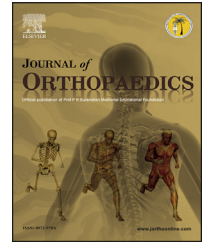


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## Original Article

# Severe vascular complications and intervention following elective total hip and knee replacement: A 16-year retrospective analysis



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## ARTICLE INFO

## Article history:

Received 17 July 2014

Accepted 4 January 2015

Available online 11 February 2015

## Keywords:

Arthroplasty

Total hip replacement

Total knee replacement

Vascular complications

Angiography

## ABSTRACT

**Introduction:** Iatrogenic vascular injuries associated with elective orthopaedic joint procedures are relatively rare, however when they do occur they carry a risk of significant morbidity and mortality. The aim of this study was to investigate the incidence of vascular complications and resultant need for specialist intervention following elective total hip replacement (THR) and total knee replacement (TKR).

**Methods:** This was a retrospective analysis of prospectively collected data. The primary outcome measure was vascular complication requiring an interventional radiology procedure or vascular surgery. As a secondary outcome measure postoperative Modified Knee Society Scores and Harris Hip Scores were analysed to assess long term clinical outcome. **Results:** Six cases of vascular injury requiring specialist intervention were identified. From 2073 total TKRs there were one cases of popliteal artery injury, one case of venous injury and two case of lateral geniculate artery injury (0.19%). From 1601 THRs there were two cases (0.12%) of arterial injury. All patients were treated successfully by a vascular surgeon or an interventional radiologist. Patient outcome varied considerably with the poorest results seen in the THR group.

**Conclusions:** Iatrogenic vascular complications following elective THR and TKR carry a risk of significant morbidity and mortality. It is important that surgeons and trainees performing these procedures are conscious of these risks and able to identify vascular injuries promptly when they occur. Detailed preoperative assessment, an awareness of anatomical variants and close liaison with a vascular surgeon may all help to reduce the number and severity of adverse outcomes.

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<http://dx.doi.org/10.1016/j.jor.2015.01.008>

## 1. Introduction

Despite the anatomical proximity of the large veins and arteries to the surgical field during lower extremity arthroplasty, the incidence of vascular injuries during total knee and hip arthroplasty is low, ranging from 0.03% to 0.2%.<sup>1–4</sup> Nevertheless the resultant morbidity and mortality associated with such injuries necessitates that surgeons and trainees are aware of both the risk of vascular insult and the variety of ways in which these injuries may manifest. Immediate and early signs of arterial injury following arthroplasty can vary from massive haemorrhage and shock to acute limb ischaemia. However some patients will present with more chronic features including persistent pain, swelling, or resistant anaemia secondary to pathologies including false aneurysm or arteriovenous fistula. Surgeons must be aware of these presentations in order to reduce diagnostic confusion and avoid the harmful outcomes associated with delayed diagnosis.

The mechanism of direct vascular injury following TKR can be classified into four general categories: arterial occlusion, arterial severance, arteriovenous fistula formation, and arterial aneurysm formation. The most common vessels injured during TKR are the popliteal artery and tibial artery. The incidence and distribution of venous injury is less well described in the literature.

## 2. Methods

This was a retrospective analysis of data collected prospectively from the Assaf Harofeh Medical Centre. Data were extracted from a local electronic database and cross-checked with clinical notes for verification and acquisition of supplementary information. 1601 THRs (326 revisions) and 2073 TKRs (223 revisions) performed consecutively between 1995 and 2011 were analysed (Table 1). All procedures were performed by, or under the supervision of, two lead arthroplasty consultants. The mean age of patients was 67 years and 58% of patients were male. Electronic and paper records were interrogated for the type of surgery performed, number of previous surgeries, and concurrent co-morbidities including atherosclerosis, diabetes, and hypertension. Specific attention was paid to any record of vascular complication, the clinical presentation of complications, the imaging modality utilised in the diagnosis of the vascular complication, subsequent intervention, and clinical outcome. In all cases of TKR, Thigh

Tourniquet was used (300 mmHg) as part of the femoral and tibial components cementation. The primary outcome measure was vascular complication requiring treatment from an interventional radiologist or vascular surgeon. As a secondary outcome measure postoperative Modified Knee Society scores and Harris Hip Scores were analysed to assess any long term clinical outcome.<sup>5,6</sup> This was achieved by inviting all patients identified as suffering a significant vascular complication back for interview and clinical assessment. Isolated thromboembolic events were excluded from the study.

