IJSCIA

International Journal of Scientific Advances
ISSN: 2708-7972
Volume: 5 | Issue: 2 | Mar – Apr 2024 Available Online: www.ijscia.com
DOI: 10.51542/ijscia.v5i2.22

Sapheno Femoral Graft End-to-End Anastomose due to Total Occlusion of Left Popliteal Artery: A Case Report and Literature Review

AA Gde Agung Anom Arie Wiradana[1*], Ida Bagus Budiarta[2], IGAB Krisna Wibawa[2], and Gde Rastu Adi Mahartha[3]

[1]General Surgeon, Division of Vascular and Endovascular Surgeon, Faculty of Medicine, Udayana University/ Udayana University General Hospital, (80113)

[2]Division of Vascular and Endovascular Surgery, Department of Surgery, Faculty of Medicine, Udayana University, Prof. Dr. IGNG Ngoerah General Hospital, Denpasar, Indonesia (80113)

[3]Department of General Surgery, Faculty of Medicine, Udayana University, Prof. Dr. IGNG Ngoerah General Hospital, Denpasar, Indonesia, (80113)

E-mail: anomwiradana@gmail.com; budiartaidabagus@gmail.com; krisnawibawa64@gmail.com; rastumahartha@gmail.com

Corresponding details: AA Gde Agung Anom Arie Wiradana; anomwiradana@gmail.com

ABSTRACT

Background: For patients suffering from trauma around the knee joint, the clinician should be highly vigilant about the risk of popliteal artery acute thrombosis. It is essential to promptly detect and treat acute popliteal artery thrombosis for limb salvaging. Further diagnostic procedures may be performed according to the patient's hemodynamics. Doppler should be considered done bedside, while CTA should be considered if the obstruction could not be concluded by physical examination. ***Case:*** A 40-year-old male complained of a bluish left leg, difficulty in movement, and decreased sensation. Computed tomography angiography (CTA) evaluation revealed total occlusion of the left popliteal artery. An open wound that was managed improperly was referred to a vascular surgeon in the central hospital to be further treated. The patient was hospitalized for 3 days for anastomosis monitoring and discharged uneventfully. ***Conclusion:*** Sapheno Femoral Graft End-to-End Anastomose is an effective therapeutic option in patients with total occlusion popliteal artery.

Keywords: total occlusion; saphenous femoral graft; vascular surgery

INTRODUCTION

In patients suffering from trauma around the knee joint, the clinician should be highly vigilant to the risk of popliteal artery acute thrombosis. Arterial injuries can include discolouration, intimal disruption, puncture, lateral disruption, arteriovenous fistula, and transaction. Managing a patient with multiple injuries involves two main objectives. The first is to address life-threatening issues through fluid resuscitation, haemorrhage control, and ensuring proper oxygen levels. The second goal is to repair the damaged vessel and preserve the limb. It is essential to detect and treat acute popliteal artery thrombosis in a timely for limb salvaging.

Further diagnostic procedures may be performed according to the patient's hemodynamics; Doppler should be done at the bedside.

CTA should be considered if occlusion cannot be concluded by physical examination. In this case, we report a prolonged trauma in the left calf that resulted in popliteal artery injury (complete rupture) and performed anastomosis, but the condition didn't get any better. Patients were referred to a vascular surgeon for further investigation.

CASE REPORT

A 40-year-old male patient was referred from a peripheral hospital complaining of a bluish left leg, difficulty in movement, and decreased sensation. The patient had a history of an open wound on the left calf after being hit by a rooster's spur 3 days ago. At that time, the patient was in a hypovolemic shock condition and received resuscitation treatment and exploration by a surgeon at the peripheral hospital.

During the operation, a complete rupture of the left popliteal artery, measuring 1cm in longitudinal shape, was found, and an end-to-end anastomosis was performed.

Postoperatively, a CTA evaluation revealed total occlusion of the left popliteal artery (Figure 1). The patient was referred to the Vascular Surgeon at the University Hospital for further management.

FIGURE 1: Computed tomography angiography (CTA) evaluation revealed total occlusion of the left popliteal artery.

