

Case Series

Vascular injuries associated with total knee arthroplasty

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ABSTRACT

Iatrogenic vascular injuries are rare but potentially devastating complications of total knee arthroplasty (TKA). This retrospective study analyzes vascular injuries associated with total knee arthroplasties in an urban, tertiary level referral hospital between 01 April 2010 to 31 March 2020 consisting of 6548 TKAs. Six patients sustained vascular injuries which included five primary, and one revision TKAs. Three patients were bilateral, and two were unilateral primary TKAs. The mean age-adjusted Charlson's comorbidity index was two (range 1-3). Only two injuries were recognized intraoperatively. They underwent successful vascular repair. The third patient was diagnosed and underwent a vascular repair on the first postoperative day but experienced a permanent foot drop. Two other patients underwent thrombectomy on the fifth postoperative day; one required above-knee amputation, and the other continued to suffer from vascular claudication and paraesthesia. Another patient developed a pseudoaneurysm, which was identified and repaired five months after the primary TKA. The site of vascular injury was popliteal artery in five and superficial femoral artery in one patient. The mechanism of injury was a direct laceration in three, posterior Hohman's retractor in one, the effect of tourniquet on calcified vessels in one, and unknown in one patient. Early recognition was the only factor that significantly altered the functional outcome and limb salvage. Bilateral simultaneous total knee arthroplasties had no higher risks. A mandatory institutional protocol to recognize the early signs of vascular injuries is necessary for successful vascular repair.

Keywords: Complications of total knee arthroplasty, Vascular injury, Popliteal artery injury, Iatrogenic vascular injury

INTRODUCTION

Iatrogenic popliteal arterial injuries associated with total knee replacements are few but are a serious and dreaded complication.¹⁻⁶ The frequency of vascular complication after total knee arthroplasty (TKA) is between 0.03% and 0.23%.^{3,6-15} Greater risks of vessel associated complications are reported in patients with pre-existent vascular insufficiency such as vessel claudication, atherosclerosis, significant preoperative deformities, smoking, prior coronary bypass surgery, renal failure, and revision surgeries.^{6,14,16,17} Most common reasons of injury include stretching, compression, transection, or heat related injury from bone cement.^{6,14,18-20}

Early studies by Rand et al in 1987 reported a 0.03% incidence of popliteal artery injury, but more recent studies report a range from 0.09% to 0.17%.^{3-6,8,9,12,15} Thrombosis and indirect trauma are said to be the most common reasons of vascular injury.^{2,6,12} Because of the uncommonness of these complications, there are hardly a few long-term, studies in the literature.^{3,5,6,9,10,21} Majority of the studies are case reports of various clinical scenarios and their treatment.^{1,2,4,12,21,22} An association between the outcome and time to revascularization is well established in the literature.^{5-7,9-11} Vascular injuries detected during or immediately after the surgery had good functional outcomes.^{6,9-11,21} Therefore, there is a need to introduce a mandatory institutional mechanism to recognize and document the early clinical signs of vascular injury in

every patient to improve the outcomes of vascular reconstruction.

This case series study sought to analyze the incidence, causative factors, and types of vascular intervention, complications, and long-term outcomes of vascular injuries associated with total knee arthroplasties in consecutive 6548 total knee arthroplasties in a single institution.

CASE SERIES

After the approval from the institutional ethical committee, a retrospective review of the hospital database was performed to identify the patients who underwent TKA during the period between 01 April 2010 and 31 March 2020. The details of patients who suffered from iatrogenic vascular injuries were retrieved retrospectively. These patients were identified using our prospectively collected data from a physical register maintained in the operation theatre (OT), and the data was cross-checked with electronic data stored in a local computer in the OT complex. Then the hospital central medical records (digital) were also searched using institutional codes for total knee arthroplasty and vascular repairs. Any vascular repair or secondary surgical procedure performed during the same admission after TKA or within the next six months involving the same limb was identified. The demographic details, preoperative clinical features, radiological factors, operative details, and outcome data were retrieved. The Charlson comorbidity index (CCI) is used to categorize the preoperative risk factors.²³ CCI consists of 19 medical comorbidities based on the international classification of diseases (ICD), with each condition weighted according to its influence on mortality. Patients were categorized into low-risk (score of one or two), medium-risk (three or four), and high risk (five or more).^{23,24}

