



Arterial Injuries in Total Knee Arthroplasty

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12.1 Introduction

Total knee arthroplasty (TKA) has raised as one of the most clinically successful and cost-effective medical procedures in the last century [1, 2]. It is a more and more common procedure, with an expected increasing in next decades, parallel to population aging. In the same way, although complications are less and less frequent in relative terms, they will increase in number as well.

Vascular complications in TKA are mainly classified in two groups: those affecting the venous system (like thromboembolism) and those affecting the arterial vessels (i.e., arterial injuries).

Veins can be affected preoperatively, during surgery or after surgery. Preoperative varicose veins determine slow flow and blood retention, favoring deep thromboembolism. They can be injured on superficial dissection during surgery, but are more frequently affected immediately after surgery, developing blood stasis and deep vein thrombosis (DVT). In contrast, arterial system is injured during surgery and misdiagnosis of this complication can be catastrophic. DVT exceeds the objective of this chapter, so we will focus on arterial injuries.

12.2 Definition and Epidemiology

Arterial injuries are defined as intraoperative vascular injury requiring surgical repair, bypass grafting, or stenting [2]. They suppose one of the worst complications in a TKA, with catastrophizing consequences, including compartment syndrome and amputation. Although it is decreasing with new diagnostic and therapeutical techniques, it has been communicated a mortality rate of 7% and amputation of up to 41% [3].

Fortunately, they are very infrequent, with an estimated incidence of 0.08–0.5% of cases [4–6]. Although percentage of injuries may stay stable along the time, increasing number of total knee replacements may lead to an increased absolute number of arterial injuries. In case of revision surgery, it has been reported a risk of 2.4 in comparison with primary surgery [7].

Some previous patient conditions have been related with vascular complications. These include peripheral vascular disease, weight loss, renal failure, coagulopathy, and metastatic cancer [8, 9].

There are four main clinical syndromes related to arterial complications in TKA needing vascular surgeon implication: acute ischemia, hemorrhage, ischemia with hemorrhage, and pseudoaneurysm formation [10].

The most common location for vascular injuries in the context of a TKA is the popliteal artery [4]. It can be injured by traction or direct trauma with surgical instruments. Superficial femoral

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artery can be injured as well, but in this case by tourniquet application, causing a dissection of intimal flap [11].

12.2.1 Acute Ischemia

Acute ischemia is usually due to occlusion of a main vessel. This occlusion can be due to thrombosis, embolization, or dissection of the vessel.

Thrombosis is the result of the classical Virchow's triad: slow flow, endothelial damage, and hypercoagulability. Low blood flow is a consequence of tourniquet application or varicose veins [7]. Endothelial damage can be produced by microtears, stretching of vessels during manipulation or thermal damage by cement. These conditions in combination with hypercoagulability context (dehydration, blood loss, genetic conditions, etc.) can produce acute ischemia.

Another mechanism of acute ischemia is release of parietal calcifications in proximal arterial vessels that can occlude the vessel distally (i.e., at the site of tourniquet application).

12.2.2 Ischemia and Hemorrhage

This type of injury can be due to a partial/complete disruption of the vessel.

12.2.3 Hemorrhage

Hemorrhage is due to direct vascular injury to the vessel wall, usually with Hohmann retractors on posterior tibial plateau or oscillating saw during posterior tibial and femoral cuts.

12.2.4 Pseudoaneurysm

This type of injury is due to injury of the vessel's wall, leading to a widen extravascular compartment where the blood is retained (Fig. 12.1). It usually requires delayed treatment, but with narrow surveillance, because pseudoaneurysm's wall is very thin and can broke leading to a massive hemorrhage.

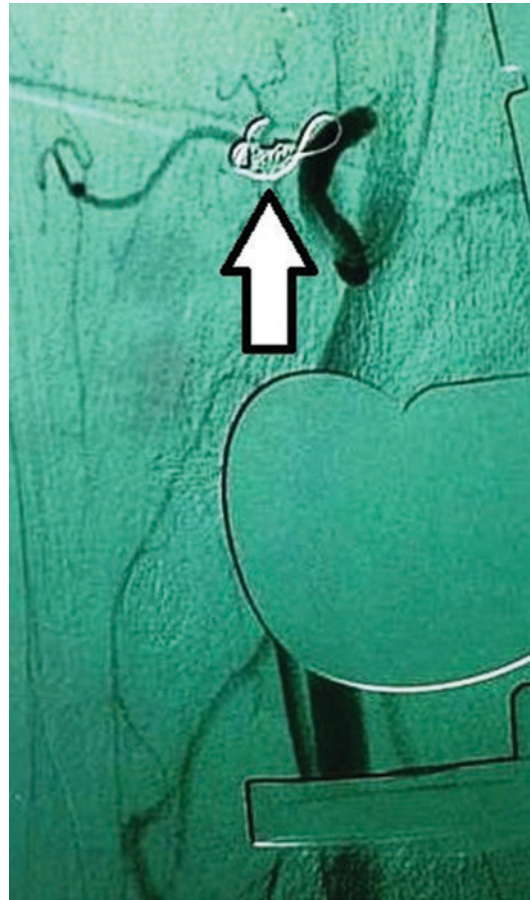


Fig. 12.1 Six days after the implantation of a semi-constrained prosthesis (CCK, constrained condylar knee) due to severe preoperative deformity, a pseudoaneurysm was suspected. A computed tomography (CT) angiogram and a digital subtraction arteriography were performed, which demonstrated the existence of a pseudoaneurysm in a superior lateral geniculate artery. The arterial embolization which was carried out immediately afterwards using a helical microcoil (arrow) succeeded in occluding the pseudoaneurysm. Note the helical microcoil (arrow) which can be seen as a metallic spot above the knee prosthesis

12.3 Clinical Course

Diagnosis of vascular complications is usually clinical and special tests are utilized to confirm the diagnosis. There are five classical signs of ischemia (in this order of apparition): pain, pallor, pulseless, paresthesias, and paralysis.

