Original Article

Epidemiology of lower limb musculoskeletal trauma with associated vascular injuries in a tertiary care institute in India

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Abstract

Background: Vascular trauma associated with bony injuries is an orthopaedic emergency. Lack of timely intervention can lead to loss of limb or even life. Inspite of the rising incidence of high speed road traffic accidents in India, there is paucity of literature regarding the demographic pattern, clinical morbidity, management strategies and outcome of arterial injuries associated with lower limb trauma. The aim of this study is to describe the epidemiology and outcome of lower extremity musculoskeletal trauma with associated vascular injuries in a tertiary care institute in India.

Materials and Methods: All individuals who presented to our tertiary care trauma center from July 2013 to December 2014 with lower extremity vascular injury associated with lower limb fractures were identified from a retrospective trauma database for this descriptive study. For the 17 months, there were 82 lower extremity vascular trauma cases admitted in our trauma center, of which 50 cases were included in the study. 32 patients with crush injuries, traumatic amputations, and those with head injury and blunt trauma to chest or abdomen were excluded from the study.

Results: Out of the 50 cases of lower extremity vascular injury with associated lower limb fractures, 19 limbs were salvaged, 28 amputated, and three patients expired. Young males in the age group of 20–39 years were frequently injured. Motor vehicle accident (MVA) (82%) was found to be the most common cause followed by pedestrian injury. Popliteal artery (62%) was the most common vessel injured, followed by femoral artery (28%). The salvageability percentage was much higher (64%) in the femoral artery injury group when compared to popliteal artery injury group (25%). There were 32 open fractures, with amputation rates (60%) being higher and all three cases of death falling in this group. In addition, the limb salvageability percentage was 43.2% when the patient presented within 12 h of injury and this decreased to a mere 16.7% when the patient had presented more than 24 h after injury.

Conclusion: MVAs are the leading cause of vascular injuries in India. Road safety measures and prevention programs are the need of the hour to prevent these kinds of injuries in the future.

Key words: Epidemiology, lower extremity, tertiary trauma care center, vascular trauma
MeSH terms: Epidemiology, lower extremity, trauma centres, traumatology, arteries

Introduction

Orthopedic injuries associated with vascular insult are an important cause of morbidity and mortality. There is a paucity of literature regarding the epidemiology, management strategies, and outcome of vascular trauma in India. And in particular, there have been very few studies highlighting the pattern, causes, and effects of lower extremity vascular trauma. The aim of this study is to describe the lower limb musculoskeletal trauma associated with vascular injury in a tertiary trauma center in India in terms of epidemiology and patient outcome.

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Materials and Methods

This was a single-center, retrospective, observational study of patients with traumatic lower extremity vascular injury who presented to our tertiary trauma center in North India, between July 2013 and December 2014. All patients with traumatic lower extremity vascular injury with lower limb fracture were included in the study. Patients with crush injuries, traumatic amputations, and those with head injury and blunt trauma to chest or abdomen were excluded from the study.

Clinical parameters

Clinical data including demographics, mechanism of injury, severity of vascular lesions, diagnostic and therapeutic management, and complications were evaluated by a review of patient files. Whenever a patient with lower extremity injury presented to the emergency department, the orthopedic surgeon at the emergency department attended the patient first, and if the surgeon suspected a vascular injury, the vascular surgeons were called for help. If it was an open fracture wound, it was washed with 6 liters of normal saline, betadine and hydrogen peroxide and the patients were started on triple antibiotics [Injection Cefuroxime 1.5g, Injection Amikacin 1g, Injection Metronidazole 800mg]. Doses were altered according to the patient's renal function. After ruling out head injury, chest and abdominal injury, patients were included in the study. Computed tomography angiography was used for localizing the site of vascular injury in all the patients with clinical suspicion of vascular injury. The patients were managed by a team of surgeons, including orthopedic, vascular, and plastic surgeons.

Statistical analysis

Statistical analysis was performed by utilizing the IBM SPSS statistics software program (version: 20.0, SPSS Inc., Chicago, IL, USA). Fisher's exact test was used for the univariate risk factor analysis of variables related to amputations. Stepwise logistic regression analysis was used to identify independent risk factors for amputations. Odds ratio (OR), 95% confidence interval, and *P* value were calculated. *P* value was assumed to be statistically significant if ≤0.05 in all tests.