During the study period, 6548 total knee arthroplasties were performed in 4563 patients. There were 6419 (90%) primary total knee arthroplasties, including 1985 bilateral (3970 knees, 60.6%), 2449 unilateral (37.4%), and 129 (1.97%) revision TKAs. Six cases (incidence of 0.092%) of vascular injuries associated with TKAs were identified during this period. Tourniquet was used in all the cases.

Case 1

66 years male patient, a known case of hypertension was diagnosed to have rheumatoid arthritis afflicting both the knees. Patient had a BMI of 23.5. Presented with 15 degrees of valgus and fixed flexion deformity of 30 degree in the left injured knee. He had a CII of 2.²³ Patient underwent bilateral total knee replacement and was diagnosed of popliteal thrombosis of the left knee on day 5 post surgery, as he presented with progressive pain and edema in the operated limb. He underwent Thrombectomy and fasciotomy for the same. The result was unsuccessful

leading to above knee amputation, and further revision of the stump after 5 months.

Case 2

A male patient of age 41 years with no comorbidities, non-smoker was diagnosed of post traumatic osteoarthritis left knee for which he underwent primary total knee replacement which got infected. Patient was further treated with prosthesis removal and antibiotic spacer application, now planned for second stage revision TKR. Patient had a BMI of 32.3. He presented with a deformity of 20 degrees of valgus and fixed flexion. CII was 1. Patient underwent revision TKR and was diagnosed to have intraoperative laceration of popliteal artery. Patient underwent popliteal artery bypass graft and also thrombectomy procedure within 24 hours for the same, which was a success without any further complications.

Case 3

60-year male patient with no comorbidities, chronic smoker presented with osteoarthritis of both knees. Patient had a BMI of 26.6, with evidence of vascular calcifications. Presented with deformity of valgus 10 degrees. Patient had a CII of 2. Patient underwent bilateral knee replacement, was diagnosed of left popliteal artery laceration on post operative day 5, as he presented with progressive pain and edema in the operated limb. Patient underwent thrombectomy and vascular repair for the same. The overall outcome was successful however, patient had chronic ischemia presenting with complications of claudication and paraesthesia of foot, which were treated conservatively.

Case 4

Female patient of age 70 years, a known case of hypertension presented with osteoarthritis of the left knee. The body mass index was 19. The patient presented with a deformity of 10 degrees of varus and 10 degrees of fixed flexion. She underwent left knee total knee replacement and was diagnosed of popliteal artery and vein laceration intraoperatively. Patient underwent popliteal artery and vein repair with vein patch. The outcome was a success with nil additional procedures or complications.

Case 5

59-year-old female with hypertension presented with bilateral knee osteoarthritis. The patient has a body mass index of 30.6. Presented with varus deformity of 15 degrees and had a CII 3. Patient underwent bilateral total knee replacement and was diagnosed to have thrombosis of Superficial Femoral and popliteal artery of the right knee after 22 hours post-surgery. She underwent thrombectomy and vein patch repair for the same. The outcome was a success, but presented with foot drop as complication.

Table 1: Case presentations.

