

The Outcome of Surgery for Vascular Injuries in Major Limb Trauma

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ABSTRACT

The incidence of vascular injuries of extremities is scaling new heights in Pakistan. This substantial vascular surgical profile of general surgery demands significant knowledge and skill to manage traumatic vascular injuries.

Aims & Objectives:

1. To record the mode of presentation of acute peripheral vascular injuries in limb trauma patients admitted through Accident and Emergency Department, Jinnah Hospital, Lahore.
2. To evaluate and analyze the outcome of various types of vascular repair carried out for such injuries.
3. Comparison of results with international data.

Study Design: Prospective analytical and observational study.

Setting: Conducted in Surgical Unit-I, Jinnah Hospital, Lahore

Period: From January 2015 to January 2016.

Methodology: A total of 31 limb trauma patients with associated acute vascular injuries were managed.

Results: 30 patients were male and one was female with mean age of 27 years. Major limb trauma associated with vascular injuries were caused by firearm in 19 (61.2%) cases, stab in 3 (9.6%) and blunt trauma in 9(29%). Arterial bleeding from the wound was the commonest presentation in 15 (48.3%) then deficient distal pulses in 13 (41.9%). Upper limb was involved in 15(48.3%) cases and lower limb in 16 (51.6%)cases. 27 (87%) patients had arterialinjuries,4(12.9%) isolated venous and 8 (25.8%) had associated venous lesions. Axillary artery was the most common vessel injured in 7 (22.5%) cases. Autogenous saphenous vein graft was interposed in 17 (62.9%)patients, 6 (22.2%) had endtoend repair and 4 (14.81%) had lateral repair of injured artery. Lateral venorrhaphy was done in 7 (22.58%) venous injuries. 6 (19.3%) developed postoperative wound infection, 6(30%) out of 20fasciotomy wound infection and 5 (16.1%) got distal limb edema. Amputation and mortality rates were 3.22% each.

Conclusion: Timely surgical intervention, regular use of interposition vein graft and low threshold for fasciotomy gave better results. Time is the decisive feature for final outcome of vascular surgery.

Key Words: Major limb trauma, vascular injury

INTRODUCTION

Third cause of death in the population is trauma and the foremost cause of death up to age of 44 years – a staggering loss of productive years of life.¹With continued urbanization over the last few decades there has been an alarming increase in the incidence of severe trauma in our society. Not surprisingly there has been a commensurate rise in traumatic vascular injuries. Not only this but increased incidence of terrorist violence in Pakistan demands increased awareness of major vascular trauma complicating limb injuries. Experience obtained from the major wars of twentieth century provides the basis for present approach to peripheral vascular injuries.^{2,3}

Peripheral arterial injuries are most common in the extremities i.e. around 90%.In military experience the lower is common and upper limb more in civilian experience.³Morbidity and mortality in the traumatized patient considerably increase if wounds involve vascular structures of extremity.

Injured arteries were routinely ligated in extremity trauma during world war-II. Amputation rate for Popliteal artery injuries was 73%. Peripheral vascular injuries were formally repaired in the Korean conflict⁴at first and these techniques were further refined during the Vietnam war³ during which Popliteal artery repair improved the limb salvage and amputation rate declined to 32%.

Extremity vascular injuries cannot only result in limb loss but also serious lifelong functional disability or even death. These problems may occur in spite of prompt and correct diagnoses because of overwhelming nature of injuries, the observation of treatment priorities that preclude vascular repair, or the failure of an attempted repair for whatever reason. However it is particularly tragic when such an unfavorable outcome can be traced back to delayed or failed recognition, or simply to incorrect or incomplete assessment of the extent or severity of the vascular injury. Ongoing advances in on scene trauma management, vascular reconstruction, skeletal fixation, antibiotic therapy and advanced ambulance system have frequently led to more aggressive attempts at limb salvage in an otherwise doomed extremity. All the above mentioned measures have reduced overall limb loss in civilian series to less than 5%.⁵

The purpose of this study is to record mode of presentation of acute peripheral vascular injuries in limb trauma and to analyze the outcome of various types of vascular repair.

OBJECTIVES

1. To record the mode of presentation of acute peripheral vascular injuries in limb trauma patients admitted through Accident and Emergency Department, Jinnah Hospital, Lahore.
2. To evaluate and analyze the outcome of various types of vascular repair carried out for such injuries.
3. Comparison of results with international data.

