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**Original Article**

**Lower Extremity Vascular Trauma Assiut University Hospital Experience**

**Mohammed Shahat, Mostafa Abdelmonem**

Department of Vascular and Endovascular Surgery, Assiut University Hospitals, Asyut, Egypt

**Abstract**

**Background:** There is globally increase incidence in vascular trauma as a result of increase rate of civilian violence and increase rate of road traffic accident. Vascular injury affects young males and associated with high mortality and long-term morbidity. Here, we present our experience as tertiary health centers in the management of this type of injury, also we present our result as regards to primary and secondary amputation rates. The most important factors affecting these rates were ischemia time and condition of surrounding soft tissue. **Aims and Objectives:** Detect rate of limb salvage after trauma injury in assuit university hospital , and risk factors for limb loss. **Materials and Methods:** Our study is prospective study of all patients who vascular lower extremity trauma from January 2014 to January 2015 during the period of the study(from January 2014 to January 2015), 135 cases of vascular injury presented to Assiut University Hospital, 87 of them had lower limb vascular injury representing 64.4%. **Results:** Surgical intervention was done in 82 patients representing 94.3%, endovascular intervention was done in 2 patients representing 2.3, 1 patient had endovascular balloon control then surgical intervention representing 1.15%, and two patients had conservative management representing 2.3%. **Conclusion:** vascular trauma is prevalent health problem in our locality, which have huge socioeconomic impact in our community as it affects mainly young men. The main controlling factor in secondary amputation rate is ischemia time, infection which accompanies severe soft tissue damage. At the end trauma with vascular injury is considered, a complex process needs urgent intervention with multidisciplinary team in well-equipped facility.

**Keywords:** Limb salvage, lower extremity, secondary amputation, trauma, vascular injury

**INTRODUCTION**

Traumatic vascular injury to the lower limbs is considered prevalent pattern of trauma in our locality pattern of vascular trauma. Civilian pattern of vascular insult represents about 1% to 2% of all trauma reported at all. However, these traumas may be more than 20% of all trauma-related mortality.[1] The most common cause of lower extremity vascular injury was road traffic accident (RTA), followed by firearm injury (FAI). Vascular injury trauma to lower limb may lead to arterial, venous, or both arterial and venous injury. Management of vascular extremity trauma remains challenging and requires multiple complicated and malleable algorithms in various clinical circumstances.[2] Algorithm and protocols of treatment are usually dependent on the experience of others. Actually, a large percentage of trauma with vascular subtype have delayed transfer to vascular trauma

the economic status of the patient, especially and on community on general.[3] Surgery of vascular trauma may be so challenging due to difficult access to vascular injuries, especially in the major arterial tree. Furthermore, AVF and the aneurysms modify the shape and disrupt the anatomical features therefore more difficult surgical treatment. Endovascular techniques can be used as toll in the armamentarium of vascular surgeon.[4]

**PATIENTS AND METHODS**

Informed written consent with risk explanation was obtained from all participating patients. Our study is prospective study of all patients who vascular lower extremity trauma

**Address for correspondence:** Dr. Mohammed Shahat,

E-mail: dms\_here@yahoo.com

center. The impact of trauma ranges from death and amputation

which leads to devastating implication on physical, mental social life of the patients, the negative effect also makes it shadows on

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from January 2014 to January 2015 during the period of the study (from January 2014 to January 2015), 135 cases of vascular injury presented to Assiut University Hospital, 87 of them had lower limb vascular injury representing 64.4%. Data collected are demographics, duration of transportation to the hospital, mechanism of trauma, details of injured vessels and associated injuries, Injury Severity Score (ISS). Preoperative investigations, surgical intervention, duration of hospital stay, and outcome (amputation or death) were obtained. In the present study, we divided the ISS into three ranks of <16, 16–25, and >25.[5] The arterial injuries were diagnosed by physical examination (soft/hard signs), Doppler ultrasound and arteriography, if necessary.

# Procedure

Patient evaluation of patient with lower extremity trauma or trauma of the junction zone vascular trauma follows Advanced Trauma Life Support Algorithm.[6] First of all, manual compression or tourniquet application to stop bleeding is mandatory to treat shock. Junctional vascular injuries represent challenge for control as this injury does not suitable for tourniquet application and so hard to stop bleeding by compression, rapid operative intervention may save life.

If there is no external bleeding, physicians have time to perform clinical examination of the lower extremity, particularly vascular assessment of the vascular tree branches femoral, popliteal, and pedal pulses. Palpation is further assessed by Doppler. Doppler ultrasound used for the diagnosis of vascular trauma distal to the injury site and calculation of ankle-brachial index (ABI). Assessment of hard or soft signs of vascular injury, hard signs are considered as near sure indicators vascular trauma by disruption or occlusion and include pulsatile bleeding, expanding hematoma, palpable thrill, audible bruit or profound ischemia distal to the point of injury. Soft signs are suggestive vascular trauma but less clear less sure. These include reports of bleeding at the scene of injury, the presence of a peripheral nerve deficit, an injury pattern (including long-bone fracture or dislocation, indicative of vascular compromise), and injury in close proximity to a main or axial extremity vessel.

