Surgical hemostasis after tourniquet release does not reduce blood loss in knee replacement

A prospective randomized study of 81 patients

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We studied the effect of timing of tourniquet release on blood loss in 81 patients (85 knees) who were operated on for total knee replacement. The patients were randomly allocated to one of two groups. In one group, the tourniquet was released for hemostasis before wound closure and in the other group, the tourniquet was not released until the wound was closed and a compressive dressing applied. We found no difference in total blood loss between the two groups and conclude that intraoperative release of the tourniquet for hemostasis is not effective for reducing blood loss in total knee replacement.

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In total knee replacement surgery, surgeons differ in their practice of deflating the tourniquet, before or after wound closure. We wanted to find out which point in time for tourniquet deflation would entoil less loss of blood.

Patients and methods

81 patients (85 knees) who had total knee replacements for osteoarthrosis or rheumatoid arthritis were studied (Table 1). They were allotted to one of two groups by means of a table of random numbers just before the operation. The surgeon was aware of the patient's allocation at the time of surgery. In group 1, the tourniquet was deflated for hemostasis before wound closure. In group 2, the tourniquet was not released until the wound was closed and a compressive dressing was applied. A power analysis was made to decide the number of patients. If the mean total blood loss is supposed to be 1000 mL (mean value at our clinic), with a standard deviation of 400 mL in the group with postoperative release of the tourniquet, a difference of 300 mL or more, compared to the intraoperative release group would be detected if there were 28 patients in each group. This is true when the risk level is 5% with a power of 80%, two-sided hypothesis. The ethics committee of Karolinska hospital approved the study. All patients gave their informed consent.

Table 1. Clinical features, mean (range)

Variable	Tourniquet release intraop. (n 46)	Tourniquet release postop. (n 39)
Age, years	72 (49–86)	71 (49–86)
Weight, kg	76 (55–103)	76 (48–108)
Male / female	11 / 35	11 / 28
Diagnosis OA / RA	44 / 2	36 / 3

We excluded patients with a history of bleeding disorders or warfarin medication. The patients were not allowed to take NSAID within 1 week before surgery. A bleeding test was performed preoperatively according to Ivy et al. (1941) and those with pathologically prolonged bleeding time (> 570 seconds) were excluded. Anticoagulant therapy with low molecular heparin (Fragmin® 5000 IU once daily) was started on the day before surgery and was continued for 5–7 days.

Operative technique

The procedures were performed by the regular staff of 15 surgeons at St. Göran's and Karolinska Hospitals. All patients were operated on spinal anesthesia. A cemented AGC (Biomet®) prosthesis was used. A pneumatic tourniquet was placed on the upper thigh and inflated to 300–350 mmHg. A

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Table 2. Results

Variable	Tourniquet release intraop. (n 46) Mean	(CI)	Range	Tourniquet release postop. (n 39) Mean	(CI)	Range	P-value
Intraop. blood loss, mL	256	(68)	12–650	–	–	–	
Postop. blood loss, mL	777	(114)	217–1905	985	(196)	190–2964	0.06 [a]
Total blood loss, mL	1026	(129)	288–2014	985	(196)	190–2964	0.7 [a]
Blood transfusion, mL	276	(86)	0–1080	280	(112)	0–1132	1.0 [a]
Op. time, min	93	(9)	40–186	81	(3)	45–122	

[a] Student's t-test. CI 95% confidence interval

straight midline or a slightly medially-curved skin incision was used with a medial parapatellar arthotomy. Intramedullary femoral and extramedullary tibial guides were used in all procedures. The posterior cruciate ligament was retained. The hole in the distal femur made for the intramedullary guide was not plugged. One 14 Ch active suction drain (Bellovac®, Astra), shortened by 5 cm, was employed. Full weight bearing was allowed on the first postoperative day. Patients with a bilateral procedure were not randomized. In these cases, the knees were placed in different groups and only the values of blood loss and pre- and postoperative range of movement (ROM) were included in calculations.

