Popliteal vascular injuries: an experience from Medical City in Baghdad

Ali N Abed[1], Nazar B Elhassani[2], Mohammed H Nemat[3]

[1] FIBMS, Vascular Surgeon, Surgical Specialities Teaching Hospital, Medical City Teaching Complex, Baghdad, Iraq.

[2] FRCS, Professor of Cardiovascular Surgery, Surgical Specialities Teaching Hospital, Medical City Teaching Complex, Baghdad, Iraq.

[3] FIBMS, Cardiac Surgeon, Iraqi Centre for heart Diseases, Medical City Teaching Complex, Baghdad, Iraq.

Corresponding Author:

Ali N Abed, Surgical Specialities Teaching Hospital, Medical City Teaching Complex, Baghdad, Iraq.
E mail: alinajimalkhazali@gmail.com.

ABSTRACT

INTRODUCTION: Popliteal vascular injury is a common vascular injury that endangers life and limb viability.

OBJECTIVE: The aim of this study was to identify the most critical factors associated with amputation and mortality in popliteal vascular injuries.

METHODS: This is a retrospective, record based study of 128 cases of popliteal vascular injury that were admitted to the vascular surgery department / Surgical Specialty Hospital / Medical City / Baghdad from 1st of March 2003 to 30th of July 2007. Demographic data, mechanism of injury, ischemic time, associated fractures and nerve injuries, surgical techniques, and amputation and mortality rates were analysed.

RESULTS: The most common cause of injury was bullet and shell injury in 97.5%, stab injury in 1.5 % and blunt in <1%. Males represented 86% of the cases, most of them were young. The surgical techniques used to repair the arteries were end to end anastomosis in 77 % of cases, reversed saphenous vein graft in 8.2 %, synthetic graft (PTFE) in 4.5 %, arteriorrhaphy in 0.9 %, embolectomy in 1.8 % and ligation in 7.3 %. Venous injuries were dealt with by ligation in 87 % of cases and venorrhaphy in 13 %. Associated fractures were dealt with by external fixation in 29 % of cases and p.o.p anterior slab immobilization in 71 %. Faschiotomy was done in only 15.5 %. Amputation has been done for 19.5 % of cases mostly due to extensive associated local injuries and/or delayed presentation. Mortality was 4.7 % (5 cases due to irreversible shock and its sequel and one case due to renal failure).

CONCLUSION: The most important factors associated with increased amputation rates were long ischemic time (>6 hours) and the presence of associated injuries (fractures and soft tissue injuries).

Key words: Popliteal artery, Penetrating trauma, Amputation rate.

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INTRODUCTION

Vascular injuries account for 2 % of all casualties.[1] It can be encountered among civilians especially in urban areas where violence is endemic. The causes of vascular trauma vary according to the medical centre reporting the data and the composition of the respective patient population.[1] The commonest causes employed being penetrating injuries (gun-shot wounds, missiles and edged instruments); blunt injuries (e.g. road traffic accidents) and iatrogenic injuries.[2] The distribution of arterial injuries by anatomic location; however, has less noticeable variation than the causes (table 1)

Table 1: Distribution of arterial injury by body location

	Perry[3]	Darpanas[4]	Feliciano[5]
Neck	8.2 %	5 %	6.1 %
Chest	5.3 %	4.6 %	4.6 %
Abdomen	4.7 %	13.5 %	10.2 %
Upper extremity	46.4 %	47.8 %	40.5 %
Lower extremity	35.2 %	28.8 %	38.4 %

Prompt effective diagnosis, resuscitation and early revascularization are necessary for limb salvage. Attempt to revascularize, after "the first 8 golden hours", though technically successful will have progressively higher rates of amputation, especially in the lower limbs.[3]

In this research the mechanism of injury, ischemic time, associated injuries, surgical techniques, amputation and mortality rates were analysed. The key objectives were to define the

mortality and amputation rates and factors contributing to limb loss.

METHODS

Setting of the study: A documentary study was conducted by reviewing the record of 128 patients who were presented with popliteal vascular injuries admitted to the vascular department at the Hospital of Surgical Specialities, Medical City Complex in Baghdad from 1st of March 2003 to 30th of July 2007.

Inclusion criteria: All patients who were admitted to vascular surgery department complaining of popliteal vascular injury whether isolated or associated with other vascular injuries or fractures of bone were enrolled in this study.