## 3. Results

Data on 1601 THRs (326 revisions) and 2073 TKRs (223 revisions) were analysed. Six patients were identified as sustaining a substantial vascular injury that required the input of a vascular surgeon or interventional radiologist. In the TKR group there were Three cases of acute arterial injury (popliteal artery and two cases of lateral geniculate artery), one case of venous injury (branch of popliteal vein). In the THR group there were two cases of acute arterial injury (obturator artery and external iliac artery). All cases were treated successfully with the assistance of either a vascular surgeon or an interventional radiologist. All operated limbs were salvaged. At final follow up all patients were ambulating independently or with minimal assistance however there were considerable variations in functional outcome scores.

## 4. Patient 1

A 73-year-old female underwent an elective left TKR for osteoarthritis six months after an uneventful similar procedure on the opposite leg. Past medical history included hypertension and ischemic heart disease. Pre-operative radiographs illustrated calcified popliteal vessels however there were no clinical signs of vascular impairment at pre-operative assessment.

Immediately following tibial resection a massive pulsatile haemorrhage was encountered. After attempts to achieve anterior vascular control failed the vascular surgeons were called. The patient was turned into a prone position to facilitate a posterior approach. A 270° tear of the popliteal artery, probably caused by the saw blade, was identified and sutured by the vascular surgeon. The procedure was abandoned due to haemodynamic instability however definitive arthroplasty was resumed after six weeks with an uneventful course. At latest follow up (7 years post procedure) range of motion was 0–85° and the patient was ambulating without aids. The modified knee society knee and functional scores were 80 and 70, respectively. Radiographs demonstrated well aligned components with no signs of loosening.

## 5. Patient 2

A 73-year-old female underwent an elective right TKR for osteoarthritis six months after an uneventful similar procedure on the opposite leg. Five days after discharge from

**Table 1 – TKA and THA performed in our institution between the years 1995–2011.**

Technique	Primary TKA	Revision TKA	Primary THA	Revision THA
Cemented	1829	223	426	
Cementless	24		849	326
Total	2073		1601	

TKA = total knee arthroplasty, THA = total hip arthroplasty.

hospital (10 days post procedure), the patient was re-admitted with worsening right knee pain and substantial knee swelling. No additional trauma was reported. The patient was taking 40 mg of enoxaparin once daily as per the departmental routine thromboembolic prophylaxis regimen. Her physical examination demonstrated slightly diminished dorsalis pedis and tibialis posterior pulses. A sterile aspiration produced 50 ml of blood. After 24 h of observation with no improvement, angiography was performed. The angiogram demonstrated a hypertrophied lateral geniculate artery with a vascular blush in the lateral aspect of her right knee. An embolization of the aneurismal lateral geniculate artery was carried out successfully. No further complications were recorded. At latest follow up (2 years post procedure) range of motion was 5–100°. The Modified Knee Society Knee and Functional Scores were 76 and 80 respectively.

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### 6. Patient 3

A 66-year-old female who had previously undergone a revision left THR was admitted for a two stage revision–revision arthroplasty due to prosthetic infection. Past medical history included systemic lupus erythematosus, rheumatoid arthritis, and abdominal hysterectomy with bilateral salpingo-oophorectomy followed by radiotherapy 14 years prior to the current admission for cervical carcinoma. Her reconstructive history included a left THR followed by revision arthroplasty of the acetabular component following a fall 3 weeks post surgery resulting in protrusio acetabuli. This was complicated by a deep infection (coagulase positive, methicillin sensitive, staphylococcus aureus) five months later requiring a two stage revision.

Intra-operatively, following acetabular component removal and acetabular bed curettage, a massive haemorrhage was witnessed. Following failure of coagulation and packing, vascular assistance was requested. An intra-operative angiogram was performed which demonstrated an injury to the left external iliac artery. After an attempt to stent the lesion failed, a Gortex bypass graft anchoring the external iliac and common femoral arteries was established. A total of 15 units of packed red cells, eight units of fresh frozen plasma and 29 units of platelets were infused. Arthroplasty was completed and the patient recovered from surgery, although suffered from a persistent deep infection which was treated by suppressive antibiotics due to patient refusal for further surgery. Despite the infection the gortex graft continued to function. At latest follow up (4 years post surgery) the Harris Hip Score was 43.