* In most of cases, the hard signs of limb vascular trauma indicate urgent operative intervention. In the presence of complex factors such as multiple levels of trauma in the lower extremity, on the bed arteriography in hybrid room may represent clue. Furthermore, other imaging such as duplex or computed tomographic angiography (CTA) may be appropriate even in the setting of presence of hard signs. In case of soft signs of vascular injury, using Doppler to produce ABI and the injured extremity index (IEI) is mandatory. quality of the audible in (wrist, ankle, and foot) may inform about the vascularity[7]
* In complex trauma, arteriography must be obtained in the operating room (OR). In cases of extremity fracture or dislocation, performance of arteriography in the OR may be combined with procedures such as fracture reduction or fixation.

# Definitions

Salvageable limb was defined as the limb with signs of viability (warm, positive distal pulses, >90% oxygen saturation, and intact neurological signs), with repairable soft tissues and skeletal injuries. The inclusion and exclusion criteria were set as:

## Inclusion criteria

* All the patients who presented with vascular injuries of extremities with or without associated orthopedics and soft tissue injuries
* Presentation within 12 h with signs of viabilities
* Patients who presented with salvageable limbs with duration of >12 h from the injury.

## Exclusion criteria

* Associated head injuries or major injuries to abdomen necessitating urgent attention at first
* Nonsalvageable limb (with major tissue loss/mangled limbs)
* Delayed presentation, i.e., after 12 h of injury with no signs of viability.

# Statistical analysis

Statistical analysis was performed by use of the SPSS statistics software program (SPSS Inc., Chicago, IL, USA). The Fisher exact test was used for the univariate risk factor analysis of variables related to amputations; customary caution should be considered when the results of this test are interpreted because of the multiplicity of analysis. Stepwise logistic regression analysis was used to identify independent risk factors for amputations. *P* was assumed to be significant if less than 0.05 *P* < 0.05 was considered statistically significant.

**RESULTS**

* During the period of the study (from January 2014 to January 2015), 135 cases of vascular injury presented to Assiut University Hospital, 87 of them had lower limb

**Table 1: Demographic data**

***n*=87, *n* (%)**

Age (years)

<14 7 (8)

15-29 31 (35.6)

30-44 26 (29.9)

45-59 11 (12.6)

60-74 9 (10.3)

75-89 3 (3.4)

>90 0

Mean±SD (range) 33.67±17.56 (1.5-86.0)

Sex

Male 76 (87.4)

Female 11 (12.6)

SD: Standard deviation

vascular injury representing 64.4%. Among them, 76 were males and 11 were females, ranging from 1.5 to 86 years with a mean age of 33.7 years, 35.6% were between 15 and 29 years. Fifteen patients were hypotensive on presentation and responded well to resuscitation; one of them had a cardiac arrest then responded to resuscitation [Table 1]

* Thirty-six patients were smokers representing 41.4%, 10 suffered from diabetes mellitus representing 11.5%, 8 were hypertensive representing 9.2%, two were cardiac representing 2.3%, and 48 of them had no risk factors representing 55.17% [Table 2]
* Penetrating trauma accounted for a higher proportion of vascular trauma admissions than general trauma admissions representing 61 patients (70.1%), on the other hand, 21 patients suffered from blunt trauma (24.1%) and 5 patients suffered from iatrogenic vascular injury (5.7%). Motor car accidents were the most frequent cause of vascular injuries in 30 patients (34.5%) followed by firearm injuries in 27 patients (31%). Motor car accidents were the predominant cause of blunt vascular injuries. When compared to penetrating vascular injuries, patients with a penetrating mechanism were more severely injured and more frequently shocked [Table 3]
* Among the recruited patients, 82 patients representing 94% had arterial injuries, 44 of whom had concurrent venous injuries (50.6%). Five patients representing 6% had isolated venous injuries. In terms of anatomical distribution, the SFA was the most common injured vessel in 37 patients representing 42.5% followed by the popliteal artery in 30 cases representing 34.5% [Table 4]
* Bone fracture was the most common associated lesion in 52 patients representing 59.7% followed by nerve injury in 26 cases representing 29.8%. Preoperative fixation was done in 37 cases while postoperative fixation was done in 4 cases. Ten cases with bone fracture had primary amputation without fixation while 1 case with fracture fibula was kept conserve [Table 5]
* Fifty-six patients presented with acute ischemia representing 64.4%, 20 patients presented with active bleeding representing 23%, 7 patients presented with picture of arteriovenous fistula and pseudoaneurysm representing 8%, 3 patients presented with increasing hematoma representing 3.4%, and 1 patient presented with uncorrectable shock representing 1.1%.

