Case Report

Delayed Arterial Occlusion Presenting as Foot Drop Following Primary Total Knee Arthroplasty in a Varus Knee: A Case Report and Review of the Literature

Clayton Del Prince John Reza Matthews Matthew Phillips

Jacobs School of Medicine and Biomedical Sciences, Buffalo, NY, USA

Keywords

Total knee arthroplasty · Vascular · Arterial injury · Varus knee

Abstract

We present a 69-year-old male with osteoarthritis of a varus mechanically aligned left knee that developed delayed arterial thrombosis after primary total knee arthroplasty (TKA) requiring stenting and subsequent trans-metatarsal amputation. This case is unique since initial presentation involved neurologic instead of ischemic changes. We also performed a literature review of arterial injuries in primary TKA. This case highlights the importance of maintaining a high clinical suspicion for vascular insult in patients undergoing correction of varus malalignment with initial complaints of neurologic dysfunction.

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Published by S. Karger AG, Basel

Introduction

Iatrogenic vascular injury in total knee arthroplasty (TKA) can have devastating results. The incidence of vascular complications is between 0.06 and 0.2% [1–4]. These complications include vessel occlusion, transection, arteriovenous fistula, and aneurysm/pseudoaneurysm formation, among others [5]. Complications commonly result from indirect trauma such as mechanical stretching/compression from retractors but can occur from direct injuries with the saw blade [4, 6, 7]. The reported sequela includes neurologic deficit, compartment syndrome, amputation, infection, and death [4, 7, 8].

Preoperative screening for underlying peripheral vascular disease may help identify higher risk patients [9, 10]. It is essential for surgeons to understand the risk factors, preventative

Clayton Del Prince
Orthopaedic Surgery
Jacobs School of Medicine & Biomedical Sciences
462 Grider St., Buffalo, NY 14215 (USA)
claytond@buffalo.edu

Fig. 1. Full-length standing (a), lateral (b), and sunrise (c) left knee X-rays demonstrating a 15-degree varus mechanical axis alignment on the left with complete loss of articular cartilage along the medial and patellofemoral compartments as well as osteophyte formation. On the right, there is a stemmed total knee component in good position with an overall 2-degree varus mechanical axis alignment.

measures, recognition, and management of arterial injuries. We present a case report of a 69-year-old male with osteoarthritis of a varus mechanically aligned left knee that developed delayed arterial thrombosis requiring stenting and subsequent trans-metatarsal amputation (TMA). We also performed a review of the literature pertaining to arterial injuries in primary TKA.

Methods

To ascertain all studies pertaining to arterial injuries in primary TKAs, we performed a literature search of articles published in English between 1985 and February 2020. We searched PubMed, Embase, and the Cochrane database. The search terms were (“primary total knee” or “TKA”) and (“vascular” or “vascular complication”). We excluded abstracts, narrative reviews, articles not written in English, commentaries, and topics not focused on arterial complications. The results of the literature search were independently reviewed by 2 authors in detail and summarized. In total, 187 studies were identified, but 41 remained after exclusion.

Case Report

The patient was a 69-year-old male with hypertension, coronary artery disease, hypothyroidism, gastric reflux, and prior right superficial femoral artery (SFA) stenting on Aspirin/Plavix with left knee pain. He had an antalgic gait with 5–110 degrees of knee flexion with pain and crepitation. Palpable dorsalis pedis (DP) and posterior tibial (PT) pulses were present with a warm, well-perfused foot. He had a prior right TKA that was uncomplicated. Imaging studies demonstrated degenerative arthritis with a varus mechanical alignment and mild vascular calcification (Fig. 1).

After failed nonoperative management the patient elected to proceed with surgery. He underwent a left Mako robotic-assisted TKA. Intraoperatively, the tourniquet was inflated to

Fig. 2. Immediate postoperative AP (a) and lateral (b) X-rays of the left knee demonstrating total knee replacement.

250 mm Hg for a total of 36 min. Stryker Triathlon CR uncemented implants were used. Post-closure motion demonstrated 0–130 degrees of flexion. There were no recognized complications, and he had a palpable DP pulse. X-rays were obtained in recovery (Fig. 2).