Case	Age (yr)	Sex	Diagnosis	Deformity (in degree)	Bilateral/unilateral TKA	Time to diagnose vascular injury	Type of vascular injury	Type of vascular repair	Out-come of vascular repair	Additional-procedures	Complications
1	66	M	RA	Valgus 15, FFD 30	Bilateral (left injured)	Day 5	Popliteal thrombosis	Thrombectomy and fasciotomy	Unsuccessful	Above-knee amputation	Stump revision after five months
2	41	M	Post trauma (revision)	Valgus 20, FFD-20	Revision TKR (left)	Intraoperative	Popliteal artery laceration	Popliteal artery bypass graft	Successful	Underwent thrombectomy within 24 hours	Nil
3	60	M	OA	Valgus 10	Bilateral (left injured)	Day 5	Popliteal artery laceration	Thrombectomy and repair	Successful with chronic residual ischemia	Nil	Claudication and paraesthesia of foot
4	70	F	OA	Varus 10, FFD 10	Unilateral (left injured)	Intraoperative	Popliteal artery and vein laceration	Popliteal artery and vein repair with vein patch	Successful	Nil	Nil
5	59	F	OA	Varus 15	Bilateral (right injured)	22 hours	Superficial femoral and popliteal thrombosis	Thrombectomy and vein patch repair	Successful	Nil	Footdrop
6	52	M	Psoriatic arthritis	Valgus 20, FFD 20	Unilateral (right)	5 months	Pseudoaneurysm	Excision of pseudoaneurysm site and repair with interposition saphenous vein graft	Successful	Nil	Nil

RA: rheumatoid arthritis; OA: osteoarthritis.

Case 6

A male 52 years of age, a known case of hypertension, psoriasis, hepatitis C and interstitial nephritis presented with psoriatic arthritis of right knee. The patient had body mass index of 29.7. He presented with valgus deformity of 20 degrees and fixed flexion deformity of 20 degrees. The CII of 3. Patient underwent total knee replacement of right knee and was diagnosed pseudoaneurysm in the popliteal artery after 5 months post-surgery, as the patient presented with progressive pain and popliteal swelling. He underwent excision of the pseudoaneurysm and repair with interposition of saphenous vein graft. The procedure was a success with no further complications.



Figure 1: Angiogram showing a small rent and pseudoaneurysm of popliteal artery.

DISCUSSION

In our study, the incidence of vascular injury associated with TKA was 0.091%, similar to previously published reports of 0.09% to 0.17%.^{3,6-15} Vascular injuries associated with TKAs are rare, and hence there are only a few studies with many cases and long-term follow-up in the literature.^{3,5,7,9,10,21} However, there is some evidence to suggest that the incidence of these injuries may be increasing.^{7,8} Because TKAs are performed in large numbers, and the number increases every year, recognizing and treating these catastrophic complications is of paramount importance.

The literature demonstrates a higher risk of systemic complications and mortality after bilateral TKA than unilateral TKA.²⁷⁻²⁹ However, no study in the literature has evaluated the incidence of vascular injuries in bilateral simultaneous TKAs to the best of our knowledge. Our study has a large number of bilateral TKAs (3970 knees in 1985 patients) with an incidence of vascular injuries in three (0.075%) patients compared to an incidence of two (0.081%) patients in unilateral cases (out of 2449 TKAs), which is statistically not significant ($p < 0.01$). Several risk factors which are associated with vascular injuries are described in the literature.^{6,9,26} However, absolute risks associated with these factors are not defined in most studies, including the present study, because of the small

number of cases reported. Padegimas et al found a significant association between the female gender and vascular injuries, especially in black people.⁹ Parvizi et al and Dua et al reported a significant correlation with the female gender.^{6,30} While some other studies had no significant association with either gender, as noted in our study.^{21,31,32}

In the present study, a high body mass index (BMI) of more than 25 kg/m² was found in four patients (66.66%) with vascular injuries, while two patients (33.33%) had a BMI of more than 30 kg/m². Some studies showed statistically insignificant but higher BMI in their patients with vascular injuries.⁹ In our study, the average BMI was 26.95 kg/m², and two of the patients were obese (33.3%). A higher incidence of vascular injuries was noted in smokers in previous studies.^{6,33} In our study, one patient was a chronic smoker (16.6%). None of the patients was suffering from diabetes mellitus.

Revision surgeries involve complex osseous and soft tissue reconstruction with a higher incidence of vascular complications.^{3,21,34,35} A 2.4-times higher incidence of arterial injury is noted in revision arthroplasty.³¹ In our study, one patient (0.77%) undergoing a revision TKA sustained a popliteal artery injury that required on-table vascular reconstruction. This patient was undergoing a second stage revision for an infected TKA.