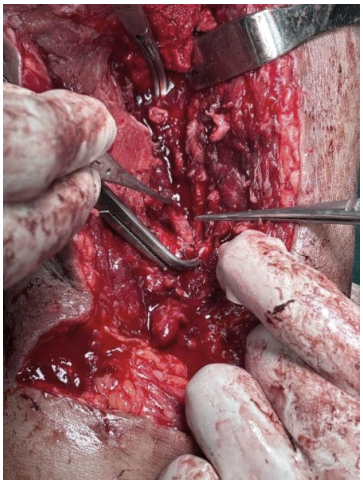

FIGURE 2: Open wound gets a total occlusion of the left popliteal artery was found, extending 3cm proximal to the branching of the posterior tibial artery.

Upon physical examination upon the patient's arrival, it was discovered that the left leg was bluish up to the knee, felt cold to the touch, and had a strong, palpable pulse in the left femoral artery. However, the pulse in the left popliteal artery was not palpable, distal saturation was unreadable, and the capillary refill time was less than 2 seconds. Laboratory support results were within normal limits. It was then decided to proceed with a re-operation for the patient.

The surgical procedure was performed under general anaesthesia. During exploration, a total occlusion of the left popliteal artery was found, extending 3cm proximal to the branching of the posterior tibial artery (Figure 2). It was then decided to perform an anastomosis. The right femoral artery was opened to search for a graft from the right great saphenous vein (Figures 3 and 4). The lumen of the left popliteal artery was refreshed by 1cm, followed by an end-to-end anastomosis with the contralateral saphenofemoral graft. During the operation, evaluation revealed a thrill (+) and bruit (+), the left foot felt warm, and there was good distal pulsation (Figures 5 and 6). A drain and backslap were applied.

FIGURE 3: Right femoral.

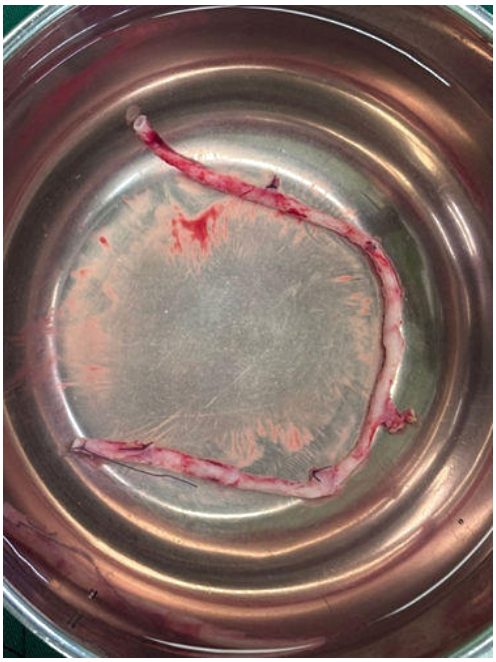

FIGURE 4: Right femoralis Saphena magma graft.

The patient was hospitalized for three days for anastomosis monitoring. The pulsation of the left femoral artery was strongly palpable throughout the wound care, and there was good perfusion in the left leg. Sensory and motor functions of the left leg were normal. The drain was removed on the 5th day of treatment, and the patient was discharged in good condition on the 7th day.

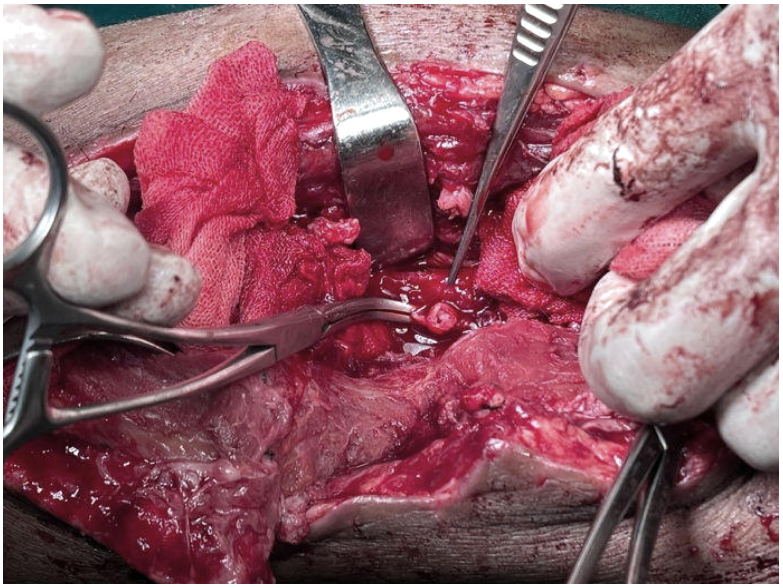

FIGURE 5: Refreshening in the left popliteal artery.