Exclusion Criteria: Patient who had popliteal vascular injury associated with other injuries requiring surgical intervention by another specialities at other hospitals like abdominal surgery, neurosurgery were excluded from the study because of lack of or inaccurate of data required to complete the study.

Procedure: We had reviewed all the records at vascular surgery department to collect those belonged to patients who were presented due to vascular injury in general, those who had injury of the popliteal artery were extensively reviewed to have data required to complete our study, these data were:

1. General demographic data about age and gender.
2. Details about the injury; mechanism, location, degree and time of ischemia on presentation, associated fractures, nerves and soft tissue injuries, and investigations.
3. Extensive history about the type of surgical repair and its time.
4. Complications after surgery which included infection, mortality and amputation rate.

We split the patient included in our study into two parts according to whether they had ended with amputation or not then we studied the effect of time to repair, type of repair and presence of some associated injuries on the need for amputation.

The protocol of management of vascular injury at vascular department in Surgical Specialties Hospital, Medical City is to have immediate evaluation of the patient through full physical examination and necessary imaging studies and laboratory investigations. Angiography was not always available as an emergency investigation; instead hand held Doppler is used to aid establishing the diagnosis.

Any active bleeding is usually controlled by tight bandaging and wounds were examined by vascular surgeon to determine the location and mechanism of injury. Examination to exclude fractures, nerves and extensive soft tissue injuries are always coincide with vascular examination and properly dealt with by neurosurgeons and orthopaedicians.

Resuscitations of patients are usually started as soon as possible with preparation for early surgical intervention. Arterial repair is usually done by using continuous monofilament non-absorbable suture (polypropylene suture size 6/0). In paediatric age group we use interrupted sutures to avoid the risk of future narrowing in the growing artery.

Heparin was given to all cases except for cases ended with ligation of the artery; the mode of administration differs according to the type of surgical repair performed. It is used locally in a solution of 10 IU/ml (5000 IU in 500 ml normal saline) and irrigation of the distal arterial segment by 100 to 150 ml is done in all cases of repair. Systemic heparin was given in cases of reversed saphenous vein graft (RSVG) interposition, synthetic graft interposition and cases of venous ligation. Heparin continued postoperatively in a dose of 5000 IU, subcutaneously four times daily for 2 to 5 days in cases of reversed saphenous vein graft (RSVG) interposition and in cases of popliteal vein ligation, while it is changed to warfarin in cases of synthetic graft interposition.

Statistical analysis: simple descriptive statistics were used to analyse the data.

RESULTS

Percentage of popliteal injuries: There were 606 cases of injury in the vessels of extremities and neck during the studied period. Popliteal vascular injury was found in 128 patients (17%) (figure 1). For some demographic features of the sample see table 2.

Presentation of patients: Nearly all patients but one had injury to the popliteal artery due to a penetrating mechanism; bullet injury in 104 (81%) patients, shell injury in 21 (16.5%) patients

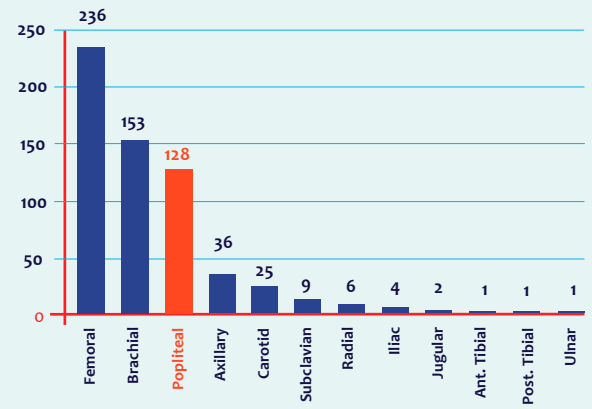

Figure 1: Vascular injuries encountered at the study time period.

Table 2: Distribution of Popliteal injuries according to age group and gender

Age Group (Yrs)	Gender		
	Male (%)	Female (%),	Total (%),
1-10	4 (3.65)	2 (11.1)	6 (4.6)
11-20	25 (22.7)	3 (16.7)	28 (21.8)
21-30	42 (38.2)	6 (33.3)	48 (37.5)
31-40	25 (22.7)	5 (27.8)	30 (23.4)
41-50	4 (3.65)	2 (11.1)	6 (4.6)
51-60	8 (7.3)	0	8 (6.2)
61-70	2 (1.8)	0	2 (1.5)
Total	110 (86)	18 (14)	128 (100)

Table 3: Shows proportions of arterial and venous popliteal injuries.