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### 7. Patient 4

A 52-year-old woman with a past history of developmental dysplasia of the hip underwent left THR. Prior surgery included a subtrochanteric varus derotational osteotomy of the left hip nine years previously followed by removal of a blade plate. During resection of the soft tissue surrounding the anterior wall of the dysplastic acetabulum, a massive haemorrhage erupted from a branch of the obturator artery. Following failed attempts to achieve control, assistance was requested. A senior vascular surgeon was able to locate and repair the injured vessel through

the surgical incision. The procedure was resumed with insertion of an uncemented acetabular cup and femoral stem. Total blood consumption was five units of packed red cells. No additional bleeding or other vascular complication was observed postoperatively and the patient made an uneventful recovery. Three years post procedure the patient was ambulating independently with a Harris Hip Score of 67.

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### 8. Patient 5

A 65-year-old female underwent an elective right TKR for osteoarthritis. Past medical history included hypertension, ischemic heart disease and morbid obesity (BMI 33). At pre-operative assessment there were no symptoms or signs of vascular compromise.

Intra-operatively, following tibial resection, a massive non-pulsatile haemorrhage was observed from the posterior aspect of the knee. When initial measures taken to control the haemorrhage failed, a vascular surgeon was called who was able to stem the bleeding with packing. A Doppler-assisted examination confirmed a laceration of the popliteal vein with excellent dorsalis pedis and tibialis posterior pulses and the decision was taken not to explore the popliteal fossa. The procedure resumed without complication. No further vascular complications were observed postoperatively. Three years post procedure the Modified Knee Society Knee and Functional Scores were 81 and 75 respectively.

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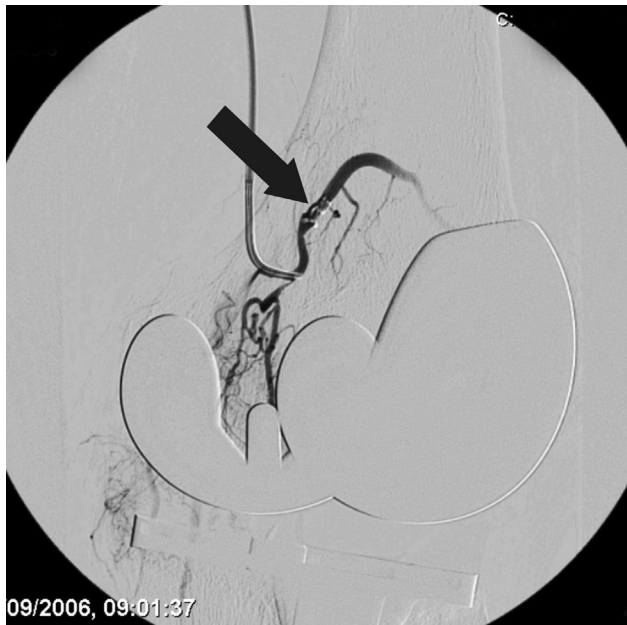
### 9. Patient 6

A 69-year-old male underwent an elective left TKR for osteoarthritis. The procedure was recorded as unremarkable. Five days post surgery the patient developed an asymptomatic deep vein thrombosis in a left calf vein. This was demonstrated on venography as part of a study protocol he was under. Consequently he was commenced on warfarin anti coagulation therapy reaching a target INR of 2.5. Over the following 3 months and regular outpatient clinic reviews the patient complained of recurrent and knee swelling. Following discussion with senior haematologists, anticoagulation therapy was withheld for a trial period of one week. When the swelling failed to settle despite normalisation of clotting markers and platelets, a sterile aspiration was performed demonstrating frank blood. Both arterial and venous angiograms were performed. The arterial scan illustrated a hypertrophic lateral geniculate artery with evidence of vascular blush. This aneurysm was subsequently embolized by coils (Fig. 1). There were no further vascular complications and the swelling subsided. Six years post procedure the patient was fully ambulatory with Modified Knee Society and Functional Scores of 78 and 73 respectively.

