Incidence of Injuries to Major Blood Vessels in the Lower Limb

Mohammad A Abd-alla** *(M.Sc.),* * Saad A Mohammad** *(M.Sc. , D.F.M)*

Abstract

Background: Blood vessels injury is one of the most common causes of medical emergencies that admitted to hospitals and at the same time it regarded as one of the most important causes of death. They may represent less than 15% of all injuries; they deserve special attention because of their severe complications.

Objective: The aim of the present study is to assess anatomically the injures of major arteries and veins in the lower limb with their management.

Methods: The present study extended from April 2006 to February 2007, in which 65 patients with lower limb vascular injury were examined in Emergency Department and Forensic Medicine Department of Tikrit Teaching Hospital in Salah-Aldin governorate. Diagnosis was made by clinical diagnosis alone, or in combination with angiography. Some surgical interferences as vascular repair was carried out, but if not possible the interposition graft was used by great saphenous vein for vascular reconstruction.

Results: The total cases were 65 patients (49 males and 16 females), ranging from 16 years to 67 years with a mean age of 41.5±6.4 years. Penetrating trauma was the main cause of injury for 52 patients. Seventeen cases had bilateral limbs vascular injuries. Arterial injuries were most common in the femoral arteries, followed by the tibial and finally the popliteal arteries. Vascular repair were performed in 16 cases, while in 11 cases great saphenous vein interposition graft were done. There were 17 cases associated with venous injury, of which 11 cases had surgical vascular repair, and 6 had vein graft interposition. There were concomitant femur fractures in 2 cases, fibula fractured in 3, tibia fractured in 1 and the foot bones fractured in 3.

Conclusion: Lower limb vascular injured patient should be transferred to vascular surgery centers as soon as possible. After first aid management, anticoagulant treatment may be started post operatively to prevent the propagation of the thrombosis. Early fasciotomy is done if there is any suspicion of occurrence of compartment syndrome.

Key words: lower limb, vascular injuries, vascular repair.

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Introduction

There are several types of vascular injuries that including: intimal contusion, intimal disruption, puncture, arteriovenous fistula and transection [(1).] To do a successful management for patients with multiple vascular injuries there are two goals: the first is to treat the life-threatening problems by fluid resuscitation, controlling the bleeding and ensuring adequate oxygenation; the second is to repair the injured vessel and save the limb [(2).] New methods of vascular surgery, fracture fixation, and soft tissue reconstruction have improved dramatically the potential for limb salvage [(3).] Although the incidences of vascular injuries represent less than 15% of all injuries, they deserve special attention because of their severe complications [(4).]

Methods

The present study extended from April 2006 to February 2007, in which 65 patients with lower limb vascular injury were examined in Emergency Department and Forensic Medicine Department of Tikrit Teaching Hospital in Salah-Aldin governorate.

Diagnosis was made by clinical diagnosis alone, or in combination with angiography. Bleeding from the injured lower extremity arteries was sufficiently controlled in most patients by direct external pressure. In cases with combined orthopedic and vascular injuries, the vascular injury was repaired prior to bony fixation; systemic heparinization was employed in the absence of massive soft tissue and muscle destruction to arrest thrombus formation in the small distal vessels. Fogarty catheters were passed distally to remove any thrombus and a diluted heparin solution was done routinely to flush distal arterial bed.

All patients were received a preoperative prophylactic antibiotic course of first generation cephalosporin. Different surgical procedures as end-to-end anastomosis (ETEA) were carried out as primary vascular repair; and interposition graft by great saphenous vein for the vascular reconstruction. Associated venous injuries were repaired whenever possible in an attempt to prevent postoperative venous hypertension and to minimize development of compartment syndrome. More severe soft tissue and muscle injuries occurred with blunt trauma, gunshot wounds and explosive materials that might need debridement of all grossly nonviable tissue, removal of foreign bodies and copious irrigation with isotonic solution plus vascular repair. Fasciotomies were performed following vascular reconstruction in patients with clinically suspicious compartment syndrome.

The wounds were inspected frequently during the postoperative period, and the case was taken back to the operating room for repeat debridement or fasciotomy as often as necessary. The anastomotic suture lines were covered by soft tissue and rotated muscles to prevent desiccation and disruption. Patients with obviously unsalvageable lower limb injury requiring primary amputation were excluded from the study.

Chi-square test was used for statistical analysis. A p value of less than or equal to 0.05 was accepted as being statistically significant.

