ORIGINAL ARTICLE

MANAGEMENT OF EXTREMITY VASCULAR INJURIES IN UPPER EGYPT DURING THE EGYPTIAN REVOLUTION

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Abstract

Aim of work: To evaluate the pattern of clinical presentation, diagnosis and management outcome of different techniques of extremity vascular repair.

Materials and Methods: This prospective study was conducted at Sohag University Hospitals from February 2011 to July 2013 and involved 162 patients with extremity vascular injuries who underwent various surgical interventions. Patients were evaluated for the mechanism of trauma, site and type of injury, associated injuries, methods of vascular repair and their outcomes.

Results: Firearm injury and stab penetrating injuries were the most common causes (45.7%, 28.4%) respectively. Lower extremities were affected more commonly (53.75%) and superficial femoral artery (SFA) was the most common injured one (37.65%). Combined arterial and venous injuries were present in 50 patients (30.9%). Forty-eight patients (29.6%) had associated fractures. Interposition autogenous reversed saphenous vein graft was the most common method of repair (74.7%). Synthetic graft was used only in 6 patients (3.7%). Wound infection was the commonest complication (17.3%). 14 patients (9.25 %) had secondary amputation and 11 patients (6.8%) died due to associated head, chest and / or abdominal injuries. Vascular reconstruction was successful in 136 cases (84%).

Conclusion: Early detection and proper management of vascular injuries save the vast majority of limbs with vascular injuries.

Keywords: Extremities, vascular injuries, management, Egyptian revolution.

INTRODUCTION

The Egyptian Revolution of 2011 was part of the Arab Spring that took place after the Tunisian revolution following a popular uprising that began on 25 January 2011.[1] Vascular injuries occur mainly in young male population all over the world[2] and they comprise 2-3% of all cases of trauma.[3] Extremity arterial injuries account for 50% of all arterial traumas caused by penetrating injuries in 64 %-82 %.[4] Vascular injuries in the extremities can result in limb disability, limb loss, and even death. These unfortunate outcomes resulted from delayed recognition or inappropriate assessment of the injured limb.[5] Although penetrating arterial injuries are usually diagnosed immediately, diagnosis of blunt vascular injuries may be delayed.[6] It may be explained by the relatively asymptomatic patients or the presence

of additional life threatening injuries that take priority in the resuscitation process. So, prompt assessment and treatment are mandatory to avoid unpleasant results for the patient's limb and life.[7] With improvement in vascular repair techniques, early referral of patients to experienced health care hospitals concerning with vascular surgery, limb salvage reaches to more than 90% and amputation rate has gone down to less than 10%.[8,9]

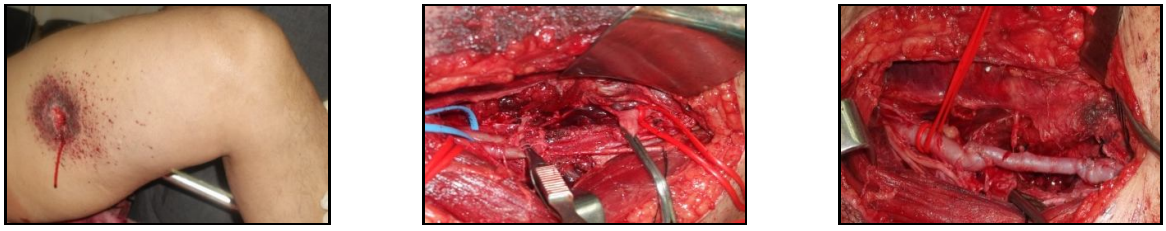
The aim of this study was to find out the pattern of vascular injuries and to detect the outcome of different techniques of vascular repair and related complications.

MATERIAL AND METHODS

This prospective study was carried out from February 2011 to June 2012 on 162 patients (149 males, 13 females) with a mean age of 28.4 years (range from 13 - 45 years) in Sohag University Hospitals. All patients with vascular trauma involving upper or lower extremity were included in the study. Patients with late vascular injuries or those with Mangled Extremity Severity Score (MESS) ≥ 7 points were excluded from the study.