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### 10. Discussion

The findings of this case series illustrate that these rare but potentially catastrophic injuries can provide challenges both in diagnosis and management. Furthermore, this series calls



**Fig. 1 – Selective angiography of the geniculate artery and embolization by coils (arrow).**

into question the need for orthopedic surgeons to acquire the necessary skills to manage vascular emergencies, or at very least operate in centers where vascular support is available.

Most arterial complications following TKR are associated with tourniquet use and are related to indirect vessel injury and thrombosis.<sup>7-11</sup> Nevertheless direct vascular do occur. We encountered two cases of direct vessel injury which presented with large intra-operative bleeds requiring urgent intervention. There were two further subacute presentations of pain, swelling and chronic haemarthrosis secondary to lateral geniculate artery injury. The overall incidence of arterial injury in our series of 0.144% is similar to those previously reported in the literature (Table 2).

Direct laceration of vessels is most frequently seen in patients undergoing revision surgery classically due to anatomical distortion and the need for removal of a prior prosthesis.<sup>3,4,10,13</sup> However, direct lacerations occurring at primary arthroplasty are well reported. Ninomiya et al suggested that the risk of injury to the popliteal artery may be minimised if posterior retractors are placed medial to the midline of the tibial plateau and if care is taken to avoid extremes of both flexion and extension.<sup>12</sup>

The lateral inferior geniculate artery arises from the popliteal artery under the cover of the origin of the lateral gastrocnemius muscle and winds close to the lateral meniscus with nothing intervening except the popliteal tendon. It is possible to damage this artery at the time of excision of the lateral meniscus or by overzealous retraction whilst protecting the lateral structures. This complication may be avoided by following a few simple precautions, such as a leaving a thin rim of lateral meniscus and using cautery rather than a blade at the popliteal hiatus region. In order to reveal any abnormal bleeding in the surgical area, it may be prudent to minimize the use of tourniquet. In our experience we prefer to inflate the tourniquet for cementation only, and

**Table 2 – Reported case series of vascular injuries following hip and knee arthroplasty.**

Authors	Year	Incidence of vascular injury in TKA (%)	Incidence of vascular injury in THA (%)
Calligaro et al. <sup>2</sup>	2003	0.17	0.08
Wilson et al. <sup>4</sup>	2003	0.005 (overall incidence)	
Hwang et al. <sup>17</sup>	1997		0.25
Fruhwh et al. <sup>23</sup>	1997		0.3
Calligaro et al. <sup>2</sup>	1994	0.17	

TKA = total knee arthroplasty, THA = total hip arthroplasty.

deflate it prior to wound closure in order to notice and address any substantial vascular injury.<sup>13</sup> Even with such precautions not all injuries are apparent at surgery and in our series 50% (two out of four) of the arterial injuries encountered were identified in the early and late post-operative phases. Saini and Rukavina reported two cases of lateral geniculate artery injury following primary TKR that was presented as early post op recurrent haemarthrosis, successfully treated by coil embolization.<sup>21,22</sup>

In contrast to injuries around the knee, a greater proportion of vascular injuries encountered during hip arthroplasty tend to be of acute onset.<sup>14</sup> Risk factors include: revision THA, intrapelvic migration of the acetabular components, the anterolateral approach, and left-sided procedures.<sup>15</sup> Vascular injury is most frequently associated with the use of screws for fixation of structural grafts, acetabular components and protrusio rings or cages.<sup>16,17,19,20</sup> The most commonly injured vessels in THR are the external iliac artery and vein and the common femoral artery. Metha et al reported an unusual injury to the femoral artery and vein by a cerclage wire passed around the femoral midshaft during revision THA.<sup>18</sup> No such injuries were recorded in our case series.

This study is limited by its retrospective nature. Future studies would benefit from both pre-operative functional scores, and comparative post-operative scores from a cohort of patients who avoided severe vascular complications in order to accurately assess the effect on long-term outcome. Unfortunately these data were not available.

## 11. Conclusion

Vascular complications associated with elective total hip and knee arthroplasty are relatively rare, however when they do arise they carry a risk of significant morbidity and mortality. Challenges lie both in the diagnosis and management of these adverse incidents. A detailed pre-operative assessment, a thorough knowledge of anatomical variants, a high index of suspicion not just in the acute environment but in the post-operative setting, and the support of vascular specialists may all help to optimise results and reduce potentially catastrophic outcomes.



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## Conflicts of interest

All authors have none to declare.

