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REVIEW

Multidisciplinary team approach in the management of popliteal artery injury

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Abstract: Popliteal artery injuries (PAIs) remain a challenging entity and carry the greatest risk of limb loss among traumatic lower extremity vascular injuries. Operative management of traumatic popliteal vascular injuries continues to evolve. Improved diagnostic imaging and the introduction of endovascular techniques offered alternative modalities to traditional surgical management. Despite major efforts in establishing protocols and guidelines in the management of vascular trauma, optimal strategies of traumatic PAIs are still under investigation. Herein, we discussed the role of multidisciplinary team, involving trauma and endovascular surgeons, emergency department personnel, and interventional radiologists in the management of complex PAIs.

Keywords: multidisciplinary, popliteal artery injury, trauma

Introduction

Extremity vascular injuries account for ~5% of all major traumas encountered in urban trauma centers.[1] The overwhelming majority of these injuries are secondary to penetrating trauma. Popliteal artery injuries (PAIs), in particular, remain uncommon, accounting for 0.2% of all traumas, but are potentially devastating injuries with a relatively high morbidity.[1] Experience in both the military and civilian settings have remarkably improved the surgical technique and perioperative management of these lesions. Optimal outcomes can be achieved with prompt diagnosis, expedited surgical management, and coordinated multidisciplinary care.

A stepwise multidisciplinary team (MDT) clinical pathway to traumatic injuries is associated with improved morbidity and decreased in-hospital mortality.[2–4] An organized approach is of paramount importance in the expedited delivery of care between the trauma team leader and the nursing staff and subspecialties, such as interventional radiology, orthopedics, anesthesiology, emergency department personnel, and vascular surgeons.[5] Despite major efforts in establishing protocols and guidelines in the management of vascular trauma, optimal strategies of traumatic PAIs are still under investigation.[6] We aim to discuss the complex care of PAIs and the role of an MDT approach in the management of these potentially morbid injuries.

Incidence and mechanism of injury

The incidence of PAIs is well documented in the civilian trauma literature but remains uncommon even in busy urban trauma centers, only accounting for 0.2% of all traumas and an overall incidence of 5% among all vascular injuries.[1,7,8] PAI in particular has been reported as 35%–70% of all infrainguinal arterial injuries.[9,10–13]

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Major blunt trauma is associated with the transmission of force to the lower extremity that can lead to vascular, bone, nerve, and soft tissue injury.[13,14] PAIs are associated with high-energy impact injuries due to blunt mechanisms, resulting in potential debilitating orthopedic injuries as seen with posterior knee dislocations, complex tibial plateau fractures, or supracondylar femur fractures[1,14] (Figure 1). The floor of the popliteal fossa is formed by the knee joint's capsule, popliteal surface of the femur, and the fascia of the popliteus muscle. In this location, the popliteal artery becomes most susceptible to injury, especially because of osseous injuries, such as complex fractures or dislocations[1,13,14] (Figure 2). Neurovascular examination including ankle–brachial index (ABI) should be assessed before and after reduction of osseous fractures.

Major orthopedic injuries are usually secondary to blunt trauma including traction-type injuries, avulsions, or transections of the popliteal artery from the adjacent bone fragments.[13,14] The injuries are associated with increased hospital and intensive care unit length of stay.[13] These injuries require expedited multidisciplinary management usually led by a trauma surgeon to increase overall limb salvage. A review by Sciarretta et al[1,13] showed the overall contributing factors to limb loss included nerve injury and compound fractures. Surgeons with limited experience with vascular traumatic injuries should consult a senior vascular surgeon. Cases with significant soft tissue loss, orthopedic and neurovascular compromise require a stepwise MDT approach to improve limb salvage rates by surgical specialists including orthopedics, plastic surgeons, and neurosurgeons.

