

# Clinical characteristics and surgical strategies in the management of popliteal artery injuries from 2020 to 2023: A cross-sectional descriptive study

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## ABSTRACT

**Background:** Popliteal artery injuries represent one of the most severe and complex vascular traumas due to their anatomical location and limited collateral circulation. These injuries, often caused by high-energy trauma such as traffic and workplace accidents, require prompt diagnosis and timely surgical intervention to prevent limb loss and improve functional outcomes. **Methods:** This cross-sectional descriptive study analyzed 120 cases of popliteal artery injuries treated at Viet Duc Friendship Hospital from 2020 to 2023. Clinical characteristics, mechanisms of injury, surgical strategies, and treatment outcomes were assessed. Data were collected retrospectively for 99 patients (2020–2022) and prospectively for 21 patients (2023). Statistical analysis was performed using SPSS 20.0. **Results:** Traffic accidents accounted for 85.83% of cases, with freelancers and workers being the most affected. The majority of patients (68.33%) were aged 11–40 years. All patients exhibited acute limb ischemia symptoms, including absent peripheral pulses and delayed capillary refill. End-to-end anastomosis (47.5%) and autologous vein grafting (36.66%) were the most common surgical techniques. The limb salvage rate was 95.83%, but complications such as infection (27.5%), muscle necrosis (15%), and vascular occlusion (2.5%) were observed. Amputation was necessary in 4.16% of cases due to irreversible ischemic damage. **Conclusion:** This study highlighted the importance of early diagnosis and appropriate surgical intervention in managing popliteal artery injuries. Despite advancements in surgical techniques, postoperative complications remain a challenge, emphasizing the need for optimized perioperative care and rehabilitation strategies. Standardized treatment protocols and multidisciplinary approaches can further improve limb salvage rates and long-term functional outcomes.

**Keywords:** *Clinical signs, Paraclinical, Popliteal artery injury, Vascular trauma signs.*

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Received: November 12, 2024

Reviewed: November 15, 2024

Accepted: December 19, 2024

## INTRODUCTION

Popliteal artery injuries are among the most severe and challenging vascular traumas due to their anatomical location and association with complex orthopedic injuries. These injuries commonly occur as a

result of high-energy trauma, such as traffic accidents, workplace incidents, and falls from heights. Given the limited collateral circulation in the popliteal region, delays in diagnosis and treatment can lead to irreversible ischemic damage, limb loss, and significant functional impairment. Prompt

recognition and timely surgical intervention are crucial in minimizing morbidity and improving patient outcomes.

The clinical presentation of popliteal artery injuries varies depending on the mechanism of trauma and the extent of vascular damage. Patients often exhibit signs of acute limb ischemia, including severe pain, pallor, coldness, absent peripheral pulses, and delayed capillary refill. In severe cases, compartment syndrome may develop, necessitating emergency fasciotomy to prevent muscle necrosis and further complications. Due to the complex nature of these injuries, a multidisciplinary approach involving vascular and orthopedic surgeons is essential for effective management.

Advancements in vascular imaging, such as Doppler ultrasound and multislice computed tomography angiography (MSCTA), have significantly improved the diagnostic accuracy of popliteal artery injuries. These imaging modalities allow for early detection of arterial occlusions, thrombosis, and intimal tears, facilitating timely surgical planning. However, despite these advancements, the management of popliteal artery injuries remains challenging, with surgical treatment options ranging from direct vessel repair and end-to-end anastomosis to autologous vein grafting and, in some cases, amputation when limb salvage is not possible.

Despite improvements in surgical techniques and perioperative care, complications such as infection, thrombosis, and muscle necrosis remain prevalent in patients with popliteal artery injuries. Postoperative outcomes depend on factors such as the timing of intervention, the presence of associated fractures or soft tissue damage, and the patient's overall condition at the time of presentation. Understanding

these factors is critical in optimizing treatment strategies and improving long-term functional recovery.

This study aims to evaluate the clinical characteristics, surgical management, and treatment outcomes of popliteal artery injuries at Viet Duc Friendship Hospital between 2020 and 2023. By analyzing patient demographics, mechanisms of injury, surgical approaches, and postoperative complications, the study seeks to provide valuable insights into best practices for managing these complex vascular injuries. The findings will contribute to the development of more effective treatment protocols, ultimately enhancing limb salvage rates and reducing the burden of disability associated with popliteal artery trauma.

