Original Article

A Study of Pattern, Management, and Outcome of Complex Soft-Tissue Injuries

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Abstract

Background and Objectives: Complex soft-tissue injuries are one of the leading causes of morbidity and mortality following road traffic accidents (RTA). This article is regarding the pattern, management, and outcome of complex soft-tissue injuries. **Methods:** This observational study was conducted on 519 patients, from January 01, 2010, to April 30, 2013, at a tertiary care center in southern India. We analyzed the demographic profile, mechanism of injuries, management, and outcome of complex soft-tissue injuries during this study. **Results:** Of 519 patients with soft-tissue injury, blunt and penetrating injuries were seen in 81.7% and 18.3% of all cases, respectively. The most common cause of injury was RTA 74.3%. Isolated moral Lavelle injuries without associated neurovascular injuries occurred in 26.3% of patients. Soft-tissue injury was associated with bony, vascular, nerve, and tendon injuries in 52.0%, 44.7%, 20.0%, and 16.3% of all the cases, respectively. Patients who presented early (within 6 h of injuries) and patients with bone-only injuries had higher limb salvage rates. The overall morbidity rate among adults was 16.3% and the mortality rate was 1.9% and the most common cause of death was hemorrhagic shock. Mortality and morbidity in the pediatric group are higher than in the adult group. **Conclusions:** In summary, health education about road safety and proper safety protocol for two-wheelers and four-wheelers will reduce the incidence of RTA, thereby reducing the incidence of complex soft-tissue injury. The early and aggressive intervention will prevent a high amputation rate in bony injuries combined with vascular injury. A low threshold of blood transfusion and early aggressive treatment in the pediatric population will reduce the high mortality rate.

Keywords: Flap, graft, management, morbidity, mortality, outcome, pattern, soft-tissue injuries

Introduction

Trauma is a leading cause of disability and mortality and has been projected to be the third most common cause of death by 2020. Globally injuries contribute to around 10% of total death and 15% of disability-adjusted life years.[1] The management of complex soft-tissue injuries needs an early assessment and a multispecialty approach for a better outcome. Sound knowledge of the various types, their mechanisms of injuries and most importantly, the management gives a better outcome. These injuries are complicated by the presence of vital anatomical structures such as vessels, ducts, nerves, and muscles.

Complex soft-tissue injury involves severe soft-tissue damage associated with neurovascular lesions and joint involvement, which entails a high risk for complications. Complex soft-tissue injury is one of the most common causes of morbidity and requires timely care for its management. The management of complex soft-tissue injury depends on (1) the nature of the injury, (2) extent of the injury, and (3) the timing of the injury.

The World Health Organization reports that every year 1.2 million people die in traffic accidents and more than 50 million are injured. In traffic accidents, the upper part of the passenger's body is well protected, but the upper and lower limb is vulnerable. Complex soft-tissue injury affects

Access this article online

Quick Response Code:

Website: www.archtrauma.com

DOI: 10.4103/atr.atr_74_22

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How to cite this article: Pandiaraja J, Shalini A. A study of pattern, management, and outcome of complex soft-tissue injuries. Arch Trauma Res 2023;12:34-8.

Received: 27-11-2022, **Revised:** 12-03-2023,
Accepted: 08-04-2023, **Published:** 29-04-2023.

the lives of patients, represents a high cost for health-care systems, and has an impact on the productive activity of countries. Our study aimed to assess the pattern, management, and outcome of complex soft-tissue injuries. This gives you an idea regarding the most common cause of soft-tissue injuries, which group of patients needs to be intervened early, the outcome of isolated injury versus complex injuries, and mortality and morbidity of soft-tissue injuries. In this scenario, there is an area not yet adequately defined between injuries that cannot be reconstructed and those where the best outcome is amputation. In this article, we present a literature review and management of complex tissue injury to help in decision-making.