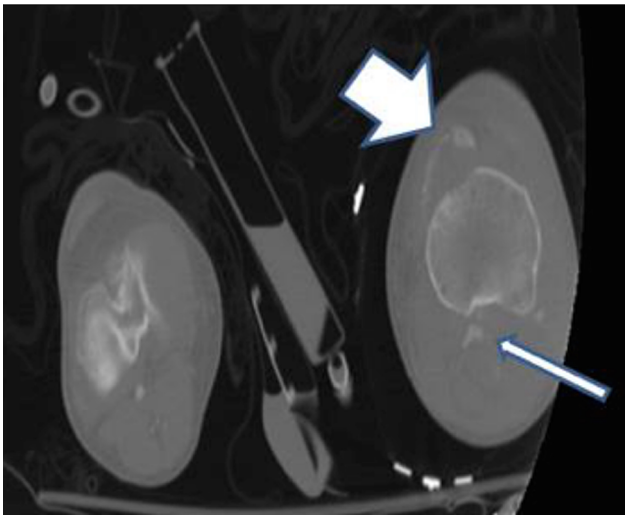

Figure 1 Tibia plateau fracture with active extravasation from the left popliteal artery.
Notes: Tibia plateau fracture (thick arrow) with active extravasation from the left popliteal artery (thin arrow).

Figure 2 A complex left open partial amputation of the lower thigh following a motor vehicle collision and ejection.

Diagnosis and clinical presentation

Early recognition of lower limb vascular injuries can improve overall patient outcomes. Immediate engagement of the trauma team is essential for early resuscitation and prevention of existing exsanguination. Hard signs of vascular injury, including hemorrhage, expanding hematomas, pulsatile bleeding, presence of bruits or thrills, and signs of distal ischemia, require immediate surgical intervention[1,13,15] (Table 1). Diagnostic procedures are frequently unnecessary and lead to delay in definitive care. Additional information may be obtained intraoperatively through the use of Doppler, Duplex ultrasound, or angiography as necessary. Evidence of cyanosis, neurological deficit, and temperature change are reliable findings predictive of vascular compromise.[1,15]

Injury to the popliteal artery can occur in the form of transection, occlusion, intimal injury, pseudoaneurysm, or fistula formation (Figure 3).[16,17] Initial evaluation requires a thorough vascular exam. A comprehensive neuromuscular

Table 1 Clinical features of vascular injury

Hard signs	Soft signs
Rapid external hemorrhage	History of arterial bleeding
Expanding or pulsatile hematoma	Proximity of wound/blunt injury to a named artery
Signs of distal ischemia	Nonpulsatile hematoma
Thrill/bruit	Neurologic deficit
Absent pulses	

Figure 3 A left posterior knee dislocation resulting in an intimal flap of the popliteal artery (arrow).

assessment should be completed by physical exam, ABI, and Doppler exam and Duplex ultrasound. If an abnormal pulse exam or ABI of <0.9 is present, additional radiographic imaging should be undertaken. Radiographic imaging with either computed tomography (CT) angiography (CTA) or formal angiography is readily available in most trauma centers (Figure 3). Conventional angiography, classically described as the "gold standard" for vascular evaluation, has largely been supplanted by CTA because of longer acquisition time and resource burden associated with subtraction angiography. However, the presence of significant shrapnel or foreign debris may obscure CT imaging by artifact scatter.[17]

There are institutional differences in the approach to the diagnosis and management of a PAI causing limb compromise. Institutional-driven protocols and MDTs expedite the management of suspected PAI to improve outcomes.[18] The orthopedic group at Case Western demonstrated in a series of 105 patients that the presence of palpable dorsalis pedis and posterior tibial artery pulses with an ABI >0.9 had a 100% negative predictive value. Likewise, they demonstrated a 99% predictive value for vascular injury with an abnormal ABI.[19] In the anatomically aligned knee with an intact distal neurovascular exam, angiography can be safely excluded.[16,20]

Early involvement of orthopedic and vascular surgeons to ensure that any vascular repair will be preserved during definitive fixation through placement of external fixators to maintain length and by providing insight into their future operative fields allows proper placement of bypasses and incisions. Early physical therapy, occupational therapy, prostheses, case management, and other team members have been previously demonstrated to improve length of stay and patient outcomes.[21]

Management

Historically, PAIs have been approached surgically in the operating room suite. Surgical literature and vascular experience may dictate treatment plans with nonocclusive PAIs. Clinically occult injuries commonly have a benign natural history and can be safely observed but with serial vascular exam.[11,22] The MDT approach with complex injuries require coordinated efforts to expedite surgical treatment. Specialty consultations may include interventional radiology or an endovascular specialist for potential minimally invasive therapy and orthopedic surgery for early stabilization and assessment of limb viability.