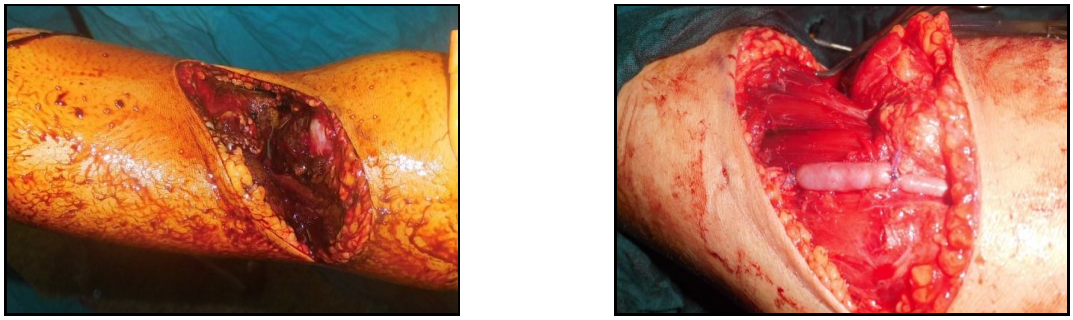
All patients were assessed by the surgeon on duty in trauma unit and then by vascular surgeon. Patients were resuscitated according to the guidelines of Advanced Trauma Life Support protocol. Patients were reassessed clinically after resuscitation with special concern to time interval between the occurrence of injury and arrival to hospital, mechanism of injury (penetrating, blunt or road traffic accidents), associated injuries and applying the MESS as a standard protocol for deciding on primary amputation for severe limb injuries and excluded those with score of ≥7 points. Clinical examination included hard and soft signs of vascular injuries, hand held doppler and pulse oximetry of the affected limbs. Duplex ultrasound was done in all cases. CT angiography was done in 21 patients (13%) only. Complete blood picture, blood grouping with cross-matched blood and x-rays of the affected region were advised before transfer to the operative theatre. Broad spectrum antibiotics was started before surgery and continued postoperatively. All patients were operated under general anaesthesia, spinal anaesthesia or epidural block. Both lower limbs in case of lower extremity injury or injured upper limb and one lower limb in case of upper extremity injury were sterilized and draped. All injuries were explored through a longitudinal incision extending both proximally and distally. Proximal and distal control was achieved first before exploring the injury site. Extension and type of vascular injury were assessed and method of repair was decided. Associated venous injury if present was assessed and planned for its treatment. In need for autogenous saphenous vein graft, it was prepared from the contralateral limb. Associated injuries; nerves, muscles and tendons were assessed. Debridement of surrounding non-viable soft tissue was done and the injured nerves were marked with polypropylene suture before repair of the vascular injury. Associated fractures were fixed by orthopedic surgeon. Both proximal and distal ends of the injured vessels were cleared from any residual thrombus with Fogarty catheter and flushed with heparinized saline. Method of repair depended upon the extent and type of injury. Reversed autogenous saphenous vein graft was the commonest type of repair performed in this study. Repaired vessels were irrigated with saline and covered with muscles and soft tissue after placing of suction drain. Prophylactic fasciotomy were performed in 46 patients (28.4%), when ischemia time exceeded more than 6-8 hours, patients had combined arterial and venous injury or those with extensive musculoskeletal injuries. If conditions allowed, intraoperative heparin (5000 IU) was administered followed postoperatively by daily subcutaneous low molecular weight heparin (LMWH) (40 mg) to prevent thromboembolic event followed by oral warfarin therapy.

Immediately in the post-operative period, patency of repaired vessel was assessed by regaining intact distal pulses, hand-held doppler and capillary refill in cases of inability to feel pulse. Post-operatively all patients were followed up and monitored for manifestations of complications e.g. wound infection, compartment syndrome and secondary hemorrhage. Patients were discharged after satisfactory wound healing and advised to follow-up in vascular outpatient clinic.



A B C

Fig 1. (a) Shows firearm injury in left thigh, (b) shows complete cut of superficial femoral artery (SFA) with segment loss, (c) shows repair with reversed interposition vein graft.



A B

Fig 2. (a) Shows cut wound injury in right upper limb following road traffic accident, (b) shows repair of brachial artery with vein graft.

A B

Fig 3. (a) Shows multiple stab wound injury in right forearm, (b) shows primary repair of both radial and ulnar artery.