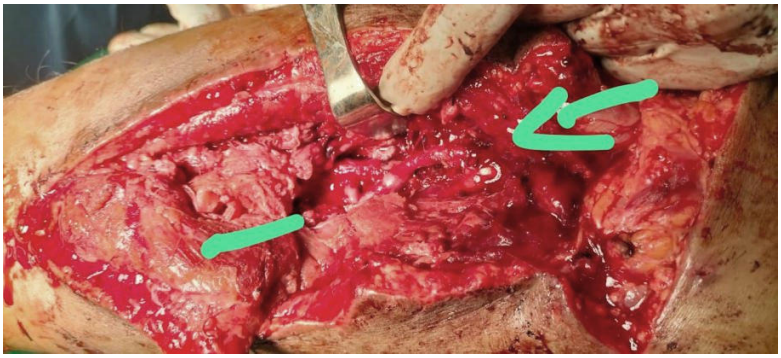

FIGURE 6: Anastomose end to end sapheno femoral Graft contralateral.

FIGURE 7: Durante operasi.

DISCUSSION

Popliteal artery injury (PAI) in the context of trauma is a seldom encountered yet significantly comorbid condition linked with enduring disability, limb amputation, and potentially fatal outcomes[1]. Acute popliteal artery thrombosis is an infrequent but limb-endangering traumatic occurrence. It may result in tissue necrosis or lower limb amputation. Clinicians should maintain a high level of alertness to the possibility of popliteal artery acute thrombosis in patients with knee joint trauma [2]. Various types of popliteal artery injury include transection, occlusion, intimal injury, pseudoaneurysm, or fistula formation [3].

Nonetheless, transection remains the most prevalent form of popliteal artery injury. A delay in its diagnosis is the leading cause of amputation in this limb-threatening injury. Failure to revascularize within 6–8 hours results in an unacceptably high amputation rate [4]. It is crucial to promptly identify and provide treatment to individuals with traumatic popliteal artery thrombosis to save the affected limb [2].

The risk of peripheral artery disease (PAD) is higher in the elderly population, patients with diabetes mellitus (DM), and smokers [5]. Atherosclerotic disease is the main cause of most PADs in the lower extremities, with the superficial femoral artery (SFA) and popliteal artery (PA) being the most commonly affected sites [6]. In a study by Godfrey et al. (2017), it was found that a patient who suffered a car crash and had a right knee dislocation experienced acute thrombotic occlusion of the right popliteal artery [7]. Occlusion of the popliteal artery can occur in approximately 30%–50% of patients with knee dislocation [8]. Additionally, iatrogenic injury can also lead to popliteal artery thrombosis. Total occlusion in the popliteal artery in a post-operative setting is not a common case, but it is considered a complication after surgery, especially in an emergency setting. A study in Japan by Imanaka et al. (2013) reports an acute thrombotic occlusion after elective total knee arthroplasty [9]. It is considered a rare but life-threatening complication. In the study, an 84-year-old woman without underlying disease and no medical history of coronary risk factors underwent a total knee replacement for left knee osteoarthritis with general anaesthesia with a medial parapatellar approach. Intraoperative was uneventful, but after surgery, her lift limb below the knee was pale, pulseless, painful, and swollen. Vascular evaluation revealed pulselessness in the left popliteal, posterior tibial, and dorsalis pedis arteries, and CECT showed an absence in the left popliteal artery with thrombus formation.

Risk factors for patients with popliteal usually are people with age older than 65 years old, BMI more than 25, history of hypertension, or peripheral arterial diseases [10,11]. On the other hand, dyslipidemia, diabetes, and smoking were also on the list [12]. All these factors indicated poor artery condition and proneness to occlusion. Individuals with a history of cancer may be at a higher risk of developing a hypercoagulable state, making them more prone to thrombosis compared to others [13]. Consequently, these individuals should be closely monitored for potential arterial occlusion following knee arthroplasty. Popliteal artery occlusion or stenosis is most commonly caused by atherosclerosis [6]. The development of atherosclerosis typically begins with an endothelial injury, triggering a cascade of cellular mediators and excessive production, ultimately forming fibrotic plaque. This plaque has the potential to calcify, rupture, or ulcerate, leading to bleeding and ultimately impeding blood flow or causing vessel thrombosis [14]. In a case reported by Dewan et al. l (2022), the patient's BMI of 36 kg/m^2 likely contributed to the severity of his injuries, which is popliteal artery transection [1]. Recent data suggest that BMI may influence the severity and sequelae of a vascular injury in the setting of blunt trauma [15].