In recovery, the patient was found to have a partial peroneal and tibial nerve palsy. The TED stocking was removed and his knee was flexed over a pillow. DP pulse was palpable. The next morning, he had near-complete peroneal and tibial nerve palsies with weak tibialis anterior (TA), extensor hallucis longus (EHL), flexor hallucis longus (FHL), and gastro-soleus (GS) function. He also had diminished sensation along the lateral aspect of the shin and dorsal foot. He continued to have a palpable DP pulse with brisk capillary refill. He was restarted on his home anticoagulation regimen. On postoperative day 2, the patient had worse TA, EHL, FHL, and GS function with unchanged paresthesias. He continued to have a palpable DP pulse and was discharged home.

He was seen in office 1 week later with foot swelling with diminished sensation along the dorsal medial 3 digits with continued weakness in TA, EHL, FHL, and GS. His incision was clean with no surrounding erythema. Active ROM was 5–100 degrees of flexion. His calf was soft and nontender. He was started on Gabapentin due to persistent nerve pain and physical therapy to prevent achilles contracture.

The following week, the patient called the office due to persistent swelling and foot blistering. He was given a prescription for Silvadene and instructed to keep his leg elevated. He presented for follow-up 1-month post-op with extensive erythema over the ankle dorsally and plantarly to the level of the tarsometatarsal joint with overlying blisters. He had diminished sensation along the dorsal and plantar aspect of his foot. The toes were swollen and cold with no palpable DP or PT pulse. Repeat imaging demonstrated stable bilateral total knee replacements (Fig. 3). The patient was emergently sent to the vascular laboratory where noninvasive arterial studies demonstrated an ankle-brachial index (ABI) of 0.27 on the left relative to 0.9 on the right. A duplex scan revealed extensive arterial occlusive disease with

Fig. 3. Long-standing lower extremity X-ray demonstrating stable bilateral total knee replacements.

severe flow reduction in the SFA and popliteal artery with collateral flow. Angiogram demonstrated patent common, external, iliac, and deep femoral arteries. There was occlusion of the proximal SFA with re-constitution in the middle third with extensive collateral circulation (Fig. 4a). The popliteal artery had multiple areas of stenosis involving the supra-/infra-geniculate regions and takeoff of the anterior tibial artery. All lesions appeared to be standard atherosclerotic disease without evidence of intimal trauma. He underwent angioplasty of the superficial femoral, popliteal, tibio-peroneal trunk, and posterior tibial (PT) arteries and stenting of the popliteal and SFA. Repeat angiogram demonstrated no residual stenosis (Fig. 4b). The patient then underwent irrigation and debridement of his left foot. Over the next week, he had repeated foot debridements due to poor healing and eventually underwent a TMA.

He was seen in the office for 4 months following the index procedure. The knee was stable with 5–115 degrees of flexion. His foot demonstrated interval healing but continued to lack active dorsiflexion and his passive maximum dorsiflexion was 10 degrees of plantar flexion.

At his 1-year follow-up, the patient continued to have no active ankle dorsiflexion. His passive dorsiflexion was 5 degrees of plantar flexion. The foot amputation wound was healed.

Fig. 4. **a** Angiogram of the proximal femoral vasculature demonstrating severe stenosis of the superficial femoral artery. **b** Angiogram demonstrating a patent SFA status post angioplasty and stenting. SFA, SFA, superficial femoral artery.

His knee was benign and demonstrated 5–115 degrees of flexion. He was offered a referral to a foot-ankle specialist but was happy with his progress.

Discussion

Vascular complications following TKA can have devastating results. Early diagnosis and treatment are essential for limb salvage [7]. A review of arterial injuries after TKA by Li et al. [11] found pulselessness to be the most common presentation usually occurring within 24 h. We presented a unique case of delayed arterial thrombosis after primary TKA with initial complaints of neurologic dysfunction that required a TMA.

Risk factors for arterial complications include peripheral arterial disease (PAD), prior bypass, arterial calcification on radiographs, revision surgery, weight loss, renal failure, coagulopathy, metastatic cancer, and Afro-Caribbean origin [3, 12]. In a series of acute arterial thromboses, ischemic complications occurred only in patients with atherosclerotic disease [2]. Due to this higher risk in patients with atherosclerotic disease, Papadopolous et al. [5] recommended vascular consultation. Our patient had several risk factors including vascular calcification on radiographs and peripheral vascular disease with previous contralateral stenting.