Materials and Methods

Study design

It is an observational study, conducted from January 01, 2010, to April 30, 2013, in the tertiary care center, in southern India. A census sampling method is followed here for the study purpose. Data were collected in all soft-tissue injury patients during the above said period and tabulated.

Methodology

Ethical clearance was obtained from the institute's ethics committee. All patients with complex soft tissue injuries were admitted during the study to the tertiary care center, located in the southern part of India (Tamil Nadu). Patients with severe head injuries, and isolated chest and abdominal injuries were excluded from the study. Data were collected from medical records and the computerized patient record system of the hospital.

Initial evaluation included the complete assessment of patients, i.e. detailed primary and secondary survey with radiological and biochemical investigations. Patients were resuscitated as per advanced trauma life support protocol. Complete details regarding the demographic profile of the patient, mechanism of injury, place, mode of injury, and method of transport to the hospital were noted. All details regarding soft-tissue injuries such as size, the extent of the soft-tissue defects, and associated neurovascular and musculoskeletal injuries were assessed. The severity of the injuries was assessed using an abbreviated injury scale and an injury severity scale. Ultrasound, Doppler, and computed tomography angiography were done in selected patients with severe extremity injuries. The outcome was noted in terms of clinically significant morbidity graded as per Clavien–Dindo classification, i.e. Grade 3 and above infection, limb survival following vascular repair, hospital stay, and mortality. Outcomes of surgical procedures such as split-thickness skin graft (STSG) and local flaps were assessed after 7 days of the procedure.

Statistical analysis

Statistical analysis of the data collected was done using descriptive statistics such as mean, median, and mode. Quantitative data were analyzed using the Student's *t*-test. Qualitative data were analyzed using the Chi-square test. The confidence interval of 95% with a $P < 0.05$ was taken as statistically significant.

Results

A total of 519 patients with complex soft-tissue injuries presented during this study. There were 462 (89%) male and 57 (11%) female patients. Among 519 patients, 263 were retrospectively and 256 patients were prospectively included in the study. Demographic profile, mode of presentation, mechanism of injury, and time to reach tertiary care center since injury and triage are tabulated in Table 1.

Isolated extremity injury and polytrauma were present in about 407 (78.5%) and 112 (21.5%) patients, respectively. Out of 112 patients, 56 (50%) had abdomen injuries, 19 (16.9%) had chest injuries, 26 (23.2%) had head-and-neck injuries and 11 (9.8%) had both chest and head-and-neck injuries. Surgical debridement and complete wound exploration were done in almost all patients with a crush injury.

Table 1: Demographic profile and baseline characters (n=519)

Parameters	Number of cases (%)
Age (years)	
0<18	109 (21)
19–64	399 (76.9)
65 and above	11 (2.1)
Sex	
Male	462 (89)
Female	57 (11)
Regional background	
Chennai	394 (75.9)
Kanchipuram	48 (9.2)
Chengalpatu	45 (8.6)
Tiruvallur	33 (6.3)
Mode of transport to hospital	
Private vehicle	124 (23.9)
Ambulance	200 (38.6)
Police van	145 (27.9)
Others	50 (9.6)
Times to reach the hospital (h)	
0–1	35 (6.7)
1–6	219 (42.2)
6–24	204 (39.3)
>24	61 (11.8)
Mechanism of injury	
RTA	386 (74.4)
Occupational injury	70 (13.5)
Fall from height	39 (7.5)
Assault and others	24 (4.6)
Triage at the initial presentation	
Red	282 (54)
Yellow	142 (28)
Green	95 (18)

RTA: Road traffic accident

The outcome of vascular injuries

Of 232 patients with vascular injury (femoral, popliteal, and brachial vessels), 34 (14.6%) patients had extremely mangled injuries with signs of irreversible ischemia clinically and underwent amputation as a primary procedure. In 140 patients, there was associated long bone injury requiring concomitant orthopedic intervention. Repair of vessel injury was done after debridement and skeletal fixation. Primary vessel repair was done in 127 patients (54.7%), repair using reverse saphenous vein graft was done in 68 patients (29.3%), and prosthetic graft (expanded polytetrafluoroethylene) was used in three patients (1.5%). The overall success rate was 64%. The most common cause of failure was thrombosis and delayed hospital presentation. Secondary amputation was done in 72 (36%) patients.

