

Arterial complications after knee arthroplasty

4 cases and a review of the literature

Anders Holmberg, Jan Milbrink and David Bergqvist

We reviewed 40 cases of arterial complications after total knee replacement from the literature and report 4 of our own cases. The incidence is low (0.03%–0.2%), but the prognosis is poor, with death or amputation in one fourth of the cases. Preexisting arterial insufficiency, absent pedal pulses, arterial calcification on plane radiographs, femoro- popli-

teal/distal grafts are all predisposing factors. Therefore, preoperative risk factor evaluation as well as rapid and adequate handling in case of bleeding and/or ischemic complications pre- and postoperatively are crucial. Cooperation with a vascular surgeon is also essential.

Departments of Surgery and Orthopedics, University Hospital Uppsala, S-751 85 Uppsala, Sweden
Tel +46 18-66 46 28. Fax -66 46 32
Submitted 95-06-24. Accepted 95-10-09

Arterial complications after total knee replacement are rare. Because of poor collateral circulation, severe ischemia may give rise to irreversible tissue damage necessitating amputation if not adequately recognized and treated. We review 40 cases from the literature and 4 of our own cases. Incidence, prognosis, treatment, potential risk factors and measures to prevent injury are analyzed.

Case 1

A 72-year-old woman underwent bilateral total knee arthroplasty. After the operation she had severe pain in her right foot. Pallor and peroneal palsy with drop-foot were noted and Doppler studies confirmed the diagnosis of arterial occlusion. Exploration of the popliteal artery was undertaken 12 hours after the knee operation. An intimal tear with overlying thrombosis was found. Thrombectomy, extirpation of the fractured intima and a patch graft using polytetrafluoroethylene (PTFE) were performed, as well as fasciotomy. The postoperative course was unremarkable, with normal circulation in the foot.

Case 2

A 70-year-old woman had a left total knee replacement. Preoperatively, the pedal pulses were not evaluated. When the tourniquet was deflated, the pedal pulses were absent. However, there were no signs of acute limb ischemia and Doppler flow assessment revealed signals from the posterior and the anterior artery. On another examination by a vascular surgeon 8 days postoperatively, the arterial circulation was

normal with palpable pedal pulses. 40 days after the knee operation she noted sudden pain in the left popliteal fossa and numbness of the foot. Physical examination revealed a pulsating mass in the popliteal fossa and a palpable posterior tibial artery. However, the resting ankle brachial index was 0.7. The diagnosis was completed by ultrasonography that showed a 5 × 5 cm false aneurysm and a functioning popliteal artery. An excision of the false aneurysm with subsequent end-to-end anastomosis of the artery was performed. Ultrasonography was found to be normal 39 days after this operation and the resting ankle brachial index was 1.0.

Case 3

A 48-year-old woman with HLAB 27-associated severe arthritis affecting both knees and the right hip underwent a right-sided hip arthroplasty and total knee replacement simultaneously. When the tourniquet was deflated, there was severe bleeding from the knee. Immediate exploration showed an almost divided popliteal artery. A 4 cm long interposition graft from the short saphenous vein was used for repair. The recovery was uneventful and an ultrasonographic examination as well as ankle pressure measurements 51 days postoperatively were normal.

Case 4

A 74-year-old woman underwent medial unicompartmental knee arthroplasty. Preoperative physical examination revealed poor pedal pulses. On the first postoperative day she complained of severe pain and

a cold right foot. After she started to recover, the symptoms recurred a few days later. An arteriogram was performed and showed extensive arteriosclerosis as well as aneurysmatic dilatation of the abdominal aorta and superficial femoral artery. The distal part of the popliteal artery was occluded and the anterior tibial artery was the only visible vessel in the distal part of the leg. Thrombectomy was performed of the popliteal and posterior tibial arteries 1 week postoperatively from a popliteal approach. She recovered without sequelae.

Case 1 is from another hospital. Cases 2, 3 and 4 are from our hospital giving an incidence of 0.2% (3/1483).

Discussion

Arterial complications in connection with knee replacement surgery are rare. 28 cases have been reported as well as 2 estimations of the incidence. At the Mayo clinic 9,022 operations were performed between 1971 and 1986 with an incidence of 0.03% (Rand 1987), which is lower than in our series (0.2%), but the true incidence is difficult to establish from a small series. Rush et al. (1987) circulated a questionnaire among all Fellows of the Australian Orthopedic Association. 100 out of 470 reported 12 arterial complications. With the addition of our 4 cases, the discussion will be based on the experience in 44 patients.

Thrombotic occlusion was commonest.

The outcome was 21 cases of limb salvage, 11 amputations from the mid-tarsal level to above the knee, 1 death and 1 patient lost to follow-up (Table 1). With a combined death and amputation rate of one fourth, the seriousness of this complication is obvious in patients undergoing surgery to improve their quality of life.