Seventeen of the patients presented with acute ischemia were acute partial ischemia representing 30.4%, 18 patients presented with acute total ischemia representing 32.1%, 21 patients presented with acute late ischemia representing 37.5% [Table 6]

* Median duration of transportation to hospital was

2.05 h (h) (range 15 min to 44.30 h). Fifty-eight patients presented within 6 h after the injury representing 66.7%, 17 patients presented after 7–12 h representing 19.5%, four patients presented after 13–24 h representing 4.6%,

Mechanism of injury

|  |  |
| --- | --- |
| **Table 2: Risk factors** |  |
| **Risk factors** | ***n*=87, *n* (%)** |
| Smoking | 36 (41.4) |
| DM | 10 (11.5) |
| HTN | 8 (9.2) |
| Cardiac | 2 (2.3) |
| No risk factors | 48 (55.17) |
| DM: Diabetes mellitus, HTN: Hypertension |  |
| **Table 3: Mechanism of injury** |  |
|  | ***n*=87, *n* (%)** |

Penetrating 61 (70.1)

Blunt 21 (24.1)

|  |  |
| --- | --- |
| IatrogenicType of trauma | 5 (5.8) |
| MCAs | 30 (34.5) |
| FAI | 27 (31.0) |
| MBAs | 7 (8.0) |
| Iatrogenic | 5 (5.7) |
| Blunt trauma | 4 (4.6) |
| Stab wound | 3 (3.4) |
| Train accident | 3 (3.4) |
| Animal kick | 2 (2.3) |
| FFH | 2 (2.3) |
| Animal bite | 1 (1.1) |
| Gunshot | 1 (1.1) |
| Heavy object trauma | 1 (1.1) |
| Machine injury | 1 (1.1) |

MCAs: Motor car accidents, FAI: Firearm injury, MBAs: Motor bike accidents, FFH: Fall from height

|  |  |
| --- | --- |
| **Table 4: Injured blood vessels** |  |
| **Injured blood vessel** | ***n* (%)** |
| Arterial | 38 (43.7) |
| Venous | 5 (5.7) |
| Both | 44 (50.6) |
| **Injured blood vessels** | ***n*=87, *n* (%)** |
| Internal iliac artery | 1 (1.1) |
| Common femoral artery | 5 (5.7) |
| SFA | 37 (42.5) |
| Superficial femoral vein | 18 (20.7) |
| Profunda femoris artery | 3 (3.4) |
| Profunda femoris vein | 2 (2.3) |
| Popliteal artery | 30 (34.5) |
| Popliteal vein | 22 (25.3) |
| Leg vessels | 11 (12.6) |
| SFA: Superficial femoral artery |  |

and eight patients presented after more than 1 day representing 9.2% [Table 7]

* Surgical intervention was done in 82 patients representing 94.3%, endovascular intervention was done in 2 patients representing 2.3, 1 patient had endovascular balloon

**Table 5: Associated injuries**

Associated lesion

***n*=87, *n* (%)**

|  |  |
| --- | --- |
| Fracture | 52 (59.8) |
| Nerve injury | 26 (29.9) |
| Abdominal trauma | 4 (4.6) |
| Head trauma | 4 (4.6) |
| Soft tissue injury | 4 (4.6) |
| DVT | 1 (1.1) |
| NoTime of fixation Preoperative | 48 (55.2)37 (71.2) |
| Postoperative | 4 (7.7) |
| Conserve | 1 (1.9) |
| Amputation | 10 (19.2) |
| DVT: Deep venous thrombosis |  |
| **Table 6: Presentation and type of ischemia** |  |
|  | ***n*=87, *n* (%)** |
| PresentationIschemia | 56 (64.4) |
| Active bleeding | 20 (23.0) |
| AVF + pseudoaneurysm | 7 (8.0) |
| Hematoma | 3 (3.4) |
| ShockType of ischemia (*n*=56) | 1 (1.1) |

Nonviable 21 (37.5)

Marginally threatened 17 (30.4)

Immediately threatened 18 (32.1)

AVF: Artriovenous fistula

**Table 7: Time of presentation**

**Time of presentation (h) *n*=87, *n* (%)**

1-6 58 (66.7)

7-12 17 (19.5)

13-24 4 (4.6)

>24 8 (9.2)

control then surgical intervention representing 1.15%, and two patients had conservative management representing 2.3% [Table 8]

Those who had arterial vascular injury were managed as follows, 44 patients had interposition vein graft (IPVG) from great saphenous vein representing 53.7%, 10 patients had primary amputation of the limb representing 12.2%, 6 patients had ligation of the injured artery representing 7.3%, 5 patients had repair of the injured artery representing 6.1%, 5 patients had thrombectomy representing 6.1%, three patients had end-to-end anastomosis representing 3.7%, two patients had angio-embolization of the injured artery, one patient had bypass, one patient had extra-anatomical bypass, one patient had endovascular balloon control then surgical management, one patient had just fasciotomies, and one patient had interposition synthetic graft [Table 9]