The outcome of bony injuries

Among 519 patients, 96 (18.4%) had bone-only injuries, and 140 patients (26.9%) had both vascular and bony injuries. In patients with bone-only injuries, the limb salvage rate was 100%. Whereas in patients with both vascular and bony injuries, the limb salvage rate was only 48.5%.

Primary repair of nerve and tendon injuries

Out of 519 patients, primary nerve repair was done in 65 (12.5%) cases. Median, ulnar, and radial nerves were mostly repaired early. Primary tendon repair was done in 57 (10.9%) cases.

Outcomes of soft-tissue reconstruction

Among 519 patients, 415 (79.7%) patients required soft-tissue reconstruction. Soft-tissue defects were due to primary de-gloving injuries (Morel-Lavallee), amputation stump sites, and secondary to fasciotomy wounds. In the majority of the patients, soft-tissue reconstruction was done by a Split skin graft. Graft take was assessed on the 7th postoperative day. In 91 (21.9%) patients, soft-tissue reconstruction was done by the flap. The flaps used in our study were mainly rotation advancement and transposition flaps (groin and lower abdominal flaps in 30 [7.2%] cases for hand and upper extremity defects, sural flap in 20 [4.8%] cases, and local trans positional flap in 41 [9.8%] cases for lower extremity and heel defects [Figure 1]).

Out of 324 who underwent STSG, 307 (94.7%) patients had more than 80% graft take, 12 (3.7%) patients had graft take between 50% and 80%, and 5 (1.5%) patients had less than 50% grafts take. Among STSG patients, 5 patients (1.5%) had hematoma/seroma, and 7 (2.16%) had the infection.

Of 91 patients, who underwent flap reconstruction, 80 (87.9%) patients had no necrosis or infection, 6 (6.5%) patients had an infection and improved after oral antibiotics and 5 (5.4%) patients had partial necrosis. Types of injuries and the number of treatment procedures are tabulated in Table 2.

Analysis of outcome between blunt and penetrating injury

In our study, patients with complex soft-tissue injuries had an injury severity score (ISS) of 10.6 in blunt injuries and 9.9 in penetrating injuries. The average duration of hospital stay among blunt injury and penetrating injury patients was 17.3 and 10.5 days, respectively. There was a statistically significant difference between the blunt and penetrating injury groups with an average number of procedures, hospital stays, and clinically significant mortality rates.

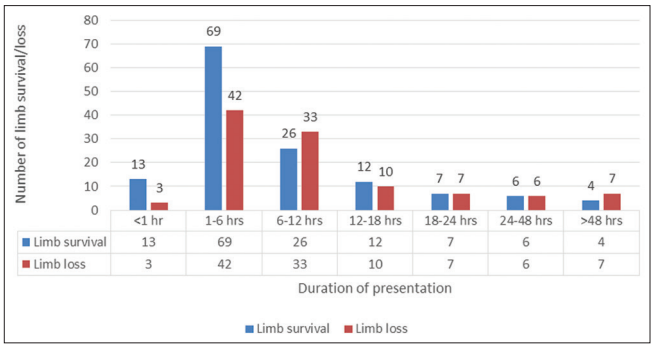

Figure 1: Relationship of limb viability with the duration of the presentation

Analysis of outcome between isolated and combined injury

The average number of procedures done among isolated extremity injury patients was two and among combined injury patients was three. The average duration of hospital stay among isolated injuries and combined injuries was 14.6 and 21.2 days, respectively. The mortality rate of isolated injury was 0.9% and combined injury was 5.3% [Figure 2]. There was a statistically significant difference between isolated and combined injuries with the average number of procedures, hospital stays, and mortality [Table 3].

