



## Mini-Review Article

## Medical Examination of Ring Burn Injury Management; Mini Literature Review

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## ABSTRACT

Ring burns are often circumferential, increasing the chance of compartment syndrome and ischemia distal to the injury site. The burn size is usually small. However, sometimes injury management may be difficult or threaten the limb, leading to amputation. Different effective treatment methods include conservative therapy, grafting, flap surgery, or amputation. This study reports the therapeutic management of two patients with ring burn injury. Two patients with ring burn injuries who were admitted to the burn ward were treated with initial surgical debridement and full-thickness skin grafts. At the same time, one of them underwent the advancement flap technique by adjacent tissue recruitment. Even though patients waited up to 3 weeks before the operation, they underwent surgery immediately after admission, and the long-term result was excellent, and acceptable. So, training of medical staff and efforts to prevent ring burn injury is highly recommended.

## GRAPHICAL ABSTRACT



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## Introduction

The hand surface area (HSA) is estimated at 1% and a total of about 3% of the body surface area (BSA). So, hand burn functional impairment is of great importance. Electrical or chemical hand injuries are associated with high morbidity. Generally, second or third-degree hand burns are considered a major burn injury, and it is mandatory to refer them to the burn center [1-3]. Contracture following hand burns is common, and movement limitations could decrease quality of life, significantly. Therefore, initial management by a specialized medical care team is crucial [4-7].

Hand injuries usually occur due to occupational exposure to hazardous conditions, natural disaster, or recreational accidents [8]. Electrical burns occur directly due to the electrical current or following severe muscle contractions induced by an electrical current. Electrical voltage also determines the severity of burn injury [9]. Overall, low-voltage injuries cause local skin burns at the contact sites, while high-voltage burns may damage skin tissue. High-voltage burns also cause indirect injury at the entry and exit of electricity flow site, generally referred to as entrance and exit wounds [10].

Moreover, electrical burn damage is related to the object's resistance, the electrical current passes through it, and the duration of contact [8, 9]. Ring burn injuries are a particular type of low-voltage injuries, in which electrical current passes through the ring worn on fingers. Metal rings could cause a circumferential burn, which is sometimes deep. Electrical damage occurs when energy flows through the body due to contact with an electrical source. Injuries occur due to either the flow of current through the body or arc flash [11-13]. Ring burns often have circumferential nature. Therefore, it increases the chance of compartment syndrome and ischemia distal to the injury site. The burn size is usually small. However, the injury is sometimes hard to manage and might threaten the organ's physiological normal function leading to

amputations [14-16]. However, there is much controversy regarding the best therapeutic method available to manage ring burn injury, and some believe that conservative management yields the best results [17]. Others have introduced the surgical approach several weeks after the onset of the injury. We presented two patients with ring burn injury treated with early surgical debridement during the first post-injury days with full-thickness graft or advancement flap surgery with good long-term results. As a result, we discuss different methods and studies regarding the best ring burn injury treatment [18].

## Material and Methods

This study introduces two patients with ring burn injury referred to a referral burn center. The collected data include patient demographics, location, severity and size of the burn, patients' referral time, complications, grafted area, length of hospital stay, and time to complete healing.

### Case Presentation

Two patients with ring burn injuries were referred to the burn unit. The first case was a 14-year-old girl with a ring burn injury. This lesion occurred when her father wanted to cut the ring using a milling machine. She was admitted for a week after the burn injury. On physical examination, her finger was viable, and distal capillary refill time (CRT) was acceptable. Finger sensation tests were also normal. The range of motion was quietly limited in flexion due to pain. The wound was circumferential and on the fourth finger of the right hand, while it was 1 cm deep and 1 cm wide. Before admission, she had washed the wound and changed her daily dressing at home. She then ran for Surgery. The wound was debrided, and no injury to tendons or vessels was found. A full-thickness graft was obtained from the same side inguinal region. The patient was discharged the day after Surgery. Figure 1 demonstrates 3 days and 3 months after the operation, respectively. Both the donor site and finger healed uneventfully.



**Figure 1:** A. The day after Surgery. B. Three months later

The second case was a 37-year-old man who was referred due to an electrical burn while trying to fix his personal computer at home and touching the capacitors. He was referred three days after the injury. On physical examination, the finger was viable, and the distal capillary filling was acceptable. Finger sensation tests were normal. The range of motion was quite normal. The wound was circumferential on the fourth finger

of the right hand with 1cm in depth and 1cm in width. The wound was clean. He had diabetes mellitus Type 2 and consumed anti-hyperglycemic agents (Metformin 500 mg TDS). Fortunately, no major injury to tendons or vessels was noted. The defect was repaired by an advancement flap from the adjacent soft tissue (video of finger movement after a year is also available on request).



