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Outcomes of Popliteal Artery Injury; Level 1 Trauma Center Experience from Pakistan

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ABSTRACT

Background: Traumatic vascular injuries, especially popliteal artery injuries, carry a high risk for limb loss which poses a major healthcare problem for patient management in the developing world. **Aims:** This study is aimed to investigate the outcomes after traumatic popliteal artery injuries. Our primary objective was to evaluate limb salvage. Secondary objectives included evaluating postoperative functional outcomes at 3 and 6 months. **Methods:** A retrospective study was conducted at the Department of Vascular & Endovascular Surgery SMBBIT, Karachi from January, 2020 to December, 2022 after ethical review. All patients with a proven popliteal artery were included and data was collected regarding the patients' demographics, mode of injury, time since injury, coexisting injuries, and peri-operative complications. **Results:** We identified 103 cases of Popliteal artery injury, including 96% (n=99) males, with a mean age of 30 +/- 12.75 years. The commonest mechanism of injury was firearm assault totaling 59.2% (n=61). The median (IQR) time since presentation was 10 hours. 31.1% (n=32) cases presented within 6 hours of injury. RGSV interposition graft repair was undertaken in 70.9% (n=73) cases while the rest underwent primary amputation (25.2%, n=26) or Popliteal artery ligation (3.9%, n=4). The mean length of stay was 9.0 days (Median 7.0). We recorded a single post-operative mortality (0.9%). At 3- months follow up, 3 patients had undergone a secondary amputation. 18 cases were complicated by wound infections needing debridement. At 6 months, 68.1% were fully ambulating independently fully whereas 23.4% of the patients were ambulating with difficulty. Limb salvage rates were comparable for patients presenting initially to our hospital and referred cases. **Conclusions:** In conclusion, popliteal artery injuries remain a significant challenge with difficult limb salvage. Early diagnosis, prompt intervention, and meticulous wound care are crucial for optimizing.

INTRODUCTION

Vascular trauma is one of major causes of mortality and morbidity constituting significant yet preventable cause of death after injury.[1] Traumatic vascular injuries poses a major healthcare problem for patient management in third world countries, constituting around 3-5% in civilian population.[2, 4]. The popliteal artery is one of the most commonly injured vessels resulting from wide range of mode

of trauma [3, 4]. It only has a few collateral branches which, if compromised, poses a risk of severe ischemia for the distal lower extremity. [5] It is thus, that of all peripheral vascular injuries, popliteal artery injuries are associated with the highest risk of amputation.[6] The literature varies regarding most common mode of presentation; however, studies done in subcontinent showed blunt trauma to be most common cause of injury.[7] Popliteal artery injuries (PAI) are usually coupled with fracture mechanisms, concomitant soft tissue injury, and posterior knee dislocation causing traction or avulsion of the vessel,[5,6] with amputation rates ranging between 10 and 50% .[10] On the contrary, penetrating injuries are less common and tend to have a better outcome, with limb salvage rates of up to 84%.[8,6]

PAI requires early diagnosis and management for patients with hemostasis, arterial repair, venous injury, and fasciotomy. Popliteal artery injuries are critical for early repair before ischemia sets in, reducing limb loss. Alerhayem et al. [11] recommend re-vascularizing lower limbs within 6 hours of injury, as the optimal time to ischemia is typically 6 hours. Although CT angiogram and damage control techniques have improved prognosis [9], limb loss from calf muscle necrosis remains a significant threat.[10]

Role of multidisciplinary team (MDT) clinical assessment to traumatic injuries is associated with improved morbidity and decreased in-hospital mortality.[13] In spite of the nation's salient public issues boiling down to a lack of awareness of traffic laws, rash driving, underdeveloped architecture and worsened by a rise in urban violence, there is limited data from Pakistan on Popliteal Artery Injuries.[14] Vascular surgeons in Pakistan are scarce, [12]therefore knowledge of these injuries is important for early referral and improved outcomes.

This study was aimed to assess the different modes of presentation, management strategies offered and outcomes of popliteal artery injury in terms of limb salvage and functional status at 3 months and 6 months.

As Shaheed Mohtarma Benazir Bhutto Institute of Trauma is one of the high flow referral center for vascular trauma in the province. Therefore, the data from our study is expected to shed light on contemporary findings of presentation and outcomes of this devastating vascular injury from local perspective.