Mortality

Clinically significant infection rate including organ dysfunction among the pediatric age group 12 (17.14%) and adult group 56 (12.78%). Out of 519 patients, 10 (1.9%) patients expired (six patients had death <24 h, two within 72 h and two died after 2 weeks. The most common cause of death was a hemorrhagic shock, followed by multiple organ dysfunction syndromes septic shock.

Discussion

Complex soft-tissue injury is an important public health problem accounting for a substantial proportion of all trauma admissions. From our results, it is evident that road traffic accidents (RTA) were the major etiological factor of complex soft-tissue injuries and blunt trauma was the most common mechanism of injury in our center. Young adult males were the main victims indicating the need to improve road safety measures among youth. This finding highlights the need for awareness programs regarding road safety, especially for the high-risk group. Similar findings were reported by Sanyang *et al*. showed risk factors reduction will reduce RTA.[2]

Most of these patients were referred from peripheral hospitals (lower level medical centers). It is prudent to note that only 6% reached the center within 1 h (golden hour)

Table 2: Types of complex injury and procedures (*n*=519)

Parameters	Number of cases (%)
Isolated extremities	407 (78.4)
Polytrauma	112 (21.6)
Bony injuries	270 (52)
Vascular injuries	232 (44)
Nerve injuries	104 (20)
Nerve repair was done in a nerve injury patient	65 (62.5)
Tendon injuries	85 (16.3)
Tendon repair was done in a tendon injury patient	57 (67.0)
Types of orthopedic procedures performed	
Fixation of bone without vascular injury	96 (18.5)
Fixation of bone with vascular repair	140 (26.9)
Primary amputation	34 (6.6)
Secondary amputation	72 (13.9)
Graft procedures	
STSG	324 (62.4)
Flap procedures	91 (17.5)

STSG: Split-thickness skin grafting

Table 3: Severity and outcomes to type of injuries

Parameter	Type of injury		
	Isolated extremity injuries	Combined injuries	*P*
ISS	9.3	12.6	<0.005
The average number of procedures	2.1 (0.52)	2.6 (2.3)	<0.005
Average days stay in hospital	14.6	21.2	<0.005
Mortality	0.9	5.3	<0.005

ISS: Injury severity score

of trauma, and 51.1% of the patients reached our center after 6 h of injury. Several studies have reported prolonged ischemic time due to late presentation is associated with amputation.[3,4]

In our study, primary amputation and secondary amputations were 10% and 36%, respectively, among patients with vascular injuries. The secondary amputation rate was high in patients with combined bone and vascular injuries. Dua *et al*. reported the outcome of 68 patients with traumatic popliteal injury. In their study, they reported blunt injury was the most common cause of traumatic injury and the primary amputation rate was 11% similar to our study, however, they reported a lower secondary amputation rate of 10%.[3] In contrast to our study Huh *et al*. showed a higher incidence of early amputation (16.9%) and a lower incidence of late amputation (5.2%) in open tibial fracture.[5] The limb salvage rate decreases with an increase in the time of presentation to tertiary care in our study [Figure 2] similar to previously published data.[6,7] This increased secondary amputation could be attributed to several reasons. First, the higher percentage of patients with combined vascular and bony injuries second

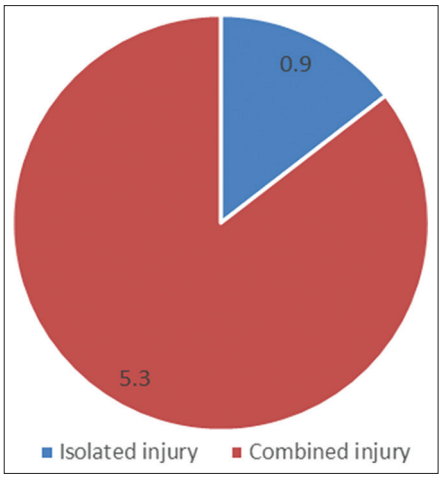

Figure 2: Analysis of mortality rate in isolated and combined injuries

delay in the majority of cases to reach a trauma center, and thirdly could be a result of referral bias.