Lower extremity pain is a frequent reason for seeking care in the emergency department. On the other hand, acute limb ischemia (ALI) is a rare occurrence. It is crucial to maintain a high level of suspicion when faced with acute limb pain, especially when it presents unilaterally. Potential causes of unilateral and bilateral leg pain encompass musculoskeletal issues (such as shin splints, stress fractures, myositis, and osteoarthritis), neurological conditions (including bilateral sciatica, cauda equina syndrome, and spinal canal stenosis), and vascular problems (such as atherosclerosis, vascular claudication, vasculitis, and thromboembolism) [16]. Additional factors contributing to leg pain may involve cellulitis, psychogenic origins, and fibromyalgia. Atherosclerosis plays a significant role in vessel narrowing and subsequent distal ischemia [17].

Physical evidence of obstruction of total occlusion of the popliteal artery is the absence of a pulse in the peripheral arteries, such as dorsal pedis and tibialis posterior, evaluation of capillary refill time, and oxygen saturation [10]. Clinical assessment of ALI should include the duration of symptoms, pain intensity, and severity of motor and sensory deficits [17]. When the six clinical signs of acute ischemia in the injured limb are observed, which include pain, pulseless, pallor, perishing cold, paraesthesia, and paralysis, it is crucial to perform imaging tests to assess the condition of the popliteal artery. In the past, angiography was considered the most reliable method for identifying blood vessel damage. Nevertheless, its utilization has decreased due to the extended time required for image acquisition and the resources needed for subtraction angiography [3].

The absence of an arterial signal indicates that the limb is threatened. Losing both arterial and venous signals means the limb may be irreversibly damaged[17]. The approach to managing suspected vascular injuries in the lower limb has shifted over time, moving from mandatory exploration to routine imaging. A study conducted in the UK by Godfrey (2017) recommended using duplex ultrasonography for screening vascular pathologies whenever possible, whether for elective procedures or emergency cases [7].

The bedside examination should also involve arterial and venous assessments using a handheld Doppler. In situations where duplex ultrasonography is not available after regular office hours or when the pathology is more complex (involving multiple specialities), computed tomography [CT] is preferred over magnetic resonance [MR]. It is rare for patients to go directly to diagnostic catheter arteriography (alone) for vascular malperfusion [7].

The controversy surrounding the role of angiography and the choice between routine and selective imaging in suspected cases of vascular injuries after posterior knee dislocations has been a topic of discussion. In the early 1990s, it was widely believed that arteriograms should be performed routinely for all knee dislocations to rule out PAI [18]. However, this belief has lost popularity with the increased use of computed tomography angiography. A study utilizing the National Trauma Data Bank from 2003 to 2015 revealed a decrease in below-the-knee amputation (BKA) rates resulting from PAI, from 7.1% to 5.1%. This decrease has been attributed, in part, to the reduced utilization of formal angiograms and their associated complications, as well as the reduced time from diagnosis to definitive intervention [19].

In a stable patient, obtaining a CTA of the lower extremity to aid in preoperative decision-making and determine the source of vascular injury was considered reasonable but not entirely necessary. Limited retrospective series suggest that a thorough physical examination can predict the presence or absence of PAI with a 94.3% positive predictive value and 100% negative predictive value [20]. CTA is a more cost-effective and accessible option compared to angiography. Research indicates that patients could save up to $1,166 per limb in hospital costs and spend less than $12,922 in total hospital expenses by opting for CTA over angiography [21]. Over the last decade, CTA has been widely utilized for the swift diagnosis of lower extremity arterial trauma, boasting a remarkable 100% sensitivity and 100% specificity in detecting arterial injury [19]. Additionally, duplex ultrasonography is a valuable method for evaluating popliteal artery injury, with a sensitivity ranging from 95% to 100% and a specificity between 99% and 100% when assessing vessel stenosis and occlusion [21]. Various treatment options for popliteal artery occlusion are currently available, including lifestyle adjustments, systemic thrombolysis, anticoagulation therapy, surgical embolectomy, interventional thrombolysis, and mechanical thrombectomy [8].

