Original Article

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Surgery Section

Aetiology and Management of Vascular Injuries in Extremity Trauma: An Observational Study

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ABSTRACT

Introduction: Management of peripheral vascular injury is a challenging task. To save life and to salvage the limb, early diagnosis and prompt intervention is required.

Aim: To analyse the cause of injury, surgical approach, outcome and complications in patients with peripheral vascular trauma.

Materials and Methods: This observational study assessed 60 consecutive patients who were operated for peripheral vascular injuries in the last one and half year (October 2018 to March 2020). Diagnostic tools were clinical examination in combination with vascular Doppler. Vascular repair with interposition autologous vein graft or primary repair was performed. Extensive injury with non-viable limb requiring primary amputation was excluded from the study. The primary outcome in form of limb salvage was selected. Fisher-exact test was used to analyse limb salvage rate between two groups having median revascularisation time less than six hours and more than six hours.

Results: In the present study there were 55 male patients (91.6%) out of 60 patients. The mean age was 24.8±7.0 years. The mechanism of injury in 28 (46.6%) cases was blunt trauma and in 32 (53.3%) cases it was penetrating trauma. The associated orthopaedic injury was present in 20 (33.3%) patients. The most commonly injured artery was brachial 26 (43.3%) followed by popliteal 13 (21.6%) and femoral artery nine (15%). Primary repair was performed in 18 (30%) cases and interposition vein graft in 42 (70%) cases. Majority of patients, 53 cases (88.3%) had functional viable limb. Complications found were wound infection in six cases (10%), revision surgery in five cases (8.3%) and secondary amputation in seven cases (11.6%). Median time interval between injury and revascularisation surgery was 9.04 hours. Those who presenting late (>6 hours) had a higher amputation rate but it was not statistically significant.

Conclusion: Management of vascular injuries require prompt localisation and early surgical intervention. A successful outcome is seen in patients who were early diagnosed. However, limb salvation is possible, even in patients with delayed presentation.

Keywords: Amputation, Repair, Revascularisation, Vessel injury

INTRODUCTION

Trauma has now become a major public health problem in developing as well as developed countries. It is the third leading cause of death. Vascular injuries account for 2-3 % of civilian trauma and around 7% of combat related trauma [1]. Peripheral vascular trauma comprises about 80% of vascular injuries manifested by fatal haemorrhage or limb threatening ischemia. The most common causes of vascular injury in extremity are penetrating trauma (bullets and knives), blunt trauma, such as Road Traffic Accidents (RTA), falls from height or iatrogenic injuries [2]. However, the mechanism of injury varies in different parts of world [3].

Arterial reconstruction for acute traumatic limb injury results in a good limb salvage rate. The salvage of life and limb following acute vascular injuries during the past three decades has been largely attributed to principles of diagnosis and therapy evolved from the cumulative military experience particularly Korean and Vietnamese wars [4]. Successful treatment not only saves life, but also restores limb function [5]. Functional recovery is often related to the presence of simultaneous injury to peripheral nerve [6].

Vascular injuries according to delay in revascularisation since the time of trauma were labeled as early or late (before six hours or after six hours of injury) [7]. The aim of this study was to assess the different mechanisms of vascular trauma, arteries involved, associated orthopaedic injuries and types of vascular repairs performed and complications associated with the management.

MATERIALS AND METHODS

This was an observational (retrospective cohort) study. Present study included 60 patients who underwent operative intervention for extremity vascular injuries over a period of one and half year period between October 2018 to March 2020. Study was performed by single vascular unit at Cardiothoracic Vascular Department of Medical College, Jabalpur.

As, it is a retrospective study hence, no new intervention was done. Study was done in accordance with the Helsinki declaration and its amendments.

Study Protocol

Present study included all patients who presented with extremity vascular injuries at emergency department. Patients with unsalvageable extremity injury and requiring primary amputation were excluded from the study. All patients were resuscitated according to advanced trauma life support protocols [8]. Relevant demographic characteristics, including age, gender, mechanism of trauma, timing of presentation, anatomical site of injury and length of hospitalisation were collected from hospital records. All patients were assessed by clinical examination. Clinical history of six P's; Pulselessness, Poikilothermia, Pallor, Pain, Paresthesia or Paralysis as well as clinical hard and soft signs of vascular injury (arterial bleeding, expending pulsatile hematoma) were used in diagnosis. It was confirmed by use of vascular Doppler. All patients underwent surgical intervention either primary repair or interposition autologous vein graft. Associated bony injury was also attended at the same time. Surgical complications were graded according to Clavien-Dindo classification. It is classification system of surgical complications. It is based on type of therapy needed to correct the complications [9].