Type of vessel involved	No.	%
Arterial injury only	55	43
Arterial + venous	65	51
Venous only	8	6

Table 4: types of surgical intervension according to type of the vessels.

Type of vessels	Type of repair	No. (%)
Arterial	Resection + direct end to end anastomosis	84 (77)
	Reversed saphenous vein graft interposition	9 (8.2)
	Synthetic graft interposition	5 (4.5)
	Arteriorraphy (lateral suturing)	1 (0.9)
	Embolectomy	2 (1.8)
	Ligation	8 (7.3)
Venous	Ligation	54 (87)
	Venorrhaphy	8 (13)
AVF	End to end to the artery+ venous ligation	4 (36)
	RSVG for the artery + venous ligation	1 (9)
	RSVG for the artery +venorraphy	1 (9)
	Ligation of the fistula only	1 (9)
	End to end to the artery+ venorraphy	3 (27)
	Arteriorraphy + venous ligation	1 (9)

and stab injury in 2 (1.5%) patients. The only one patient who injured by blunt mechanism was due to road traffic accident.

Patients with injury of the popliteal artery had presented with absence of the distal pulses 107 (84%), pain 119 (93%), coldness 107 (84%), pallor 110 (86%), hematoma 100 (78%), parasthesia 90 (70%), edema 18 (14%), paralysis 73 (57%) and mottling 18(14%).

According to pathophysiology of arterial injuries, arteries were completely severed in 90 (75%) patients, partially severed in 14 patients (11.75%), arteriovenous fistula "AVF" 11 patients (9%), intimal injury (thrombosis) 4 patients (3.5%) and false aneurysm in one patient (0.75%). For distribution of arteriovenous injury see table 3.

Local injuries which were associated with injury of the popliteal artery had included venous injury 65 patients (51%), bone fractures in 59 patients (49%), and tibial nerve injury 36 patients (30%); in addition to the soft tissue damage which was seen in all patients. Nerve repair have not been done in any case, but it had been left for secondary intervention.

Associated fractures included fracture of femur in 44 patients (34.3%); tibia in 6 patients (4.6%), femur and tibia in 8 patients (6.2%), and femur, tibia and fibula in 1 patient (0.7%).

Management: All arterial injuries, apart from arteriovenous fistula (table 4), had undergone repair.

The relation between the outcome of surgical intervention and the time from injury to surgical repair is shown in table 5 (N.B. cases of AVF are not included because the limbs in such cases are usually not ischemic, and time factor is less important, also cases of venous without arterial injury are not included). This table has showed that time is very important predictor to the fate

Table 5: The relation between the outcome of surgical intervention and the time from injury to surgical repair.

Time (hr.)	No. (%)	Good results (%)	Poor results* (%)
<6	78 (71.5)	67 (86)	11 (14)
6-9	17 (16.5)	9 (53)	8 (47)
>9	14(12)	0 (0)	14 (100)
Total	109	76	33

*Poor results refer to the cases that ended with amputation or death.
Note: 11 cases with arteriovenous fistula and 8 cases with only venous injury were not included in this table because there is not ischemia.
P value < 0.001

Table 6: Postoperative complications

Complications	No.	%
Oedema	103	80
Joint stiffness	75	59
Wound infection	37	29
Ischemia and gangrene*	26	21
DVT**	22	17
Paralysis	18	14
Bleeding	5	4
Thrombosis	1	0.8
Renal failure	1	0.8
Amputation	25	19.5
Death	6***	4.7

*Patients mostly had extensive injuries or delayed presentation

**Diagnosis was made clinically

*** Four died preoperatively due to irreversible shock, one died in the second day postoperatively due to irreversible shock. The last one died in the 7th day due to renal failure.

of injury of the popliteal artery.

Table 6 summarizes the post operative complications in our study. Five cases developed secondary bleeding, 3 of them ended with amputation. Table 7 shows the effect of some factors like time from injury to surgery, some associated injury, and type of repair on the need for amputation.

DISCUSSION

In our study, popliteal artery injuries accounted for 17 % of extremity and neck vascular trauma. Other series have shown variable percentages; it ranges from 6.5 - 30%.[1]

Men in the young age group (20–30 years) are most commonly affected (86%), this is due to being more active and more susceptible to violence. This result is comparable to other studies; Subasi[6] had reported that 85 % of patients were men and 15 % were women with a mean age of 23 years. Haba[7] in a study at Ibn Al-Nafees hospital in Baghdad Iraq in 2005, had shown that men constituted 90 % of the victims while women had involved in 10 %.