Before medical and surgery intervention, lifestyle modifications should be made, such as smoking cessation and walking programs, that resolve partly the symptoms [11]. Conservative treatment, including anticoagulation, thrombolysis, and Heparin 1000U for intravenously anticoagulant, was one of the earliest treatments given if arterial occlusion was suspected [10]. After angiography and ballooning, 12.500U heparin in 50ml saline was given at a rate of 1mL/h and activated partial thromboplastin time (APTT) was maintained for around 40 s while monitoring peripheral pulses closely.

Surgical treatments included thrombectomy, balloon angioplasty, bypass graft, and stent. The most common surgical treatment was surgical or endovascular thrombectomy. If the limb remains ischemic for over 6 hours, irreversible damage will ensue [22]. Consequently, there is a significant amputation rate associated with popliteal artery occlusion. One study indicated an amputation rate of 30% to 60% [22]. Compared to conservative treatment, surgical intervention showed a notably higher success rate [10]. Nevertheless, the amputation rate can drop to 10% if treatment for popliteal artery occlusion is administered within 6 hours [21].

The fundamental clinical manifestation of PAD is frequently valuable in classifying the disease and establishing treatment protocols. The American College of Cardiology/American Heart Association Practice Guidelines outline the presentation of PAD through four categories: asymptomatic, claudication, critical limb ischemia, and acute limb ischemia (ALI). Various classifications have been utilized for ALI/PAD, such as Fontaine classification, Rutherford Classification, Bollinger Angiographic Classification, Graziani's Morphologic Categorization, Trans-Atlantic Inter-Society Consensus Document II (TASC II), and Angiosomes Classification.

The first-line revascularization strategy recommended in the Trans-Atlantic Inter-Society Consensus Document (TASC) II Class D SFA occlusions is identified as femoropopliteal bypass surgery [23]. At the same time, surgical femoropopliteal bypass is recommended in patients with SFA who are classified as TASC D [24]. Surgery is recommended for TASC II C and D lesions leading to excessive calcification [25]. However, recent evidence also suggests that EVT is applicable in treating>90% of femoropopliteal occlusions [26].

In the Imanaka et al. study, an immediate assessment was conducted by inserting a 6-Fr sheath into the left femoral artery in an anterograde manner. Subsequently, an endoluminal balloon was inflated, and manual thrombus aspiration was performed using the guiding catheter and aspiration device [9]. The post-procedure angiogram revealed a perforation in the popliteal artery and significant contrast extravasation. Endovascular balloon angioplasty and stenting have become increasingly common for managing aneurysmal and stenotic arterial conditions, particularly in the lower limb. However, the relatively higher restenosis rate is a notable concern associated with the endovascular approach.

Early detection, vascular restoration, and compartmental release are crucial elements in improving the likelihood of limb preservation. It is widely acknowledged that the optimal window for reperfusion therapy following the onset of acute arterial occlusion is between 4 and 6 hours.

A study indicated that relying solely on thrombectomy for revascularization was inadequate, with 71% of patients necessitating a lower extremity bypass. Failure to restore blood flow may result in the need for a major knee amputation. As a result, surgical procedures such as above-knee to below-knee popliteal artery saphenous vein bypass grafting have been utilized to address popliteal artery injuries. Additionally, individuals may experience sensory deficits and paresthesia in certain areas of the dorsal aspect of the foot.

Close monitoring, promptly diagnosing CTA, initiating immediate treatment, and employing a range of effective interventions can prevent the need for amputation [2]. A significant risk factor for limb loss is the onset of compartment syndrome. Compartment syndrome arises when the pressure within one or more osteofascial compartments increases. Compartment syndrome has been associated with delays in blood flow restoration, the presence of concomitant venous injuries, and fractures in the lower extremities [27]

The prognosis of arterial occlusion after knee arthroplasty is influenced by various factors such as age, arterial disease history, pre-operative peripheral pulses, tourniquet use, and level of artery occlusion. A study by Li et al. (2019) found that age younger than 65, arterial disease history, abnormal pre-operative peripheral pulses, no tourniquet use, and artery occlusion above the popliteal level were associated with a higher risk of failure in arterial occlusion treatment after knee arthroplasty [10]. Interestingly, the interval between presentation and surgical treatment did not impact the success rate. Still, an interval of less than one day resulted in fewer sequelae during a mean follow-up of 16 months.