Tourniquet-caused fractures of atheromatous plaques either as a solitary mechanism or in combination with distortion and traction of the artery during knee surgery are discussed by several authors (Starsiak 1980, Rand 1987, Rush et al. 1987, Zahrani and Cuschieri 1989, Hagan and Kaufman 1990, DeLaurentis et al. 1992) and this was probably the etiology in our case 4. However, this etiologic factor was not significantly related to arterial injury when populations with (6) or without (62) arterial insufficiency were studied prospectively (DeLaurentis et al. 1992). Correction of a flexion contracture of the knee has been supposed to cause either arterial thrombosis or reversible extension-dependent occlusion of the popliteal artery (Arden 1973, Robson et al. 1975,

Table 1. Number of reported complications after total knee arthroplasty

Reference	A	B	C	D	E
Arden					2
Calligaro	7				
DeLaurentis	2				
Dennis			2		
Fortune	1				
Hagan	1				
Hozack	1		1		
McAuley	1			1 ^a	
Rand	3				
Robson					1
Rush ^b	7	3	2		1 ^c
Starsiak	1	1			
Zahrani	2				
Our series	2	1	1		
Total (amputation)	29 (11)	5	6	1	3

A thrombosis, B severed popliteal artery, C arteriovenous fistulas and false aneurysms, D accelerated development of arteriosclerotic disease, E others.

^a Questionable causality

^b Australian data

^c Death

Fortune 1986). The latter condition may require a plaster cast in flexion (Arden 1973) or division of tight musculofascial structures compressing the artery (Robson et al. 1975). When a longstanding flexion contracture with ankylosis is present, surgery must be performed with the knee flexed. In one patient reported by Starsiak as well as in our case 3 the popliteal artery was transected during such conditions. Preexisting popliteal aneurysms gave rise to thrombotic occlusion in one patient (Hozack et al. 1990). Functioning PTFE grafts to the below-knee position were occluded by fresh thrombus in one patient with (Rand 1987) and one without (DeLaurentis et al. 1992) a tourniquet. An intimal tear with the development of an occlusive thrombus was noted by McAuley et al. (1984), as well as in one of our patients.

False aneurysms and arteriovenous fistulas are supposed to develop from partial laceration of the artery with or without injury of the adjacent vein. The clinical presentation could be an enlarging pulsating mass associated with a bruit with or without pain and sometimes with peripheral neuropathy. The peripheral circulation may be normal, but there is a risk of microembolization. Pseudoaneurysms originating in the inferior medial geniculate artery occurred in 2 patients reported by Dennis et al. (1987). The artery was supposed to have been injured in connection with making a flap of periosteum, the pes anserinus and the medial collateral ligament. The popliteal artery was the origin of the false aneurysm in one patient

Table 2. Symptoms and signs associated with acute limb ischemia

Pulselessness
 Pallor
 Pain
 Paresthesia
 Paralysis

Table 3. Fasciotomy should be considered in the following situations

Adequate arterial reconstruction is delayed 4-6 hours
 Extensive limb swelling
 Paresthesia and paralysis
 Pain associated with passive extension of the muscles

Table 4. Preoperative risk factors for arterial injury in connection with total knee arthroplasty

Intermittent claudication
 Ischemic rest pain
 Arterial ulcers
 Limb pulses not palpable
 Popliteal aneurysm suspected
 Previous arterial reconstruction
 Arterial calcification on plain radiographs

reported by Hozack et al. (1990) as well as in one of our patients.

Accelerated arteriosclerotic progress stimulated by initial intimal disruption with development of an arterial occlusion 16 months after the knee operation was suggested by McAuley et al. (1984). The causality is far from clear in this patient and may only have been the natural history of his arteriosclerotic process.

Predisposing factors for arterial complications are atheromatous plaques in the vessels where the tourniquet is applied or in the popliteal artery when the knee is manipulated. True popliteal aneurysms entail a large risk of thrombosis, which is also the case for patients with existing arterial insufficiency in the lower extremities, absent pedal pulses, functioning femoropopliteal/distal bypasses, especially PTFE, and longstanding flexion contracture with ankylosis.

Arterial injury must always be suspected when abnormal bleeding or a large expanding hematoma occurs in association with tourniquet deflation. Acute ischemic signs in the lower limb, as indicated by the 5 p's (Table 2), must be recorded in the routinely performed postoperative evaluation but they may be difficult to interpret. Paresthesia and paralysis are early symptoms, since peripheral nerves are sensitive to anoxia. Pulses may be palpable, in spite of arterial

injury in some cases, at least initially. This is because an intimal tear may gradually cause dissection, with a thrombotic process accompanied by occlusion several hours after the injury. Pain may be related to the operative trauma and may also be absent when an epidural pain-relieving block is maintained. Pallor may be secondary to hypovolemia. Hence, the suspicion and diagnosis of arterial injury must be based on the combination of factors mentioned above.

