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Total knee replacement under tourniquet control: A prospective study of the peripheral arterial vasculature using colour-assisted duplex ultrasonography

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ABSTRACT

Background and purpose: A tourniquet may potentiate rare and devastating arterial complications after total knee replacement (TKR) in patients with peripheral vascular disease (PVD). Most prior studies that evaluated peripheral arterial blood flow primarily used the ankle-brachial index (ABI).

Methods: We assessed the prevalence and risk factors for PVD in a cohort undergoing TKR. Clinical and radiological evaluations, including duplex ultrasonography, were performed one week prior to, and six weeks post-TKR performed under tourniquet control. Forty patients were analysed (20 male, 20 female; mean age 67 yrs, range: 53–80 yrs).

Main findings: Hypertension (50%) and hypercholesterolaemia (50%) were the most common co-morbidities. Distal pulses were present in all patients preoperatively. Six patients (15%) had arterial calcification on their preoperative knee X-rays. Three patients (7.5%) had moderate PVD. There was no change in blood flow postoperatively in patients with or without PVD ($p > 0.05$). Vascular stenosis was less than 50% in all patients preoperatively and postoperatively. No postoperative vascular complications occurred.

Conclusions: Severe PVD is not common in patients undergoing TKR. Performing total knee replacement under tourniquet control does not adversely affect the vasculature in patients with less than 50% vascular occlusion.

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Introduction

Arterial complications after total knee replacement (TKR) are uncommon (0.03%–0.5%) and include acute limb ischaemia

due to thrombosis of the popliteal artery, popliteal artery transection, and pseudoaneurysm formation.^{1–8} The sequelae of such serious morbidities can be devastating, sometimes necessitating amputation and occasionally causing severe sepsis and death.^{1–4,6} In patients who have co-existing

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peripheral vascular disease (PVD) the potential for such complications is greater.^{3,4,9} DeLaurentis et al. analysed 1182 TKR patients and found that ischaemic complications only occurred in patients with PVD, in whom the incidence was 25%.⁹ Consequently, it has been suggested that a tourniquet should not be used in patients with PVD who have radiographic calcification of their popliteal artery.^{2,9} A survey of British knee arthroplasty surgeons reported that over 70% had turned down a patient for TKR due to concerns regarding vascular ischaemia.⁸ Paton and Neal also concluded that TKR may be contraindicated in some patients with severe PVD.¹⁰

We identified five previous studies that have evaluated the effects of TKR performed under tourniquet control on peripheral arterial blood flow; the prevalence of co-existing PVD in patients undergoing TKR was highly variable (2%–45%).^{10–14} Patil et al.¹² excluded diabetic patients from their cohort, which is surprising given the strong association between diabetes and the development of PVD.^{15,16}

Although most studies evaluated changes in the ankle brachial pressure index (ABI), Scriven et al. evaluated the arterial structure itself using duplex scanning.¹¹ Unfortunately, they provided limited information on patient demographics and did not specify how many subjects had ABI's consistent with PVD (ABI < 0.9). Bowman et al. also reported on the lower limb blood flow after TKR using duplex evaluation to determine changes in vessel diameter and blood flow velocity.¹⁴ They noted a very high level of pre-existing PVD but a high drop out rate of 40% limited their study and clinical evaluation for pedal pulses was not performed. Both Scriven et al. and Bowman et al. did not assess preoperative radiographs for pre-existing vascular calcification.^{11,14}

In this prospective study, we evaluated patients clinically and radiologically for evidence of peripheral arterial disease both preoperatively and at six weeks postoperatively. The principle aims were to determine the prevalence of PVD in a consecutive cohort undergoing TKR, and to assess possible changes in peripheral arterial flow after TKR was performed under tourniquet control.

Methods and materials

Patients

Patients undergoing TKR for end-stage knee osteoarthritis (OA) were identified from two university affiliated hospitals over a 6 month period (September 2009 to February 2010). Prior to recruitment, ethical approval was obtained from the ethics committee of Cappagh National Orthopaedic Hospital. Informed consent was obtained from all patients enrolled in this study.

We did not recruit those with a previous history of lower limb trauma given the potential for prior vascular traumatic injury. Additional exclusion criteria were age less than 50 years, inflammatory arthritis and active lower limb ulceration. Patients who had prior vascular surgery were considered eligible.

Fifty seven patients fulfilled the inclusion criteria. Nine declined to participate (mean age 70.4 years; range: 58–84) of which six felt the distance to travel for assessment was too

great, and one patient cancelled her TKR as her symptoms had improved. Although agreeing to inclusion, six patients did not attend for their preoperative evaluation (mean age 67.5 years; range: 58–80), and were consequently withdrawn. Due to limitations in resources, there was no availability to scan two patients before their surgery (aged 69 and 53 years), and they were also withdrawn from the study.

Clinical assessment

Following recruitment, all patients completed a detailed questionnaire to identify risk factors of PVD (smoking history, hypertension, diabetes, ischaemic heart disease [IHD], and hypercholesterolaemia). Subjects were also questioned about symptoms suggestive of PVD including lower limb claudication and rest pain. Any prior history of vascular surgery was documented. The lower limbs were assessed clinically and bilaterally, looking for evidence of trophic changes associated with PVD (hair loss, skin and/or nail changes). Plain film radiographs of the affected knee undergoing TKA were also obtained and reviewed by a single clinician (RW) to determine if there was any vascular calcification preoperatively.

Lower limb pedal pulses (dorsalis pedis and posterior tibial) were evaluated by one clinician (RW) one week prior to surgery and again at six weeks postoperatively. These were documented as present, reduced, or absent. A vascular technician (JOM) then recorded the ABI in both the affected and contralateral limbs using a standard sphygmomanometer and a handheld Doppler system (Mini Dopplex D900; Huntleigh Diagnostics, Cardiff, UK). In the lower limb, the posterior tibial pulse was used. In cases where the ABI was >1.4 due to vascular calcification, the toe-brachial index (TBI) measurement was calculated. A normal ABI (Grade 1) was an index greater than 0.90; mild PVD (Grade 2) was 0.80–0.90; moderate PVD (Grade 3) was 0.50–0.79; and severe PVD (Grade 4) was less than 0.50. An abnormal TBI was considered with values less than 0.65.

Duplex ultrasonography

All the patients were scanned by one vascular technician (JOM) using a GE LOGIQ 9 ultrasound machine with a 10 MHz

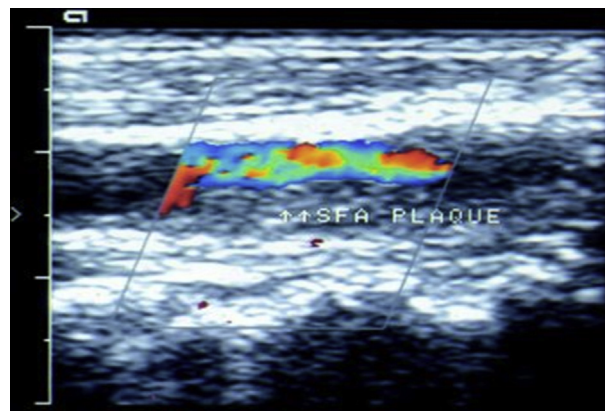


Fig. 1 – Representative duplex image of a superficial femoral arterial plaque.

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