Results

82 lower extremity vascular trauma cases admitted in our trauma center, of which 50 cases were included in the study [Flowchart 1]. Of the 50 cases, 49 were male and there was only a single female patient. The only female patient was an 11-year-old child with Salter Harris Type 2 distal femur physeal injury with popliteal artery injury. Fifty percent of the study population were in the age group of 20–39 years with the mean age being 31 years [Flowchart 1 and Graph-1]. The rate of amputation was the highest (71.4%) in the age group of ≥40 years, followed by 20–39 years group (60.9%) and least (40%) in the <20 years age group.

Mechanism of injury

Motor vehicle accidents (MVAs) accounted for 82% (*n* = 41) of the cases [Tables 1 and 2]. The next most common cause was pedestrian injury (PI), which accounted for 10% (*n* = 5). Both MVA (amputation rate = 63.2%, OR = 2.1) and PI (amputation rate = 40%, OR = 2.4) were highly associated with amputation. Two cases of blunt injury trauma were due to accidental fall of a log on the patient's leg. Work place machinery injury and railway accident accounted for one case each.

Type of associated fractures and nature of vascular injuries

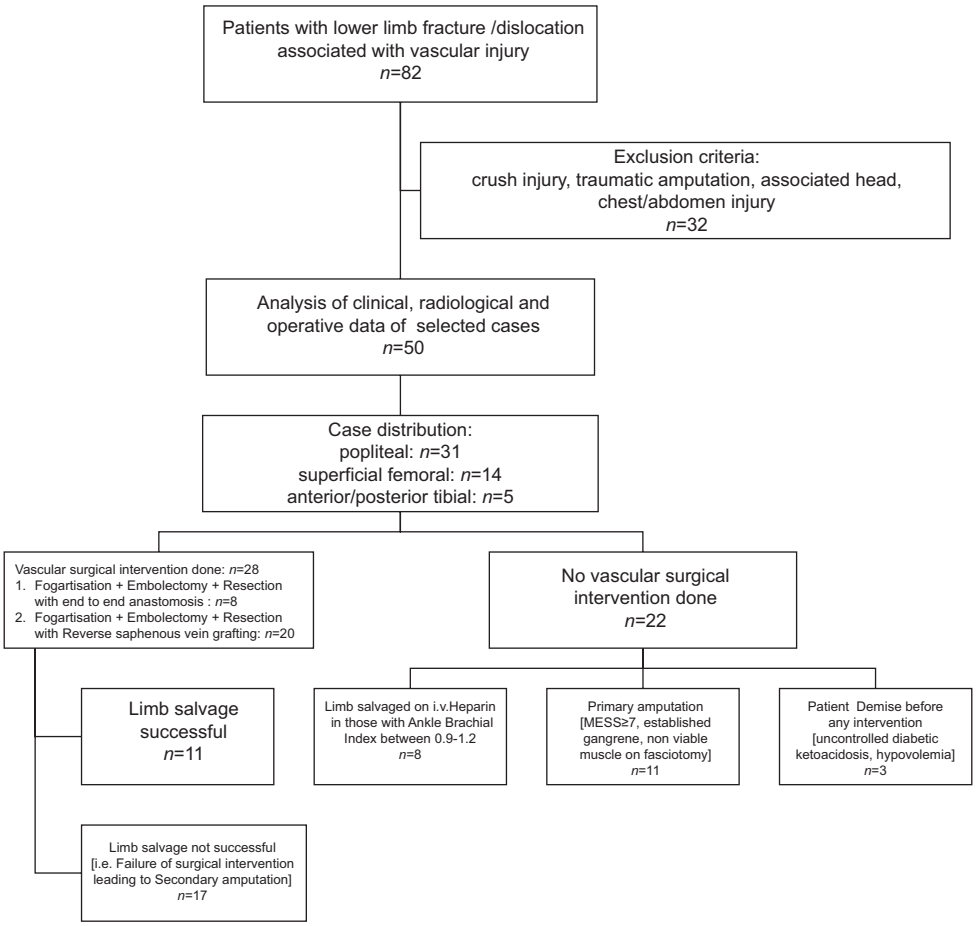
Of the 50 cases, 32 cases (64%) were open fractures and 18 (36%) were closed fractures. Twenty seven out of the 32 (84.4%) open fractures were due to MVA. Open fractures were associated with higher risk for amputation (62.1%, OR = 1.3) when compared with closed fractures (55.6%, OR = 0.2). Popliteal artery was most commonly injured (*n* = 31, 62%) followed by superficial femoral artery injury (*n* = 14, 28%) and anterior and posterior tibial artery injury (*n* = 5, 10%). The risk of amputation was higher with popliteal injury (68.9%, OR = 2.8) and tibial vessel injury (60%, OR = 1.0) when compared to superficial femoral artery injury (38.5%, OR = 0.3). Overall, 60% of the cases had complete vessel tear (transection), 14% had partial tear (laceration), and 26% had intravascular contusion thrombosis. The rate of limb loss was significantly higher with complete tear (77.7%, OR = 6.5, *P* = 0.04) and partial tear (71.4%, OR = 0.7, *P* = 0.003) when compared with thrombosis (15.4%, OR = 1.1, *P* = 0.85).