CONCLUSION

Treatment options for popliteal artery occlusion include lifestyle adjustments, systemic thrombolysis, anticoagulation therapy, surgical embolectomy, interventional thrombolysis, and mechanical thrombectomy. In this case, the Sapheno Femoral Graft End-to-End Anastomose is an effective therapeutic option for patients with total popliteal artery occlusion.

REFERENCES

[1] Dewan KC, Kandasamy S, Grieff AN, Huntress L, Rahimi SA, Chao J, et al. Complete popliteal artery transection in the setting of blunt trauma. Annals of Vascular Surgery - Brief Reports and Innovations 2022; 2:100111. https://doi.org/10.1016/j.avsurg.2022.100111.

[2] Zhang S, Xu B. Acute Popliteal Artery Thrombosis Resulting from a Closed Comminuted Tibia Fracture. Orthopaedic Nursing 2022; 41:295–7. https://doi.org/10.1097/NOR.0000000000000865.

[3] Cooper N, Roshdy M, Sciarretta JD, Kaufmann C, Duncan S, Davis J, et al. Multidisciplinary team approach in the management of popliteal artery injury. J Multidiscip Healthc 2018; Volume 11:399–403. https://doi.org/10.2147/JMDH.S151498.

[4] Chapman J. Popliteal artery damage in closed injuries of the knee. J Bone Joint Surg Br 1985;67-B:420–3. https://doi.org/10.1302/0301-620X.67B3.3997952.

[5] Kasapis C, Gurm HS. Current Approach to the Diagnosis and Treatment of Femoral-Popliteal Arterial Disease. A Systematic Review. Curr Cardiol Rev 2009; 5:296–311. https://doi.org/10.2174/157340309789317823.

[6] Dhaliwal G, Mukherjee D. Peripheral arterial disease: Epidemiology, natural history, diagnosis and treatment. Int J Angiol 2007;16.

[7] Godfrey AD, Hindi F, Ettles C, Pemberton M, Grewal P. Acute Thrombotic Occlusion of the Popliteal Artery following Knee Dislocation: A Case Report of Management, Local Unit Practice, and a Review of the Literature. Case Rep Surg 2017; 2017:1–5. https://doi.org/10.1155/2017/5346457.

[8] Wright LB, Matchett WJ, Cruz CP, James CA, Culp WC, Eidt JF, et al. Popliteal Artery Disease: Diagnosis and Treatment. RadioGraphics 2004; 24:467–79. https://doi.org/10.1148/rg.242035117.

[9] Imanaka T, Fujii K, Fukunaga M, Miki K, Kawasaki D, Tamaru H, et al. A case of acute thrombotic occlusion of the popliteal artery occurring immediately after the total knee arthroplasty recanalized by ballooning alone. J Cardiol Cases 2013; 8:190–2. https://doi.org/10.1016/j.jccase.2013.08.008.

[10] Li Z, Xiang S, Bian Y, Feng B, Zeng R, Weng X. Diagnosis and Treatment of Arterial Occlusion after Knee Arthroplasty: The Sooner, the Better. Orthop Surg 2019; 11:366–72. https://doi.org/10.1111/os.12494.

[11] Donias HW. Treatment Strategies for Femoropopliteal Chronic Total Occlusions. Medtronic Medical Affairs Corner 2019; 1:1–4.

[12] Shawky K, Marzouk AA-E, El-Baz WA, Abd-ElHaseeb AR, Elsayed AMA, Abdelmawla MH. Superficial femoral artery chronic total occlusion crossing strategies. Int J Health Sci (Qassim) 2022:2438–53. https://doi.org/10.53730/ijhs.v6nS4.7163.

[13] Debourdeau P, Espié M, Chevret S, Gligorov J, Elias A, Dupré PF, et al. Incidence, risk factors, and outcomes of central venous catheter-related thromboembolism in breast cancer patients: the <scp>CAVECCAS</scp> study. Cancer Med 2017; 6:2732–44. https://doi.org/10.1002/cam4.1201.

