Surgical Techniques for Haemostasis in Penetrating Trauma to Femoral Artery

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Objectives: To analyse the efficacy of various operative procedures and factors affecting the outcome especially the effect of limb ischemia time in penetrating trauma to the femoral artery. **Study Design:** Prospective. **Setting:** Study was conducted at West Surgical Ward, Mayo Hospital Lahore. **Duration:** August 2001 to July 2004. **Materials and Methods:** All the patients >12 years of age referred from periphery as well as directly admitted with penetrating trauma to the femoral vessels alone or associated with other organ injuries having hard/soft physical signs of an arterial injury were included in the study. **Results:** 39(97.5%) patients were male, age ranged from 14-53 years with the mean limb ischemia time of 7.8 hours in the series. 35(87.5%) patients sustained firearm injuries. Superficial femoral artery was injured in 23(57.5%) followed by vein in 12(30%) and major vessels were found intact in 4(10%) patients. Lateral arteriorrhaphy was performed in 4(10%) & venorrhaphy in 3(7.5%) patients with 100 % success rate, resection and primary anastomosis in 18(45%) patients with pseudo aneurysm formation in 1(2.5%) patient. Reverse great saphenous vein graft was interposed in 9(22.5%) patients with graft failure rate of 5% (2 patients). Femoral vein was ligated in 12(30%) patients with development of deep vein thrombosis in 2(5%) patients. There were 3(7.5%) deaths. No synthetic graft was used in the series. **Conclusion:** Exsanguination, prolonged injury duration, associated organ injuries and extensive soft tissue and skin damage of the extremities were the major factors responsible for increased morbidity particularly limb loss and mortality. Proximity of injury to the femoral vessels was a poor predictor of an arterial injury in the study. Arteriorrhaphy and primary end-to-end anastomosis are the main stays for an arterial injury repair, next comes the use of autogenous vein graft, in our setup. Moreover ligation of femoral vein is not associated with leg amputation.

Keywords: Penetrating trauma, femoral artery and vein, reverse vein graft, end-to-end anastomosis, venorraphy, limb loss.

The need for control of haemorrhage has been evident as long as there has been recognition of the need to manage serious injuries. The need for vascular surgery has been a modern development. During times of disasters or violence, injuries are obviously inherent. From these unfortunate circumstances there has been a major advance in the surgery of trauma. When examining the history of vascular trauma the context can be recognized as control of haemorrhage & repair during major wars especially the Korean Conflict[1,2].

Femoral vessels are among the most commonly injured peripheral vessels comprising 70% of all arterial injuries. More than 90% of these injuries are due to penetrating trauma resulting from firearm injuries in 76% & stab wounds in 24%[3,4]. The management of femoral vessel injuries seems to be straightforward in most situations, however some unit presentations may challenge even the most experienced trauma surgeon. Wounds that involve the vascular structures of the extremity are a significant cause of morbidity and mortality in the traumatized patient.

Materials and methods:

The prospective study was carried out in West Surgical Ward, Mayo Hospital Lahore for a period of 3 years. All the patients above 12 years of age either referred from periphery or admitted directly through Accident and Emergency Department with penetrating trauma to femoral vessels alone or associated with other organ injuries were included in the study. After the primary survey, the lower extremities were evaluated for the presence of vascular injury with the help of hard/soft physical signs of an arterial injury in all patients[5,6]. Duplex scan, angiography and magnetic resonance angiography were not available in our emergency department.

Antibiotic, Tetanus toxoid and analgesics were given to all patients pre-operatively. Haemodynamically unstable patients were directly shifted to operation theatre for resuscitation and exploration and stable patients were prepared for exploration after resuscitation and necessary investigations. Proximal and distal control of the femoral vessels were taken in all patients and the injury severity was assessed for an appropriate procedure. Proline 5-0/6-0 was used after passing Fogarty catheter through proximal and distal segments of the femoral artery. Single shot of Heparin 1 ml intravenously and 1 ml in the distal segment of the artery was given at the time of vessel repair. Heparin/Clexane was given for 7 days to all patients in whom reverse saphenous vein graft was used, taken from healthy limb. After proper debridement of dead soft tissue and extensive irrigation, healthy tissue cover from surroundings was provided to femoral vessels with external drainage. Fasciotomy was performed where indicated. Associated organ injuries were managed according to their own priority and protocol. Third generation Cephalosporin and analgesics were given to all patients and were observed keenly for the early detection of post-operative complications and their immediate management. The hospital stay varied from 4-30 days with the mean of 9.8 days.