METHODOLOGY

A retrospective observational study for the period January 2020 to December 2022 will be conducted. Patients with popliteal artery injury who were admitted and operated on by the Department of Vascular & Endovascular Surgery at Shaheed Mohtarma Benazir Bhutto Institute of Trauma (SMBBIT), Karachi from January 2020 till December 2022 will be included in the study. Data will be extracted from the files based on ICD and CPT coding using popliteal artery injury/vascular injury as searching theme after approval from the Institutional Ethical Review Committee (ERC). Data will be recorded on predesigned proforma, attached in annexure noting patient demographics, age, mode of presentation, cause of injury, and time since injury. The hemoglobin level at presentation as well as bleeding, pulse status and calf swelling at presentation will also be noted. Discharge cards and files will be used to extract information on primary procedure, need of secondary procedure and ICU stay. Functional status of the patients, having been assessed on follow-up at 3 months and 6 months in OPD and ward and included in patient files, will be assessed using the attached questionnaire.

Inclusion and Exclusion criteria

Patients with age ≥18 years, having injury to popliteal vessels with or without soft tissue and orthopedic injuries, having undergone revascularization or vascular ligation in the Department of Vascular and Endovascular Surgery between January 2020 and December 2022 will be included in the study.

Patients with popliteal arterial injury below 18 years of age, those who underwent initial repair of vessels outside the SMBBIT, those presented with nonviable limb and underwent primary amputation or patients who expired before repair will be excluded from the study. Patients not providing consent, those with missing data on outcomes and patients not presenting in follow-ups or lost to follow-ups will also be excluded from the study.

Statistical analysis carried out with the statistical package for social sciences (SPSS) version 26 software. The number variables e.g. age, GCS, hemoglobin at presentation, etc., expressed

as means and standard deviations, while categorical data like gender, mechanism of injury, type of surgery, complication etc as frequency and percentages. Continuous variables will be compared using the Student's t-test and categorical variables by using Chi-square/Fischer's Exact test. The p-values of ≤ 0.05 will be considered significant. When assessing the limb loss, binary logistic regression analysis will be performed calculating odds ratio (OR), 95% confidence interval (CI) and p-value ≤0.05.

RESULTS

We identified 103 cases of Popliteal artery out of which more than 96% (n=99) were males and less than 4% were females (n=4). The mean age was 30 +/- 12.75 years. More than 98% of these patients (n=101) were received in the ER. The remaining 2 injuries were taken on in the Vascular OPD. One of these patients had an AV fistula of the popliteal artery & vein after a history of gunshot and the other had developed a traumatic Pseudo-aneurysm of the Popliteal Artery 2 months after a fall. The most common mechanisms of injury were due to firearms totaling 59.2% (n=61), followed by 37.9% of RTAs (n=39), and 2.9% (n=3) of falls. All of the patients in our study arrived in an alert state, with a GCS of 15/15.

Figure 1

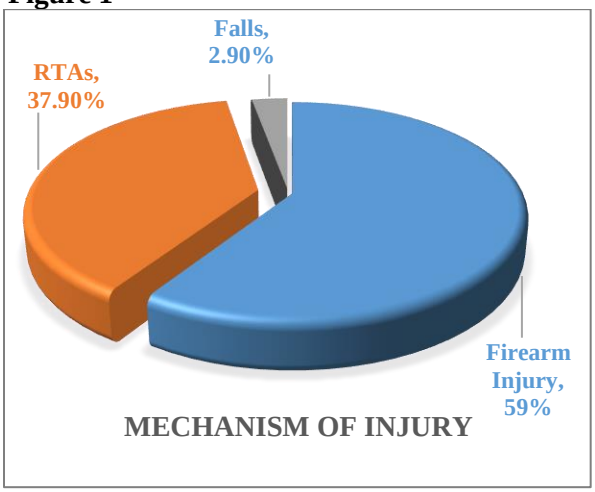
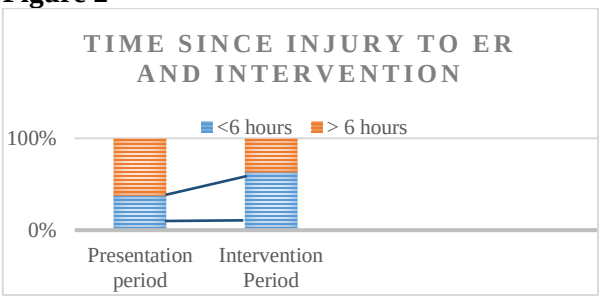