STATISTICAL ANALYSIS

Successful outcome was recorded in form of limb salvage. All patients underwent handheld Doppler after completion of revascularisation and postoperative period. Effect of delayed presentation on limb salvage was also analysed. Analysis was done with SPSS, IBM Corp, version 21. Fisher-exact test was used to compare limb salvage rate in two groups having median revascularisation time more than six hours and less than six hours.

RESULTS

Baseline Parameters

A total of 60 patients were evaluated of whom 55 (91.6%) were males. The mean age was 24.8±7.0 years (range 5-35 years). Penetrating trauma was present in 32 patients (53.3%) and blunt trauma in 28 patients (46.6%). Overall Road Traffic Accidents (RTA), 43 cases (71.6%), was the single most common cause of extremity vascular injury in both penetrating and blunt trauma [Table/Fig-1].

Mechanism of Injury	Number of patients [N=60(%)]
Penetrating trauma	32 (53.3%)
Road Traffic Accidents (RTA)	25
Stab	6
Gun-shot	1
Blunt trauma	28 (46.6%)
RTA	18
Fall from height	5
Assault	5
Anatomic site of injury	
Axillary	2 (3.3%)
Brachial	26 (43.3%)
Radial/Ulner	6 (10%)
Femoral	9 (15%)
Popliteal	13 (21.6%)
Crural	4 (6.6%)
Length of hospitalisation (days)	14.8±5.07

[Table/Fig-1]: Details of Mechanism of Injury, anatomic site of injury and length of hospitalisation.
RTA: Road traffic accidents

Most of the patients presented with acute bleeding i.e., 32. In patients presenting with bleeding, the commonest vessel injured was brachial artery in 18 out of 32 (56.25%). Popliteal artery injury was the most common vessel involved in 12 out of 26 (46.15%) cases of acute ischemia. Interposition vein grafts were the most common methods of repair in 42 out of 60 cases (70%) [Table/Fig-2]. Associated skeletal trauma and concomitant vein injury was present in 20 patients (33%) and in 25 patients (41.6%), respectively.

Complications

The overall complication rate was 43.3% [Table/Fig-3]. Grade II complications were most common requiring blood transfusion in eight patients (13.3%). Wound infection was mostly associated with lower limb trauma and was present in six patients (10%). They were treated with appropriate antibiotic as per culture report, and frequent dressings. Four of them had Klebsilla and two of them had *E. coli* in culture report. All were treated with imipenam and amikacin. Revision surgery for vascular repair was required in five patients (8.3%) due to secondary haemorrhage. Secondary amputation was done in seven patients (11.6%).

Outcome

Limb salvage could be achieved in 53 out of 60 patients (88.3%). Cause of limb loss was graft occlusion in three patients and infection related graft failure in four patients. The median time to revascularisation was 9.04 hours. It was less than six hours in 23 patients and more than that in the remaining patients. On comparison, it was found that amputation rate was high with delayed presentation (13.5% vs 8.7%), but it was not statically significant (p=0.57) [Table/Fig-4].

Vessel injured	Direct repair	Vein graft	Number (%)
Injuries presenting with bleeding			32 (100%)
Brachial	6	12	18 (56.25)
Femoral	2	4	6 (18.75)
Axillary		2	2 (6.25)
Radial/ulner	6		6 (18.75)
Injuries presenting with acute ischemia			26 (100%)
Popliteal	2	10	12 (46.15)
Brachial	2	6	8 (30.7)
Femoral		2	2 (7.6)
Crural		4	4 (15.3)
Injuries presenting as pseudoaneurysm			2 (100%)
Popliteal		1	1 (50)
Femoral		1	1 (50)
Total	18 (30%)	42 (70%)	60

[Table/Fig-2]: Presentation and method of management of vascular trauma cases in the study.