The use of a tourniquet in TKA has been a topic of debate. The force generated by tourniquet application may fracture a calcified artery resulting in plaque embolization or anchor the SFA increasing the risk of traction injuries during knee manipulation. Tourniquets have also been reported to cause thrombosis of the SFA or develop thrombosis in preexisting popliteal aneurysms due to the low flow state [8]. Although tourniquet-related complications

are rare, they are potentially limb and life-threatening. Potential complications include arterial compromise, pulmonary edema, neurologic injury, pulmonary emboli, and muscle injury. One author recommended avoiding a tourniquet in patients with preoperative ABIs less than 0.50, radiographic evidence of vascular calcification, lack of palpable pedal pulses, or known peripheral atherosclerotic disease [2].

The most common presenting symptoms after arterial injury following TKA include pulseslessness, poikilotherm, pain, paresthesia, pallor, poor capillary refill, paralysis, decreased ABI, mottling, swelling, blistering, and necrosis [11]. Motor weakness can also be a sign of vascular injury. Most peroneal palsies are experienced after correcting valgus deformities, but our patient had a 15° varus mechanical alignment [13]. Our patient's initial postoperative complaint was neurologic similar to one of the patients in the Padegimas et al. [14] case series who had a peroneal nerve palsy along with vascular injury. This series included a vascular calcification score according to the Iijima scale [15]. Our patient's preoperative imaging demonstrated a vascular calcification score of 1. When performing arthroplasty procedures in patients with calcified vessels and significant deformity, the surgeon must remain highly suspicious of vascular insult.

Early diagnosis of vascular injury requires meticulous neurovascular examination, with greater emphasis in high-risk populations. Regarding management in our case, preoperative Doppler scan should have been considered given the previous history of occlusion. As blistering can be associated with vascular injury or compartment syndrome, vascular evaluation at the time of this finding could have been advised. At our institution, we now obtain noninvasive arterial studies and vascular consultations for patients with postop palsies that have undergone correction of varus malalignment. With an increasing number of TKAs performed on an outpatient basis, there is concern over limited serial neurovascular monitoring [16]. Orthopedic surgeons should carefully select candidates for outpatient TKAs.

We present a review of the literature pertaining to arterial injuries following primary TKA (Table 1). The studies included in this review include case reports, case series, and systematic reviews. The purpose of this review is to outline the comorbidities, timing, diagnostic studies, treatments, and outcomes that have been reported. The time to diagnosis of arterial injury ranged from intraoperative to 3 years post-op for aneurysm [12, 19]. The diagnoses were made through a combination of physical exam findings and diagnostic tests. Diagnostic investigations included ABI, Doppler/duplex studies, and angiograms [12, 25, 36]. Treatments included observation, direct repair, angioplasty, stenting/bypass, thrombectomy, endarterectomy, coil embolization, ultrasound compression, fistula resection, and amputation [4, 12, 14, 18, 22, 25, 42]. Outcomes ranged from complete resolution of symptoms to amputation and mortality [4, 36, 46]. This review shows that the majority of arterial complications are diagnosed within the first few days after surgery and are more common in patients with a history of hypertension or coronary artery disease. In comparison with these cases, our patient's diagnosis was delayed compared to the majority but still within what has been previously reported. Most patients in this review presented with early findings of a cold, pulseless limb, while our patient had early neurologic findings with delayed loss of pulse. This review agrees with the previous literature that has shown there is no consensus on optimum management and intervention must be determined by the specific pathology [12].

Conclusion

Initial presentation of vascular complications following primary TKA may include neurologic findings as opposed to ischemia. This case highlights the importance of maintaining a high clinical suspicion for vascular insult in patients that undergo correction of varus malalignment with initial complaints of neurologic dysfunction.