Table 1

Variable		n (%)
Total no of cases of Popliteal artery injury		103
Gender	Male	99 (96%)
	Female	4 (4%)
Presented via	ER	101 (98%)
	OPD	2 (2%)
Mechanism of injury		
Firearm		61 (59.2%)
Road traffic accident		39 (37.9%)
Fall		3 (2.9%)
Time of Presentation		
Median (IQR) time		10 hours
Within 6 hours of injury		32 (31.1%)
After 6 hours of injury		53 (51.5%)
Intervention time after initial presentation		
Within 6 hours		17 (62.9%)
After 6 hours		10 (37.1%)
Primary Procedure		
Popliteal artery repair with autogenous great saphenous vein graft		73 (70.9%)
Above knee amputation		26 (25.2%)
Popliteal artery ligation		4 (3.9%)
Concomitant Injuries		
Venous		26 (25.2%)
Bony		45 (43.7%)
Intervention in case of bony injuries	External fixation	35%
	ORIF	4.9%
	POP back slab	3.9%
Patients who came for follow up		
With primary repair		33 (42.85%)
With primary amputation		14 (53.84%)
Secondary Amputation required		3 (9%)
Stump wound debridement secondary to infection		18
Ambulatory status at 6 months		
Fully independently		68.1%
With difficulty		23.4%
Non-functional		3
Mobile independently post amputation		13 out of 14

The median (IQR) time since presentation was 10 hours and only 31.1% (n=32) cases presented within 6 hours of injury whereas 51.5 %(n=53) presented after 6 hours of injury. The data on time since injury was was found to not be recorded in 17.5% of cases (n=18). We also recorded the response/intervention time which showed that among patients who presented within 6 hours, only 62.9%(n=17) were taken to the OR within the initial 6 hour window, the remaining 37.1% (n=10) patients were taken to the OT late than the 6-hour threshold.

Figure 2



The median (IQR) hemoglobin at presentation was 9.4 (2.24 Std. dev) g/dL. 21.4 % of our subjects did not receive any transfusion whereas all remaining 78.6% of patients received at least 1(32%) and a maximum of 4(2.9%) red cell transfusions.

Table 2

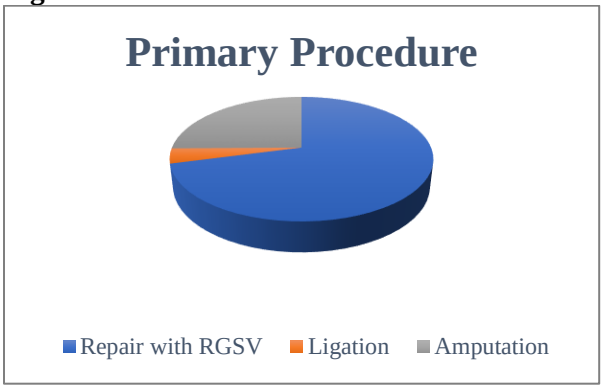
Parameters	
Median Hb at presentation	9.4 mg/dL
Fractures	43.7 %
Deep Venous injuries	25.2 %
Fasciotomy	55.3 %
Anesthesia	88.3 %

Popliteal artery repair with autogenous great saphenous vein graft was undertaken in 70.9% (n=73) cases while primary major amputation (above knee in all cases) was performed in 25.2% (n=26) patients. 3.9% (n=4) of the patients had undergone ligation of the Popliteal Artery.

Concomitant venous injury and fractures of the affected limb were encountered in 25.2%(n=26) and 43.7%(n=45) cases respectively. Bony injuries were treated with an Ex-Fix (35%), ORIF(4.9%) and POP back-slab(3.9%). Venous injuries were addressed by ligation of the lacerated popliteal vein in all 26 patients. The mean length of stay was 9.0 days (Median 7.0). There was a single post-operative mortality (0.9%).

Of the 77 patients that did not undergo a primary amputation, we were able to retrieve follow up data for 33 patients (42.85%). At 3-months follow up, 3 patients had undergone a secondary amputation. 14(53.84%) of the 26 patients who had underwent primary amputation could be followed up. 5 of these patients had needed a debridement and 1 needed proximalization of the amputation stump.