Results:

The study included 40 patients with penetrating trauma to femoral artery alone or associated with other organ injuries. In the series 39(97.5%) patients were male and only 1(2.5%) patient was female. Age of the patients ranged from 14-53 years with the mean of 29.8 years.

Of the penetrating vascular trauma, firearm injuries were the most common cause of trauma to femoral artery in 35(87.5%) and stab wounds in 5(12.5%) patients.

In the series, majority of the patients 31(77.5%) were presented in emergency within 6 hours of their injury duration and 2(5%) young patients, 31 year male and 24 year female were referred from periphery after their injury duration of more than 72 hours with gangrene of their respective extremities (Table 1).

Table 1: Limb ischemia time (Injury duration)

Injury duration (hours)	n=40	%age
<6	31	77.5
6-12	5	12.5
13-24	2	5
>72	2	5

Duration of limb ischemia time varied from half hour to 90 hours with the mean of 7.8 hours.

On exploration superficial femoral artery was the commonest injured site found in 23(57.5%) patients followed by vein in 12(30%) patients (Table 2).

Table 2: Site of vascular injury

Anatomical site	n=40	%age
Common femoral		
Artery	11	27.5
Vein	3	7.5
Superficial femoral		
Artery	23	57.5
Vein	12	30

More than one site of vessel injuries was found in the some patient.

After assessment of the injury severity to the femoral vessels, various operative procedures were performed like resection and end-to-end anastomosis in 18(45%) and above knee amputation for gangrenous limb in 2(5%) patients (Table 3).

Table 3: Operative procedures performed

Procedure performed	n=40	%age
Lateral arteriorrhaphy	4	10
Arteriotomy and thrombectomy	1	2.5
End-to-end anastomosis	18	45
Vein interposition graft	9	22.5
Venorrhaphy	3	7.5
Ligation of femoral vein	12	30
Above knee amputation	2	5

Major femoral vessels were found intact in 4(10%) patients; all of them had soft physical signs of an arterial injury. Fasciotomy to decompress four quadrants of calf was required in 8(20%) patients. Associated organ injuries including small and large gut, stomach, liver, spleen, profunda femorus vessels, fracture femur, sciatic and femoral nerve were managed according to their severity and own protocol (Table 4).

Table 4: Anatomical location of associated injuries

Injury location	N=40	%age
Abdomen	10	25
Chest	5	12.5
Upper limb	3	7.5
Femur	4	10
Nerve	2	5

Some patients had associated injuries in more than one anatomical site

All the patients were observed keenly for the early detection of post-operative complications and their prompt management. Wound infection in 4(10%), graft failure due to sepsis was seen in 2(5%) patients (Table 5).

Table 5: Post-operative complications with management

Complication	n=40	Management
Wound infection	4 (10%)	Open and dressing
Deep vein thrombosis	2 (5%)	Anticoagulants
Graft failure	2 (5%)	Ligation of vessels-later on above knee amputation
Pseudo aneurysm	1 (2.5%)	Excision and ligation of vessels- limb saved
Urinary tract infection	2 (5%)	Antibiotic and fluids
Jaundice	1 (2.5%)	Conservative

Mortality recorded in the series was 7.5% (3 deaths). One patient expired on the operative day due to exsanguination and 2nd patient died on 3rd post-operative day because of multiple organ failure and 3rd patient died on 11th post-operative day due to uncontrolled sepsis.