In case of hemorrhage, hemarthrosis and bleeding through the surgical wound are the main symptoms. Localized edema, swelling, pulsatile

mass, palpable thrill, or neurological compression are typical of arteriovenous fistula and pseudoaneurysms [7, 10, 12].

12.4 Diagnosis

If TKA is performed with tourniquet, all these conditions will be detected after tourniquet release. Classically, tourniquet release was after implantation and before wound closure, to detect any bleeding and practice surgical hemostasis. Actual blood saving protocols recommend to deflate the tourniquet after skin closure and wound bandage. This may difficult diagnosis in first minutes in comparison when the tourniquet is deflated before skin closure. In addition, most patients are operated under spinal anesthesia, so they will not complain of pain immediately. It is paramount to check the vascular status of the limb after tourniquet deflation. If we are not aware of the possibility of these complications, diagnosis can be delayed with catastrophic consequences. In fact, hemorrhage diagnosis can be delayed for hours until it becomes obvious [4, 12]. The best way to avoid misdiagnosis is peridical clinical checking after tourniquet release.

Once diagnosis has been suspected, several radiological tests can confirm the problem. Doppler is present in most surgical recovery units today. Absent of pulse in tibial or peroneal arteries should put us on the way of a possible ischemic injury. It can be useful to detect bleeding vessels and to check distal filling after reperfusion.

AngioCT is considered today the best test to detect any bleeding or stop in blood circulation in any part of the body. However, knee prosthesis can artifact radiological images and diagnosis can be sometimes difficult. Recent advantages in subtraction of implants image have increased sensitivity and specificity of this test.

Arteriography remains as the gold standard to detect vascular injuries. Although it has a sensitivity and specificity close to 100%, it is time-consuming and, at this moment, it is only indicated and performed by vascular surgeon or radiologist for addressing the injury intraoperatively.

12.5 Treatment

12.5.1 General Treatment

Endovascular techniques are preferred over open techniques for the treatment of vascular injuries. These techniques include diagnostic techniques (i.e., arteriography), contention techniques (i.e., endovascular balloon for stopping distal hemorrhage), and revascularization techniques (i.e., endovascular prosthesis, stent, coils).

Most frequent endovascular therapeutic techniques are: (1) thrombectomy with Fogarty catheter; (2) angioplasty with ballon and/or stent; (3) coil embolization (typically for pseudoaneurysms); (4) pharmacomechanical thrombolysis; (5) endoprosthesis [7, 10].

Endovascular addressing of vascular injuries proportionates a high rate of success, avoiding huge medial wound associated to open revascularization and its consequences (scarring, stiffness, infection, etc.) [12]. It also avoids contralateral saphenous harvest. Although open revascularization is a good option with similar rates of limb salvage in comparison with endovascular strategies, associated morbidity is quiet high in open procedures [5].

12.5.2 Acute Ischemia or Ischemia and Hemorrhage

Usually, ischemia is diagnosed sometime after tourniquet release. Once it is diagnosed, vascular surgeon (or radiologist) should be localized. Usually an arteriography is performed to detect the cause of ischemia (thrombosis, intimal flap, dissection, or transection) and adequate treatment is performed in consequence [7]. Endovascular treatment can be an option for most cases of thrombosis, intimal flap, dissection, or partial transection. They can be treated with endovascular prosthesis or stent. When endovascular treatment is unaffordable and in complete transection, open revascularization (direct repair or bypass) is indicated.

12.5.3 Hemorrhage

Hemorrhage should be managed initially with tourniquet inflation. If it is diagnosed intra-operatively (less commonly with recent blood saving protocols), it can be packaged until further evaluation by the vascular surgeon [7]. It is the only injury that it is still better managed with open procedures.

12.5.4 Pseudoaneurysm

This entity is usually diagnosed and treated later (few days or weeks after index surgery). Endovascular techniques are of election for its treatment [7]. Endovascular prosthesis, coils, or stents are used to exclude the pseudoaneurysm of the circulation (Fig. 12.1).

12.6 Conclusion

Most frequent endovascular therapeutic techniques for treating arterial injuries in TKA are: Thrombectomy with Fogarty catheter; angioplasty with balloon and/or stent; coil embolization (typically for pseudoaneurysms); pharmacomechanical thrombolysis; and endoprosthesis. Endovascular addressing of arterial injuries proportionates a high rate of success, avoiding huge medial wound associated to open revascularization and its consequences (scarring, stiffness, infection, etc.). It also avoids contralateral saphenous harvest. Although open revascularization is a good option with similar rates of limb salvage in comparison with endovascular strategies, associated morbidity is quiet high in open procedures.

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