Operational Definitions:

- a) Major limb trauma i.e. any extensive limb trauma comprising injury to the skin, muscles or bones associated with vascular damage
- b) Limb salvage i.e. complete anatomical and functional recovery
- c) Vascular injury i.e. any main arterial or venous injury of the limb

PATIENTS AND METHODS

This is a prospective, analytical and observational study conducted in surgical Unit-I, Jinnah Hospital, Lahore from January 2015 to January 2016. Sampling technique was non probability consecutive sampling. Thirty one patients with major limb trauma i.e. any extensive limb trauma comprising injury to the skin, muscles or bones

associated with vascular damage regardless of mode of trauma, regardless of age and sex presented in Accident and Emergency Department of Jinnah Hospital, Lahore were included in the study. All patients with extensive limb destruction amounting to auto amputation, delayed presentation with development of irreversible complications or already gangrenous limb were not included. All the patients were resuscitated with intravenous fluids, analgesics, tetanus prophylaxis and antibiotics (second generation cephalosporins). Performa was filled accordingly. The parameters considered were age, sex, mode and pattern of injury, time since injury, vessel involved, associated injuries and mode of presentation. The diagnostic criteria was mainly clinical i.e. the type and site of injury, venous or arterial bleeding, distal pulses, rapidly expanding hematoma and circulation distal to injury. All patients were examined by senior registrar. Investigations carried out prior to operation included CBC, urea / creatinine, BSR, grouping and cross-matching, ECG, urine C/E, chest x-ray, radiological survey of injured limb, and ultrasonography of abdomen. Hand held Doppler ultrasonography was performed in doubtful cases. Any associated fracture was fixed with external devices and carried out before definite vascular repair. In all patients longitudinal incisions were placed on the extremities for suspected vascular injuries. Site and extent of vascular injuries were defined followed by assessment of associated injuries.

Fogarty catheter was used to retrieve any thrombus (proximally and distally) along with gentle flushing with heparinized saline. Repair of injured vessel was carried out either by lateral repair, end-to-end anastomosis or interposition of autogenous reverse saphenous vein graft. In case of a rent in lateral wall of artery, simple repair with 5/0 or 6/0 prolene on non traumatic needle was carried out. In cases when loss or damage to the arterial wall was less than 2cm, mobilization of the two ends and then anastomosis with 5/0 or 6/0 prolene was done. If gap was longer then autogenous reverse saphenous vein graft taken from contra lateral extremity was placed. In case of associated injury to main vein, minor lacerations was repaired with direct sutures. Vein grafting was attempted if there was a significant loss of vein wall. Fasciotomy was done when time of injury was more than 6 hours, on clinical suspicion of compartment syndrome, combined arterial and

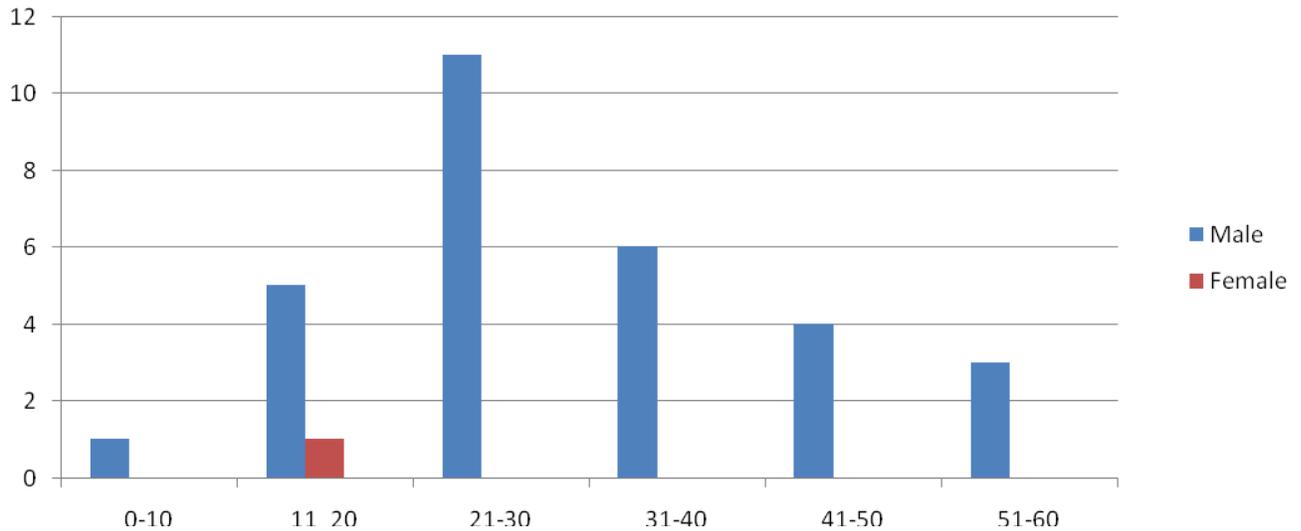
venous where post revascularization edema was anticipated. Secondary closure of fasciotomy wounds were performed 7-10 days later. Systemic heparin 5000 u s/c x 8 hourly was given for 5 days in uncomplicated cases (isolated vessel injury). All patients in this study were subjected to Doppler studies along with daily bedside clinical evaluation. Postoperative physiotherapy was employed in all cases. All patients were followed-up after two weeks in first month then monthly for two months. Any complication including wound infection,