* Patients who had venous vascular injury was managed as following: in 31 patients, the injured veins were ligated representing 63.3%; in 5 patients, the injured vein was repaired representing 10.2%, end-to-end anastomosis of the injured vein was done in one patient representing 2%, 8 patients had primary amputation representing 16.3%, 3 patients were treated conservatively, and one patient had fasciotomy [Table 10]

|  |  |
| --- | --- |
| **Table 8: Line of management** |  |
| **Type of management** | ***n*=87, *n* (%)** |
| Surgical | 82 (94.3) |
| Conserve | 2 (2.3) |
| Endovascular | 2 (2.3) |
| Endovascular + surgical | 1 (1.1) |
|  |  |
| **Table 9: Management of arterial injury** |  |
| **Management of arterial injury** | ***n*=82, *n* (%)** |
| IPVG | 44 (53.7) |
| Amputation | 10 (12.2) |
| Ligation | 6 (7.3) |
| Repair | 5 (6.1) |
| Thrombectomy | 5 (6.1) |
| End to end | 3 (3.7) |
| Angio-embolization | 2 (2.4) |
| Bypass | 2 (2.4) |
| Conserve | 2 (2.4) |
| Endo control then IPVG | 1 (1.2) |
| Fasciotomy | 1 (1.2) |
| Synthetic graft | 1 (1.2) |
| No arterial lesion | 5 |
| IPVG: Interposition vein graft |  |
| **Table 10: Management of venous injury** |  |
| **Management of venous injury** | ***n*=49, *n* (%)** |
| Ligation | 31 (63.3) |
| Amputation | 8 (16.3) |
| Repair | 5 (10.2) |
| Conserve | 3 (6.1) |
| End to end | 1 (2) |
| Fasciotomy | 1 (2) |
| No venous lesion | 38 |

Patients who had vein or synthetic grafts were classified according to the length of the graft into patients with graft length 5 cm or less 19 patients representing 40.4% and patients with grafts length more than 5 cm 28 patients representing 59.6%. Fasciotomy was done in 22 patients representing 25.3% of patients with vascular injury [Table 11]

* Forty-three patients of those with arterial vascular injury regained distal pulsation after management representing 52.4%, 27 patients regained distal signals in the injured limb representing 32.9%, ten patients had primary amputation representing 12.2%, and two

**Table 11: Fasciotomy and length of graft**

Fasciotomy

***n*=87, *n* (%)**

**Time of presentation Complications *P***

**Table 14: Relation between time of presentation and presence of complications**

Yes 22 (25.3)

No 65 (74.7)

Length of graft (*n*=47)

5 cm or less 19 (41.4)

>5 cm 28 (59.6)

Mean±SD (range) 7.44±5.12 (4.0-35.0)

SD: Standard deviation

**Table 12: Outcomes**

**Results *n*=87, *n* (%)**

|  |  |
| --- | --- |
| 1ry Amputation | 10 (11.5) |
| Distal pulse | 43 (49.4) |
| Distal Doppler signals | 27 (31.0) |

No signals 2 (2.3)

**Table 13: Presence and type of complications**

***n* (%)**

Complications (*n*=87)

Yes 25 (28.7)

No 62 (71.3)

Type of complications (*n*=25)

Infection 11 (44.0)

Compartment 5 (20.0)

Revasculartion 5 (20.0)

|  |  |  |  |
| --- | --- | --- | --- |
|  | ***n*=25, *n* (%)** | **Percentage** |  |
| 1-6 h | 4 | 16 | 0.019\* |
|  |  | 74,202 |  |
| 7-12 h | 5 | 20 | 0.118 |
|  |  | 14.5 |  |
| 13-24 h | 6 | 24 | 0.692 |
|  |  | 3.2 |  |
| >24 h | 10 | 40 | 0.869 |
|  |  | 8.1 |  |

*P* value is considered significant if <0.05

**Table 15: Relation between length of graft and presence of complications**

**Length of graft (cm) Complications (*n*=25), *n* (%) *P***

1-5 5 (25) 0.022\*

>5 15 (75)

*P* value is considered significant if <0.05

**Table 16: Relation between development of postoperative infection and different variables**

**Postoperative infection *P***

**(*n*=11), *n* (%)**

Diabetic patients 7 (63.6) 0.00000592\*

Patient presented >6 h 7 (63.6) 0.037\*

Thrombosis 4 (16.0)

patients (2.3%) did not regain distal pulsation or Doppler

Patient with associated fracture

Patient without associated fracture

8 (72.7) 0.514

3 (27.3) 0.514

signals postoperatively and were managed medically and improved [Table 12]. In the five patients who had isolated venous injury, the vein was ligated and suffered from edema which was treated by anticoagulation, anti-inflammatory, analgesic, and limb elevation