Current surgery included removing antibiotic cement spacer, correcting valgus deformity of about 20 degrees, and flexion deformity of about 20 degrees. A thigh Tourniquet was utilized in all the patients if there were no contraindications. A tourniquet is shown to be a risk factor in some studies.^{12,20,36} One patient in our study developed a superficial femoral and popliteal arterial obstruction in the background of chronic ischemia. His radiographs and angiograms showed popliteal and superficial femoral vascular calcification. Vascular injury in this patient could well be attributed to the usage of a tourniquet. Likely, his chronic peripheral vascular insufficiency was not symptomatic and was not addressed preoperatively. Vascular calcification is an additional risk factor while using a tourniquet.^{32,33} Careful evaluation of preoperative radiographs is vital to assess the calcification of the lower limb vessels. Patients with any history or signs of vascular insufficiency should be assessed by vascular surgeons preoperatively.

Reported mortality and amputation rates are 7% and 42%, respectively after vascular injuries associated with TKA.^{20,21} Early recognition of vascular injury is of paramount importance to prevent them. A minimal number of these injuries are recognized in the operation theatre during the primary surgery (7.7% Padegimas et al, 37.5% Bernhoff et al).^{9,21} Many are recognized within 24 hours (64% Sundaram et al, 84.6% Padegimas et al, 63% DaSilva et al, 55% Parvizi et al, 33% Pal et al, and 70% Troutman et al).^{6,9,13,15,31,33} In our study, two patients (33.3%) out of the six injuries were recognized during the

surgery, vascular reconstruction of them has given excellent results. In another patient, the vascular injury was recognized within 24 hours of surgery. In this patient, limb salvage was achieved but with a permanent foot drop. Of the two patients where the vascular injury was detected after five days, one underwent an above-knee amputation, and the other survived probably because of pre-existing good collateral circulation due to chronic ischemia. However, this patient continued to suffer from vascular claudication and burning sensation on foot.

The cardinal signs of vascular insufficiency viz. pain, pallor, pulselessness, and paraesthesia could be masked or altered by medications, sedation, epidural anesthesia, and nerve blocks used in the postoperative period. Two of our patients were presented with unilateral foot drop, which was initially confused for a common peroneal nerve injury in one and a motor weakness due to epidural anesthesia in another patient. Pain and swelling could easily be confused with deep vein thrombosis, which is more commonly seen after lower limb arthroplasty than vascular injuries. Another etiological process related to delayed presentation is a slowly developing arterial thrombosis and iatrogenic vascular trauma resulting in a pseudoaneurysm, as seen in our study. In these situations, a high index of suspicion is needed to investigate vascular signs and involve a vascular surgeon early.

Doppler ultrasound scan of the lower limb gives a rapid initial assessment of the vascular injury. This modality was utilized in all cases except two, where the injury was recognized intraoperatively. In these two patients, the vascular repair was undertaken immediately without further imaging. The other three patients underwent CT angiogram and, one underwent fluoroscopy in an angiogram suite. A well-equipped angiogram suite can be handy both for diagnosis and immediate endovascular procedures. In our study, all the patients required open exploration and a vein patch repair in one, bypass grafting in three, thrombectomy in two patients. One patient underwent endovascular treatment in the angiography suite to remove the thrombus a day after the primary vascular repair. Studies have shown lesser morbidity, lower risks of complications, and improved outcomes with endovascular management.^{9,31}

Limitations of the study include a small number of positive cases, and it is a retrospective study. Incidence could be slightly higher than the reported numbers if we consider the subclinical, missed, lost to follow-up, and undocumented cases, which may be the case with many other studies published on this topic.^{3,6,9,11,21,31,32} However, it is challenging to conduct a prospective study because of the rare nature of this complication. In addition, the retrospective studies can only be conducted in institutions with a high surgical volume and robust, retrievable patient data.