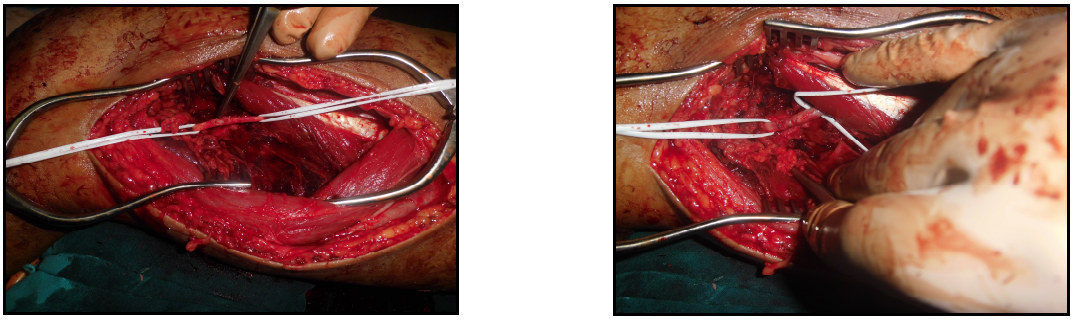


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Fig 4. (a) Shows incomplete cut of lower SFA following firearm injury in right thigh, (b) shows repair with venous patch.

RESULTS

Firearm injuries and stab wound penetrating trauma were the most common causes of injury (45.7%) and (28.4%) respectively followed by blunt trauma (17.3%). (Table 1) Time interval between occurrence of injury and presentation in our hospital ranged from 4 - 12 hours. Lower limb was more commonly affected (53.75%) and superficial femoral artery (SFA) was the most frequently involved artery (37.65%). (Table 2) 50 patients (30.9%) had Combined arterial and venous injury. Incomplete transection was the commonest type of vascular injury (54.94%) (Table 3). Interposition reversed autogenous saphenous vein graft was the most common type of repair (74.7%) (Table 4). Fasciotomy was performed in 46 patients (28.4 %). Wound infection was the most common complication (17.3%) (Table 5). 11 patients (6.8%) developed secondary hemorrhage due to anastomotic blow-out that were treated by reexploration of the site of repair, control of bleeding but rebleeding occurred few days later and ended by ligation of vessels as life-saving measure that followed later by limb amputation. Graft thrombosis occurred in 8 cases (4.9%) who underwent reexploration. Thrombectomy was performed while re-thrombosis occurred in 3 patients who finally ended by limb amputation. 11 patients (6.8%) died due to associated other major injuries in head, chest or abdomen.

Table 1. Mechanism of vessel injury.

	No. (%)
Firearm injury	74 (45.7%)
Stab penetrating injury	46 (28.4%)
Blunt trauma	28 (17.3%)
Road traffic accident	14 (8.6%)

Table 2. Type of injured vessel.

	No. (%)
Superficial femoral artery (SFA)	61 (37.65%)
Popliteal artery	12 (7.4%)
Common femoral artery	5 (3.1%)
Anterior tibial artery	3 (1.85%)
Posterior tibial artery	2 (1.25%)
Brachial artery	37 (22.8%)
Axillary artery	12 (7.4%)
Subclavian artery	6 (3.7%)
Radial artery	13 (8%)
Ulnar artery	3 (1.85%)
Venous injuries	8 (4.9%)

Table 3. Type of vascular injury.

	No. (%)
Complete transection	41 (25.3%)
Incomplete transection	89 (54.94%)
Thrombosed vessel	18 (11.1%)
Contusion and spasm	14 (8.64%)

Table 4. Technique of vascular management.

	No. (%)
Saphenous vein graft	121 (74.7%)
Primary repair	3 (1.9%)
End-to-end anastmosis	11 (6.8%)
Venous patch repair	13 (8%)
Synthetic graft	6 (3.7%)
ligation	5 (3.08%)

Table 5. Complications.

