ORIGINAL ARTICLE

TRAUMATIC LESIONS OF THE POPLITEAL ARTERY: OPEN SURGERY CONTINUES TO BE THE GOLD STANDARD

ABSTRACT

Introduction: Despite the great development of endovascular therapy even in trauma, open vascular surgery continues to be the most appropriate alternative in popliteal artery trauma due to its more frequent presentations such as hemorrhage and ischemia of the limb. The objective of this article is to reaffirm our concept in the open management of these injuries. **Material and method:** Retrospective study between the years 2016-2020, identifying 10 patients with traumatic injuries of the popliteal artery (PA) treated at the Hospital de Urgencia Asistencia Pública, a trauma referral center in Chile. **Results:** The injury mechanism was penetrating trauma in 50% of the cases and blunt in the other 50%. A complete section was found (n= 4), a partial section (n= 4) and in 2 patients there was thrombosis due to an intimal lesion. To repair these lesions, inverted saphenous vein or primary repair was performed. The mean time of ischemia was 10 hours. The fasciotomy rate was 60% in this series and there was one death. The limb salvage percentage was 100%. **Discussion:** Popliteal artery lesions represent a great challenge due to their complexity and low frequency. Early diagnosis and surgery decrease the period of ischemia and the rate of amputations. Regarding repair, primary repair or interposition with an inverted contralateral saphenous vein is recommended. Likewise, we believe that fasciotomy of the compartments plays an important role in the final result, as well as the presence of an orthopedic surgeon in case of associated bone injuries and the availability of other specialists to deal with coverage defects or nerve injury.

Keywords: *popliteal artery, open repair, amputation*

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INTRODUCTION

Peripheral vascular trauma accounts for approximately 4-6% of major traumas[1]. Although popliteal vessel trauma is infrequent, accounting for 0.2% of cases, it is associated to high morbidity and mortality if not early diagnosed and treated[1].

In general, popliteal vessel lesions are associated to significant concomitant lesions, such as soft tissue loss, fractures and nervous lesions, representing up to 65% probability of limb amputation[2]. It has been proven that limb recovery in patients with popliteal artery lesions is affected by prolonged ischemia[3]. For this reason, the fundamental principle in the treatment of traumatic popliteal artery lesions is avoiding prolonged ischemia in order to reduce the risk of irreversible ischemia and morbidity.

Open vascular surgery continues to play a significant role in the repair of these lesions, since most of them start with ischemia or hemorrhage. Although endovascular surgery is now available, it cannot be applied in cases of lesions with the presence of ischemia or hemorrhage and no long-term results are available. We are presenting here our series of popliteal artery repair with an open or traditional surgery technique.

MATERIAL AND METHODS

Retrospective study involving the period 2016-2020 using electronic records data (protocol) and written records and using as inclusion criteria: search by "popliteal artery lesion associated to reperfusion syndrome" diagnosis[4].

Ten patients with traumatic lesions of the popliteal artery were identified. Patients with superficial femoral artery and primary traumatic amputation were excluded.

Demographic variables and specific data related to the lesion and its management were analyzed, including gender, age, hemodynamic status at admission, lesion mechanism, type of vascular lesion, time of ischemia, type of vascular repair, performance of fasciotomy and complications.

In most cases the diagnosis was established by angio CT and clinical findings based on the presences of signs of vascular lesion, i.e. pulsatile bleeding, expansive hematoma and signs of ischemia. All patients were operated by a vascular surgeon.

Assessed results were: mortality, range of amputation and range of limb salvage, type of trauma, duration of ischemia, associated lesions and need of fasciotomy, management method, associated venous lesion and vascular complications.

RESULTS

Ten patients were treated during this period with the diagnosis of popliteal artery lesion, 8 men and 2 women. The average age was 32.5 years.

The specific lesion mechanism was penetrating trauma in 5 patients and blunt trauma in 5 patients. Within the blunt trauma group, the reason for consultation in 3 patients was traffic accidents (run down), one case of attack with penetrating object and one case of iatrogenesis following orthopaedic intervention. Penetrating mechanisms were gunshot lesion in 4 patients and stabbing in one case.

In our patients, 90% of cases were confirmed by angio CT of the lower limbs and angiography has been used only to revise the repair *(Figure 1)*.

FIGURE 1. Angio CT: Knee dislocation associated to popliteal artery lesion.

As for associated lesions, 7 out of 10 patients had sustained fracture or fracture-dislocation, 3 patients loss of soft tissues. Four cases presented associated lesion of the popliteal vein and 2 a nervous lesion. Ninety percent (90%) of the patients with popliteal artery lesion had significant associated lesions.