vascular patency, graft complication, and limb amputation rate were recorded. Data was analyzed using the statistical package for social sciences version 17 (SPSS 20 Chicago, IL, USA).

RESULTS

This study comprised 31 patients. 30(96.7%) patients were male. 1 (3.2%) patient was female. The age incidence varied from 6 to 57 years.

Fig. 1: Age and Sex Distribution (n=31)



The response time.

Table 1: Response Time (n = 31)
Range = 3-13 hours Mean = 7.2 hours

Hours	Number	%
0-3	10	32.5
4-7	8	25.8
8-10	8	25.8
11-13	5	16.1

Table 2: Mechanism of Injury (n - 31)

Mechanism	Number	Percentage
Penetrating	22	70.96
- Firearm	19	61.2
- Stab	3	9.6
Blunt	9	29.3

22 (70.9%) patients had penetrating injuries out of which 19 (61.2%) were caused by firearm

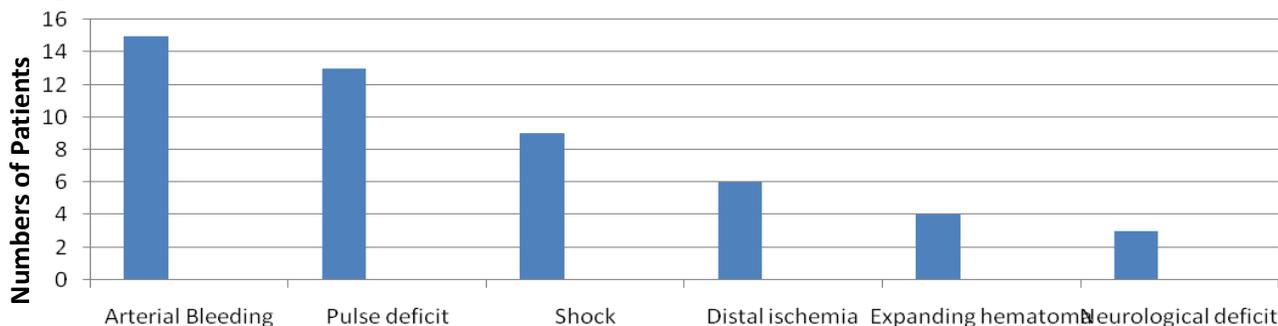
and 3 (9.6%) by stab (2 stab injuries were with knife and one was due to fall on broken glass). 9(29.7%) cases sustained blunt trauma which was responsible for vascular injuries.

The commonest feature was arterial bleeding from the wound recorded in 15 (48.3%) patients followed by absent distal pulses in 13 (41.9%) cases. 9 (29%) patients were in shock and 6 (19.3%) had distal ischemia.

Table 3: Modes of Presentation (n: 31)

Mode of Presentation	No.	Percentage
Arterial bleeding	15	48.3
Pulse deficit	13	41.9
Shock	9	29
Distal ischemia	6	19.3
Expanding hematoma	4	12.9
Major neurological deficit	3	9.6

Fig. 2: Modes of Presentation (n: 31)



15 (48.3%) patients had upper limb vascular injuries and 16(51.6%) had lower limb vascular involvement. Axillary artery was the commonest vessel involved in 7 (22.5%) cases in upper limb trauma followed by brachial in 6 (19.3%) cases.

