



Thermal crush injury of the hand caused by roller type ironing press machine

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Industrial garment machines may cause occupational hand injuries. However, combined thermal and crush injuries are uncommon, and their etiologies are varied. We present a case of thermal crush injury of the hand caused by laundry roller type ironing press machine. The circumstances of this injury and preventive measures are discussed.

Key words: Hand injuries; industrial machines; occupational accidents.

Despite increasing awareness and precautionary measures in the garment industry, hand injuries unfortunately still happen. However, combined thermal and crush injuries of the hand are relatively rare. Review of the literature revealed only a few articles on this type of injury.^[1-4]

Tissue reconstruction procedures, particularly skin flaps, are the most important measures for the plastic and reconstructive surgery repair of thermal crush burns, in which muscles, muscle tendons, vessels, and nerves are destroyed, in addition to full-thickness skin loss. The effects of simultaneous mechanical and thermal disruption are united in these injuries.^[5] The proper treatment of injury and especially its timing are controversial.^[1] The problem is the choice of surgical covering, according to the site, size, and depth of the burn, and reliable opportunities.^[6] Failure in early reconstructive procedure has lead us to re-evaluate our case for a perfect and predictable approach.

Case report

A 22-year-old male textile worker was admitted to our burn care unit with thermal crush injury involv-

ing the left hand. According to the history, he was alone in the laundry while he was ironing garments, and his left hand was closely pressed in a roller type ironing press machine for 5 min.

Upon the arrival at our hospital, the patient was immediately taken to a cleaning tank. His hand was irrigated with heated (37°C) sterilized water for 30 min. Physical examination revealed deep circumferential burns of all fingers and the aspect of the palm and dorsum of the hand (Fig. 1). Radial and ulnar pulses were palpable, and palmar arch pulses could be detected with Doppler ultrasonography.

The patient was hospitalized immediately for close monitoring of perfusion after the escharotomy of fingers. On radiography, there were no fractures of the phalanges. The extremity was elevated. Antiedema treatment, parenteral antibiotics, high molecular weight dextran in saline (35 mL/h), and heparin infusion (initially intravenous 5000 units, and then 1000 units/h) were started. Digital fingers' perfusion was monitored. Suitable antibiotic therapy was begun with the consultation of the infectious disease department.



Fig. 1. (a, b) Appearance of industrial thermal crush burn caused by roller type ironing press machine on the left hand; and (c) injury before debridement with exposed tendons, vessels, and nerves.

Blood supply for free flap was assessed preoperatively with Doppler, angiography and physical examination. At the first reconstruction attempt, we decided to use free muscle flap for coverage of exposed structures because flaps are reliable and significantly decrease the number of operations, allowing quicker wound coverage. The patient was operated on third day following the injury. The necrotic and granulation tissues were removed. Subsequently, the right latissimus dorsi muscle flap was transferred for coverage. The flap was grafted with split-thickness skin graft (Fig. 2). Unfortunately, the perfusion of flap and all fingers excluding the thumb was poor. On the sixth postoperative day, the muscle flap failed, and all the fingers excluding the thumb appeared necrotic at the level of the metacarpophalangeal joint (Fig. 3). The tendons and neurovascular structures of the left hand were necrotic. Following

demarcation, the necrotic fingers were amputated at adequate levels, and burn area grafted with a split-thickness skin graft. The stumps and graft healed uneventfully. The patient was followed up for 9 months (Fig. 4).



Fig. 3. The fail of muscle flap on the postoperative 6th day.

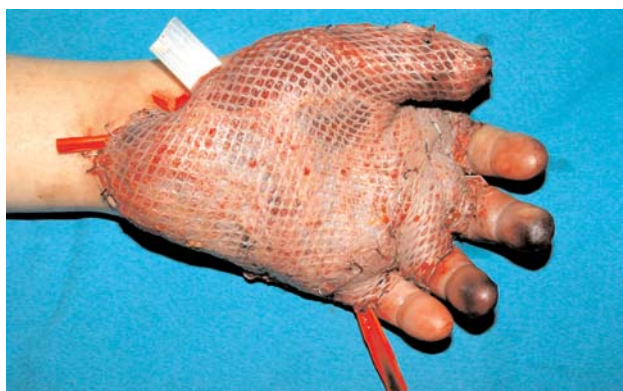


Fig. 2. Intraoperative view of transferred latissimus dorsi muscle flap and split-thickness skin grafting after microsurgical anastomosing of the vascular pedicle to the dorsoulnar artery.