Among the 82 patients who had lower limb vascular injury, 25 developed postoperative complication representing 28.7%, 11 patients developed wound infection representing 12.6%, 5 patients developed compartment syndrome

representing 5.7%, 5 patients developed revascularization syndrome representing 5.7%, and four patients developed thrombosis of the graft representing 4.6% [Table 13]

* During the study, 14 patients had amputation of the limb with injured vascular injury representing 16.1%, among these 14 patients, 10 had primary amputation representing 11.5% due to extremely mangled limb and late ischemia, the remaining four patients had secondary amputation after revascularization due to wound infection which failed to respond to medical treatment, they represent 4.6%
* The relation between the time of presentation and the presence of complications is illustrated in Table 14. Furthermore, the relation between the length of graft and the presence of complications is demonstrated in Table 15

Patient with vascular graft 9 (81.8) 0.102

Penetrating trauma 10 (90.9) 0.162

Acute late ischemia 7 (63.6) 0.003\*

*P* value is considered significant if <0.05

* The relation between the development of postoperative infection and different variables is demonstrated in Table 16. The rate of infection was higher and statistically significant in diabetics (*P* = 0.000005), in patients presented more than 6 h (*P* = 0.037) and in those with acute late ischemia (*P* = 0.003). The rate of infection was higher but statistically insignificant in patients with associated fractures (*P* = 0.5) and in those with vascular grafts (*P* = 0.102). The relation between the development of postoperative thrombosis and different variables is demonstrated in Table 17. The rate of thrombosis was higher and statistically significant in patients with graft length more than 10 cm (*P* = 0.001). The rate of thrombosis was higher but statistically insignificant in patients with injured SFA (*P* = 0.308), in diabetic patients (*P* = 0.063), patients with associated venous injury (*P* = 0.128), and in patients with vascular grafts (*P* = 0.124)
* The relation between the development of postoperative revascularization syndrome and different variables is

**Postoperative *P***

**Table 17: Relation between development of postoperative thrombosis and different variables**

**thrombosis (*n*=4), *n* (%)**

|  |  |  |  |
| --- | --- | --- | --- |
| Patient with vascular graft | 4 (100) | 0.124 |  |
| Patients with graft length > 10 cm | 3 (75) | 0.001\* | Extremities vascular trauma is considered common in developing |
| Patients with associated venous injuriesPatients who had fasciotomy | 4 (100)2 (50) | 0.1280.568 | countries. Trauma of vascular origin caused by penetratingtrauma causes significant deaths and morbidity in civilian as a warfare injury. The percentage is about 3% of civilian injuries and |

|  |  |  |
| --- | --- | --- |
| Injured SFA | 3 (75) | 0.308 |
| Diabetic patients | 2 (50) | 0.063 |
| Smoking | 3 (75) | 0.302 |

combined mortality of infectious diseases like TB, malaria, HIV. Resources deficiency for management of vascular trauma combined with late transfer to well equipped centers affect the result of such trauma and increase mortality. Infection is also the problem of major health concerns as it preferentially affects youth disproportionately, which have a major impact on social life, and economic burden, especially in the health-care system.[8]

SFA: Superficial femoral artery, *P* value is considered significant if <0.05

**Table 18: Relation between development of postoperative revascularization syndrome and different variables**

**Postoperative *P***

**revascularization syndrome (*n*=5), *n* (%)**

Penetrating trauma 4 (80) 1.000

Age between 45 and 59 4 (80) 0.001\*

Number of males 5 (100) 0.618

Presentation as ischemia 5 (100) 0.156

Presentation as acute late ischemia 4 (80) 0.011\* Injured SFA 4 (80) 0.159

Associated fracture 5 (80) 0.079

Patient presented within >6 h 5 (100) 0.003\*

Patients with no venous injury 4 (80) 0.163

Preoperative fixation 5 (100) 0.012\* SFA: Superficial femoral artery, *P* value is considered significant if <0.05

demonstrated in Table 18. The rate of revascularization syndrome was higher and statistically significant in age group 45–59 years (*P* = 0.001), in patients presented more than 6 h (*P* = 0.003), patients who had preoperative fixation of their fractures (*P* = 0.012) and in those with acute late ischemia (*P* = 0.011). The rate of revascularization syndrome was higher but statistically insignificant in patients with associated fractures (*P* = 0.079), male patients (*P* = 0.618), patients presented with ischemia (*P* = 0.156), patients with injured SFA, and in those with penetrating trauma (*P* = 1.000)

* With multivariate analysis, preoperative, intraoperative, and postoperative variables were entered. Factors were identified as independently associated with increased risk of amputations. These were the presence of tense compartment at presentation, the presence of limb neurologic deficit at presentation (late presentation), association of lower limb arterial injury with compound fractures, arterial transection on exploration, and occluded graft.