Table 4: Distribution of Vascular Injuries (n:31)

Vessel	Number	Percentage
Upper Limb	15	48.3
Axillary	7	22.5
Brachial	6	19.3
Radial	2	6.4
Lower Limb	16	51.6
Common femoral	5	16.1
Superficial femoral	4	12.9
Popliteal	7	22.5

Table 5: Types of Vascular Injury (n:31)

Type of injury	No.	Percentage
Incomplete or simple puncture	4	12.9
Complete transaction	14	45.1
Laceration with Loss of vessel wall	11	35.4
Closed injury	2	6.4

In lower limb Popliteal artery had main involvement i.e. in 7 (22.5%) cases, followed by common femoral artery which was observed in 5 (16.1%)patients. In this study, 27 (87%) patients had arterial injury, 4 (12.9%) had isolated venous and 8 (25.8%) had associated venous injuries.

4 (12.9%) patients had incomplete transaction or simple puncture of vessel, 14 (45.1%) had complete transaction, 11 (35.4%) had laceration with loss of vessel wall while 2 (6.4%) had closed injury.

12 (38.7%) patients had associated fracture, 10 (32.2%) had extensive soft tissue

injuries, 6 (19.3%) had skin loss and 4 (12.9%) patients had nerve injury. Major neurological deficit with paralysis was observed in one patient whereas paresis due to neuropiraxia was recorded in three patients which improved afterwards.

Table 6: Surgical Technique of Vascular Repair (n:31)

Vessel	Type of repair	No.	%
Artery (27)	Autogenous vein graft	17	62.2
	End-to-end repair	6	22.2
	Lateral repair	4	14.8
Isolated venous (4)	Lateral venoraphy	3	75
	Ligation	1	25
Associated venous (8)	Lateral venoraphy	4	50
	Ligation	4	50

Fasciotomy was performed in 20 (64.5%) patients.

6 (19.3%) developed wound infection and 6 (30%) had fasciotomy wound infection. Wound infections were treated with dressings and antibiotics. 2 (6.4%) patients developed postoperative thrombosis in graft. Thrombus was retrieved with Fogarty catheter by re exploring the vessel in both cases with successful revascularization of the limb. 5 (16.1%) patients developed postoperative distal limb edema which settled with limb elevation and physiotherapy. 1 (3.2%) limb was amputated due to gangrene as an aftermath of technical failure of vascular repair and 1 (3.2%) patient died due to extensive associated chest and head injuries.

Fig. 3: Associated injuries (n-31)

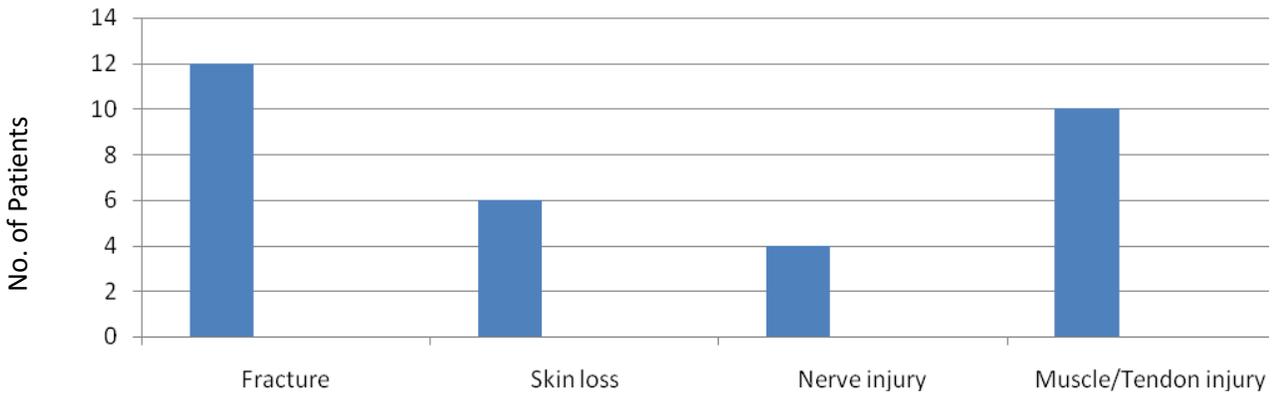


Table 7: Postoperative Complications (n:31)

Complication	Number	Percentage
Wound infection	6	19.3
Fasciotomy wound infection	6	30
Distal limb edema	5	16
Graft vein thrombosis	2	6.4