Time of presentation

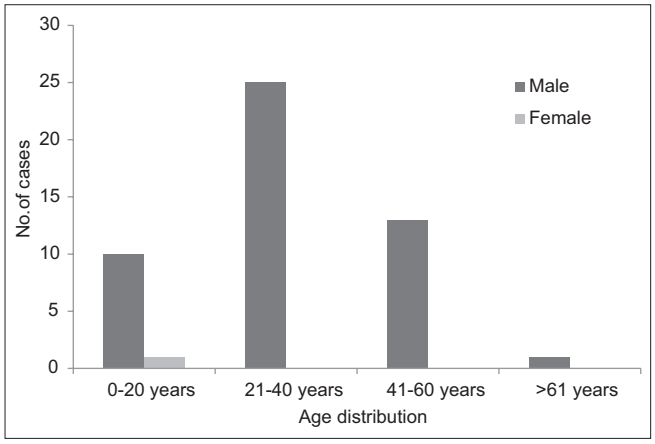
The time of presentation has been classified into three categories, namely, early (<12 h), intermediate (12–24 h), and late (>24 h). Seventy eight percent of the study population presented early, 10% were intermediate, and 12% were late. Late presentation was associated with higher amputation risk (83.3%, OR = 3.9) than early (56.8%, OR = 0.6) and intermediate presentations (50%, OR = 0.7).

Management strategies

All the patients in this study underwent angiograms after being confirmed as a case of vascular injury by the doctor in the emergency department. Vascular surgery was performed in 28 (56%) of the 50 cases. Fogartisation and



Flowchart 1: Study flow chart



Graph 1: Bar diagram showing age and gender demographics

embolectomy followed by resection with reverse saphenous vein (RSV) grafting were done in twenty cases (71.4%), and resection with end-to-end anastomosis (EEA) was done in eight cases (28.5%). The rate of failure of vascular surgical intervention (and hence, the rate of secondary amputation) was significantly higher with RSV (75%, OR = 3.2, $P = 0.06$) when compared with EEA (25%, OR = 0.7, $P = 0.04$).

Patient outcome

Out of the 50 cases, 19 (38%) were salvaged successfully, 28 (56%) underwent amputation and 3 patients (6%) died. Vascular intervention was done in 11 out of the 19 patients (57.9%) whose limbs were salvaged. Rest of the eight patients (42.1%) were started only on postoperative intravenous heparin after the orthopedic and plastic surgical procedures since they had a normal ankle brachial index value between 0.9 and 1.2. Overall, 28 patients underwent amputation either as a primary surgery (primary amputation) or as a secondary procedure after failed vascular intervention (secondary amputation). Eleven patients (39.3%) underwent primary amputation without any form of vascular intervention in view of mangled extremity severity score of ≥7 and/or established gangrene and/or presence of nonviable muscle in superficial posterior compartment in addition to any one of the other three compartments of the leg (anterior, lateral, and deep posterior) after a liberal two-incision, four compartment fasciotomy. Secondary amputation was done in 17 patients (60.7%). Of the 19 salvaged limbs, 14 cases were due to MVA, two cases due to blunt injury, and one each in pedestrian, machinery, and railway injury categories.