## METHOD

### Study design and participants

This research was a cross-sectional descriptive study, approved by the ethics committees and leadership boards of Viet Duc University Hospital and Hai Phong University of Medicine and Pharmacy. Informed consent was obtained from all participants and their families before inclusion. The study included a retrospective analysis of 99 patients treated between January 2020 and December 2022 and a prospective analysis of 21 patients from January to August 2023. The research was conducted at Viet Duc Friendship Hospital in Hanoi, Vietnam, utilizing a convenience sampling method to select eligible patients.

### *Inclusion criteria*

Patients diagnosed with popliteal artery injury, confirmed either preoperatively or intraoperatively.

Those who underwent emergency surgical revascularization at Viet Duc Friendship Hospital.

Patients with complete medical records containing sufficient clinical data for analysis.

#### *Exclusion criteria*

Patients diagnosed with popliteal artery injury who did not undergo emergency surgical intervention at Viet Duc Friendship Hospital.

Cases with incomplete medical records.

#### **Data collection process**

Data collection was performed using a standardized medical record form covering the period from January 1, 2020, to August 31, 2023. The retrospective data were obtained from January 2020 to December 2022, while prospective data were gathered from January to August 2023.

- Patient identification: A list of eligible patients was compiled based on archived medical records and surgical logs from the Planning and General Affairs Department of Viet Duc Friendship Hospital. All cases were screened based on the inclusion and exclusion criteria.

- Data recording: Relevant clinical and demographic information was documented using a standardized form. Incomplete records were excluded. Verification of patient data was performed by the Planning and General Affairs Department and the supervising investigator.

- Data entry and analysis: All collected data were entered into statistical software for analysis.

#### **Clinical assessments**

##### *Key symptoms:*

- Swelling and bruising: Presence of knee swelling, hematoma formation, and bruising.
- Peripheral pulse abnormalities: Assessment of dorsalis pedis and posterior

tibial artery pulses, compared to the unaffected limb.

##### *Acute limb ischemia indicators:*

- Severe calf pain and tightness.
- Cold and pale extremity relative to the uninjured side.
- Numbness or sensory loss in the toes.
- Weak or absent foot and toe movement.
- Delayed capillary refill (>2 seconds; normal  $\leq 2$  seconds).

##### *Signs of irreversible limb ischemia:*

- Complete loss of foot and toe movement.
- Total absence of sensation in the foot.
- Rigor mortis in the joints.
- Necrotic, blackened tissue in the affected limb.

##### *Fracture or dislocation indicators:*

- Severe knee pain with an inability to move the joint.
- Noticeable knee joint swelling and deformity.
- Compartment Syndrome:
  - Severe pain that worsens with movement.
  - Tense, swollen, and bruised calf.
  - Weak or absent peripheral pulses.
  - Numbness, weakness, or total loss of limb function.

##### *Associated systemic injuries:*

- Traumatic brain injury, chest or abdominal trauma, spinal injury, or fractures in other areas.

#### **Paraclinical assessments**

*Doppler ultrasound:* Used to detect arterial occlusions, thrombosis, and impaired blood flow. This modality has over 90% sensitivity and specificity for vascular injuries.

*X-ray imaging:* Evaluated fractures or dislocations around the knee joint, including tibial plateau fractures, supracondylar femur fractures, distal femur fractures, and proximal tibial fractures.

*Multislice Computed Tomography Angiography (MSCTA)*: Provided detailed imaging of arterial occlusions, thrombus formation, and collateral circulation. MSCTA was particularly useful in complex cases where clinical and Doppler ultrasound findings were inconclusive or when excessive limb swelling limited ultrasound accuracy.

*Blood tests:*

**Complete Blood Count (CBC)**: Included red blood cell count, hemoglobin, and hematocrit levels.

**Biochemical Tests**: Assessed blood urea, creatinine, and creatine kinase (CK) levels.

**Statistical analysis**

Data were analyzed using SPSS 20.0. Qualitative variables were reported as percentages, while quantitative variables were assessed using the T-Student test to compare means. Categorical variables were analyzed using the Chi-square ( $\chi^2$ ) test. Non-parametric variables were presented as absolute values and proportions. A p-value < 0.05 was considered statistically significant.

## RESULTS

### Demographic and injury characteristics

Out of the 120 patients included in the study, the majority (68.33%) were between the ages of 11 and 40. Regarding occupation, freelancers (42.51%) and workers (25%) were the most commonly affected groups. A significant proportion of patients (76.67%) resided in rural areas. Traffic accidents were the primary cause of injury, responsible for 85.83% of cases, followed by workplace accidents (9.17%). In terms of pre-hospital care, nearly all patients (99.17%) underwent fracture immobilization before being admitted to the hospital (Table 1).