Table 8: Amputations (n:31)

Number	Percentage
1	3.2

Table 9: Mortality (n:31)

Number	Percentage
1	3.2

DISCUSSION

Vessels injuries are common and occur more often in vicious societies such as ours or during army conflicts.⁶ Peripheral vascular injury is a life threatening condition which most of the times results in great morbidity in the form of amputation which in our society is social stigma as well as a major problem for the manual laborers of the country.⁷ The alarming rise in the incidence of vascular trauma demands that clinician working in accident and emergency department should be very keen while examining polytrauma patients.¹⁷ The common sufferers are adolescent males. Hardin et al⁸ shows that 86.6% of victims are male, Menzoian et al⁹ noted 94.6 % being male, Ahmed et al¹⁰ reported 84.2% being male, Majid et al⁶ observed 93.6% male whereas in this study 96.7% victims were male. Male to female ratio was 30:1. The mean age reported by Hardins⁸ and

Menzoian⁹ was 28.8 years and 32 years respectively whereas Ahmed and Afzal^{9,10} reported mean age as 25 years and 26 years. In this study mean age was 27 years. Firearm injuries are the commonest reason of vessel injury reported by many authors^{6,12} which supports our outcome (61.2%). Blunt injuries are second most common cause of peripheral vessels injury as reported by Franklin¹² and Majid.⁵ In the present study, blunt trauma (29%) is the second frequent cause of vascular injury which is in contradiction to Javaeed's study¹³ which shows the stab (24.6%) as second common cause of peripheral vascular trauma. Sharp penetrating injuries (9.6%) were the third common cause in this study.

Arterial hemorrhage from the wound was the most common presentation (48.3%) in this study which contrasts the results of Stumm¹⁴ where pulse deficit was the commonest mode of presentation found in 61.2%. In this study pulse deficit was seen in 13 (41.9%) patients. Pulse beyond injured area may be palpable in around 25% of patients so the location rather than dimension of skin wound should alert the surgeon in patients with sharp injuries overlying vascular structures.¹⁵ 17% of vessels injuries may come up late with either arteriovenous fistula or aneurysm¹⁶ though no such complication was encountered in this study. Arterial injuries alone are more common than combined arterial/venous injuries or only venous injuries as shown by Hardin⁷ (arterial 61.9%, arteriovenous 28.5%, venous 9.5%), Menzoian⁸ (Arterial 64.2%, Arterial/venous 23.2%, venous 12.5%) and Majid⁵ (Arterial 63%, Arterial/venous 21%, venous 6%). This study also had the similar results as given by above studies (arterial 61.2%, arterial/venous 28.8%,

venous (12.9%). Most of vascular injuries were complete (45.1%) which are in accordance with Majid (75.7%). Laceration with Loss of vascular wall was the second common type of injury (35.4). The diagnostic criteria in this study was clinical but in doubtful cases hand held Doppler ultrasonography was performed. Duplex ultrasonography has a specificity of 99% in identifying and localizing the vascular injury¹⁷ but this could not be performed in this study due to nonavailability. The role of preoperative angiogram is controversial in vascular trauma as it can prolong the ischemia time¹⁸ while preoperative arteriography can be quick, cost effective and is a valuable tool to augment diagnostic accuracy of vascular damage. Emergency room (Preoperative) arteriography is strongly recommended by Macfarlane¹⁹ and Ramanathan.²⁰ According to them it is the most useful diagnostic procedure in peripheral vascular trauma and it also prevents the unnecessary exploration of the vessels in 20% cases. We could not perform the emergency room arteriography in this study due to nonavailability. Trauma to lower limb vessels is higher than upper limb as quoted by Ahmad⁹ (57% lower limb, 42% upper limb) and Afzal¹⁰ (61% lower limb and 39% upper limb). In this study 51% injured vessels were from lower limb and 49% from upper limb. Axillary vessels (22%) from upper limb and Popliteal from lower limb (22%) were the commonly injured vessels in this study which are in contradiction with other studies^{10,11} which show the femoral and brachial vessels to be injured with maximum frequency. Average requirement of blood transfusion in this study was five units. Much study shows²¹ that haemodynamically unstable patients with pelvic fractures needed 15 units blood and 3.4 units for stable patients. Repair of traumatic vessel gives most promising results²² however placement of grafts is also recommended in specific circumstances.²³ A variety of grafts have been tried such as arteries²⁴, veins²², intestinal submucosa²⁵, dacron and polytetrafluoroethylene.²⁶ We didn't use any synthetic conduit and 54.8% cases has placement of autogenous reverse saphenous vein graft with excellent outcomes. The basic problem with vein graft is its fragility if gets infected which causes transmural necrosis and torrential bleeding. The reported incidence of interpositional vein graft thrombosis is 19.3%. In this study only two patients (6.4%) had this complication. Fasciotomy was performed in 20 (64.5%) patients simultaneously.