	No. (%)
Wound infection	28 (17.3%)
Limb edema	21 (13%)
Secondary hemorrhage	11 (6.8%)
Graft thrombosis	8 (4.9%)
Amputation	14 (9.25%)
Death	11 (6.8%)

DISCUSSION

Increasing terrorist activities and operations against terrorism led to increase in the incidence of vascular injuries. Majority of our patients were victims of penetrating injury and were young adult males as reported in other series worldwide.[9,10]

Although the number of patients in this study was relatively small, it was noted that other studies were also similar in number of patients such as Yavuz et al,[3] who performed his study on 158 patients. However other series were smaller than this study such as Siddique and Ahsin,[11] Rozycki et al,[7] and Jawas et al,[12] who studied 54, 62 and 36 patients respectively.

Firearm injury and stab penetrating injury were the most

common mechanisms and occurred in (45.7%, 28.4%) respectively. This might be attributed with increased frequency of terror attacks and violence during fighting the terrorism. Similar results were obtained by other studies.[13-15] Blunt trauma occurred in (17.3%) in this study while Cargile et al, recorded (12%) percentage of blunt trauma. Conversely, in developed countries, such as the Northern European countries, Oller et al,[16] had reported that blunt trauma was the most common reason for vascular injuries.

We applied the Mangled Extremity Severity Score (MESS) during patient assessment. It allocates points to 4 parameters of the injury named degree of skeletal or soft-tissue injury, limb ischemia, the degree of shock and patient age.[17] Also, Yavuz et al,[3] had reported in his study that the rate of poor outcomes was significantly higher in patients with higher MESS scores (>4) compared to those with lower MESS scores ($p < 0.001$). Starnes et al, had published on his series regarding injuries on the battlefield that saving a life comes before saving a limb in decision making of vascular injuries and the decision for limb amputation is more difficult than it seems. So sometimes, early amputation is the best solution for saving life.[18]

Superficial femoral artery was the commonest arterial injury in this study and accounted for (37.65%). Makins et al,[19] had reported on a British review during World War I that the incidence of femoral artery injuries was (31%). De Bakey and Simeone[20] had reported less percentage of femoral artery injuries during World War II which was (21%). Also Weaver et al,[21] recorded (35.1%) according to the data based on the Vietnam War. On the contrary, Yavuz et al,[3] and Feliciano et al,[14] had reported that femoral artery injuries occurred more frequently and accounted for (70%) and (65%) respectively of all the peripheral vascular injuries. Presence of hard signs of vascular injury (pulsatile bleeding or increasing hematoma, presence of thrill or bruit and distal ischemia) is the indication of immediate exploration without any diagnostic investigation.[22]

Feliciano et al,[14] and Cargile et al,[13] had reported higher percentages of preoperative angiography (63% and 45%) respectively because the majority of patients were admitted with soft signs e.g. significant hemorrhage by history, diminished pulse compared to contralateral extremity. On the contrary, Asensio et al,[15] used angiography in (15%) only. In this study, preoperative CT angiography was done in 21patients (13%) only as it was not available during the whole day and diagnosis was dependant mainly on physical examination, hand held doppler and duplex ultrasonography in assessment of most of vascular injuries and this was approved by Meissner et al,[23] who recommended combination of physical examination, doppler and duplex ultrasonography examinations as optimum screening methods for assessment of vascular injury. On the other hands, Peng et al,.[24] had reported that CT angiography could replace conventional arteriography in assessing extremity vascular trauma in stable patients with equivocal clinical finding.

Time interval between the onset of injury and intervention ranged from 4 -12 hours. Sfeir et al,[25] had reported that time interval had a significant effect on the outcome of limb salvage and complications. However Hafez et al,[26] had argued that there was no correlation between arrival time after trauma and the treatment outcome. Also, he reported that the severity of tissue ischemia depended on many factors rather than time interval alone e.g. state of the arterial injury, efficiency of collateral circulation and extent of tissue damage.

Technique of vascular injury repair depends upon the mechanism of injury, type and extent of injury and associated injuries. Reversed autogenous vein graft was the commonest method used for vascular repair in this study. Saphenous vein graft is the best choice because it has a high rate of long-term patency and less incidence of infection.[15] It was noted that other series were also similar in their use of the same graft.[27-30] However end-to-end anastomosis was the preferred method in cases without segmental loss of the blood vessel.[3]

Polytetrafluoroethylene (PTFE) graft could be used when the autogenous vein graft was not appropriate, but it was known by its poor patency and increased incidence of infection than the native one.[26,29,31,32] In this study, PTFE was used in 3.7% of cases. Similar series reported nearly equal results such as Yavuz et al, Asensio et al, and Cargile et al,.[3,13,15]