Local symptoms from the knee such as pain, an enlarging pulsating mass and a bruit, as well as peripheral neuropathy without simultaneous limb ischemia, indicate that a false aneurysm or an arteriovenous fistula has developed. These complications generally occurs several weeks postoperatively.

When an arterial complication is suspected or recognized, immediate steps must be taken to treat it which, in most cases, means that a vascular surgeon must be contacted. In case of acute limb ischemia, an emergency exploration has to be done, any delay reduces the likelihood of limb salvage. If for some reasons angiography should be necessary, it should preferably be made intraoperatively, not to lose time in the angiography section. If the time delay exceeds 4-6 hours, irreversible neuromuscular injury may ensue. To prevent this, a temporary intraluminal shunt must be considered, the authors' preference is for a Pruitt-Inahara shunt. This is a plastic shunt with inflatable balloons for bleeding control proximal and distal and a separate canal where the blood can pass during the arterial reconstruction. Possible surgical procedures include thrombectomy, application of an arterial patch, a bypass and direct anastomosis. Fasciotomy should be considered in various situations (Table 3).

In case of severe bleeding on release of the tourniquet, it is important not to try blind hemostasis with an artery forceps or suture ligatures. Instead, dissection and identification of the injury as well as proper reconstruction, if a main artery is damaged, should be performed.

False aneurysms and arteriovenous fistulas are subacute or chronic. Diagnostic ultrasonography or angiography should be done before operation, with excision and vascular repair.

Prevention of arterial complications at total knee replacement consists of several steps. There must be an evaluation concerning preoperative risk factors (Table 4) and, in case of any doubt, a vascular surgeon should be involved in the evaluation. Ankle pressures should be measured, if any preoperative risk factors are present. Especially in patients with extensive arterial calcification the use of a tourniquet should be questioned. If a tourniquet is necessary in

spite of existing risk factors, a thorough postoperative clinical investigation should be done. Minimizing intraoperative manipulation of the knee is especially important in patients with risk factors. Any postoperative sign of ischemia (Table 1) must be considered to be caused by a major arterial injury until the opposite is proven. Spasm is extremely rare.

Acknowledgement

Swedish Medical Research Council 00759.

References

- Arden G P. Total knee replacement. *Clin Orthop* 1973; 94: 92-103.
- Calligaro K D, DeLaurentis D A, Booth R E, Rothman R H, Savarese R P, Dougherty M J. Acute arterial thrombosis with total knee arthroplasty. *J Vasc Surg* 1994; 20: 927-32.
- DeLaurentis D A, Levitsky K A, Booth R E et al. Arterial and ischaemic aspects of total knee arthroplasty. *Am J Surg* 1992; 164: 237-240.
- Dennis D A, Neumann R D, Toma P, Rosenberg G, Mallory T H. Arteriovenous fistula with false aneurysm of the inferior geniculate artery. *Clin Orthop* 1987; 222: 225-60.
- Fortune W P. Complications of total and partial arthroplasty in the knee. In: *Complications in orthopaedic surgery*. 2nd Edition (Ed. Epps C H Jr). J B Lippincott, Philadelphia 1986; 1109-45.
- Hagan P F, Kaufman E E. Vascular complications of knee arthroplasty under tourniquet: a case report. *Clin Orthop* 1990; 257: 159-61.
- Hozack W J, Cole P A, Gardner R, Corces A. Popliteal aneurysm after total knee arthroplasty. Case reports and review of the literature. *J Arthroplasty* 1990; 5: 301-5.
- McAuley C E, Steed D L, Webster M W. Arterial complications of total knee replacement. *Arch Surg* 1984; 119: 960-2.
- Rand J A. Vascular complications of total knee arthroplasty. *J Arthroplasty* 1987; 2: 89-93.
- Robson L J, Walls C E, Swanson A B. Popliteal artery obstruction following Shiers total knee replacement. *Clin Orthop* 1975; 109: 130-3.
- Rush J H, Vidovich J D, Johnson M A. Arterial complications of total knee replacement: the Australian experience. *J Bone Joint Surg (Br)* 1987; 69: 400-2.
- Starsiak C R. Arterial occlusion after total knee arthroplasty. *J Am Osteopath Assoc* 1980; 79: 768-72.
- Zahrani H A, Cuschieri R J. Vascular complications after total knee replacement. *J Cardiovasc Surg* 1989; 30: 951-2.