Tourniquet release for hemostasis increases bleeding

A randomized study of 77 knee replacements

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We conducted a prospective, randomized study of 77 primary knee replacement operations on 75 patients (52 women), with a mean age of 71 years, to evaluate the effect of tourniquet release for hemostasis on blood loss and transfusion requirements. The operations were all done with spinal anesthesia and the use of a midline skin incision and medial parapatellar approach. In group I, the tourniquet was released for hemostasis before the wound was closed. In group 2, the tourniquet was first released after the wound was closed and a compressive dressing had been applied.

The total intra- and postoperative blood losses were, on average, 858 mL (SD 443) in group I and 589 mL (347) in group 2 (p = 0.01). The median units of blood given and the postoperative decreases in hemoglobin values were similar in both groups. In a subgroup of 45 cementless prostheses, the 25 patients with prostheses allocated to group 1 lost 1022 mL (397) blood, compared to 646 mL (333) by the 20 patients with prostheses in group 2 (p = 0.01). Our findings speak against the efficacy of tourniquet release for hemostasis in knee replacement surgery.

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Prosthetic knee replacement (TKR) is associated with much blood loss, primarily during the first postoperative hours through the surgical drains, and directly into the periarticular soft tissues. The blood loss has been reported to range from 0.8 to 1.5 L, and 40% to 100% of the patients are treated with blood transfusions (Lotke et al. 1991, Barwell et al. 1997, Harvey et al. 1997). Limited availability of quality-controlled blood and concern about blood-transmitted diseases have increased the need to reduce the amount of blood transfused. We studied the effect of tourniquet release for hemostasis on total blood loss and need for transfusion.

Patients and methods

77 consecutive primary unilateral prosthetic knee replacements in 75 osteoarthrotic patients (52 women), with a mean age of 71 (44–86) years, were prospectively randomized (random tables) into two groups (Table 1). Patients receiving anticoagulants or steroids for a long time were excluded. The Ethics Committee of Lund University Hospital approved the study. The patients in the two groups were comparable with respect to age, sex distribution, height, weight, preoperative hemoglobin values, consumption of nonsteroidal anti-inflammatory drugs and type of cementing technique.

Thromboprophylaxis was started in the patients the evening before the operation with 40 mg enoxaparin (Klexane®) subcutaneously, and continued once daily for 1 week. Antibiotic prophylaxis was started peroperatively with 2 g cloxacillin natrium (Ekvacillin®) i.v. and continued three times daily for 3 days. The operations were all done under spinal anesthesia. A pneumatic tourniquet was inflated to 300 mm of mercury on the upper thigh. A straight longitudinal midline skin incision was used and the capsule was opened by a medial parapatellar approach. The choice of prosthesis and fixation technique was left the discretion of the surgeon. Intramedullary femoral and extramedullary tibial resection guides were used in

Table 1. Demographics of the 75 patients receiving prosthetic knee replacements; mean (SD). Number of patients on nonsteroidal anti-inflammatory drugs

	Group 1	Group 2
Number of prostheses	42	35
UKR/TKR	4 / 38	5 / 30
Cemented	14	8
Hybrid	3	7
Uncemented	25	20
Age	71 (9)	71 (10)
Female/male	33 / 9	20 / 15
Height, cm	165 (7)	167 (9)
Weight, kg	76 (13)	78 (12)
Preoperative hemoglobin	134 (11)	140 (13)
NSAID	7	7
Tourniquet time, min	75 (19)	89 (19)

UKR unicompartmental knee replacements,
TKR bi- or tricompartmental knee replacements.

all cases and the posterior cruciate ligament was retained. In group 1, the tourniquet was released before the wound was closed, to allow identification and cauterization of bleeding vessels. In group 2, the tourniquet remained inflated throughout the operative procedure, and was first released after the wound was closed and a compressive dressing had been applied. A passive drain was placed in the joint and left for 24 hours. The capsule, subcutaneous tissues and skin were sutured separately and a compressive dressing was applied. The staff of the Department of Anesthesia estimated bleeding during the operation and, in addition, the total loss of drainage blood was noted in the patient's chart. Blood transfusions, prescribed after the operation, were given as judged needed by the surgeons, and noted. Hemoglobin levels were determined preoperatively and on the third postoperative day. The patients were mobilized on the first postoperative day, after removal of the drain. Flexion exercises, including the use of continuous passive motion machines were started on the first postoperative day, to achieve active flexion range from zero to 90°, within 1 week.