Table 1: Injury characteristics and outcome

Parameter	*n*	Salvage (*n*=19)	Primary amputation (*n*=11)	Secondary amputation (*n*=17)
Age group (years)				
<20	10	6 (60.0)	3 (30.0)	1 (10.0)
20-39	23	9 (39.1)	6 (26.1)	8 (34.8)
≥40	14	4 (28.6)	2 (14.3)	8 (57.1)
Mode of injury				
Motor vehicle accident	38	14 (36.8)	8 (21.1)	16 (42.1)
Pedestrian injury	5	3 (60.0)	1 (20.0)	1 (20.0)
Blunt injury	2	2 (100)	0	0
Work machinery	1	0	1 (100)	0
Railway accident	1	0	1 (100)	0
Associated bony injury				
Closed fracture	18	8 (44.4)	3 (16.7)	7 (38.9)
Open fracture	29	11 (37.9)	8 (27.6)	10 (34.5)
Time of presentation (h)				
Early (<12)	37	16 (43.2)	6 (16.2)	15 (40.6)
Intermediate (12-24)	4	2 (50.0)	2 (50.0)	0
Late (>24)	6	1 (16.7)	3 (50)	2 (33.3)
Type of vessel injury				
Popliteal	29	9 (31.0)	7 (24.1)	13 (44.8)
Superficial femoral	13	8 (61.5)	2 (15.4)	3 (23.1)
Tibial (anterior/posterior)	5	2 (40.0)	2 (40.0)	1 (20.0)
Nature of injury				
Complete tear	27	6 (22.2)	9 (33.3)	12 (44.4)
Thrombosis	13	11 (84.6)	1 (7.7)	1 (7.7)
Partial tear	7	2 (28.6)	1 (14.3)	4 (57.1)
Type of intervention				
No	19	8 (42.1)	11 (57.9)	0
EEA	8	6 (75.6)	0	2 (25.0)
RSV	20	5 (25.0)	0	15 (75.0)

EEA=End-to-end anastomosis, RSV=Reverse saphenous vein

Table 2: Univariate analysis of various factors related to amputation

Parameter	OR (95% CI)	*P*
Mode of injury		
Motor vehicle accident	2.1 (0.5, 9.3)	0.310
Pedestrian injury	2.4 (0.4, 16.2)	0.357
Associated bony injury		
Open fracture	1.3 (0.3, 4.3)	0.65
Closed fracture	0.2 (0.05, 1.2)	0.08
Time of presentation (h)		
Early (<12)	0.6 (0.1, 2.5)	0.45
Intermediate (12-24)	0.7 (0.8, 5.0)	0.68
Late (>24)	3.9 (0.4, 36.5)	0.23
Type of vessel injury		
Popliteal	2.8 (0.8, 9.3)	0.10
Superficial femoral	0.3 (0.08, 1.1)	0.07
Tibial (anterior/posterior)	1.0 (0.1, 6.8)	0.98
Nature of injury		
Complete tear	6.5 (1.9, 23.6)	0.04
Partial tear	0.7 (0.1, 0.3)	0.004
Thrombosis	1.1 (0.2, 5.6)	0.85
Type of intervention		
EEA	0.7 (0.3, 0.9)	0.04
RSV	3.2 (1.1, 13.6)	0.06

OR=Odds ratio, CI=Confidence interval, EEA=End-to-end anastomosis, RSV=Reverse saphenous vein

Three patients expired in total (mortality rate = 6%). One case was a known case of diabetes mellitus which turned into full-blown uncontrolled diabetic ketoacidosis after trauma and the patient expired. The other two cases expired in the emergency department during resuscitation due to hypovolemia. All the three cases were due to MVA, who had open fractures and complete vessel tear.

Discussion

The incidence of lower extremity vascular trauma has been on the rise mainly due to increase in high-speed MVAs in India. Exsanguination is perhaps the most significant cause of death after vascular injury,[1,2] while ischemic tissue damage can lead to high rates of amputation. Deaths due to vascular injuries constitute up to 20% of trauma deaths and these patients have the highest utilization of hospital resources among the trauma population.[3] Although advances in surgical techniques of repair of injured structures have minimized the rate of amputation due to these injuries,[4] amputation due to extremity trauma is still a major source of morbidity in trauma patients in developing countries.[5,6] This study is one of the first to characterize the

epidemiology of vascular trauma in a tertiary trauma care center in India. In the present study, the epidemiology and clinical morbidity and mortality of lower extremity arterial trauma associated with lower extremity fractures have been studied in detail.

