The tourniquet in total knee arthroplasty

A PROSPECTIVE, RANDOMISED STUDY

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We assessed the influence of the use of a tourniquet in total knee arthroplasty in a prospective, randomised study. After satisfying exclusion criteria, we divided 77 patients into two groups, one to undergo surgery with a tourniquet and one without. Both groups were well matched. The mean change in knee flexion in the group that had surgery without a tourniquet was significantly better at one week ($p = 0.03$) than in the other group, but movement was similar at six weeks and at four months. There was no significant difference in the surgical time, postoperative pain, need for analgesia, the volume collected in the drains, postoperative swelling, and the incidence of wound complications or of deep-venous thrombosis.

We conclude that the use of a tourniquet is safe and that current practice can be continued.

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The use of a tourniquet is an integral part of a large number of routine orthopaedic operations. Over 25 000 knee arthroplasties are performed in England and Wales every year, most under tourniquet. There is still controversy about its use, and the benefits must be weighed against the potential risks. The tourniquet has the obvious advantage of a bloodless field and should, theoretically, provide a better cement-bone interface in a cemented arthroplasty.

Reported complications include nerve paralysis¹⁻⁴ and vascular injury, especially in the presence of atherosclerosis.^{5,6} Other effects include postoperative swelling and

stiffness,⁷ delay in recovery of muscle power,⁸ changes in the circulatory volume with limb exsanguination, limb hyperaemia on release of the tourniquet and potential cardiac or respiratory complications in patients with a poor cardiac reserve.⁹⁻¹¹ Rare reported complications include acute pulmonary oedema¹² and cardiac arrest immediately after release of the tourniquet.¹³ Its use may, theoretically, increase the risk of deep-venous thrombosis (DVT) by causing venous stasis, direct trauma to the vessel wall or increased platelet adhesion in the valve pockets after distal limb ischaemia.^{14,15}

Abdel-Salam and Eyres⁸ reported an increased incidence of wound complications, more postoperative pain, and delays in recovery of muscle power with the use of a tourniquet in total knee arthroplasty (TKA). There was also a higher rate of DVT. By contrast, Harvey et al¹⁶ reported that the incidence of DVT was not related to the use of a tourniquet. We have performed a prospective, randomised study to assess the influence of the use of a tourniquet in TKA.

Patients and Methods

We divided 77 consecutive patients undergoing TKA into two groups using random numbers. Group A (37 patients) had the operation with a tourniquet and group B (40 patients) did not. We excluded any patient with diabetes, rheumatoid arthritis, previous thromboembolism, active malignancy, and those having one-stage bilateral procedures.

An analogue scale assessed preoperative pain and we recorded the range of movement. We measured the circumference of the limb at the level of the superior pole of the patella and at points 10 cm above and below. We accepted that there was a significant interobserver and intraobserver error but our aim was to see if there was a trend in the measurements after operation. There is also no other simple method of assessing swelling objectively.

All patients had identical anaesthesia which included premedication with temazepam and general anaesthesia with fentanyl. No patient had spinal or epidural anaesthesia. Postoperatively, all had 'patient-controlled analgesia' (PCA) with an infusion of morphine sulphate. We assessed the postoperative requirement of morphine in both groups.

Operative technique. The patients received intravenous

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cefuroxime (1.5 g) after induction of anaesthesia and twice postoperatively. Those in group A had TKA under a tourniquet after the leg had been exsanguinated. The tourniquet pressure was twice the systolic blood pressure. Patients in group B did not have a tourniquet applied to the leg.

Exposure of the knee was through a midline skin incision and a deep medial parapatellar approach. All patients had an Insall-Burstein Mark II (Zimmer Ltd, Swindon, UK) cemented arthroplasty. Patellar resurfacing was selective. Pulsed lavage of the bony surfaces preceded the cementing of all the components. The wound was closed in layers over one drain with all soft-tissue releases recorded. When operating without a tourniquet, surgeons commented on whether or not bleeding was a problem. All patients had identical DVT prophylaxis, and used thromboembolic deterrent stockings for four weeks. Low-dose warfarin was given to maintain the International Normalised Ratio between 1.3 and 2.0, and was continued until discharge from the hospital. Mobilisation began on removal of the drains, 48 hours after operation.

DVT assessment. Using a computerised sonographic machine (Ultramark 9 HDI; Advanced Technology Laboratory, Bothell, Washington) 51 out of 77 (66%) patients had both preoperative and postoperative Duplex ultrasonography to assess DVT on the day before operation and again one week later.

Clinical assessment. Clinical assessment of pain, wound healing, swelling and the range of movement was carried out at one week, six weeks and four months after operation. An analogue scale recorded pain and the measurement of leg circumference assessed swelling.

Statistical analysis. For the statistical analysis,¹⁷ we calculated summary measurements for each patient that included changes in pain, knee flexion and limb circumference from the preoperative values and those at one and six weeks and at four months. We applied the Student's *t*-test to the means of changes.

Results

Despite randomisation, the two groups of patients were well matched in terms of age, gender and the number of patellae resurfaced (Table I). There was no significant difference in the mean preoperative pain score, the range of knee flexion or the operating time between the two groups.

In group B, surgeons considered bleeding a nuisance in seven knees, and noted moderate to heavy bleeding in another six. In the remaining 27, absence of a tourniquet did not pose any problem.

The results are shown in Table II. There was no significant difference in the mean pain score between the two groups at one and six weeks or at four months. Leg measurements for swelling did not show any significant difference. There was no difference in the mean postoperative morphine requirement in the two groups.