In patients with only bony injuries, the limb salvage rate was 100%, whereas both vascular and bony injuries were associated with limb salvage was 48.5% (nearly 50%). Hence, patients with both vascular and bony injuries need to be treated aggressively and early. This will reduce the limb loss rate. Similar findings were reported by Gopinathan *et al*. and it showed 56% of limb loss when orthopedic injuries are associated with vascular injuries.[8]

Patients with polytrauma and blunt injuries had a higher severity score when compared to the severity score of isolated extremity and penetrating injuries. As per Wong *et al*., Combining the new ISS with an anatomical polytrauma injury variable predicts mortality better than the new ISS and the ISS.[9] The most common cause of soft-tissue defects was due to primary de-gloving injuries, amputation stump sites, and secondary to fasciotomy wounds. The overall outcome of soft-tissue reconstruction was good with acceptable morbidity and mortality. As per our study, most of the soft tissue defects can be managed with split skin graft and it showed higher graft uptake. These findings tell us primary wound debridement will early graft will reduce the infective rate and higher graft uptake. Those patients were soft tissue defects that cannot be managed with graft, planned for flap procedures mainly rotational advancement flap and transposition flaps. Similar findings reported by Hacquebord *et al*. showed flap is effective for large and complex soft-tissue injuries coverage.[10]

Blunt injuries have a longer hospital stay compared with penetrating injuries. The hospital stay for isolated injury was shorter and the complex injury was longer. A study conducted by Hokkam *et al*. in Saudi Arabia showed prolonged admission, higher incidence of transfer to the operation room, higher incidence of intensive care unit admission, and delayed referral to the hospital.[11]

The mortality of the pediatric group is significant compared with the adult group, so early intervention and aggressive

management in the pediatric group will reduce the complications. Similar findings reported by Sharma *et al*. showed higher pediatric mortality, particularly between the age group of 1–3 years showed higher mortality (39.21%).[12] The mortality mostly occurred in <24 h. The most common cause of mortality here was a hemorrhagic shock, so a low threshold of blood transfusion will reduce mortality. The second most common cause of mortality is sepsis which occurs in the later part of treatment. Children have less reserve of blood, so the pediatric age group reported higher mortality which can be reduced by early blood transfusion, particularly in the pediatric population. Similar findings were reported by Chagomerana *et al*. showed higher morbidity and mortality.[13]

Limitations of the study

This study has a few limitations. Details regarding the first aid given at the accident site and care received by the patient before attending the trauma center were not available. Functional outcomes of complex soft-tissue injury had not been collected. Details regarding complex perineal and gluteal injuries had not been collected. The sampling method is a simple census sampling method. It needs a simple random sampling to further validate the findings.

Conclusions

The following conclusion is arrived at based on our study findings. RTA are the most common cause of soft-tissue injuries. Reducing RTA with health education will reduce soft-tissue injuries. The outcome of penetrating soft-tissue injuries is better than blunt soft tissue injuries. Patients with both vascular and bony injuries are associated with higher amputation rates, so these patients need to be intervened early and aggressively. Graft and flap survival are good in most soft tissue injury patients, so these patients can have good uptake of graft. The morbidity and mortality in the pediatric age group are higher than adult group, so the pediatric group needs to be treated aggressively with a multimodality team. Most of the mortality is due to hemorrhagic shock within 24 h, so a low threshold of blood transfusion reduces the rate of mortality. Proper referral systems reduce the time between injury and the definitive treatment thereby improving the outcomes of such patients. Proper training of healthcare workers about complex injuries will reduce the referral time from primary care to the tertiary care center, thereby reducing the mortality rate and limb loss rate. This study emphasizes the need to prioritize road safety awareness among policymakers and the general public to prevent such injuries.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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