Results

The total cases were 65 patients (49 males and 16 females), ranging from 16 years to 67 years with a mean age of 41.5±6.4 years. Forty nine patients were hypotensive on arrival to emergency department, three of those patients were not responded to resuscitation, one of them had a cardiac arrest then responded to resuscitation. Thirty five patients with significant vascular injury following penetrating trauma were taken directly to operating room. Angiography was performed in 9 patients prior to surgery and the angiographic findings were flap in 2 patient, occlusion in 3, pseudoaneurysm in 3 and arteriovenous fistula in 1. The majority of vascular injuries in this study were due to penetrating trauma. **(Table-1)**

Twenty cases had bilateral limbs vascular injuries. There were 27 arterial injuries **(Table-2);** and the most common injures were in the femoral artery, followed by the tibial and finally the popliteal arteries. There were 17 cases associated with venous injury, of which 11 cases had surgical vascular repair, and 6 had vein graft interposition **(Table-3).**

There were concomitant femur fractures in 2 cases, fibula fractured in 3, tibia fractured in 1. The time interval between the trauma and arrival to hospital was ranged from 1 to 11 hours with a mean of 6 hours.

Seventeen femoral artery injuries were recorded in the present study and all except 2 were the result of penetrating mechanisms. Of these 17 cases with femoral artery injuries, only 4 had common femoral artery injuries of which one had at the level of common femoral bifurcation and the remaining 13 cases had superficial femoral artery injuries as in **(Fig-1).** Direct surgical repair was performed in 10 patients, and venous graft by the great saphenous vein was used in 7 patients. In one patient who had injury at the level of common femoral bifurcation, injured profunda femoral artery was ligated due to extensive injury, and the great saphenous vein interposition graft was employed between common and superficial femoral artery. One patient with femoral artery pseudo-aneurysm and 2 patients with femoral arteriovenous fistula were managed by surgical repair. Ten patients had simultaneous injuries of the femoral artery and femoral vein. There were no saphenous vein graft related amputations, only one case resulted from graft thrombosis and 1 from graft infection and subsequent hemorrhage.

There were 5 patients with neurological injury, one of which resolved within three months; however, the remaining had prolonged disability. Three patients had a crush injury to the thigh; and the superficial femoral artery and vein were repaired with great saphenous vein interposition grafts. All these grafts were occluded within the first day. Despite revision of these grafts one patient of them eventually required a below knee amputation. At control angiography, graft was found occluded; however, limb was felt to have adequate collateral flow in spite of thrombosis, and no attempt was made to reopen the graft.

There were 3 popliteal artery injuries, 2 from penetrating wounds and only 1 from blunt trauma. Primary suturing was performed in 1, interposition great saphenous vein graft in 1 as in **(Fig-2).** All popliteal arterial injuries had popliteal venous injuries.

The prophylactic fasciotomies were performed in 9 patients with combined vascular and large soft tissue injuries (2 blunt traumas and 7 penetrating injuries). Additionally, another patient performed fasciotomy due to penetrating gunshot injury during the postoperative period for suspected compartment syndrome based on clinical findings. Clinical evidence of infection was noted in one patient with femoral artery and vein injuries. This patient had associated fractured femur, nerve and severe soft tissue injuries; and great saphenous vein interposition graft to femoral artery and vein was done. Then the infected graft was removed and progressive muscle necrosis subsequently developed, this led to above knee amputation. The second patient with simultaneous femoral artery and vein injuries and fractured femur had deep venous thrombosis in the right lower limb after operation. He was free of symptoms 2 months after discharge.

In the present study, there were no surgical repair failures in 27 patients who had primary vascular repair. However, there were 3 failures in 17 patients who had interposition vein grafts, 1 involving vein and 2 involving artery ($p<0.05$). There were no deaths during the operations. On discharge, all patients examined for distal artery palpable pulses, and the follow-up evaluations ranged from 1 to 6 months.

Discussion

In the present study, approximately 80% of vascular injuries are due to penetrating trauma, so that arteriography in those cases and the detailed physical examination can replace arteriography in the majority of patients with proximity wounds. The patients with obvious signs of vascular injury should be taken directly to surgery; and the time of preoperative evaluation should be as short as possible to prevent potential ischemic changes. The cause of most common injuries in this study was penetrating trauma from gunshot wounds (35.4% of the total vascular injuries); in which only 4 patients without a suitable vein for graft interposition were present; and prosthetic graft material not used in the venous system injuries of the lower limb because of the prosthetic venous graft thrombosis in the extremity is high.