[14] Tendera M, Aboyans V, Bartelink M-L, Baumgartner I, Clement D, Collet J-P, et al. ESC Guidelines on the diagnosis and treatment of peripheral artery diseases: Document covering atherosclerotic disease of extracranial carotid and vertebral, mesenteric, renal, upper and lower extremity arteries * The Task Force on the Diagnosis and Treatment of Peripheral Artery Diseases of the European Society of Cardiology (ESC). Eur Heart J 2011; 32:2851–906. https://doi.org/10.1093/eurheartj/ehr211.

[15] Georgiadis AG, Mohammad FH, Mizerik KT, Nypaver TJ, Shepard AD. Changing presentation of knee dislocation and vascular injury from high-energy trauma to low-energy falls in the morbidly obese. J Vasc Surg 2013; 57:1196–203. https://doi.org/10.1016/j.jvs.2012.11.067.

[16] Whitehouse WM, Wakefield TW, Graham LM, Kazmers A, Zelenock GB, Cronenwett JL, et al. The limb-threatening potential of arteriosclerotic popliteal artery aneurysms. Surgery 1983; 93:694–9.

[17] Helboob M, Iftikhar H, Abdurabu M, Anjum S, Kumar TS. A Rare Case of Bilateral Popliteal Artery Occlusion. Cureus 2022. https://doi.org/10.7759/cureus.20895.

[18] Feliciano D V. Blunt injury to the popliteal artery. Trauma Surg Acute Care Open 2018;3: e000215. https://doi.org/10.1136/tsaco-2018-000215.

[19] Grigorian A, Wilson SE, Kabutey N-K, Fujitani RM, de Virgilio C, Schubl SD, et al. Decreased National Rate of Knee Amputation in Patients with Popliteal Artery Injury. Ann Vasc Surg 2019; 57:1–9. https://doi.org/10.1016/j.avsg.2018.07.002.

[20] Klineberg EO, Crites BM, Flinn WR, Archibald JD, Moorman CT. The Role of Arteriography in Assessing Popliteal Artery Injury in Knee Dislocations. The Journal of Trauma: Injury, Infection, and Critical Care 2004;56:786–90. https://doi.org/10.1097/01.TA.0000075346.05460.D6.

[21] Lee CJ, Loo R, Wohlauer M V., Patel PJ. Diagnostic workup and endovascular treatment of popliteal artery trauma. Vasa 2019; 48:65–71. https://doi.org/10.1024/0301-1526/a000756.

[22] Imerci A, Özaksar K, Gürbüz Y, Sügün TS, Canbek U, Savran A. Popliteal Artery Injury Associated with Blunt Trauma to the Knee without Fracture or Dislocation. Western Journal of Emergency Medicine 2014; 15:145–8. https://doi.org/10.5811/westjem.2013.12.18223.

[23] Brountzos EN, Moulakakis KG, D. Avgerinos E, Dalainas I, G. Giannakopoulos T, Kakisis J, et al. Retrograde Transpopliteal Approach of Iliofemoral Lesions. Vasc Endovascular Surg 2011; 45:646–50. https://doi.org/10.1177/1538574411414308.

[24] Norgren L, Hiatt WR, Dormandy JA, Nehler MR, Harris KA, Fowkes FGR. Inter-Society Consensus for the Management of Peripheral Arterial Disease (TASC II). J Vasc Surg 2007;45: S5–67. https://doi.org/10.1016/j.jvs.2006.12.037.

[25] Goltz JP, Kleemann M. Complex recanalization techniques for complex femoro-popliteal lesions: how to optimize outcomes. J Cardiovasc Surg (Torino) 2015; 56:31–41.

[26] Dumantepe M. Retrograde Popliteal Access to Percutaneous Peripheral Intervention for Chronic Total Occlusion of Superficial Femoral Arteries. Vasc Endovascular Surg 2017; 51:240–6. https://doi.org/10.1177/1538574417698902.

[27] Guerrero A, Gibson K, Kralovich KA, Pipinos I, Agnostopolous P, Carter Y, et al. Limb loss following lower extremity arterial trauma: what can be done proactively? Injury 2002; 33:765–9. https://doi.org/10.1016/S0020-1383(01)00175-9.