**DISCUSSION**

The worldwide mortality rate is estimated to be n 5.8 million patients in a year or 10% all-cause mortality more than the

around 7% of combat-associated trauma. In third world sectors, it is caused by RTAs, crimes, some accidental accident.[9] Poor resources to treat this type of vascular trauma like our locality, coupled with late transfer to equipped tertiary care centres, such deficiencies affect most of third world and the developing countries, even those without military conflicts. In ours and other conclusion, the rate of vascular trauma is increasing.[10,11]

Vascular extremity trauma accounts for 80% of all vascular trauma. These traumata presented either by hemorrhage which sometimes may be fatal or ischemia that may affect limb viability. Most our victims were males at the youth age and this is consistent with other studies.[6,9-11]

In our study, penetrating trauma accounts for 70% of all victims while blunt trauma accounts for 24%, only 5.7% of patient iatrogenic injuries were recorded. The most common cause for vascular injury in our result was RTA 34.5%. The etiology of vascular trauma varies among various communities and different socioeconomic strata. In contrast to the result of multiple studies which reported that stabbing is the most common etiology in vascular trauma.[10,12,13]

The main reasons for why these are the most common etiology in our region are the unpaved roads, the use of firearm in many events such as weddings, national victories that cause many accidental events, and the conflict which occurs between families. Motor car accidents have been reported to be the most common cause of vascular injury of lower limbs in Iran.[14]

Fifty-eight patients presented within 6 h after the injury representing 66.7%, 4 patients presented after 13–24 h representing 4.6%, and 8 patients presented after more than 1 day representing 9.2% in our study. The latency of referral of the patient and time lag between the trauma and resuming of the blood flow to the traumatized extremity is a critical issue in success of the operation and limit the complication after the intervention.[15]

Regarding distribution by anatomical region, the femoral artery was the most common affected artery or veins in 37 patients representing 42.5% followed by the popliteal artery in 30 cases representing 34.5%. In different trials, especially those studying war vascular trauma and RTAs, most of the trauma affect femoral artery, second most affected vessel was popliteal followed by brachial arteries.[16-18] However, other

study performed in Turkey, the brachial vessel the most affected vessel by traumatic injury.[19]

The degree of ischemia of the limb relays on complex interconnected factors not only the ischemia time and its duration but also on the level of trauma the more proximal deficient collaterals ischemia like popliteal artery, the more imminent the ischemia, the condition of the surrounding soft tissue so, the more the damage the more prominent ischemia, and the condition of collateral supply distal to the injury. This can explain the heterogeneity in our result as regard to the duration of ischemia.[20]

Most of our patients diagnosed clinically by physical examination, Doppler used as bedside examination. Ten patients had CTA representing 11.5%, 5 patients had duplex ultrasound representing 5.7%, and one patient had preoperative arteriography representing 1.15%. In majority of cases of different studies, meticulous vascular examination was the most common method of diagnosis of vascular trauma.[21]

Surgical intervention was done in 82 patients representing 94.3%, endovascular using balloon control then surgical exploration used in on patient. The role of endovascular treatment in the management of lower extremity patient is limited compared by open surgery. Minimally invasive line by using endovascular route at arterial injuries in hemodynamically stable patients can be bused with agood results as comparable to open surgery in areas that are hard to operated and patient that cannot withstand the surgical trauma also may be used as adjunctive to open surgery in cases anticipated to have major blood loss.[22]

Those who had arterial vascular injury was managed as follows, 44 patients had IPVG from great saphenous vein representing 53.7%, 10 patients had primary amputation of the limb representing 12.2% in contrary to Sah *et al*. who reported that the most common used modality for treatment of low extremity injury was end-to-end repair.[23] Our results are consistent with Fry *et al*. who reported that IPVG was used as most common modality for treatment in 25% of cases followed by patch angioplasty in 20%.[24]

Trauma with vascular injury can be with miserable sequel with anticipated grave complications especially those who presented with delayed ischemia and when trauma was accompanied by complicated soft tissue injury and deteriorated soft tissue coverage and complex bone fracture.

The number of patients who had associated injuries beside vascular injuries in our study was 59 representing 67.8% which was much higher than what reported by Razmadze[25] (41.4%). Associated bone fractures were seen in 52 patients representing 59.8%. Guerrero recorded similar results.[26]

One patient had an interposition synthetic graft polytetrafluoroethylene (PTFE) 1.2%. PTFE in generally was demanded in cases of large vessels such as femoral artery. Reversed saphenous graft has proved to have better patency

rate and more resistance against infection when compared with synthetic grafts.[27] Patients with grafts length more than 5 cm representing 59.6%. Fasciotomy was done in 22 patients representing 25.3%.