Table 1. TKA arterial complications

Study	Patients, n	Comorbidities	Mal-alignment	Time to diagnosis	Investigation	Treatment	Outcome
Padegimas et al. [14]	13	DM, CAD, PVD, Cancer, DVT, Smoking	3- patients-valgus 5- patients-varus	1- Intraop 10- PACU 1- POD1 1- POD2	Doppler and PE (calf swelling/bruising)	9-stenting 2-endarterectomies 1-thrombectomy 1-bypass	1- persistent peroneal nerve injury 3- MUA, no revisions
Sloan et al. [17]	2			1- PACU 1- timing not listed	1- Doppler and PE (calf swelling/bruising) 1- Duplex and PE (cold/pale foot)	1- stent for pseudoaneurysm 1- thrombectomy and endovascular graft for pseudoaneurysm	1-patent arteries post stenting 1-required second vascular intervention for cold pale limb with thrombectomy and subsequent fasciotomies with skin grafting. Stents patent
Pydisetty et al. [18]	1	Prior trauma w/foot drop		POD 5	Doppler, PE (calf swelling/pain), angiogram	coil embolization for AV fistula	Swelling improved, returned to baseline foot drop
Thomas et al. [19]	1	HTN		3-year post-op	Physical exam (recurrent cellulitis and swelling), duplex	Repair of popliteal artery AV fistula	Complete resolution of symptoms
Bayne et al. [20]	1	HLD, HTN, depression, prostatism, smoking	Bilateral 12 degrees varus	POD 2	PE: paresthesias over foot with no palpable DP pulse, angiogram	SFA – popliteal bypass for popliteal thrombi	Residual numbness and paresthesias from left saphenous nerve neuralgia
Gupta et al. [21]	1			9-week post-op	PE: swelling around anterolateral aspect of knee with pulsatile mass, duplex	Percutaneous embolization of false aneurysm from anterior tibial artery	Complete resolution of symptoms
Abularrage et al. [22]	20			Not specific for TKA, includes days for all vascular injuries	Not listed	1-angioplasty 6-direct arterial repair 5-thromboendarterectomy 6-bypass 2-amputation	Not listed
Gregory et al. [23]	1	HTN, pacemaker		POD 8-increased pain in anterior compartment, decreased pulses and cold LE	PE: peroneal palsy with foot drop, doppler, ABI (0), arteriogram (Occlusive disease in SFA, profunda, and peroneal arteries)	Thrombectomy of posterior tibia artery	Initial palpable pulse post op. Ultimate outcome not listed
Pai [24]	1			POD 2-large hematoma requiring evacuation 6-week post-op	PE at 6 weeks: pain in popliteal fossa with paresthesias over sole. Pulsatile swelling in popliteal fossa, Doppler large aneurysm of inferior lateral geniculate artery	Initial arthroscopic hematoma evacuation resulted in 20 cm ³ blood, lateral portal enlarged and evacuated 500 cm ³ clotted blood. Ligation of aneurysm	Residual paresthesias over lateral half of sole, no further aneurysms

Table 1 (continued)