**Figure 2:** A. Three days after injury. B. Two days after surgery C. One year after surgery

### Results and Discussion

According to the International Burn Injury Association (ISBI), a burn injury occurs in one or all of the skin's layers. This may be caused by hot liquids or objects and flames. Any skin injury caused by radiation, smoke, inhaled heat, radioactivity, chemicals, and electricity can cause

burns [19]. Electrical induced burn damages usually involve deep layers of soft tissue, but the overlying skin might be viable partly [20]. The overlying skin should be cautiously saved as a potential source for autologous tissue grafts, and various flaps such as fillet flaps to reconstruct complex defects. In this regard, numerous studies

have been conducted, including Zunjiang *et al.*, reconstructed a digital defect caused by electrical burn using a middle ring digital artery island flap with nerve technique [21]. They constructed one finger with viable tissues of two fingers and could save one finger instead of both fingers' amputations. They also believed that reconstruction of the fifth finger is often necessary in case of other fingers missing to lessen disability [22].

In both cases, the electrical current changed into heat due to ring resistance and caused a circumferential ring burn. It seems that the electrical current did not pass from the patient's hand itself. This has been issued by some other articles as well [23-25]. Despite the importance, there is a lack of data regarding a standard protocol for treating ring burn injury. Therefore, individualized decision-making by an expert team may be considered. Here in the study mentioned above, two fingers could not be saved due to significant loss of tissue. After that, the treating team decided to use viable parts to reconstruct one finger and sacrifice the other. It is thought that because the injury is circumferential, there is no imbalance for finger soft tissue to develop contracture. Some investigators argued that any surgical intervention should be postponed for several weeks. This helps better assess the depth of burn as the injury might evolve in some days before stabilization. Peter Andrade reported a case of ring burn injury with a circumferential skin flap [26]. The outcome of Surgery was excellent, and acceptable. Despite the fact that they waited 3 weeks for surgery, we did just after admission, and the outcome was acceptable as well. This argues the theory of evolving burn injury after 1-2 weeks, and suggests that burn injury might be stabilized after 2-3 days. Early surgical debridement by an experienced surgeon might distinguish the zones of stasis and edema. This study is in line with our study, which used the advancement flap technique [27]. An advancement flap is ideal when tissue loss is not significantly broad, and the skin edges reach without much tension. Cautions regarding finger

movement during the first postoperative days help better heal the defect [28].

Sibley and colleagues reported a deep partial-thickness circumferential burn at the base of the ring finger in an auto mechanic maintenance worker treated with a full-thickness skin graft after three weeks of conservative management [29]. They showed the promising result as our first case. The difference between our procedures was the interval between the onset of the injury and grafting surgery [30]. It lasted one week in our case but three weeks in the study mentioned above. Both patients' outcome was good, therefore it can be concluded that one week might be enough for a ring injury to undergo a full-thickness skin graft with good aesthetic results [31].

On the other hand, many investigators report that they treated electro thermal burn injuries conservatively [32-34]. Baruchin A.M. reported two cases of ring burn injury that were treated without any surgical intervention. They treated patients using an outpatient approach with daily repetitive washing, home physiotherapy, and routine clinic visits for physical examination. They reported that both patients healed uneventfully without any complication or contracture [35]. Early surgical treatment is thought to have better results than conservative management. In general, a ring burn injury is rare, and there is no consensus about its standard management. Some researchers have suggested conservative medical management, while others prefer delayed surgical options, including partial or full-thickness graft, and others conducted the advancement flap technique [36].

## Conclusions

Our therapeutic approach was a full-thickness graft about the first case after a week and advancement flap for the second in the early post-injury period with a good outlook on long-term results. However, if the finger is not viable, amputation should be considered. If two or more adjacent fingers are involved, some fingers could be sacrificed based on patient condition, the surgeon's perspective, and preferences to reconstruct the others. However, we showed that early surgical debridement and reconstruction

with graft and flap yield promising results. Each of the abovementioned therapeutic approaches has its risks and benefits. Meanwhile, it is essential to educate workers at risk of ring burn injury through electricity or heat. Therefore, rings, watches, or any jewelry in the workplace should be prohibited.

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### Authors' contributions

All authors contributed toward data analysis, drafting and revising the paper and agreed to be responsible for all the aspects of this work.

### Conflict of Interest

We have no conflicts of interest to disclose.

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