According to our study, traumatic lower extremity vascular injuries are more common in young males. The mean age of incidence was 31 years, and there was only one female patient in the whole series. This is consistent with the previous reports which show that most of the traumatic extremity vascular injuries occur in young males.[7-9]

Out of the 50 cases, 41 cases (82%) were due to MVAs, 5 cases were due to PI, 2 due to blunt trauma, and 1 each due to work machinery injury and railway injury. The association between the mechanism of injury and anatomical distribution of injury has been well recognized. Lower limb injury is most commonly associated with motorbike crash and MVAs. Blunt extremity vascular trauma is relatively uncommon and it is associated with high mortality and complication rates including major amputation ranging from 28% to 71%.[10-15] However, in our series, there were only two cases of blunt injury extremity arterial injury (anterior dislocation of knee with popliteal artery injury and supracondylar femur fracture with popliteal artery injury). In both these cases, the limb was salvaged after combined orthopedic and vascular procedures.

Out of the 50 cases, there were 32 open fractures and 18 closed fracture in this series. And as expected, morbidity and mortality was more in the open fracture group. Of the 32 open fractures with associated vascular injuries, 10 limbs (31%) were salvaged, 19 were amputated (60%), and all the three cases of death fell in this group. Whereas there was a salvageability rate of 50% and amputation rate of 50% in the closed fractures' group.

In our series, we found that the amputation rates were higher in cases of MVA. Of the 28 patients who had amputation, 25 cases (89.3%) were due to MVA and the remaining three were due to PIs. This may be due to the very high energy trauma associated with MVA leading to extensive bone, soft tissue, and vascular damage and also extensive soft tissue contamination, which may require amputation at a later stage due to gross uncontrollable infection.

In our series, there were 31 cases (62%) of popliteal artery injury, 14 cases (28%) of femoral artery injury, and 5 cases of anterior tibial and posterior tibial artery injury. This goes in hand with some of the other studies which show that popliteal artery is the most common injured structure in lower limb vascular injuries.[16] On the contrary to our findings in Indian patients, according to Gupta *et al.*, femoral artery is the most common injured structure in lower extremity vascular trauma in Australian population.[17] Nevertheless, the limb salvageability percentage in popliteal artery injury group was a mere 25% whereas it was as much as 64% in the femoral artery injury group, showing that the prognosis was much better when the patient had femoral artery injury. Two out of five cases of anterior and posterior tibial artery group were salvaged, with a salvageability percentage of 40%. Of the 17 cases which underwent amputation as a second surgery in spite of having vascular repair as the first surgery, 14 cases were popliteal artery injuries which further emphasizes the fact that popliteal artery injury has a worse prognosis when compared with femoral artery injury.

The importance of rapid transport to the hospital in road traffic accidents cannot be over emphasized. We observed that the limb salvageability percentage was 43.2% when the patient presents within 12 h of injury. This salvageability percentage reduced drastically to 16.7% if the patient had presented more than 24 h after injury. Thus, the time of referral and the speed of the transport determine the clinical outcome prior even the patient reaches the hospital.

Public health measures focusing on road safety and accident prevention must target the vulnerable group i.e. young males in the age group of 20–39 years and to promote awareness regarding the morbidity and mortality associated with lower extremity vascular trauma.

Conclusion

This study shows the epidemiology of lower limb vascular injury trauma associated with lower limb fractures in India. MVA in young males is the leading cause of these injuries in India. Popliteal artery is the most commonly injured vessel, but the prognosis is much better in femoral artery injuries. Open fractures had worse morbidity and mortality outcomes. Patients presenting in the first 12 h after injury had a better limb salvageability rate. Motor vehicle safety and prevention programs targeting young males are most likely to have a greatest effect on vascular injury rate, and the results of this study may be used for preventive strategic planning of these injuries.

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Nil.

Conflicts of interest
There are no conflicts of interest.

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