Study	Patients, n	Comorbidities	Mal-alignment	Time to diagnosis	Investigation	Treatment	Outcome
Kobayashi et al. [25]	1	HTN, DM	10 degrees varus	Post-op peroneal palsy with foot drop, palpable DP pulse 10 h post-op	Worsening pain, cold foot, peroneal palsy with paresthesias. No palpable DP pulse. ABI (0.58), arteriography	Non-op tx of occlusive disease in distal popliteal artery just proximal to division from arteriosclerosis	Treatment w/ urokinase and Pg E, warfarin. Return of DP pulses 3 days post-op. Multiple years post-op had return of motor and sensory function
Ohira et al. [26]		Calcium pyrophosphate crystal deposition		Immediately post-op	PE: pale, cold limb with no palpable DP or PT pulse	Angiography 3 hours post-op demonstrated complete occlusion of popliteal artery requiring thrombolysis	Complete resolution of symptoms
Calligaro et al. [2]	7			Not listed	Not listed	7-bypass	Not listed
Hagan et al. [27]	1	Prostatic carcinoma, HLD		POD1	PE: popliteal and pedal pulses absent, angiogram: complete occlusion of distal SFA and popliteal artery	Femoral artery embolectomy	Complete resolution of symptoms
Boutchichi et al. [28]	3			1- 6 weeks 1- 18 days 1- 6 weeks	2- doppler and angiography (calf pain/swelling) 1- doppler and angiography (hemarthrosis)	2- embolization for pseudoaneurysm 1- endovascular stent for pseudoaneurysm	Complete resolution of symptoms
Gulhane et al. [29]	1		Varus	POD 6	Doppler and CT angiogram (thigh pain/swelling)	Screw insertion into previous nav-pin site to tamponade branch of SFA as it entered linea aspera	Complete resolution of symptoms
Pal et al. [12]	9	Obesity, HTN, HLD, PAD, myositis ossificans		3- Intraop 2- 2 days 1- 5 days 1- 2 weeks 1- 6 weeks 1- 3 months	2- on-table arteriography for hemorrhage 3- Doppler/arteriography for calf pain/swelling 2- arteriography for ischemia 1- doppler for calf pain/swelling	1- AKA for laceration 2- excision/anastomosis for laceration 1- AKA for AV fistula 2- LSV graft and fasciotomy for pseudoaneurysm 1- primary repair for pseudoaneurysm 1- LSV graft for thrombosis 1- fem-pop bypass for thrombosis	2- AKA 1- foot drop 1- foot drop with clawing 1- saphenous dysesthesia 1- unsightly fasciotomy scar 3- complete resolution of symptoms
Wanken et al. [30]	1			2 weeks	Doppler and angiography for ankle pain/swelling	Coil embolization for posterior tibial artery pseudoaneurysm	Complete resolution of symptoms

Table 1 (continued)

Study	Patients, n	Comorbidities	Mal-alignment	Time to diagnosis	Investigation	Treatment	Outcome
Agarwala et al. [31]	1			PACU	Angiography for high drain output	Coil embolization for inferior lateral geniculate artery bleeding	Complete resolution of symptoms
Li et al. [11]	1	HTN	None	Intraop	Angiography for pulselessness	Balloon angioplasty for occlusion	Complete resolution of symptoms
Statz et al. [32]	38			Intraop	Direct visualization	None—study on geniculate artery injury-GA injury not impacted by tourniquet use	Not listed
Darius Aw et al. [33]	1	HTN		4 years	PE, Doppler, CT angio for knee swelling	Open ligation for anterior tibial artery pseudoaneurysm	Complete resolution of symptoms
Zhao et al. [34]	1		20 degrees flexion	POD 1	PE and angiography for knee swelling	Embolization of anterior tibial artery branch pseudoaneurysm	Complete resolution of symptoms
He et al. [35]	1			PACU	Doppler and angiography for weak pulses	AKA for femoral artery occlusion	AKA
Parvizi et al. [4]	11	HTN, DM, CAD, HLD, CRF, hypothyroidism, seizures		6- PACU 4- POD 1 1- POD 12	Doppler and angiography for weak pulses	2- nonoperative 4- bypass graft 2- thrombectomy 2- angioplasty	1- AKA (bypass) 1- skin necrosis (bypass) 1- peroneal nerve palsy (thrombectomy) 1- PII (angioplasty) 7- Complete resolution of symptoms
Ammori et al. [36]	7	1- knee dislocation 26 years prior		15 days (7–27)	4- Doppler for DVT suspicion 2- angiography 1- CT angiogram	4- operative repair of pseudoaneurysm 2- stenting of pseudoaneurysm 3- fasciotomies	1- death due to hypertensive heart disease 3 days after stent 3- neuropathic foot pain
Woelfle-Roos et al. [37]	2		1- 10 degree varus, 10 degree flexion	1- PACU 1- POD 1	Not listed	2- thrombectomy of popliteal artery occlusion and fasciotomy	1- partial peroneal palsy 1- peroneal palsy and hallux amputation
Chikkanna et al. [38]	1		Mild varus	POD2	PE, Doppler, angiography for calf pain/numbness	Thrombectomy and fasciotomy for occlusion	Partial foot drop

Table 1 (continued)