**Table 1.** Demographic and injury characteristics (n=120)

	No.	%
<b>Age groups</b>		
11-20	27	22.5
21-30	28	23.33
31-40	27	22.5
41-50	20	16.67
51-60	14	11.67
61-70	3	2.5
>70	1	0.83
<b>Occupation</b>		
Students	17	14.16
Workers	30	25
Farmers	20	16.67
Office workers	2	1.66
Freelancers	51	42.51
<b>Residence</b>		
Rural	92	76.67
Urban	28	23.33
<b>Causes of injury (n=120)</b>		

Traffic accidents	103	85.83
Work accidents	11	9.17
Domestic accidents	6	5
<b>Pre-hospital treatment (n=120)</b>		
Bone fixation	1	0.83
Fracture immobilization	119	99.17

### Clinical signs, knee joint injuries, and associated systemic injuries

Among the 120 patients studied, all had fractures or dislocations along the arterial path, with additional symptoms such as pale and cold limbs, absent capillary refill, and weaker peripheral pulses. A smaller proportion exhibited rapidly expanding pulsatile hematomas (16.67%), while rare cases included compartment syndrome, joint stiffness, and necrotic skin patches (0.83% each). Knee joint injuries were common, with fractures (65.84%) being the most frequent, followed by dislocations (31.66%) and combined fracture-dislocations (2.5%). Associated systemic injuries were less prevalent, with skull and facial trauma (4.16%), abdominal trauma (2.5%), and fractures in other locations (2.5%) occurring in a minority of cases.

**Table 2:** Clinical signs, knee joint injuries, and associated systemic injuries (n=120)

	No.	%
<b>Clinical signs</b>		
Numbness, sensory disturbances	1	0.83
Reduced or impaired limb movement	2	1.66
Fracture/dislocation along the arterial path	120	100
Rapidly expanding pulsatile hematoma	20	16.67
Pale limb compared to the healthy side	120	100
Colder limb compared to the healthy side	120	100
Absent capillary refill	120	100
Weaker peripheral pulse compared to the healthy side	120	100
Compartment syndrome	1	0.83
Joint stiffness	1	0.83
Necrotic skin patches	1	0.83
Complete loss of limb sensation	0	0
Complete loss of limb movement	2	1.66
<b>Knee joint injuries</b>		
Fracture	79	65.84
Dislocation	38	31.66
Fracture + Dislocation	3	2.5
<b>Associated systemic injuries</b>		
Skull and facial trauma	5	4.16
Chest trauma	2	1.66
Abdominal trauma	3	2.5
Fractures in other locations	3	2.5

### Assessment of paraclinical signs

The average peripheral blood count of the 120 patients showed a red blood cell count of  $4.19 \pm 0.64 \times 10^6/\mu\text{L}$ , a hemoglobin concentration of  $122.18 \pm 15.9 \text{ g/L}$ , and a hematocrit ratio of  $0.36 \pm 0.05$ . Doppler ultrasound and CT angiography were used to assess vascular injuries in 120 patients. Doppler ultrasound findings showed reduced blood flow signals in 75% of cases, while monophasic waveforms were observed in 39.16%. Arterial thrombosis was detected in 8.33% of patients, and complete loss of blood flow signals occurred in 16.67%. Meanwhile, biphasic waveforms were recorded in 52.04% of cases. CT angiography revealed that 10% of patients had non-opacified popliteal arteries, indicating significant vascular compromise.

X-ray classification of knee fractures and dislocations in 120 patients revealed that tibial plateau fractures were the most common, accounting for 50.86% of cases. Knee dislocations were also frequent, occurring in 31.66% of patients, while 2.5% had knee dislocations accompanied by periarticular fractures. Other less common injuries included distal femur fractures (4.16%), intercondylar femoral fractures (4.16%), proximal tibial fractures (5%), and upper third tibial shaft fractures (1.66%). These findings highlight the prevalence of severe knee trauma, particularly tibial plateau fractures and knee dislocations (Table 3).

