Three patients had two severe extremity injuries, two patients had three severe extremity injuries and one patient had four severe extremity injuries. After admission to our centre, all patients underwent escharectomy to release the circulatory embarrassment of the extremity. Other deep burn wounds were located in the shoulder, cephalic and associated regions. After 2–7 days of hospitalisation, debridement and combined flap placement were performed on all wrists with type III circumferential electrical burns. One patient underwent amputation of three fingers, one underwent an upper limb amputation, one underwent a lower limb amputation and one underwent both an upper and lower limb amputation due to an extensive electrical burn injury. Besides placement of the combined flaps on six wrists with type III circumferential electrical burns, two free anterolateral thigh flaps were placed on two wounds of the ankles and feet, three distally pedicled sural flaps and one posterior tibial artery perforator flap were placed on wounds of the lower limb, two latissimus dorsi myocutaneous flaps were placed on the shoulders of two patients and one local flap was placed on the cephalic region. Patient details are provided in Tables 1 and 2.

1.2. Surgical techniques

1.2.1. Debridement of wrists with type III circumferential electrical burns

On the volar aspect of the wrist, hand and forearm, all eschar and devitalised muscles, tendons and nerves were thoroughly removed. The embolic blood vessels were ligated. Exploration to identify the radial and ulnar arteries was unnecessary when blood circulation was present in patients to refrain from progressive injuries. Fortunately, the tissue destruction in all of our patients decreased from the volar (III–IV degree) to dorsal (deep II–III degree) aspect of the wrist, distal forearm and hand. Therefore, debridement of the dorsal aspect of the wrist was more conservative. More active tissue was retained to benefit the blood circulation of the wrist, especially venous

Table 1 – Details of type III circumferential electrical burns of the wrist in the six male patients enrolled in the present study.

Patient number	Age (y)	Voltage (kV)	Location	Injured vital tissue	Flap size	Outcome	Follow-up (mo)
1	19	10	Distal forearm, wrist, (right)	Flexor tendon injury, median nerve injury	19 × 10 cm PF 10 × 10 cm LAF	Success	12
2	32	10	Distal forearm, wrist, hand (left)	Flexor tendon injury, median and ulnar nerve injury, ulnar artery thrombosis	27 × 11 cm PF 14 × 11 cm LAF	Success	6
3	20	10	Distal forearm, wrist, (right)	Flexor and extensor tendon injury, median and ulnar nerve injury, radial and ulnar artery thrombosis	21 × 10 cm PF 10 × 10 cm LAF	Success (interpositional vein grafting to radial artery during debridement)	9
4	19	10	Distal forearm, wrist, hand (left)	Flexor tendon injury, median and ulnar nerve injury, ulnar artery thrombosis	24 × 11 cm PF 13 × 10 cm LAF	Success	6
5	19	100	Distal forearm, wrist, hand (right)	Flexor and extensor tendon injury, median nerve injury, radial artery thrombosis	23 × 11 cm PF 13 × 11 cm LAF	Success (liquefaction and infection beneath flap, healed after debridement)	12
6	19	10	Distal forearm, wrist, hand (left)	Flexor and extensor tendon injury, median and ulnar nerve injury, ulnar artery thrombosis, middle, ring, and little finger necrosis	19 × 10 cm PF 10 × 10 cm LAF	Success (liquefaction and infection beneath flap, healed after debridement; middle, ring, and little finger amputation; radial artery thrombosis and reconstruction by vein grafting after separation of flap)	12

PF, paraumbilical flap; LAF, lower abdominal flap.