Grade of complication	Complication	Number of patients (%)
Grade I	Wound infection (treated by opening the wound at bed side)	6 (10%)
Grade II	Blood transfusion	8 (13.3)
Grade IIIa	Intervention not under general anaesthesia	Nil
Grade IIIb	Secondary haemorrhage requiring revision	5 (8.3)
	Graft thrombosis requiring amputation	3 (5)
Grade IVa	Single organ dysfunction	Nil
Grade IVb	Sepsis requiring amputation	4 (6.6)
Grade V	Death	Nil
Total		26 (43.3%)

[Table/Fig-3]: Complications as per Calvin dindo classification in study population.

Median revascularisation time	No. of patients	Limb salvage	Limb loss	p-value
<6 hr	23	21	2	0.57
>6 hr	37	32	5	

[Table/Fig-4]: Effect of median revascularisation time on limb salvage.
Fisher-Exact test was used for statistical analysis

DISCUSSION

Now-a-days incidence of vascular trauma is increasing [10]. The most common population affected by vascular trauma was young males. It is consistent with the findings of other studies [11-13]. However, mechanism of trauma varies in different societies. Approximately, 90% of arterial injuries resulted from penetrating trauma and 10-50% occurred due to blunt injury, as per the western study [7]. In this study, we had 53% cases due to penetrating trauma and 47% cases due to blunt trauma. But in areas of civil unrest and war zones gunshot and firearm injury is the primary cause [14].

Patients may present with bleeding or they may present later with symptoms of vascular insufficiency or embolisation, pseudoaneurysm or arteriovenous fistula. In this study 32 patients (53.3%) had presented with acute bleeding, 26 patients (43.3%) had acute limb ischemia and two patients (3.3%) had pseudoaneurysm. It is consistent with the wartime study from Srilanka, where 43% patients presented with bleeding, 44% presented with ischemia and 13% presented with pseudoaneurysm [15].

Anatomic site of injuries varies in different studies [12,16]. In most studies, especially those from war injuries and road traffic injury femoral artery is the most commonly injured vessel followed by popliteal and brachial arteries [17-19]. In present study, most common injured vessel was brachial followed by popliteal artery.

The diagnosis was made based on the clinical examination and Doppler study. It reduces the time to diagnosis and cost involved in routine angiography. Case based approach was applied in this study. Number of trials has shown that clinical examination alone is sufficient for the diagnosis of vascular injury in acute situations [20]. This study had six cases of multiple external injuries and with soft signs of vascular injury. Angiography was done in these cases. Ramanathan A et al., and Hafez HM et al., also has suggested that angiography is required to identify the site of arterial injury in these types of situations [21,22].

In patients with concomitant bone injury, skeletal fixation was done mostly external followed by vascular repair. It is strongly advocated in some series [23]. While some studies have mentioned the importance of reducing ischemia time by proceeding with vascular reconstruction first [16,22,24].

Mechanism and anatomical site of injury usually determines type of reconstruction. Depending on these two factors, frequency of reconstruction methods varies [25]. In this study, vascular reconstruction was performed by using an interposition vein graft mostly.

In this series, median revascularisation time was 9.04 hours. Amputation rate was high with delayed presentation but not statistically significant. As reported in the literature, the significant factor associated with increased limb loss is the time lapse demonstrated between injury and operation [26,27]. The increased time interval decreases successful outcome of repair due to progressive ischemia and thrombosis. The clinical implication of this study is that the prompt and precise management of vascular injury improves patient survival and limb salvage. This study has demonstrated it even in delayed presentation.

Limitation(s)

Small sample size, lack of comparison, randomisation and retrospective design were the limitations of the study. In this study angiography was performed only in six cases with multiple external injuries and with soft signs of vascular injury.

CONCLUSION(S)

Young males were most common sufferers from vascular injury in present center. The most common etiology was penetrating trauma due to RTA. Brachial artery was the most common vessel injured and active bleeding was the most common presentation. Limb salvage rate in patients having median revascularisation time less than six hours was 91.3% and for those more than six hours it was 86.4%. The delayed presentation of vascular trauma should not be denied for surgical intervention. An aggressive approach should be continued to salvage the limb after establishing muscle viability.

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