In our study, 25 patients developed postoperative complications representing 28.7%. A similar figure has been documented by other authors.[9,28,29] 10 patients had primary amputation representing 12.2% and two patients (2.3%) did not regain distal pulsation or Doppler signals postoperatively and were managed medically and improved. Complications were classified as infection, compartment syndrome, revascularization syndrome, thrombosis, and eventually amputation as secondary amputation. The most common complication was infection occurring in about 44% of patient, 12.2% during the study, 14 patients had amputation of the limb with injured vascular injury representing 16.1%, among these 14 patients, 10 had primary amputation representing 11.5% due to extremely mangled limb and late ischemia, the remaining four patients had secondary amputation after revascularization due to wound infection which failed to respond to medical treatment they represent 4.6%. Peck *et al*. reported that 2ry amputation occurred in 3% while death occurred in 1.5% in patients operated from vascular trauma in Iraqi freedom.[30] Furthermore, other reported that amputation rates are 20%.[31]

There is known consensus that the time of cold ischemia >6 h is accompanied by high rate of complication and secondary amputation rate.[25,32] The primary cause of 2ry amputation was infection and dead muscles with extensive tissue damage as reported by Singh *et al*.[33] in our study. The rate of infection was higher and statistically significant in diabetics (*P* = 0.000005), in patients presented more than 6 h (*P* = 0.037) and in those with acute late ischemia (*P* = 0.003). Furthermore, the rate of secondary amputation was higher and statistically significant in diabetics (*P* = 0.0004), in those with acute late ischemia (*P* = 0.011), patients with associated nerve injury (*P* = 0.026) and in those who developed postoperative infection (*P* = 0.001). The rate of secondary amputation was higher but statistically insignificant in smokers (*P* = 0.155), patients with associated fractures (*P* = 0.409), patients with combined arterial and venous injury (*P* = 1.000), patients presented with ischemia (*P* = 0.65), patients who had preoperative fixation of their fractures (*P* = 0.15), and in those with penetrating trauma (*P* = 1.000). Another study reported that the magnitude of soft tissue injury is the controlling factor in the success of revascularization or progress to secondary amputation.[34]

Late vascular intervention associated long ischemic time muscle supplies the bacteria by optimal condition for its replication and bacterial growth and eventually overt frank infection.[35]

In conclusion, most trauma affecting vascular territories in the lower extremities in our center were seen in young men, frequently caused by MCA, followed by FAI. SFA and popliteal artery were the most affected vessels by these injuries. Early vascular repair in the 1st h after injury may prevent many complications and reduce the secondary amputation rate.

**CONCLUSIONS**

Vascular trauma is prevalent health problem in our locality, which have huge socioeconomic impact in our community as it affects mainly young men. Main etiology of this type of trauma in our locality is RTA due to weak infrastructure in our locality. The main controlling factor in secondary amputation rate is ischemia time, infection which accompanies severe soft tissue damage. At the end trauma with vascular injury is considered, a complex process needs urgent intervention with multidisciplinary team in well-equipped facility.

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# Conflicts of interest

There are no conflicts of interest.

**REFERENCES**

1. Moini M, Takyar MA, Rasouli MR. Revascularisation later than 24h after popliteal artery trauma: Is it worthwhile? Injury 2007;38:1098-101.
2. Huynh TT, Pham M, Griffin LW, Villa MA, Przybyla JA, Torres RH, *et al.* Management of distal femoral and popliteal arterial injuries: An update. Am J Surg 2006;192:773-8.
3. Martin LC, McKenney MG, Sosa JL, Ginzburg E, Puente I, Sleeman D, *et al.* Management of lower extremity arterial trauma. J Trauma 1994;37:591-8.
4. Alexander JJ, Piotrowski JJ, Graham D, Franceschi D, King T. Outcome of complex vascular and orthopedic injuries of the lower extremity. Am J Surg 1991;162:111-6.
5. Andrikopoulos V, Antoniou I, Panoussis P. Arterial injuries associated with lower-extremity fractures. Cardiovasc Surg 1995;3:15-8.
6. Magee TR, Collin J, Hands LJ, Gray DW, Roake J. A ten year audit of surgery for vascular trauma in a British teaching hospital. Eur J Vasc Endovasc Surg 1996;12:424-7.
7. Ordog GJ, Wasserberger J, Ackroyd G. Hospital costs of firearm injuries. J Trauma 1995;38:291-8.
8. Feliciano DV, Herskowitz K, O’Gorman RB, Cruse PA, Brandt ML, Burch JM, *et al.* Management of vascular injuries in the lower extremities. J Trauma 1988;28:319-28.
9. Al-Salman MM, Al-Khawashki H, Sindigki A, Rabee H, Al-Saif A, Al-Salman Fachartz F. Vascular injuries associated with limb fractures. Injury 1997;28:103-7.
10. Caps MT. The epidemiology of vascular trauma. Semin Vasc Surg 1998;11:227-31.
11. Razmadze A. Vascular injuries of the limbs: A fifteen-year Georgian experience. Eur J Vasc Endovasc Surg 1999;18:235-9.
12. Bhargava JS, Kumar R, Singh RB, Makkar A. Civilian vascular trauma: An experience of 54 cases. J Indian Med Assoc 1996;94:47-9.
13. Menakuru SR, Behera A, Jindal R, Kaman L, Doley R, Venkatesan R. Extremity vascular trauma in civilian population: A seven-year review from North India. Injury 2005;36:400-6.
14. Rasouli MR, Moini M, Khaji A, Heidari P, Anvari A. Traumatic vascular injuries of the lower extremity: Report of the Iranian National Trauma Project. Ulus Travma Acil Cerrahi Derg 2010;16:308-12.
15. Humphrey PW, Nichols WK, Silver D. Rural vascular trauma: A twenty-year review. Ann Vasc Surg 1994;8:179-85.
16. Hafez HM, Woolgar J, Robbs JV. Lower extremity arterial injury: Results of 550 cases and review of risk factors associated with limb loss. J Vasc Surg 2001;33:1212-9.
17. Asfar S, Al-Ali J, Safar H, Al-Bader M, Farid E, Ali A, *et al.* 155 vascular injuries: A retrospective study in Kuwait, 1992-2000. Eur J Surg 2002;168:626-30.
18. Reichle FA, Golsorkhi M. Diagnosis and management of penetrating arterial and venous injuries in the extremities. Am J Surg 1980;140:365-7.
19. Yilmaz AT, Arslan M, Demirkiliç U, Ozal E, Kuralay E, Tatar H, *et al.*