Study	Patients, n	Comorbidities	Mal-alignment	Time to diagnosis	Investigation	Treatment	Outcome
Ceulemans et al. [39]	1			7 months	PE, doppler for palpable thrill	Resection of AV fistula	Complete resolution of symptoms
Avisar et al. [1]	4	HTN, CAD		2- Intraop 1- POD 10 1- 3 months	2- PE 2- PE and angiography for diminished pulses	1- direct repair of popliteal laceration 1- packing of popliteal vein laceration 2- embolization of lateral geniculate artery aneurysm	1- arthroplasty delayed 6 weeks 3- complete resolution of symptoms
Kehagias et al. [40]	1			Intraop	PE and angiography	Stenting of popliteal artery occlusion	Complete resolution of symptoms
Papadopoulos et al. [5]	2	HTN, HLD		1- PACU 1- POD 3	1- PE, Doppler, angiography for pain/paresthesia	1- direct repair of popliteal laceration 2- direct repair of popliteal tear/pseudoaneurysm	Not listed
Mathew et al. [41]	1	HTN		15 days	PE, Doppler, angiogram for ischemic pain	Percutaneous thrombectomy and angioplasty for popliteal thrombosis	Complete resolution of symptoms
Ko et al. [3]	633						Incidence of popliteal artery injury: 0.05% Risk factors: PAD, revision, weight loss, renal failure, coagulopathy, metastatic cancer
Bernhoff et al. [42]	32	HTN, DM, TIA, CAD		12- Intraop 8- PACU 12-41 day avg (2-90)	Not listed 25 penetrating injuries 7 blunt trauma	13- direct anastomosis 8- vein graft 2- stenting 2- fem-pop bypass 4- thrombectomy with angioplasty 1- coiling 1- hematoma evacuation 1- ultrasound compression treatment	25- functional impairment 1- AKA
Mozella et al. [43]	2			Not listed	Not listed	2- AKA for acute arterial occlusion	2- AKA

Table 1 (continued)

Study	Patients, n	Comorbidities	Mal-alignment	Time to diagnosis	Investigation	Treatment	Outcome
Holmberg et al. [6]	4	HLA B-27 arthritis with simultaneous ipsilateral THA		1- Intraop 1- PACU 1- 7 days 1- 40 days	1- PE 2- PE, Doppler for pallor/paresthesia 1- PE, angiography for foot ischemia	1- vein graft for popliteal artery laceration 1- thrombectomy, patch graft, fasciotomy for intimal popliteal tear 1- pseudoaneurysm excision with popliteal anastomosis 1- thrombectomy of popliteal and posterior tibial arteries	4- complete resolution of symptoms
Dossche and Brabants [44]	1	Extra-anatomic fem-pop bypass in operative extremity		Intraop	PE	thrombectomy	Not listed
Mureebe et al. [45]	2	A fib		1- PACU 1- POD1	2- PE and Doppler for ischemic foot	1- bypass vein graft of popliteal artery occlusion 1- bypass vein graft of popliteal artery occlusion with fasciotomies	1- superficial wound cellulitis 1- neuropathic foot
Rush et al. [46]	12			Not listed	Not listed	3- vascular repair of severed popliteal artery 1- Teflon graft of popliteal aneurysm 1- repair of lateral geniculate AV fistula 2- thrombectomy of popliteal thrombosis 3- amputation for femoral artery thrombosis	5- limb survival 1- death 2- undisclosed amputation 1- AKA 1- mid-tarsal amputation 1- BKA
Papas et al. [47]	1			POD 8	PE and doppler for weak pulses	Synthetic graft for popliteal pseudoaneurysm	Complete resolution of symptoms

POD, post-op day; PACU, post-anesthesia care unit; MUA, manipulation under anesthesia; PE, physical exam; PJI, prosthetic joint infection.

Statement of Ethics

Written informed consent was obtained from the patient for the purposes of publication of this case report and the accompanying images.

Conflict of Interest Statement

Dr. Phillips: paid consultant for Stryker Orthopedics. Paid consultant for Smith & Nephew Orthopedics.

Funding Sources

The authors did not receive any funding.

Author Contributions

Dr. Clayton Del Prince participated in the literature review, drafted the manuscript, and performed revisions. Dr. John Matthews performed the literature search, created the tables, and assisted in the manuscript drafting. Dr. Matthew Phillips provided the case and was instrumental in article selection and review. He participated in manuscript drafting as well as final revisions and edits.

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