The blood loss during the operation was measured by weighing the swabs. The drain was removed 24 hours after wound closure. Postoperative blood loss was measured by weighing the contents of the drain bag. Blood transfusions were given at the surgeon's discretion according to his clinical judgment. Hemoglobin level of 80 g/L was the lowest level for not giving a blood transfusion. Hemoglobin and hematocrit levels were recorded pre- and postoperatively.

The wound was examined at the time of discharge from the hospital (5–7 days postoperatively). ROM was recorded preoperatively and 2–3 months after surgery.

Statistics

The Student's t-test was used to analyze differences in blood losses between the randomized groups. The chi-square exact test was used to compare the differences in distribution between the groups (Metha et al. 1984). This test is an alternative to Fisher's exact test for determining whether the row and column classifications in a two-way contingency table are independent. The row and column classification is based on a qualitative variable that takes on distinct values. The statistical test is the Pearson chi-square. The StatXact program computes exact, Monte Carlo, or asymptotic p-values for the Pearson chi-square test (Metha and Patel 1995).

Results

There was no significant difference in total blood loss between the two groups. We found one superficial infection in group 1 and one deep vein thrombosis in group 2. As expected, the operating time was significantly longer in the group with the tourniquet deflated during operation. There was no significant difference in the volume of blood transfusion or in the transfusion rate (Table 2). The groups were also similar in the reduction of hematocrit and hemoglobin levels. We chose not to record the circumference of the knee since it is difficult to do this without removing the surgical dressing. Functionally, we found no statistical significant difference in ROM at the first postoperative follow-up 2–3 months after surgery.

Discussion

The timing of tourniquet release and its influence on blood loss have been studied previously. Newman et al. (1979) studied of 80 patients who were prospectively randomized to either tourniquet release before wound closure for hemostasis or after wound closure and application of the surgical

dressing. The blood loss was reduced in the latter group. Page et al. (1984) addressed the same issue and found a significant reduction of blood loss in a group with the tourniquet deflated several times for hemostasis before closure of the wound, compared to a group in which the tourniquet was deflated once or not at all. Lotke et al. (1991) prospectively randomized 121 patients into four groups in which he investigated two parameters—i.e., tourniquet release before or after wound closure and continuous passive motion (CPM) or placing the leg in a splint for 3 days. He found that blood loss increased significantly in the groups who had intraoperative release of the tourniquet but he found no significant difference between the groups whether or not CPM had been used. Burkart et al. (1994) studied 100 patients with osteoarthrosis or rheumatoid arthritis, who were randomized to intraoperative release of the tourniquet or release after wound closure. They used cemented, hybrid or cementless prostheses and general anesthesia or spinal anesthesia on a nonrandomized basis. They found no difference between the two groups in terms of perioperative blood loss.

Harvey et al. (1997) used the tourniquet in three ways and concluded that the longer is allowed to remain inflated the more the blood loss is it reduced. He also showed that the incidence of deep vein thrombosis was not related to the time while the tourniquet was kept inflated. The results of our study are consistent with those of Burkart et al. (1994). Deflation of the tourniquet before wound closure theoretically gives the option of controlling bleeding by direct observation. In our experience, however, it is difficult to identify the bleeding points which can be controlled by means of diathermy.

There is a pronounced rise in fibrinolytic activity in the first period after the release of an arterial tourniquet (Risberg 1985). The expected higher blood loss because of this fibrinolytic activity after tourniquet release can probably be reduced by applying firm pressure with an appropriate surgical dressing. If one releases the tourniquet during the operation, this pressure is difficult to achieve. Release before closure is advocated in order to detect any damage to major blood vessels—which, however, is a very rare complication.

We conclude that intraoperative release of the tourniquet for hemostasis is not effective in reducing blood loss in total knee replacement and the tourniquet can safely be inflated during wound closure and application of the compressive dressing.

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