Penetrating injuries; bullets, shells or stab wounds represented the majority in our study (>99%), while blunt injury accounted for only one case. Although many studies[4,7,8] agree that penetration injuries are more common than blunt injuries but the percentages varied from as high as 90% in Drapanas [4] to as low as 50 % in Sagraves.[8] In Iraq, Haba[7] had showed that penetrating injuries found in 85 % of patients. The very high percentages of penetrating injuries in our study in comparison to others can be explained by the eruption of civilian violence and explosions in Iraq during the studied period. Also the variation in the rules of referring systems of injured patients and geographic loca-

Table 7: Factors predicting development of amputation

		Amputated limbs*(%)	No amputation**(%)	Total	P value
Time in hours	<6	7 (8.6)	74 (91.4)	81	<0.001
	6 – 9	8 (66.7)	4 (33.3)	12	
	>9	10 (62.5)	6 (37.5)	16	
Fasciotomy		10 (50)	10 (50)	20	0.001
Venous injury***		19 (29.3)	46 (70.7)	65	0.057
Fractures		20 (33.9)	39 (46)	59	0.003
Nerve injury		17 (68.9)	19 (66.1)	36	<0.001
Ischemia and gangrene		25	1	26	<0.001
Repair	End to end	13 (15.5)	71 (84.5)	84	0.001
	RSVG	2 (22.2)	7 (77.8)	9	0.987
	Synthetic graft	2 (40)	3 (60)	5	0.383
	Ligation	8 (100)	0 (0)	8	<0.001
	Arteriorraphy	0 (0)	1 (100)	1	0.584
	Embolectomy	0 (0)	2 (100)	2	0.436

*Total number of amputation is 25

**Total Number of no amputation is 84

***Pure venous injury and arteriovenous fistula (AVF) were not included

P value <0.05 assumed to be significant

tion of the hospitals can affect this rate.

Injuries to veins, bones, and nerves are expected to be found in association with vascular injuries in the trauma of lower limbs. Many studies [7,9,10] support our findings; however, variation in the percentages of different tissue involvement depends on the mechanism of trauma and design of the study.

Injury of popliteal artery is diagnosed in our wards mainly by physical examination and sometimes with hand held Doppler, while in some studies diagnosis is performed mainly by preoperative angiogram 84%.[10]

Saving lives and limb salvage are important goals when dealing with popliteal artery injuries. The rate of limb salvage remains a good measure of success of treatment. We found, as in other studies, that the time between arterial injury and surgical intervention is crucial to avoid amputation. In our results, 7 patients (8.6%) of those who underwent intervention within 6 hours from the time of injury have ended with amputation, while 84 patients (91.4%) who underwent surgical intervention during the same period had been saved from this dreadful fate. Haba[7] and Hossny[11] have reported that you can save all patients from the fate of amputation if the surgical intervention was provided within the first 6 hours post injury.

In our study, the seven patients who ended with amputation despite being managed by surgical intervention in the first 6 hours had extensive soft tissue injuries with damage of nerves and fracture of bones which can explain the cause of amputation. The presence of these associated injuries in ischemic time ≥ 6 hours will also increase the risk of irreversible damage which may be caused by prolonged ischemia.

Gregory[12] and associates have proposed a scoring system to help identifying patients who are at great risk to have amputation, and based on this system they even recommended to do primary amputations for such limbs. This scoring system includes:

- A paralyzed extremity with nerve injury confirmed at the operating room.
- A loss of bone continuity greater than 6 cm.
- Presence of severe and extensive soft tissue injury.

In our study primary amputation had not been done, as the decision to amputate is usually postponed till the signs of dead limb are clearly obvious.

Type of surgical repair, in our study, depends on the type of injury; if there was only small lateral tear, arteriorrhaphy is done. Cases of thrombosis are dealt with by embolectomy, and this alone will suffice if there is no clear cut arterial injury and the intima looks healthy. For partially or completely cut arteries, excision and end to end anastomosis is done for arteries with a loss of no more than 1-2 cm. Mobilization of the artery proximally and distally with division of the side branches were used to provide additional length. For arteries with significant loss of length in whom direct end to end anastomosis is impossible or possible but with excessive tension that endangers vascularity or the anastomosis, then an interposition graft either reversed saphenous graft (RSVG) or synthetic graft (PTFE) is used. Ligation was done for cases with extensive soft tissue, bone fractures, venous and nerve injury in whom there is no hope for the limb to retain viability, also it is done for cases with delayed presentation and non viability of the muscles approved peroperatively. In our patients, excision with end to end anastomosis was the commonest repair method being used, 84 patients (77 %) while 14 patients (12.8 %) had underwent interposition of a graft whether synthetic or reverse Saphenous. Subasi[6] and Haba[7] have used more grafts in their patients than we had in ours 71 % and 53.75 % respectively.