The popliteal artery presented a complete section in 4 cases, partial section in 4 cases and the remaining 2 presented thrombosis with intima lesion. The lesion was in the first portion of the artery (P1) in 4 patients, in the second portion (P2) in 5 and in the third portion (P3) in one case. In the four cases with popliteal vein lesion, the lesion presented complete section.

Reverse saphenous vein interposition was performed in 6 cases for the management of arterial lesions and primary repair in 4 cases.

Four patients required multiple surgical toilettes and dermoepidermal grafts to cover the cutaneous defect resulting from the soft tissue loss related to the trauma or the fasciotomy, with adequate results in all cases.

The average time of ischemia, defined as the time from the lesion to the reestablishment of flow after definitive arterial repair was 10 hours.

Fasciotomy was performed in 6 of the 10 cases as a prophylactic measure based on the significant soft tissue loss, prolonged ischemia and concomitant venous lesion. In the case of popliteal vein lesion, ligation was performed in 3 cases and 1 primary repair. During the postoperative period, 30% developed reperfusion syndrome and both groups of patients evolved favorably.

One patient died. This patient was admitted with a stabbing wound in the lower limb, with severe hemodynamic instability and irreversible hypovolemic shock. At the time of admission the patient presented acidosis, hypothermia and coagulopathy. Primary popliteal artery and vein was performed and the patient died during the immediate postoperative period.

The percentage of limb salvage, excluding the patient who died was 100% and only 1 patient required minor amputation (tarsometatarsal).

Average ischemia time for patients that required care as a result of a traffic accident was 10 hours, whereas in those who sought care as a result of a penetrating lesion it was 4 hours.

DISCUSION

Popliteal vascular trauma, although infrequent, continues to be a challenge due to its complexity and low frequency. The most common cause of vascular lesions in the limbs is penetrating trauma, the second is closed trauma, including traffic accidents, falls from heights and crushing lesions[5]. Vascular lesions may have devastating consequences for patients since irreversible ischemia may occur in the course of only 6 to 8 hours. Ischemia may lead to long-term morbidity or even amputation of the affected limb. It is estimated that a closed lesion of the popliteal artery results in an amputation rate of 30 to 60%[6].

Most patients in the sample are males; this may be due to the higher probability of this group of facing gunshot, stabbing scenarios or traffic accidents. Even so, results do not suggest a significantly different response based on age or sex. Most of the individuals in the study (7 patients) were hemodynamically stable at admission.

Closed trauma, due to the initial presentation, is often difficult to diagnose, for which reason a high rate of suspicion and serial clinical examination are essential, at least during the first 48 hours. Physical examination may be complemented with Doppler pressure measurements and ankle-brachial pressure index[7].

As for repair, if primary repair is not possible, it is recommended to use the reverse contralateral saphenous vein as replacement, since prosthetic grafts have generally proven to have lower patency rates and higher infection rates in penetrating trauma[8]. As for the time of vascular reconstruction with bone fixation, the literature is controversial since some authors advocate that vascular reconstruction should precede ortophaedic intervention in vascular and skeletal lesions at distal and popliteal level in trauma[9]. However, our center performs bone fixation prior to vascular repair *(Figures 2 and 3)*. Further, popliteal vascular lesions are associated with high rates of compartmental syndrome. Predominant risk factors include ischemia (> 6 hours), unrepaired vein lesions and skeletal lesions combined[10]. However, the decision to perform fasciotomy is generally of a clinical or prophylactic nature, for which reason its liberal use has been broadly advocated by some groups[10]. Our institution applies the deferred closure technique by means of vascular elastics, the Shoelace technique *(Figure 4)*. With respect to the latter, the fasciotomy rate was 60%, slightly higher than that reported by the National Trauma Data Bank which amounts to 50%[2]. The liberal use of fasciotomies seems to be associated with lower amputation rates. In this series only one patient required transmetatarsal amputation. In this way, all patients in the series preserved their limb, which may be attributed to the fact that they were managed by a vascular surgeon experienced in vascular trauma.

FIGURE 2. Gunshot popliteal artery injury. The picture shows regularization of ends prior to repair with contralateral reverse saphenous vein.