Ligation of arterial injuries was a good option only in selected vessels e.g. radial, ulnar and tibial arteries in unstable patients and in polytraumatized patients with poor general conditions. In this study, ligation occurred in 5 arterial patients (3.08%), Three ulnar arteries and two posterior tibial arteries. ligation did not induce ischemia in involved limbs. Franz et al, agreed with this series who performed arterial ligations primarily in tibial vessels.[33]

Management of venous injury is controversial and challenging. Surgeon must consider whether to ligate or reconstruct the injured vein. Several factors must be considered in taking the decision; general condition of the patient, associated injuries and their treatment protocol and the complexity of venous reconstruction. Venous reconstruction has multiple advantages e.g. a return pathway is kept opened so enhances improving limb salvage especially in the presence of combined arterial and venous injuries or in cases of single venous return conduit such as the popliteal vein. It is also reasonable that open return venous conduit prevents acute venous hypertension and chronic venous insufficiency subsequently.[34] The merits of ligation rather than reconstruction of venous injury claim that a considerable percentage (30%–70%) of venous

reconstructions will thrombose within a week postoperatively.[35] and this is confirmed by the high incidence (approximately 60%) of DVT after major trauma.[36] Timberlake GA and Kerstein[37] also had reported that no extremity was lost after ligation of injured veins and the permanent sequelae of venous hypertension is quite rare. In this series, six venous injuries were ligated; one cephalic vein, two basilic veins, three superficial femoral veins while the remaining two veins (superficial femoral veins) was repaired primarily. DVT occurred in one of them causing limb edema.

Surgical treatment of combined vascular and orthopedic injuries is one of the most difficult problems in management of traumatized patients. The duration of ischemia is critical to the outcome so arterial repair should be performed first to restore circulation to the limb before the orthopedic stabilization is addressed. Sometimes, massive musculoskeletal trauma makes the limb unstable that external fixation must be placed before the vascular procedure.[38] In such cases, intraluminal shunts and rapid installation of external fixator minimize limb ischemia, thus allowing an unhurried orthopedic and vascular repair.[39]

Fasciotomies have been considered a useful adjunct to the repair of vascular injuries especially with prolonged ischemia time and associated injuries to prevent compartment syndrome.[40] Also, Field et al,[41] confirmed that prophylactic fasciotomy reduced the risk of limb loss in patients with prolonged ischemia time longer than 6 hours or those who had combined arterial and venous injury. On the contrary, Kluger et al,[42] and Yavuz et al,[3] had limited fasciotomy to the necessary cases only following vascular repair.

Wound infection was the most common complication. We believe that the incidence of wound infection can be decreased by performing adequate debridement of unhealthy and non-viable tissues, frequent irrigation of the wound by saline, starting antibiotics preoperatively and continued postoperatively, adequate hemostasis minimize hematoma formation and subsequent wound infection. Once occurred, early drainage and debridement was done, swab from contents for culture and sensitivity, frequent dressing till the wound became clean to be closed later. Hood et al,[43] had reported that unexplained fever and leukocytosis are assumed to be due to deep tissue infection until proved otherwise so re-exploration of the wound and debridement of necrotic tissue or hematoma evacuation are essential for minimizing septic sequelae, secondary hemorrhage and subsequent amputation rate. In this study, wound infections occurred in (17.3%) of cases. Similar series reported nearly equal results such as Yavuz et al,[3] who recorded (11%) incidence ,Muhammad et al,[44] who noticed that wound infection occurred in (18.2%).

In this study 11 patients (6.8%) died during the hospital stay while 14 limbs (9.25%) were amputated. Most of cases died due to associated head, chest and/or abdominal trauma. All of amputations in this study were due to secondary hemorrhage in 11 patients and thrombosed graft with failed thrombectomy in 3 patients. Yavuz et al,[3] and Jawas et al,[12] had reported (5.7%, 14%) death rate respectively. Also, Yavuz et al,.[3] had reported (5.1%) amputation rate while Jawas et al,[12] reported (14.3%) amputation rate.

Conclusion: Early detection and proper management of vascular injuries save the vast majority of limbs with vascular injuries.

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