Figure 3



18 cases were complicated by wound infections needing debridements. At 6 months, 68.1% were fully ambulating independently fully whereas 23.4% of the patients were ambulating with difficulty. 3 patients were known to have a non-functional ambulatory status of whose 2 had underwent primary above knee amputation and 1 had underwent ligation of the popliteal artery.13 of the 14 patients were mobile independently post amputation.

Age, gender, mechanism of injury or arrival hemoglobin had no statistically significant impact on limb salvage. Similarly, concomitant bony or venous injury were found to have no association with limb loss. Limb salvage rates were comparable for patients presenting initially to our hospital and referred cases.

DISCUSSION

Popliteal artery injuries pose a significant challenge in trauma surgery, with most cases resulting in substantial morbidity, oftentimes leading to limb loss (1). Our study, which was conducted at a Level-1 trauma center in Pakistan, offers valuable insights into the immediate and mid-term outcomes of such injuries. The findings of our paper highlight key factors influencing patient outcomes. These include the mechanism of injury, initial management techniques, and the timing of revascularization efforts.

The demographic profile of our study population was predominantly young males, aligning with previous reports.(4) Contrary to previous literature however, The most common mechanisms of injury found in our study were firearm-related followed by road traffic accidents.(2,3) This pattern reflects the broader epidemiological trends of trauma in Pakistan, where firearm injuries and RTAs are common causes of severe vascular trauma.(5)

Most of our patients presented well over 6 hours after the injury. These delays likely reflect upon the poor emergency services and ambulance infrastructure in Pakistan (7). Moreover, a majority of patients had been referred from other healthcare setups, with nearly half coming from outside the city. This highlights the disparity in healthcare access and the limited resources available outside of major urban centers in Pakistan. These delays in accessing adequate healthcare may contribute to a

significantly increased risks of complications, as early intervention is crucial for successful revascularization and limb salvage.(6) Our study also highlighted a crucial gap in intervention time in 37.1 % (n=10) patients who had presented to the ER within 6 hours but were taken to the OR after the initial 6 critical hours. This gap likely represents the investigation period and is consistent of inefficient and/or resource-poor settings. (7)

One of the critical factors in determining the outcome of popliteal artery injuries is the presence of viable distal circulation upon presentation. Our data revealed that 100% of patients lacked detectable popliteal and pedal pulses upon presentation, a finding that highlights the severity of trauma ischemia in this patient population. Despite this, nearly 71% of patients did not exhibit calf swelling. This suggests that clinical signs can vary widely and should not solely guide management decisions. (8) Early surgical intervention, as shown in our study, remains a key strategy for optimizing outcomes. (9)

In our cohort, Fasciotomy was performed in around 55% of patients; this was done either prophylactically or in selective patients, to overcome clinical signs of compartment syndrome. The combined percentage of fasciotomies, both prophylactic and selective is similar to the concurrent practice and literature. (10)

The rate of primary amputation in our study (25.2%) was approximately the same when compared to other studies in similar setups. (3) While we achieved a considerable limb salvage rate, a substantial number of patients required primary or secondary amputations. Moreover, wound infections emerged as the common complication, in 17.5% of cases, potentially contributing to delayed healing and an increased risk of amputation. This underlines the complexity of post-operative management in such cases, where even initial success in revascularization can be offset by mid-term complications. (11)

At the six-month mark, our data showed that 68.1% of patients were fully ambulatory, while 23.4% faced challenges with mobility. We report a modest improvement in ambulatory status compared to contemporary evidence (30.6-60%) that suggests a substantial proportion of patients experience significant functional limitations after such injuries, even when limb salvage is achieved. (12, 13, 14) The presence of associated injuries, prolonged ischemic times, and delayed rehabilitation likely contribute to these outcomes

Limitations

When assessing the findings of our research, It is vital to keep in mind the limitations faced. Our findings reflect those of a single trauma center and are based on a small sample size that limits the generalizability of our findings. Additionally, the long-term follow-up data is limited as many patients were lost to follow-up. This prevents a comprehensive assessment of long-term functional outcomes.

CONCLUSION

In conclusion, popliteal artery injuries remain a significant challenge in trauma surgery. Despite advances in surgical techniques and perioperative care, limb salvage remains difficult in many cases. The situation is further marred by poor ambulation despite limb salvage, which warrants further curious investigations. Early diagnosis, prompt intervention, and meticulous wound care are crucial for optimizing outcomes. Considering the significant impact of these injuries on patient morbidity and mortality, further research is warranted to explore strategies for improving long-term outcomes.

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