Missed arterial injuries in military patients. Am J Surg 1997;173:110-4.

1. Barros D’Sa AA. Complex vascular and orthopaedic limb injuries. J Bone Joint Surg Br 1992;74:176-8.
2. Anderson RJ, Hobson RW 2nd, Lee BC, Manno J, Swan KG, Padberg FT Jr., *et al.* Reduced dependency on arteriography for penetrating extremity trauma: Influence of wound location and noninvasive vascular studies. J Trauma 1990;30:1059-63.
3. Peck JJ, Eastman AB, Bergan JJ, Sedwitz MM, Hoyt DB, McReynolds DG. Popliteal vascular trauma. A community experience. Arch Surg 1990;125:1339-43.
4. Ashworth EM, Dalsing MC, Glover JL, Reilly MK. Lower extremity vascular trauma: A comprehensive, aggressive approach. J Trauma 1988;28:329-36.
5. Fry WR, Smith RS, Sayers DV, Henderson VJ, Morabito DJ, Tsoi EK, *et al.* The success of duplex ultrasonographic scanning in diagnosis of extremity vascular proximity trauma. Arch Surg 1993;128:1368-72.
6. Razmadze A. Vascular injuries of the limbs: a fifteen-year Georgian experience. Eur J Vasc Endovasc Surg 1999;18:235-9.
7. Peck MA, Rasmussen TE. Management of blunt peripheral arterial injury. Perspect Vasc Surg Endovasc Ther 2006;18:159-73.
8. Mills WJ, Barei DP, McNair P. The value of the ankle-brachial index for diagnosing arterial injury after knee dislocation: A prospective study. J Trauma 2004;56:1261-5.
9. Guerrero A, Gibson K, Kralovich KA, Pipinos I, Agnostopolous P, Carter Y, *et al*. Limb loss following lower extremity arterial trauma: What can be done proactively. Injury 2002;33:765-9.
10. Fowler J, Maclntyre N, Rehman S, Gaughan JP. Leslie S. The impostance of surgical sequence in the treatment of lower extremity injuries with concomitant vascular injury: A meta-analysis. Injury 2009;40:72-6.
11. Peck, Michael A. The complete management of extremity vascular injury in a local population: a wartime report from the 332nd Expeditionary Medical Group/Air Force Theater Hospital, Balad Air Base, Iraq. J Vasc Surg 2007;45:1197-205.
12. Karavias D, Korovessis P, Filos KS, Siamplis D, Petrocheilos J, Androulakis J. Major vascular lesions associated with orthopaedic injuries. J Orthop Trauma 1992;6:180-5.
13. Moniz MP, Ombrellaro MP, Stevens SL, Freeman MB, Diamond DL, Goldman MH. Concomitant orthopedic and vascular injuries as predictors for limb loss in blunt lower extremity trauma. Am Surg 1997;63:24-8.
14. Singh D. Management Of Peripheral Vascular Trauma: Our Experience. Int J Surg 2004;7.
15. Menakuru SR, Behera A, Jindal R, Kaman L, Doley R, Venkatesan R. Extremity vascular trauma in civilian population: A seven year review from North India. Injury 2005;36:400-6.
16. Franz RW, Shah KJ, Halaharvi D, Franz ET, Hartman JF, Wright ML. A 5-year review of management of lower extremity arterial injuries at an urban level I trauma center. J Vasc Surg 2011;53:1604-10.