Discussion:

There has been an alarming increase in patients sustaining penetrating injuries particularly in the absolute number and severity of firearm injuries in the past few years. Experience obtained from the major wars of the 20th century provides the basis for the present approach to civilian peripheral vascular injuries[1,7]. Lower abdomen and groin are more vulnerable to firearm injuries than vessels in other locations, with the injury of the femoral artery being the most common arterial injury[8].

Trauma is a disease of reproductive age groups especially the young males. In the study 97.5% patients were male and 2.5% were female with the mean age of 29.8 years which is in comparison with study conducted by Maltax KL, et al[8] where 84% were male and 16% were female patients with the mean age of 30 years.

The scope and ultimate outcome of a vascular injury depend significantly on the mechanism/cause of injury. In the series 87.5% patients sustained firearm injuries and

12.5% had stab wounds that is in near resemblance with the study carried out by Degiannis E, et al[9] comprised 87% patients with firearm injuries and stabbing in 13%.

Limb ischemia time and exsanguination are the major risk factors influencing the outcome in vascular trauma. In the series 77.5% patients arrived at hospital within 6 hours of their injury duration and 5% patients were referred from periphery after 72 hours of their injury time with gangrenous limbs. Mean limb ischemia time was 7.8 hours which is far more than European studies[9,10].

The technique of vascular repair required is dictated by the extent of arterial damage. Repair of the injured vessels can be accomplished by lateral repair, patch angioplasty, end-to-end anastomosis, interposition graft or by-pass graft. In the study lateral arteriorrhaphy was performed in 10%, end-to-end anastomosis in 45%, vein interposition graft in 22.5%, femoral vein ligation in 30%, above knee amputation in 5% and fasciotomy in 20% patients which is in comparison with the study conducted by Degiannis E, et al[9] where lateral arteriorrhaphy was done in 7%, end-to-end anastomosis in 26%, vein interposition graft in 26%, femoral vein ligation in 11.3% and fasciotomy in 31% cases. Associated organ injuries in the series included bone, nerve and remote injuries affecting upper extremity, chest and abdomen were present in 60% of the patients which is in near resemblance with the study conducted by Davidovic LB, et al[11] where 60.8% of their patients had associated organ injuries.

Vascular injury to the femoral vessels is associated with high morbidity but low mortality. The higher incidence of morbidity and mortality was due to exsanguination, prolonged limb ischemia time, poor resuscitation at the periphery, extensive soft tissue and skin damage of the extremity, involvement of bone and nerve and associated organ injuries. In the series deep vein thrombosis was found in 5%, 5% patients underwent above knee amputation due to graft failure and there were 7.5% deaths, which is in comparison with the study conducted by Cargile JS, et al[12] where they found deep vein thrombosis in 7.7%, limb amputation in 4.7% and 2.6% deaths.

Conclusion and suggestions:

The firearm injuries are the most likely to lead to amputations whereas the stab injuries are the least likely to do so. The hard physical signs of an arterial injury are the definite predictors but soft physical signs particularly proximity of wound to the neurovascular bundle need further evaluation with modern diagnostic tools to avoid negative explorations. The reduction in time lag between the time of injury and repair is the critical for ultimate outcome of the repair. Arteriorrhaphy and end-to-end anastomosis are procedures of choice followed by reverse saphenous vein graft in penetrating vascular trauma in our setup. The current status of our emergency departments does not permit the use of synthetic grafts. Ligation of femoral vein is not associated with the limb loss.

Licensed weapons, commandment of law and order, easy and quick delivery of justice, prevention of overcrowding in urban areas will definitely reduce the incidence of firearm injuries. Awareness among public and medical staff for proper resuscitation and immediate referral from periphery by conducting seminars and delivering lectures, better transport facilities to reduce limb ischemia time, prompt resuscitation, early recognition of vascular injury, free availability of blood and provision of latest equipments with modern diagnostic adjuncts in our emergency departments, following the basic principles of vessel repair, experienced trauma surgeons, management of associated organ injuries according to their own priority, proper debridement of extremity soft tissue damage and earlier fasciotomy where required will definitely reduce both morbidity particularly limb loss as well as mortality in penetrating trauma to the femoral artery.

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