ABSTRACT

Background: Electrical burns have the most catastrophic consequences of all burn injuries. High voltage electrical injuries of the extremities are at the risk of development of compartment syndrome during the first 48 h post injury. Damaged muscle and swelling within the investing fascia of the extremity may increase pressure to the point where muscle blood flow is compromised. Thus, the role and indication of an early fasciotomy for electrical burn injury was studied in this case series. Patients and methods: A retrospective analysis of 3 years from Jan 2016 to Dec 2018, 497 patients were admitted in our institute with high voltage electrical contact burn in upper limb. Out of 497 patients, 350 had deep burn injury to upper limb and developed compartment syndrome, 147 patients had small patchy area of deep burn which were excluded. 322 (92%) were male and 28 (8%) were female, with age group from 8 yrs to 55yrs (mean age 36yrs). Early fasciotomy done in patient with upper limb deep electric burn with compartment syndrome. Result: Out of 497 patients, 350 had deep burn injury to upper limb and developed compartment syndrome. All 350 patients were evaluated and early fasciotomy done. Out of 350 patients, we could salvage the limb in 298 (85%) patient and 52 (15%) patients had above or below elbow amputation. 212 Fasciotomy wound cover with skin graft and 86 patients had flap cover in salvage limb. Conclusion: Early fasciotomy in high voltage electrical burn in upper limb can salvage the limb and prevent amputation.

KEYWORDS: Electric Burn, upper extremity, compartment syndrome, fasciotomy.

INTRODUCTION

Electrical burn is a unique form of trauma, in which mortality and morbidity are very high when compared to thermal burns. The effects of electrical current depend on the type of current, voltage, tissue resistance, the pathway and the duration. High-tension electrical burns (1000 VOLT) results in cutaneous injuries, severe damage to underlying muscles, nerves, blood vessels and bones.

Upper limb involvement is present in majority of the electrical burn injuries. Upper limbs may have entry point, exit point or both. Injury may range from simple flash burns or low voltage contact burns to devastating gangrene of the limbs. High tension electrical burns can cause compartment syndromes in the upper extremity due to the increased interstitial tissue pressure in a limited fascial area. If timely diagnosis and decompression by fasciotomy are not obtained, ischemic contractures in the muscles that even lead to amputation following necrosis and nerve damage. In this study, efficacy of fasciotomy in salvaging upper limbs of post electric burn wounds and amputation of gangrenous parts of upper limbs were assessed and coverage of fasciotomy wound with skin graft and flap cover.

MATERIAL AND METHODS

A retrospective analysis of 3 years from Jan 2016 to Dec 2018, 497 patients were admitted in our institute with high voltage electrical contact burn in upper limb. Out of 497 patients, 350 had deep burn injury to upper limb and developed compartment syndrome, 147 patients had small patchy area of deep burn, partial thickness burn which were excluded. The patients were evaluated through parameters as the cause of burn, age, sex, deep burn area fasciotomy area, the period between the burn and fasciotomy, and treatment. Compartment syndrome diagnoses were clinically obtained. All the cases had fasciotomy under local anaesthesia. Volar incision were used in forearm fasciotomy procedures. 322 (92%) were male and 28 (8%) were female, with age group from 8 yrs to 55yrs (mean age 36yrs). Patients were presented to us with the duration from 4hours to 10 hours from the time of burn. Early diagnosis and adequate surgical decompression by fasciotomy done in patient with deep electric burn with compartment syndrome can prevent functional losses in the affected extremity.

RESULT

Out of 497 patients, 350 had deep burn injury to upper limb and developed compartment syndrome. 322 (92%) were male and 28 (8%) were female, with age group
from 8 yrs to 55yrs (mean age 36yrs). In our study, males were affected more due to their work away from the home, in farm and electrical occupation. All 350 patients were evaluated and diagnosed compartment syndrome, early fasciotomy done. Fasciotomy procedures were performed on the forearm and hand in 286 (81.71%) patients and whole upper limb in 64 (18.28%). Out of 350 patients, we could salvage the limb in 298 (85%) patient and 52 (15%) patients had above or below elbow amputation. 212 Fasciotomy wound cover with skin graft and 86 patients had flap cover in salvage limb with skin graft.

Table 1: Demographic data of patients with high voltage electrical injury to upper limb.

<table>
<thead>
<tr>
<th>Age of patients</th>
<th>8yrs -55 yrs(mean age 36yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex of patients, male: female</td>
<td>322 (92%):28 (8%)</td>
</tr>
<tr>
<td>Involvement of upper limb</td>
<td>Hand and forearm:286 Whole upper limb:64</td>
</tr>
<tr>
<td>the period between the burn and fasciotomy</td>
<td>from 4hours to 10 hours (mean 7 hours)</td>
</tr>
<tr>
<td>Compartment syndrome</td>
<td>350</td>
</tr>
<tr>
<td>Total patients</td>
<td>497</td>
</tr>
</tbody>
</table>

Table 2: Outcome of early fasciotomy in high voltage current burn in upper limb.