A major risk factor for limb loss is the development of compartment syndrome that occurs when the pressure of the one or more osteofascial compartments rises [4]. Compartment syndrome has itself been linked to delay in restoration of blood flow; because the presence of associated venous injuries and lower limb fractures [5]. Performance of the fasciotomy prior to vascular repair has been recommended to improve collateral flow and reduce distal ischemia during arterial repair [6]. Many extremity vascular injuries are associated with large soft-tissue defects [7]. Combined arterial and venous injury associated with large soft tissue defect may cause compartment syndrome. Moreover, reperfusion of a prolonged ischemic extremity also may cause compartment syndrome [5].

Selective prophylactic fasciotomies (ischemic time greater than 6 hours or combined arterial and venous injuries) effectively save limbs [8]; so that prophylactic fasciotomy performed in ten patients with combined arterial and venous injury associated with large soft-tissue defects **(Table- 4)** . Arterial puncture injuries may result from percutaneous vascular procedures. Many of these injuries heal uneventfully, but a few may persist and become expanding pseudoaneurysms [9]. Puncture injuries are seen as an eccentric irregularity or out pouching of the contrast column on arteriography [10]. Early recognition and repair of iatrogenic arterial injuries were of paramount importance in minimizing subsequent morbidity and mortality [11].

Any arterial injury may cause a serious complication months or even years later and therefore all arterial injuries must be repaired when recognized [12]. Severe soft tissue injury, concomitant venous injuries, fractures, shock and a crushed extremity were found to be associated significantly with amputation [11, 13] which is similar to the findings of this study. Vascular repair has been shown to decrease amputation rates when performed before bony stabilization [9]. Accordingly, the vascular repair performed prior to bony fixation in all patients combined with fracture present in this study. Surgical repair, as either lateral arteriorrhaphy or end-to-end anastomosis (ETEA) was associated with a 3% amputation rate and it should be performed whenever possible. The higher amputation rate of complex repairs likely is a reflection of severity of injury [8]; thus simple repair, when performed without tension, offers the best chance of limb salvage [13]. In this study, just two patients with complex repair underwent amputation.

Venous repair improves limb salvage rates by decreasing venous hypertension and reducing compartment pressures [12]. Systemic anticoagulation with heparin can prevent propagation of distal small vessel thrombosis. Wagner *et al* [11] showed a significant impact on limb salvage with systemic heparin when compared to patients without heparin. Some have chosen to use local heparin instillation to reduce bleeding from extensive injuries [4]; in the present study heparin used as a solution to flush distal arterial bed.

In contrast to venous repair, direct suture or end to end anastomosis may be more difficult in arterial reconstruction, as high blood pressure may cause tension in the anastomosis and damage of the endothelium (2). Most vascular injuries from gunshot wounds frequently necessitate an interposition graft to gain a tension-free repair [4]. Despite that other studies avoid the direct end-to-end anastomosis without graft and they preferred a vein graft whenever possible [2, 6, 8 and11], but in this study 16 arterial and 11 venous repairs were done with primary vascular repair without tension.

Injuries to the common and profunda femoral arteries are uncommon because of their short length and proximal location; while the superficial femoral artery injuries are very common [8], as was found in this study. Femoral artery injuries present the opportunity to use either surgical repair or venous graft depending on the length of lost segment and the choice of the surgeon [3]; lack of soft tissue coverage is a common reason for graft failure and infection [12]. Accordingly, all of these grafts were covered by soft tissue and rotated muscles in the present study.

In the management of one tibial artery injured with intact distal flow through the remaining vessels and a normal, non-ischemic limb; Shah indicates that all injured tibial arteries should be repaired to prevent tissue loss and long-term morbidity even with an intact vessel to the foot [10]. Some suggest that aggressive approach in repairing tibial vessels if one intact is unnecessary. If the proximal arteries are injured, reconstruction requires repair of at least one vessel because there is a communication between anterior and posterior tibial arteries; in cases with anatomical abnormalities such as hypoplasia of the posterior tibial artery or absence of the dorsalis pedis, being verified on the angiography, the two vessels must be repaired immediately [2].

Synthetic grafts are less successful in below-the knee reconstructions for trauma, just as they are in atherosclerotic disease [4]. Proponents of synthetic material feel that the great saphenous vein grafts are not suitable for all wounds requiring an interposition graft because of:- occasional inadequate lumen size, difference in diameter between the injured artery and the autogenous vein; possible non availability of a suitable vein; and the difficulty of leaving a vein graft exposed in a large, contaminated soft-tissue wound [7].