Fasciotomy plays an important part in limb salvage. It is recommended in patients with compartment syndrome, Popliteal vascular injuries and combined arterial and venous injuries.¹⁴ Kronja²⁷ recommends that when the ischemia time is less than six hours before revascularization fasciotomy is not necessary, but when the period since injury to revascularization is longer than six hours the prophylactic fasciotomy is advisable. All fasciotomy wounds were closed 7-10 days later and six out of twenty (30%) patients developed fasciotomy wound infection. Johnson et al²⁸ reported that only 5% of patients whose fasciotomy wounds were closed with skin grafts developed wound complications, compared with 51% of patients undergoing delayed closure. This could explain the reason for high infection rate in the present study.

According to Gates²⁹ there is controversy in the treatment of bony injuries along with vascular trauma. There are proponents for initial skeletal stabilization and an equal number in favor of initial revascularization. But majority³⁰ believe that repair of artery should be the priority. However substantial musculoskeletal trauma, the limb may be so unstable that external fixation is required before the vascular surgery. Shunts may be used and then rapid placement of an external fixator minimizes limb ischemia in this setting. In our setups senior orthopedic surgeon is not available and orthopedic residents do the job in emergency and there is always danger of damaging the repaired vessel if the skeletal injury is fixed after the repair of vessel. So in this study all associated bony injuries were fixed by orthopedic residents before definite procedure of vascular reconstruction. Time period between injury and vascular repair is very important due to tissue hypoxia and later ischemia. Synder et al³¹ reported that if there is knee displacement with Popliteal artery it would result in amputation rate of 13% if repair of vessel was done within 8 hours otherwise reach to 86% with increase in repair time. Similarly in developed countries where patients are referred early the amputation rate varies from 1.8% to 7%³². Response time is slightly longer in this study and is comparable to Ahmad¹⁰ but is much longer than Borroset al³³. Afzal¹⁰ and Blacklay³⁴ recommend the systemic use of heparin in uncomplicated cases but Majid⁶ does not recommend the use of heparin on the basis that a perfect vascular reconstruction with no associated injury obviates the need of postoperative systemic

anticoagulation. In this study allun complicated cases were routinely heparinized which showed very promising results. Limb Salvage was obtained in 30 (96.7%) cases and one patient underwent amputation (3.2%).This is comparable with international studies by Plucini³⁵and Sriussadaporn³⁶butmuch better than Majid (27.6%)⁵, Javeed (13%)¹³andAhmad (21%)⁹.

CONCLUSION

Over the last few years civilian hostility in Pakistan is mounting as there is increase in number of patients admitted to Accident and Emergency Department of Jinnah hospital with major limb trauma associated with vascular injuries. Most of the injuries were caused by firearm followed by blunt trauma and stab. The most frequent presentation was arterial bleeding from the injury followed by absent distal pulses. Lower limb had slightly more involvement than upper. Autogenous saphenous vein graft interposition showed marvelous outcome. Where vascular defect was not more than 1.5-2 cm end-to-end repair also showed promising results. Vascular trauma should be taken as serious emergency but insufficient services and inadequate vascular surgical units make this task even more challenging to the surgeons. Provision of appropriate equipment and trained vascular surgeons at district hospitals reduce delay between injury and vascular reconstruction. Trained paramedical staff and swift transport of injured person will add to a promising outcome. Trainee general surgeons at all teaching hospitals should be trained properly to deal with the vascular emergencies. Independent well equipped vascular units should be setup at tertiary centers to coup with such injuries. Better results can be obtained by adhering to principles of vascular repair which encompass exact definition of vascular damage, immediate limb vascularization, frequent use of interposition graft, low threshold for fasciotomy and early embulization in postoperative period. Prompt recognition of the vascular injury, skeletal fixation before vascular reconstruction, fasciotomy and systemic use of heparin results in very high limb salvage rate.

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