The orthopedic surgical team may perform open reduction and internal fixation (ORIF) of the femur to provide proper extremity alignment following vascular repair; however, we recommend restoration of blood flow prior to ORIF by temporary placement of a vascular shunt. Upon completion of ORIF, the temporary shunt may be removed and the popliteal artery can be repaired with a tension-free interposition graft. Posterior knee dislocation or "floating knees" may benefit by an interposition graft prior to any orthopedic procedures. MDT goal requires the utilization of external fixators to immobilize the knee and future ORIF when clinically improved. Occasionally, extra-anatomic bypass can provide restoration of flow if trying to avoid infected wounds or when extensive soft tissue loss is present.

Endovascular surgeons and interventional radiologists have approached PAIs selectively with successful outcomes. The literature supporting endovascular repair for lower extremity vascular injuries remains sparse and accounts for 5.9% of all treated acute peripheral arterial injuries.[23] Contraindications to endovascular approach include active external bleeding, expanding hematoma, exposed artery, suspicion of complete vessel transection, time to repair >6 hours, and

inadequate imaging equipment.[13,24,25] Challenges are met with the endovascular approach to partial transections but can be considered in selected candidates who are hemodynamically stable and without the presence of hard signs.[13,24]

Our experience

During a 6-year period, 78 traumatic vascular injuries to the popliteal vessels were analyzed: 51 (65.4%) popliteal arteries and 22 (28.2%) popliteal veins and 5 other concurrent lower extremity vessel injuries.[13] Twenty patients presented with combined popliteal arterial and venous injuries. Twenty-one patients sustained penetrating injury (19 gunshot and 2 stab wounds) 26 patients suffered blunt trauma. Concomitant injuries included bone fractures (68%), nerve injuries (8.5%), and soft tissue loss requiring muscle flaps (10.6%).

Eighteen patients (37.5%) underwent preoperative CTA. Radiographic findings included partial or total popliteal artery occlusion (50%), active extravasation (27.8%), pseudoaneurysm (5.5%), and intimal flaps (16.7%).

Patients presenting with hard signs were immediately taken to the operating room for vascular repair. In majority of cases (70.7%), reverse saphenous interposition grafting was used. Two patients (3.9%) received polytetrafluoroethylene grafting due to unsuitable autogenous grafting. Only 10.6% of patients received temporary shunts. Twenty patients (42.5%) underwent external stabilization, and fasciotomy was performed in 74.5% of cases. Eight patients (17%) underwent amputations due to their injuries. All vascular repairs were patent upon hospital discharge. The mean length of hospital stay was 35 days. The hospital stay was significantly longer in patients who had fasciotomy compared with no fasciotomy. The mortality rate was 8.5%. All of these patients underwent cardiac arrest secondary to hemorrhagic shock.

Morbidity and mortality

Overall mortality rates for these injuries ranges from 1% to 8.5%.[1,6–13] Mortality rates does not significantly differ between blunt and penetrating groups.[1,6–13,15–17,26] On long-term follow-up, many patients with successful limb salvage may demonstrate neurological disabilities associated with PAIs.[1,13] Patients experienced temporary or permanent peroneal nerve dysfunction with foot drop at discharge. Early mobilization and coordinated efforts by occupational and physical therapy provide improved recovery with muscle conditioning and strengthening.

High rates of compartment syndrome and limb loss are common sequelae of PAIs. However, the liberal use of fasciotomies can improve rates of amputation.[7,13] The decision to amputate should involve the entire MDT and, if possible, the patient when cognitively aware. Perioperative risk factors predisposing to amputation in a large series of blunt popliteal injuries included severe soft tissue injury, deep soft tissue infection, and preoperative ischemia.[1,7,13] Factors associated with limb salvage included systemic anticoagulation, primary arterial repair, and palpable pedal pulse within 24 hours.[26]

The mortality associated with lower extremity vascular trauma remains low for patients presenting with isolated popliteal vessel injury in urban trauma centers. Greater mortality results secondary to associated thoracic, abdominal, and head injuries in addition to exsanguination. Coordinated trauma care and early MDT approach starts with field triage guidelines with emergency medical services by education of early use of tourniquets and direct pressure. The liberal use of tourniquets in the field and in trauma centers has improved overall survival rates with extremity vascular injuries.

Conclusion

Traumatic PAIs are uncommon vascular injuries but carry significant morbidity despite the evolution of surgical management. Early diagnosis and prompt revascularization are required to improve morbidity and overall mortality. The clinical application and integration of an institutional MDT approach to such injuries provides a unique opportunity to improve clinical performance with the collaboration of surgical specialist while providing patient psychosocial support.

Disclosure

The authors report no conflicts of interest in this work.

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