In general, patients who suffer lower extremity arterial injury should be transferred to vascular

surgery centers as soon as possible [11]; and

anticoagulant treatment may be started as soon as possible to prevent the propagation of the thrombosis. Early fasciotomy is warranted if there is any suspicion of occurrence of compartment syndrome.

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(Table-1)
Classification of Different Types of Vascular Injuries

Type of Injury		No. of patients
Penetrating or Opened injuries	Gunshot	**23**
	Road traffic accidents	**5**
	Explosive materials	**10**
	Industrial	**5**
	Stab	**9**
Blunt trauma or Closed injuries	Road traffic accidents	**3**
	Fall from height	**4**
	Industrial	**3**
Iatrogenic		**3**
Total		**65**

(Table-2)
The Site of the Injury and the Type of Performed Arterial Repairs

Site of Injury	*Type of Surgical Procedures*		Total
	End-To-End Anastomosis (ETEA)	**Venous Graft**	
Femoral artery	**10**	**7**	**17**
Popliteal artery	**2**	**1**	**3**
Tibial arteries	**4**	**3**	**7**
Total	**16**	**11**	**27**

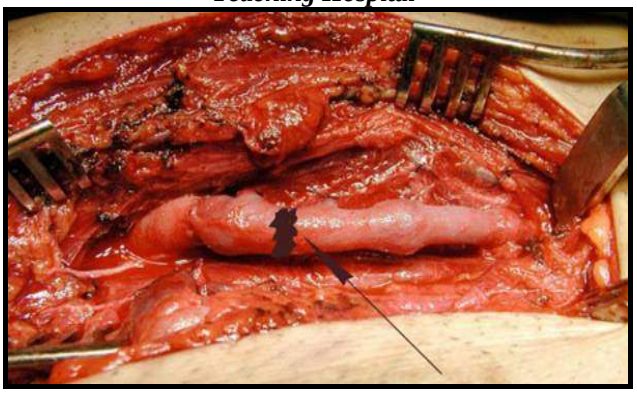
(Table -3)
The Type of Surgical Procedures Associated with the DifferentSites of Venous Injuries

Site of injury	Type of Surgical procedures		Total
	End-To-End Anastomosis (ETEA)	**Venous Graft**	
Femoral vein	6	5	11
Popliteal vein	2	1	3
Great Saphenous vein	3	0	3
Total	11	6	17

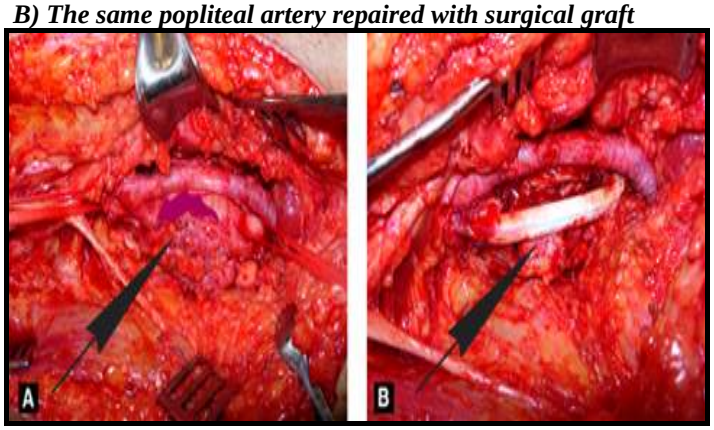
(Table- 4)
Other Tissues Injuries Associated With Vascular Injuries

Name of Injured Tissue	*No. of cases*
Soft tissue injuries	18
Nerve injuries	5
Orthopedics injuries	9
Joint injuries	7
Muscular injuries	12
Others	3
Total	54

(Figure- 1)
Suturing with ETEA of the injured superficial femoral arterydone in the emergency department of Tikrit Teaching Hospital



(Figure- 2: A)
Popliteal artery ruptured adjacent to popliteal vein;
B) The same popliteal artery repaired with surgical graft



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*** From the Department of Anatomy, College of Medicine, Tikrit University, Iraq.**
****From the Department of Pathology, College of Medicine, Tikrit University, Iraq.**

Correspondence Address to:Dr. Mohammad Ahmad Abd-alla
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