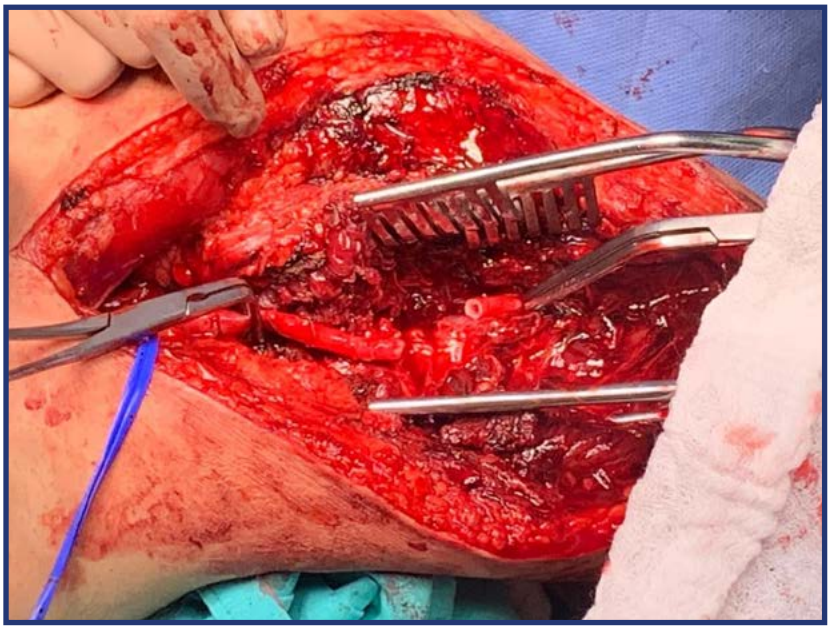
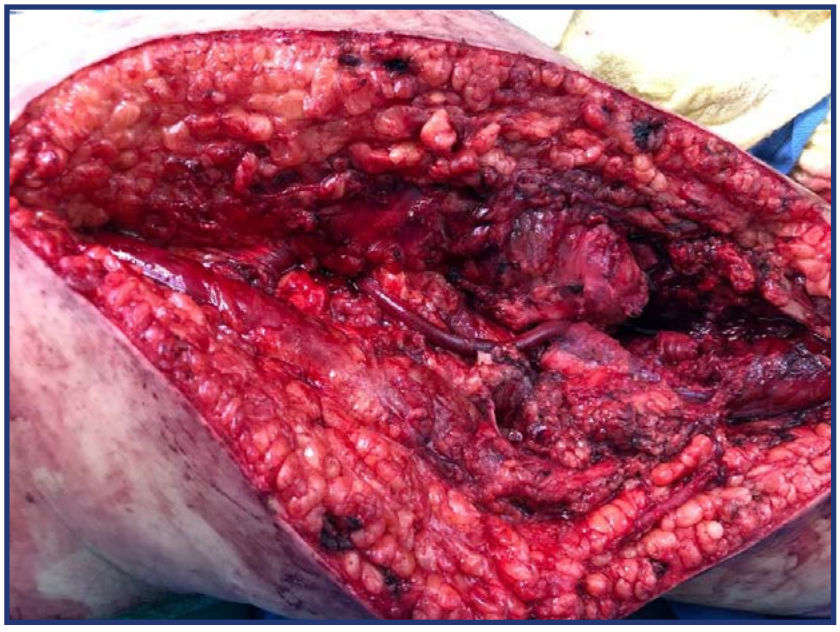


FIGURE 3. Popliteal artery lesion associated to tibial plateau fracture and fracture-dislocation of the knee. The picture illustrates the repair with contralateral saphenous vein interposition.



Some of the associated factors that lead to limb loss may be delay in vascular repair greater than 7 hours, arterial section, associated bone fracture and compartmental syndrome.

Morbidity and prolonged hospital stay is determined by fasciotomy and associated soft tissue lesions; 40% of patients required multiple surgical toilettes and dermo epidermal grafts *(Figure 5)*.

Mortality in our site amounted to 10% (penetrating lesions), similar to the rate reported in the literature that ranges from 1 to 9%[11].

As for the patient that died, we are aware of an error by having repaired artery and vein in an exsanguinated patient and we believe that we should have implemented a damage control strategy, in other words, vein ligation and the use of shunt in the artery.

As for the above described endovascular approach, it was not the choice in any patient in this case series, since some of the contraindications are active external hemorrhage, expanding hematoma, exposed artery, suspicion of complete section and time of evolution of the lesion longer than 6 hours. However, in a series published by the author in 2003, when we did not have Doppler ultrasound, angiography or angio CT available, our results were similar to these[12] and diagnosis was basically clinical.

FIGURE 4. Fasciotomy closure with Shoelace technique.

FIGURE 5. Coverage with demoepidemal fasciotomy graft performed in the context of compartmental syndrome in popliteal artery trauma.

It should be noted that these lesions required long hospitalizations, most particularly in the presence of associated lesions, mainly fracture-dislocations and soft tissue injuries. The risk of amputation increases proportionally to the time of ischemia, for which reason it is extremely important to proceed to early repair of the lesion in order to reestablish blood perfusion in the limb, preferably by means of the use of grafts with interposition of reverse autologous saphenous vein and fasciotomies as determined by the clinical evaluation of the surgeon. It is important to stress the importance of the experience of the vascular surgeon in the management of these patients; in our center exclusive management was a key factor to obtain good results.

Conflicts of interest
The authors have no disclosures to declare.

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