Based on the findings of this study and other available literature, we have adopted mandatory safeguards and

checklists to prevent delayed recognition of these injuries.^{6,9,11,33,36} These are: documentation of preoperative distal pulses and a consultation with a vascular surgeon preoperatively if a vascular abnormality is identified; Tourniquet is released before closing the wound to look for any excessive bleeding; a surgical team member must document the distal vascularity by palpating the distal pulses and using a pulse oximeter before transferring the patient out of the operation theatre, a handheld Doppler probe should be used in case of equivocal findings; distal pulses and pulse oximeter readings are documented every day until the patient is discharged; and epidural anesthesia or regional blocks should be stopped if a patient develops any neurological signs in the foot, and the vascular status should be checked immediately.

CONCLUSION

Even though rare, vascular injuries are catastrophic complications of TKA. Early recognition leading to prompt surgical intervention was the only factor that significantly altered the functional outcome and limb salvage. A mandatory institutional protocol consisting of specific clinical measures may help recognize vascular injuries early and promptly address them.

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REFERENCES

1. Rush JH, Vidovich JD, Johnson MA. Arterial complications of total knee replacement: The Australian experience. *J Bone Joint Surg.* 1987;69:400-2.
2. Langkamer VG. Local vascular complications after knee replacement: A review with illustrative case reports. *Knee.* 2001;8:259-64.
3. Ko LJM, DeHart ML, Yoo JU, Huff TW. Popliteal artery injury associated with total knee arthroplasty: Trends, costs, and risk factors. *J Arthroplasty.* 2014;29:1181-4.
4. Berger C, Anzböck W, Lange A, Winkler H, Klein G, Engel A. Arterial occlusion after total knee arthroplasty: Successful management of an uncommon complication by percutaneous thrombus aspiration. *J Arthroplasty.* 2002;17:227-9.
5. Calligaro K.D., Delaurentis DA, Booth RE, Rothman RH, Savarese RP, Dougherty MJ. Acute arterial thrombosis associated with total knee arthroplasty. *J Vasc Surg.* 1994;20:927-32.
6. Parvizi J, Pulido L, Slenker N, Macgibeny M, Purtill JJ, Rothman RH. Vascular Injuries After Total Joint Arthroplasty. *J Arthroplasty.* 2008;23:1115-21.
7. Calligaro KD, Dougherty MJ, Ryan S, Booth RE, Donnell S, Elias S, et al. Acute arterial complications associated with total hip and knee arthroplasty. *J Vasc Surg.* 2003;38:1170-5.