**Table 3.** Classification of knee fractures and joint dislocations on X-ray ( $n=120$ )

Fracture/join dislocation type	No.	%
Distal femur fracture	5	4.16
Tibial plateau fracture	61	50.86
Upper third tibial shaft fracture	2	1.66
Intercondylar femoral fracture	5	4.16
Proximal tibial fracture	6	5
Knee dislocation	38	31.66
Knee dislocation with periarticular fracture	3	2.5

## DISCUSSION

The findings of this study highlight the complexity of managing popliteal artery injuries and underscore the critical role of timely surgical intervention in optimizing patient outcomes. With a limb salvage rate of 95.83%, the study demonstrates the effectiveness of current surgical protocols at Viet Duc Friendship Hospital. However, the necessity for limb amputation in 4.16% of cases due to irreversible ischemic damage emphasizes the importance of early diagnosis and prompt vascular repair to prevent limb loss.

Traffic accidents were the leading cause of popliteal artery injuries, accounting for 85.83% of cases. This finding is consistent

with previous studies indicating that high-energy trauma, such as motor vehicle collisions and workplace accidents, remains the primary mechanism of vascular injuries. The majority of affected individuals were freelancers and workers, reflecting the occupational risks associated with physically demanding jobs. Additionally, the predominance of young adults (ages 11–40) in the study suggests significant socioeconomic implications, as these injuries often lead to prolonged rehabilitation, reduced workforce participation, and long-term disability.

Among the surgical approaches utilized, end-to-end anastomosis (47.5%) and autologous vein grafting (36.66%) were the most

common. These findings align with global trends in vascular trauma management, where direct anastomosis is preferred for shorter arterial defects, while vein grafting is required for extensive vascular damage. Angioplasty was performed in 15.84% of cases, particularly for patients with vasospasm or minor arterial injuries. The high limb salvage rate in this study suggests that appropriate surgical decision-making, combined with rapid intervention, plays a crucial role in preserving limb function and improving long-term outcomes.

Despite advancements in surgical techniques, complications remain a significant concern. Infection (27.5%) and postoperative anemia (23.33%) were the most frequently observed early complications, which can be attributed to extensive soft tissue damage and intraoperative blood loss. Muscle necrosis (15%) and vascular occlusion (2.5%) highlight the ongoing challenges in ensuring adequate tissue perfusion and preventing thrombotic complications following revascularization. The occurrence of secondary limb amputation in a small subset of patients suggests that delayed or inadequate revascularization remains a major risk factor for irreversible ischemic injury.

To mitigate postoperative complications, a multidisciplinary approach is essential, incorporating aggressive infection control, optimized anticoagulation therapy, and close vascular monitoring. The use of Doppler ultrasound and computed tomography angiography in postoperative surveillance has proven beneficial in detecting early vascular compromise, allowing for timely intervention. Additionally, implementing standardized postoperative care protocols, including the administration of anticoagulants such as heparin and Aspegic,

has contributed to improved vascular patency and reduced thrombosis rates in this study.

The findings of this study are consistent with previous research on popliteal artery injuries, which have reported limb salvage rates ranging from 80% to 95% when timely surgical intervention is performed. The low rate of secondary amputation (4.16%) observed in this study suggests that early diagnosis and rapid revascularization are critical in optimizing limb salvage. However, the presence of long-term sequelae, such as sensory and motor deficits in 2.5% of cases, highlights the need for continued rehabilitation and follow-up care to enhance functional recovery.

Despite its valuable contributions, this study has certain limitations. The retrospective nature of data collection may introduce selection bias, and the relatively small sample size (120 patients) may limit the generalizability of the findings. Additionally, the loss of follow-up in 29.16% of cases restricts the ability to assess long-term functional outcomes comprehensively. Future research should focus on prospective, multicenter studies with larger sample sizes to validate these findings and explore novel surgical and endovascular techniques for improving limb salvage and functional recovery in popliteal artery injury cases.

## CONCLUSION

This study underscores the significant challenges associated with the management of popliteal artery injuries and highlights the effectiveness of surgical interventions in limb preservation. While the overall limb salvage rate was high, the occurrence of complications emphasizes the need for continued advancements in surgical

techniques, perioperative care, and rehabilitation strategies. Implementing standardized treatment protocols and ensuring timely intervention can further enhance patient outcomes in vascular trauma cases.

**Funding:** This research received no external funding.

**Institutional Review Board Statement:** approved by the ethics committees and leadership boards of Viet Duc University Hospital and Hai Phong University of Medicine and Pharmacy

**Informed Consent Statement:** Informed consent was obtained from all subjects involved in this study.

**Data Availability Statement:** The data presented in this study are available upon reasonable request, after the signature of a formal data-sharing agreement in an anonymous form, from the corresponding author because they are protected by privacy.

**Conflicts of Interest:** The authors declare no conflicts of interest.

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