<table>
<thead>
<tr>
<th>Fasciotomy procedure</th>
<th>Forearm and hand—286 Whole upper limb—64</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limb salvage</td>
<td>298 (85%)</td>
</tr>
<tr>
<td>Amputation</td>
<td>52(15%)</td>
</tr>
<tr>
<td>Coverage of fasciotomy wound</td>
<td>212 patients – skin graft</td>
</tr>
<tr>
<td></td>
<td>86 patients – flap cover</td>
</tr>
</tbody>
</table>

Fasciotomy done for compartment syndrome in Rt forearm.

Fasciotomy wound after 7 day.

Split thickness skin graft applied over Fasciotomy wound.

Flap cover given for tendon exposed after Fasciotomy.
DISCUSSION

Electrical burns have the most catastrophic consequences of all burn injuries. High voltage electrical injuries of the extremities are at the risk of development of compartment syndrome during the first 48 h post injury as more than 1000 Volts of current damage the muscle and swelling within the investing fascia of the extremity may increase pressure to the point where muscle blood flow is compromised.\(^1,2\)

Typically, electrical injury passes from a point of contact on the body to a grounded site. Very high voltage can exit in multiple areas in an explosive fashion. Passage through the head can cause neurologic damage, respiratory arrest, and anomalies of heart conduction.\(^2\) Electrical burns are particularly difficult to treat because the surface wound does not reflect the magnitude of the deeper injury. Often damage is most severe near the exit point. Besides immediate damage of the tissues by the heat along the path of the current there is believed to be a second process of devascularisation caused by injury to blood vessels that progressively thrombose over a period of several days.\(^3\)

Compartment syndromes with pressure necrosis are also a very significant part of the pathological process. Eventually, infection becomes an issue. Dead muscle is often found near the entrance and exit as well as along the bone where the heat created by the high resistance of bone is greatest. This is also where local blood vessel thrombosis can occur. Necrosis is progressive for 4 or 5 days.\(^4\) Anceurysms have been noted to develop late in the course and some believe that neurological damage is due to vessel endothelial destruction.

Compartment syndrome may develop as a result of acute ischemic insult to the musculature. At this point, blood flow through the capillaries stops. In the absence of flow, oxygen delivery stops. Hypoxic injury causes cells to release vasoactive substances (e.g., histamine, serotonin), which increase endothelial permeability. Capillaries allow continued fluid loss, which increases tissue pressure and advances injury.\(^5\) Nerve conduction slows, tissue pH falls due to anaerobic metabolism, surrounding tissue suffers further damage, and muscle tissue suffers necrosis, releasing myoglobin. The end result is loss of the extremity and, possibly, the loss of life.

Normal interstitial pressure is 4-6 mm Hg. However, rising interstitial pressure overwhelms perfusion pressure. As intracompartmental pressure rises, venous pressure rises. When venous pressure is higher than capillary perfusion pressure, capillaries collapse. Intracompartmental pressures greater than 30 mm Hg are generally agreed to require intervention in the form of fasciotomy and decompression.\(^6,7\)

The first eight hours in the evaluation of compartment syndrome is called the “early phase” while the time that exceeds eight hours is called the “late phase”.\(^2,8\) The period between the start of the increase in post-burn intracompartmental pressure and the fasciotomy procedure is very critical and the procedure should be performed within this early phase. If reperfusion is not achieved within this period irreversible tissue injury takes place. The late period is characterized by increase in vascular permeability, cellular anoxia, local metabolic changes, cell death, and the secretion of catabolic enzymes. Irreversible damage to the muscles starts to take place in this period. This condition ends in a process including ischemic contracture in the extremity and even amputation. Irreversible peripheral nerve changes are added to the condition, in addition to muscle necrosis, in extremity ischemia that exceeds 12-24 hours.\(^9,10\)

According to Özkhan et al’s work on fasciotomy on upper limb with burn, the average fasciotomy time was 5.3 hours following burn and only three patient had amputation out of 43 patients with fasciotomy. Achauer et al study had 40% amputation rate inspite of early diagnosis and intervention. In this case series, we could salvage the upper limb of 298 patients of compartment syndrome in electric burn patients. All 298 patient were diagnosed early and fasciotomy done during early phase of compartment syndrome. 52 patients had amputation inspite of doing fasciotomy. Since the nature of the compartment syndrome cannot be exactly foreseen in especially patients with electrical current burns, early fasciotomy procedure does not guarantee the prevention of amputation.

Compartment syndrome is most frequently seen in the forearm in the upper extremity. There are three compartments in the forearm and have connections among these compartments, single fasciotomy performed from the volar area suffices for forearm decompression. Single volar fasciotomy incision was used in all the forearm fasciotomy procedures and it was sufficient in all the cases.

After fasciotomy, wound was cover with skin graft or flap once the edema of the limb reduces and debridement of the wound done. In this study, 212 Fasciotomy wound cover with skin graft and 86 patients had groin flap cover in salvage limb defect.

CONCLUSION

Early fasciotomy done in high voltage electrical burn in upper limb can salvage the limb and prevent amputation.

DECLARATION OF PATIENT CONSENT

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.
FINANCIAL SUPPORT AND SPONSORSHIP
Nil.

CONFLICTS OF INTEREST
There are no conflicts of interest.

REFERENCE