Table I. Details of the patients in both groups

	Group A (n = 37)	Group B (n = 40)
Mean age in years (range)	72.5 (57 to 85)	71.8 (43 to 91)
Male:female	11:26	14:26
Patella resurfaced (%)	7 (18.9)	9 (22.5)
Mean analogue pain score	6.01	6.23
Mean range of flexion (degrees)	106.3	106.0

Table II. Details of the postoperative changes in both groups

	Group A (n = 37)	Group B (n = 40)	p value
Mean change in pain score			
1 week	-1.62	-1.48	0.85
6 weeks	-4.41	-3.95	0.46
4 months	-5.25	-5.12	0.81
Mean change in circumference (cm)			
Thigh			
1 week	+2.7	+2.8	0.76
6 weeks	0.0	+0.7	0.36
4 months	+0.5	+1.15	0.42
Knee			
1 week	+4.1	+3.6	0.36
6 weeks	+2.4	+2.36	0.96
4 months	+1.7	+1.36	0.57
Calf			
1 week	+0.6	+1	0.46
6 weeks	+0.6	+0.9	0.6
4 months	+1	+1.13	0.78
Mean change in knee flexion (degrees)			
1 week	-41.76	-32.28	0.03*
6 weeks	-13.65	-10.73	0.49
4 months	-4.51	-1.03	0.37
Mean PCA morphine requirement (mg)			
12 hours	29.4	26.5	0.34
24 hours	53.4	43.3	0.32
Mean collection in drains (ml)	580	620	0.68

* statistically significant

The knee flexion achieved at one week was significantly better in group B than in group A ($p = 0.03$). The flexion achieved at six weeks and four months, however, did not show any significant difference. The mean change in knee flexion was also significantly better in group B at one week ($p = 0.03$), but not at six weeks and four months. The range of flexion at every stage of assessment is shown in Figure 1 for group A, and in Figure 2 for group B.

Six knees (16.2%) in group A and five (12.5%) in group B needed manipulation under anaesthesia to improve flexion.

At one week, in group A three knees had blisters, one had severe bruising and three had oozing wounds while in group B one had blisters, one had severe bruising and three had oozing wounds. At six weeks in group A one knee had a small wound leakage while all the wounds in group B had healed. All wounds in both groups had healed by four months.

Ultrasonography was negative in all patients before operation. One patient in group A had a thrombus in the popliteal vein on postoperative ultrasonography. This was

Fig. 1

The range of flexion of patients who had TKA with a tourniquet.

Fig. 2

The range of flexion of patients who had TKA without a tourniquet.

asymptomatic and was treated by anticoagulation for three months.

One patient who had surgery with a tourniquet died from unrelated causes 18 weeks after operation. Two patients who had surgery without a tourniquet died 16 weeks and 14 months after operation from unrelated causes. In all three patients the pre- and postoperative sonograms had been negative for DVT.

Discussion

The use of a tourniquet was not associated with an increased incidence of either wound complications or DVT. Although the group without a tourniquet showed more rapid recovery of flexion at one week, by six weeks there was no difference between the two groups. There was no difference in the level of pain assessed on an analogue scale. It may be that the use of a tourniquet causes some temporary loss of flexibility in the compressed thigh muscles.

Our results contrast with those of Abdel-Salam and Eysers⁸ who observed an increased incidence of wound infection and DVT in patients who had TKA with a tourniquet. This group also had higher pain scores. Their study, however, included patients with rheumatoid arthritis as well as osteoarthritis, and there was no reference to the method of assessing DVT. The effect of a tourniquet on blood loss and the incidence of DVT in TKA has been

studied by Harvey et al.¹⁶ Their findings agreed with ours in that the incidence of DVT was not related to the use or duration of the tourniquet. These authors did not specify the type of anaesthesia used in all their patients.

These studies have too many confounding factors which can affect the results. Harvey et al.¹⁶ had included patients with rheumatoid arthritis and revision arthroplasty, had three different anticoagulation regimes and a selection bias in cementing of the tibial component. When the study groups were broken down to consider the various factors, the small sample size compromised any meaningful assessment. We tried to minimise them by having strict selection criteria, randomisation into two groups which had surgery under identical general anaesthesia using an identical cementing technique and prosthesis (but selective patellar resurfacing), and identical prophylactic anticoagulation.

We used Duplex ultrasonography to assess DVT both preoperatively and postoperatively. Although contrast venography remains the best method for diagnosing DVT, Duplex ultrasound is increasingly used for routine screening. It has the advantage of being safe and non-invasive and therefore can be used without the risk of the complications of venography. When compared with venography, Duplex ultrasonography is reported to show 100% sensitivity, specificity and accuracy for the detection of proximal DVT and 88% sensitivity, 98% specificity, and 98% accuracy for distal DVT.¹⁸ White and Helpenstell¹⁹ reported 100% sensitivity, 94% specificity and 95% accuracy of Duplex ultra-

sonography for detection of distal DVT after total hip arthroplasty. Woolson et al²⁰ found 89% sensitivity, 100% specificity, and 99% accuracy for the diagnosis of proximal DVT after total hip arthroplasty. Murdock et al,²¹ however, reported only 40% sensitivity and expressed concern regarding the reliability of Duplex ultrasonography. Vanninen et al²² studied the accuracy and limitations of ultrasonography as a screening test and reported a sensitivity of 77%, a specificity of 96% and an overall accuracy of 93%. These studies suggest that while Duplex ultrasonography is an effective screening method for proximal DVT, there is some concern about its use for detection of DVT in the calf. We have not carried out a comparative study with venography to assess the sensitivity of Duplex ultrasonography.

The low incidence of DVT in our study may well be due to prophylaxis with warfarin and the possible failure of ultrasonography to detect asymptomatic small calf thrombi.

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