Fig. 4. The unsatisfactory result at 9 months after the failed flap surgery.

Discussion

In recent years, the garment industry has been developed technically and technologically. According to the statistics, the most frequent sources of workers' injuries in the garment industry are insecure method of work, violation of safe work regulations, unfavorable work organization, defective machines, tiredness caused by monotonous work, and insufficient or absent personal or collective protective means. Although most modern ironing presses have built-in devices for protection against injuries, even in the ironing phase, injuries still occur. The surface temperature of roller press may reach 160°C. This temperature causes severe deep thermal burns requiring amputation.

Thermal crush injury burns may extend beyond the subcutaneous tissue with necrosis of underlying fascia, muscle, tendon, and neurovascular structures.^[7] The severity of these injuries is often underestimated. Thermal crush injuries have high rates of amputation, functional impairment, and repeat operations. For this reason, meticulous examination of the extent of injury is important for planning successful treatment.

Full thickness circumferential thermal crush burns may contribute to distal edema, vascular compromise, damage of the vascular endothelium, thrombosis, and subsequent amputation. These injuries are more severe than other thermal burns because heat transmits more deeply through the crushed tissues. The low resistance of the neurovascular bundle permits preferential conduction and injury. Severe vascular, neurological, or tendon injuries may occur beneath the burn. Therefore, in first-line treatment, urgent escharotomies should be performed to prevent amputation. In addition, early debridement should be performed as soon as possible to facilitate healing and minimize complications. The prevention of thrombosis and adequate prophylactic treatment for infection play a significant role for deep thermal burns. However, heparinization for the prevention of thrombosis is still controversial.^[8,9]

The treatment is soft tissue coverage of bone, tendons, and neurovascular structures. The proper soft-tissue coverage, especially its timing, is controversial. Soft tissue coverage by a simple skin autograft is indicated only for very moderate exposures. In extensive exposure of structures, skin grafts are not

successful due to insufficient soft tissue for graft support and requirement for multistage reconstructions. Therefore, when tendinous, osseous, nervous, or vascular components are involved, even hand vitality is engaged; flaps are the only way to salvage the hand. Shen et al.^[10] used free flaps in acute-phase burns when the average area affected by third-degree burns was 2.2% and noted complete necrosis in 13% of cases. Guiga et al.^[11] reported partial and distal necrosis in 2.5% of cases.

In view of our presented case and the literature, the possibility of underestimation of a thermal crush injury burn should be a crucial factor in the establishment of the treatment program. Definitive treatment may be delayed if the viability of tissues is still uncertain.^[1] The decision to use excision or flap coverage was made with care and by assessing its impact on prognosis. The insufficient removal of nonviable tissues, infection, damage of the vascular endothelium, and subsequent thrombosis cause flap failure after the surgery.^[10,11] Therefore, in first-line treatment, emergency use of flaps is controversial. Some authors recommend delaying operative treatment, and other authors support early operative treatment within 3 days of injury.^[1]

In conclusion, the treatment course should be selected following careful analysis of each factor. The debridement procedure should be done as early as possible. The reconstructive ladder is the surgical principle of wound closure from the simple to the most complex alternative. Definitive reconstructive treatment should be deferred until the damage is demarcated and devitalized tissues are removed. Care should be taken to preserve surgical options for final sequela reconstruction.

These burns are preventable and therefore, some basic measures may reduce the incidence of accidental thermal crush burn due to roller type ironing press machine:

1. Manufacturers must post warnings in their owner's manuals of the danger of potential burns due to press machine.
2. The newest models of press machines have an attached safety bar that prevents the press from closing on the operator's hands. It is recommended that older models either be modified with the attachment of a safety bar or replaced entirely.

3. Employees in these occupations should be informed about the risks of these injuries as well as precautions to avoid them. Educational programs (including brochures) should be given by experienced workers.
4. Workers should be reminded to pay close attention to tasks and correct body movements on the first and last workdays of the week.

We hope that the present case report would increase awareness of the dangers involved in the laundry.

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