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## REFERENCES

1. Sharma DK, Kumar N, Mishra V, Howell FR. Vascular injuries in total hip replacement arthroplasty: a review of the problem. *Am J Orthop*. 2003;32:487–491.
2. Calligaro KD, DeLaurentis DA, Booth RE, Rothman RH, Savarese RP, Dougherty MJ. Acute arterial thrombosis associated with total knee arthroplasty. *J Vasc Surg*. 1994;20:927–932.
3. Freischlag JA, Sise M, Quinones-Baldrich WJ, Hye RJ, Sedwitz MM. Vascular complications associated with orthopedic procedures. *Surg Gynecol Obstet*. 1989;169:147–152.
4. Wilson JS, Miranda A, Johnson BL, Shames ML, Back MR, Bandyk DF. Vascular injuries associated with elective orthopedic procedures. *Ann Vasc Surg*. 2003;17:641–644.
5. Insall JN, Dorr LD, Scott RD, Scott WN. Rationale of the knee society clinical rating system. *Clin Orthop Relat Res*. 1989;248:13–14.
6. Harris WH. Traumatic arthritis of the hip after dislocation and acetabular fractures: treatment by mold arthroplasty. An end-result study using a new method of result evaluation. *J Bone Joint Surg Am*. 1969;51:737–755.
7. Mureebe L, Gahtan V, Kahn MB, Kerstein MD, Roberts AB. Popliteal artery injury after total knee arthroplasty. *Am Surg*. 1996;1996:366–368.
8. Rand JA. Vascular complications of total knee arthroplasty: report of three cases. *J Arthroplasty*. 1987;2:89–93.
9. 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;13:211–216.
10. Hozack WJ, Cole PA, Gardner R, Corces A. Popliteal aneurysm after total knee arthroplasty: case reports and review of the literature. *J Arthroplasty*. 1990;5:301–305.
11. Da Silva MS, Sobel M. Surgeons of the southern association of vascular surgery. Popliteal vascular injury during total knee arthroplasty. *J Surg Res*. 2003;109:170–174.
12. Ninomiya JT, Dean JC, Goldberg VM. Injury to the popliteal artery and its anatomic location in total knee arthroplasty. *J Arthroplasty*. 1999;14:803–809.
13. Pai VS. Traumatic aneurysm of the inferior lateral geniculate artery after total knee replacement. *J Arthroplasty*. 1999;14:633–634.
14. Reiley MA, Bond D, Branick RI, Wilson EH. Vascular complications following total hip arthroplasty: a review of the literature and a report of two cases. *Clin Orthop Relat Res*. 1984;18:23–28.
15. Shoenfeld NA, Stuchin SA, Pearl R, Haveson S. The management of vascular injuries associated with total hip arthroplasty. *J Vasc Surg*. 1990;11:549–555.
16. Barrack RL. Neurovascular injury: avoiding catastrophe. *J Arthroplasty*. 2004;19:104–107.
17. Hwang SK. Vascular injury during total hip arthroplasty: the anatomy of the acetabulum. *Int Orthop*. 1994;18:29–31.
18. Mehta V, Finn HA. Femoral artery and vein injury after cerclage wiring of the femur: a case report. *J Arthroplasty*. 2005;20:811–814.
19. Kadar A, Ankory R, Sherman H, et al. Clinical and radiographic outcomes of 139 hips with articular surface replacement total hip arthroplasty. *Isr Med Assoc J*. 2013 Sep;15:505–509.
20. Segal O, Maoz-Segal R. Metal-on-Metal hip replacement: a new concept for an old problem? *Isr Med Assoc J*. 2013 Nov;15:722–724.
21. Saini P, Meena S, Malhotra R, Gamanagatti S, Kumar V, Jain V. Pseudoaneurysm of the superior lateral genicular artery: case report of a rare complication after total knee arthroplasty. *Patient Saf Surg*. 2013 May 20;7:15.
22. Rukavina A, Kerkhoffs GM, Schneider P, Kuster MS. Recurrent hemarthrosis after total knee arthroplasty. *Knee Surg Sports Traumatol Arthrosc*. 2010 Jul;18:898–900.
23. Fruhwth J, Koch G, Ivanic GM, Seibert FJ, Tesh NP. *Unfalchirurg*. 1997 Feb 10:119–123.