8. Rand JA. Vascular complications of total knee arthroplasty: Report of three cases. *J Arthroplasty.* 1987;2:89-93.
9. Padegimas EM, Levicoff EA, McGinley AD, Sharkey PF, Good R.P. Vascular Complications After Total Knee Arthroplasty-A Single Institutional Experience. *J Arthroplasty.* 2016;31:1583-8.
10. Avisar E, Elvey MH, Bar-Ziv Y, Tamir E, Agar G. Severe vascular complications and intervention following elective total hip and knee replacement: A 16-year retrospective analysis. *J Orthopaed.* 2015;12:151-5.
11. Abularrage CJ, Weiswasser JM, DeZee KJ, Slidell MB, Henderson WG, Sidawy AN. Predictors of lower extremity arterial injury after total knee or total hip arthroplasty. *J Vasc Surg.* 2008;47:803-7.
12. Holmberg A, Milbrink J, Berqvist D. Arterial complications after knee arthroplasty: 4 cases and a review of the literature. *Acta Orthopaedica.* 1996;67:75-8.
13. da Silva MS, Sobel M, Brothier T, Oldenburg WA, Rosenthal D, Buckley CJ, et al. Popliteal vascular injury during total knee arthroplasty. *J Surg Res.* 2003;109:170-4.
14. DeLaurentis DA, Levitsky KA, Booth RE, Rothman RH, Calligaro KD, Raviola CA, et al. Arterial and ischemic aspects of total knee arthroplasty. *Am J Surg.* 1992;164:237-40.
15. Pal A, Clarke JMF, Cameron AEP. Case series and literature review: Popliteal artery injury following total knee replacement. *Int J Surg.* 2010;8:430-5.
16. Barrack RL. Neurovascular injury: Avoiding catastrophe. *J Arthroplasty.* 2004;104-7.
17. Smith DE, McGraw RW, Taylor DC, Masri BA. Arterial complications and total knee arthroplasty. *J Am Acad Orthopaed Surgeons.* 2001;9:253-7.
18. Aust JC, Bredenberg CE, Murray DG. Mechanisms of Arterial Injuries Associated With Total Hip Replacement. *Arch Surg.* 1981;116:345-9.
19. Hirsch SA, Robertson H, Gorniowsky M. Arterial Occlusion Secondary to Methylmethacrylate Use. *Arch Surg.* 1976;111:204.
20. Kumar SN, Chapman JA, Rawlins I. Vascular injuries in total knee arthroplasty: A review of the problem with special reference to the possible effects of the tourniquet. *J Arthroplasty.* 1998;13:211-6.
21. Bernhoff K, Rudström H, Gedeberg R, Björck M. Popliteal artery injury during knee replacement: A population-based nationwide study. *Bone Joint J.* 2013;95B:1645-9.
22. Mathew A, Abraham BJ, Fischer L, Punnoose E. Popliteal artery thrombosis following total knee arthroplasty managed successfully with percutaneous intervention. *BMJ Case Rep.* 2014.
23. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation. *J Chronic Dis.* 1987;40:373-83.
24. Marya SKS, Amit P, Singh C. Impact of Charlson indices and comorbid conditions on complication risk in bilateral simultaneous total knee arthroplasty. *Knee.* 2016;23:955-9.
25. Kohn MD, Sassoon AA, Fernando ND. Classifications in Brief: Kellgren-Lawrence Classification of Osteoarthritis. *Clin Orthop Relat Res.* 2016;474:1886-93.
26. Insall JN, Dorr LD, Scott RD, Scott WN. Rationale of The Knee Society clinical rating system. *Clin Orthop Relat Res.* 1989;13-4.
27. Warren JA, Siddiqi A, Krebs VE, Molloy R, Higuera CA, Piuze NS. Bilateral Simultaneous Total Knee Arthroplasty May Not Be Safe Even in the Healthiest Patients. *J Bone Joint Surg Am.* 2021;103:303-11.
28. Restrepo C, Parvizi J, Dietrich T, Einhorn TA. Safety of simultaneous bilateral total knee arthroplasty: A meta-analysis. *J Bone Joint Surg.* 2007;89:1220-6.
29. Odum SM, Springer BD. In-hospital complication rates and associated factors after simultaneous bilateral versus unilateral total knee arthroplasty. *J Bone Joint Surg.* 2014;96:1058-65.
30. Dua A, Zepeda R, Hernandez FC, Igbadumhe AA, Desai SS. The national incidence of iatrogenic popliteal artery injury during total knee replacement. *Vascular.* 2015;23:455-8.
31. Troutman DA, Dougherty MJ, Spivack AI, Calligaro KD. Updated strategies to treat acute arterial complications associated with total knee and hip arthroplasty. *J Vasc Surg.* 2013;58:1037-42.
32. Lin YC, Chang CH, Chang CJ, Wang YC, Hsieh PH, Chang Y. Vascular injury during primary total knee arthroplasty: A nationwide study. *J Formosan Med Assoc.* 2019;118:305-10.
33. Sundaram K, Udo-Inyang I, Mont MA, Molloy R, Higuera-Rueda C, Piuze NS. Vascular Injuries in Total Knee Arthroplasty: A Systematic Review and Meta-Analysis. *JBJS Rev.* 2020;8:e0051.
34. Metzdorf A, Jakob RP, Petropoulos P, Middleton R. Arterial injury during revision total knee replacement: A case report. *Knee Surg Sports Traumatol Arthrosc.* 1999;7:246-8.
35. Saleh KJ, Hoeffel DP, Kassim RA, Burstein G. Complications after revision total knee arthroplasty. *J Bone Joint Surg.* 2003;85:71-4.
36. Stewart AHR, Baird RN. The prevention and early recognition of arterial complications in total knee replacement: a vascular surgical perspective. *Knee.* 2001;8:265-7.

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