The chi-square test and the independent Student's *t*-test were used to compare the total blood loss in the two groups, after a logarithmic transformation of data to induce normality. P-values less than 0.05 were regarded as significant.

Table 2. Blood loss in mL, number of transfusions required and difference in hemoglobin, mean (SD)

	Group 1	Group 2
Intraoperative blood loss	221 (147)	0
Postoperative blood loss	637 (414)	589 (347)
Total blood loss	858 (443)	589 (347)
Number of transfusions	1.0 (1.3)	0.6 (1.0)
Number of patients receiving blood transfusion	17	10
Hemoglobin reduction [a]	28 (13)	30 (17)

[a] Preoperative hemoglobin values minus values on third day.

Results

The total intra- and postoperative blood losses averaged 858 (SD 443) mL in group 1 (tourniquet release), and 589 (347) mL in group 2 ($p = 0.01$, 95% CI: 89–448 mL) (Table 2). The intraoperative blood loss in group 1, during hemostasis, was 221 (147) mL. The median units of blood transfusion given, the percentage of patients given a transfusion, and the decrease in hemoglobin level after 3 days were similar in both groups.

In the subgroup of 45 uncemented prostheses, the 25 patients allocated to group 1 lost a total of 1022 (397) mL blood, compared to 646 (333) mL in the 20 patients in group 2 ($p = 0.01$, 95% CI: 157–595 mL).

Irrespective of group allocation, the total blood loss was significantly greater in the group of 68 total knee replacements (800 (405) mL) than in the 9 with a unicompartmental knee prosthesis (249 (108) mL) ($p = 0.01$, 95% CI: 429–674 mL).

Complications

Deep vein thrombosis (DVT) and pulmonary embolism were not objectively investigated in this study. Only 2 patients had clinical signs of DVT verified by phlebography, one in each group, and no deaths occurred during the early postoperative course. 2 patients, both in group 2, developed a superficial skin infection, which healed with conservative treatment, including prolonged use of antibiotics. No patient had local knee-swelling that necessitated restriction in the early mobilization scheme.

Discussion

In total knee replacement surgery, release of the tourniquet before closure of the wound has been recommended to control the divided geniculate branches of the popliteal artery, thereby reducing the blood loss postoperatively (Newman et al. 1979, Page et al. 1984). Only a few randomized studies have evaluated the efficacy of this procedure, and the results of these studies have been inconsistent. Burkart et al. (1994) prospectively studied 100 primary total knee arthroplasties in a similar study to ours, and found no significant difference between the groups in terms of perioperative blood loss, decrease in hemoglobin level, need for transfusion, or incidence of wound or thromboembolic complications. In the study by Lotke et al. (1991), 121 patients, who underwent unilateral cemented total knee surgery, were prospectively randomized into four groups. The combination of tourniquet release and early continuous passive motion (CPM) resulted in significantly more blood loss than any other combination of CPM and tourniquet release. However, the total blood loss was not measured per se. It was calculated on the basis of the maximum decrease in hemoglobin value between the preoperative and postoperative level and normalized to the patient's weight and height (Gross 1983). Benoni et al. (1998) recently demonstrated the effect of administering tranexamic acid in reducing local fibrinolysis, blood loss and blood transfusions in knee arthroplasty. 86 patients, operated on with TKA, were randomized to receive tranexamic acid or placebo shortly before the release of the tourniquet for hemostasis, and 3 hours postoperatively. The mean blood loss was 730 (280) mL in the tranexamic group, as compared to 1410 (480) mL in the placebo group. Although this is a significant and marked reduction in the total blood loss, the effect does not exceed our findings in group 2, the unreleased group. In Sweden, cementless knee replacements are popular and thus these constituted more than half of our cases.

We found a significantly higher total blood loss in the tourniquet release group. In our study, this was higher in the cementless operations, which usually bleed more (Mylod et al. 1990, Cushner et al. 1991, Burkart et al. 1994). The relation blood loss/transfusion was not significant. This might reflect a too generous policy of blood transfusion. In total knee replacements, in general about one third of the patients need blood transfusions (Cushner et al. 1991, Lotke et al. 1991, Barwell et al. 1997, Harvey et al. 1997).

We should point out that the calculation of perioperative bleeding is not exact, and probably is an underestimate (Lotke et al. 1991). Nevertheless, our study clearly questions the necessity of tourniquet release for hemostasis.

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