In our study, 54 patients (87 %) with venous injury were treated by ligation of the veins while in only 8 patients (13%) venorrhaphy were attempted. Haba[7] reported ligation of the veins in 26 % of patients while venorrhaphy was attempted in 40 % of patients. Our tendency for ligation of veins is based on the fact that thrombosis is eventual in cases that have been treated by an interposition graft or even end to end anastomosis although small injuries without loss of tissue can be treated with lateral suture. More complex repairs often fail and have no apparent advantage over ligation in most instances.[13] It should be noted that thrombosis does not occur acutely, but rather gradually over 1 to 2 weeks. Advantage can be taken of this fact because adequate collateral circulation, sufficient to avoid acute venous hypertensive complications, usually develops within several days. Therefore it is reasonable to use an interposition graft if needed (RSVG or PTFE) and accept

a gradual but eventual thrombosis while buying time for collateral circulation to develop. On the other hand, chronic venous hypertensive complications in the lower extremities can often be avoided by (1) elastic bandages carefully applied in the OR at the end of the procedure, and (2) continuous elevation of the lower extremities to 30˚. These measures should be maintained for a week. The patient is then ambulated. If no oedema occurs then the bandages removed, elevation is no longer necessary. It is a reasonable precaution to have the patient wear compressive stockings up to the knee a few months afterwards.[13]

A major point of controversy in the management of peripheral vascular trauma is the timing and method of fixation of associated bone injuries. Fractures and orthopedic surgery may cause soft tissue damage including vascular injury to vital collateral vessels and also increase risk of infection.[14] Stabilization of associated fractures may be performed before arterial repair if the procedure does not encroach on the viability of the limb and unless limb threatening ischemia was found, so vascular repair must always, if possible be repaired first.[15]

In our study, external fixation has been done in only 17 (29%) of cases while the other 42 (71%) stabilized by plaster of Paris slab immobilization, this is because of the fear of delay in re-vascularization that may be caused by the time imposed for external fixations (this can be explained by the none availability of orthopaedic team at all times due to the high frequency of major casualties secondary to explosions in many cases, and in these situations they don't have an extra team to send for the vascular department). In Subasi study 56% of patients underwent external fixation, 20% internal fixation (for closed clean blunt injuries), 24% plaster cast immobilization.[6]

Acute nerve injuries are either repaired at the time of initial treatment or are tagged and repaired later.[1] in this study none of the nerve injuries are repaired primarily, but are left for secondary intervention. Fasciotomy was done in only 20 cases (15.5 %) depending only on clinical judgment which was based mainly on the degree of limb swelling and tension (in Haba study 85 % of patients underwent fasciotomy[7]). The low rate of fasciotomy was possibly due to the fact that most cases are brought almost immediately after the trauma with less incidence of significant limb swelling and vascular compression.

Amputation has been done in 25 cases (19.5%), the main causes for amputation were extensive soft tissue damage and delayed referral. Our rate of amputation is nearly as being stated by Haba[7] 17.5 % and Sagraves 19 % .[8] Other figures are varies from as high as 40 %[11] or as low as 5.5%.[6]

The mortality in this study was 4.7 %, most of the cases died because of the effect of irreversible shock or DIC. This is nearly the same as that reported by Haba[7] 5% and Ratnayake[16] 5% and less than that reported by Jason[17] which was 8.5 %.

CONCLUSIONS

Injury of popliteal arteries are not uncommon in our surgical practice. It is mainly caused by bullets and shells. Young men are predominant victim of such injuries. Delaying of proper surgical intervention increases the risk of amputation. Fasciotomy has been associated with lower rate of amputation while venous injuries, nerve injuries and fractures have been associated with a higher amputation rates.

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Abbreviation list: ArterioVenous Fistula (AVF), Plaster Of Paris (POP), Poly Tetra FloruEthyline (PTFE), Reversed Saphenous Vein Graft (RSVG).

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