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ORIGINAL STUDY

Delayed release of drain in total knee replacement reduces blood loss A prospective randomised study

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Total knee arthroplasty is sometimes associated with major post-operative bleeding, often requiring transfusion. A prospective, randomised study was undertaken to assess the effect on post-operative bleeding of delaying release of the clamp on the suction drains. One hundred patients were allocated into two groups : Group A- immediate release of drain following release of tourniquet, and Group B- delayed release of the drain clamp by one hour. There was a statistically significant reduction (p = < 0.001) in postoperative bleeding between group A (1050 ml ; 95%CI 728 – 1172 ml) compared to group B (732 ml ; 95% CI 620 – 845 ml). Average drop in corrected haemoglobin and postoperative transfusion requirement were also less in the delayed group. The results show that delaying release of the drains by one hour reduces postoperative blood loss and transfusion requirement following total knee arthroplasty.

Keywords : total knee arthroplasty ; wound drainage ; clamping ; delayed drainage.

INTRODUCTION

Total knee arthroplasty (TKA) may be associated with major post-operative bleeding. Patients can bleed in excess of one litre following replacement of a single joint (*4, 8, 13*), and increased blood loss often results in anaemia requiring blood transfusion. Many methods have been tried to reduce wound drainage following TKA including surgical haemostasis following release of tourniquet (*13*), the use of fibrin tissue adhesive (*8*), instilling epinephrine into the joint post-operatively (*11*), and intravenous administration of tranexamic acid (*16*). Excessive bleeding may be caused, in part, by the insertion of drains at the end of surgery, which removes any potential tamponade (*5, 11*), It is possible to recreate the tamponade by not using a drain or by delaying the release of the drain. The purpose of this study was to determine whether delaying the release of suction drains following knee replacement by an hour reduces postoperative drainage without any adverse effects.

MATERIALS AND METHODS

One hundred consecutive patients undergoing primary total knee replacement at this institution were prospectively allocated into two groups using the closed envelope technique. In Group A, the drains were

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released immediately after deflating the tourniquet, and in Group B the release of the clamp on the drains was delayed by one hour. One hour was chosen, as the maximum amount of bleeding occurs in the immediate postoperative period, thus it was felt that maximum tamponade would be achieved during this time (*12, 14, 15*). Patients were excluded if they had a history of bleeding diathesis. Surgical technique and postoperative regime was similar in both groups. All operations were performed under tourniquet control and cemented Insall Burstein II prostheses (Zimmer™) were used in all patients. Two suction drains (Redivac™) were inserted in the joint and removed at 48 hours. All patients received 3 doses of prophylactic Cefuroxime. Patients were mobilised at 48 hours after removal of drains and reduction of dressing. Spinal anaesthesia was administered unless the anaesthetist felt a general anaesthetic was indicated. Low molecular weight heparin (LMWH) was administered for DVT prophylaxis from the first postoperative day until the day of discharge. Patients were discharged when they were independently mobile and safe on crutches. Knee flexion was not a criterion for discharge as long as it was felt patients were making satisfactory progress. Patients were seen twice weekly by the physiotherapist and were reviewed in clinic on a routine basis at 6 weeks and 3 months postoperatively unless otherwise required.

Ethical committee approval was obtained for this study. All patients were provided with a comprehensive information sheet, and written consent was obtained before inclusion. Power analysis was calculated before commencing the study : in order to show a significant difference of 300 ml blood loss, it required a minimum of 40 patients in each arm.

We monitored pre- and post-operative haemoglobin (Hb) levels, drainage volume, units of packed cells transfused, dressing changes or reinforcements in the first 48 hours, duration of hospital stay and postoperative range of motion (time to regain 80° flexion).

The corrected drop in Hb level (in g/dl) at 48 hours was calculated by subtracting the post-operative Hb from the pre-operative Hb and adding to the difference the number of units transfused (making the assumption that one unit of transfused blood increases Hb level by 1 g/dl). Wounds were assessed first at 48 hours after removal of drains, and then on a regular basis until discharge, for major or minor bruising, blisters (serous or blood), oozing. Bruising of more than 5 cm surrounding the wound was classified as major. Any other complications such as deep vein thrombosis (DVT) or pulmonary embolus (PE) were recorded. No criteria were set for postoperative blood transfusion. Patients were transfused at the surgeons' discretion following clinical assessment.

Data were processed in Microsoft Excel™ and statistical analysis carried out in SPSS for Windows™.

RESULTS

There were 50 subjects in each group. Age, sex, diagnosis (osteoarthritis or rheumatoid arthritis) and tourniquet time were evenly matched in both groups and there was no statistically significant difference in the type of anaesthetic administered between the two groups.

The average amount of postoperative drainage in the immediate release group was 1050 ml (95% CI interval : 728 to 1172 ml) compared to the 732 ml (95% CI interval : 620 to 845 ml) in the delayed release group which was statistically significant ; $p < 0.001$ (Mann-Whitney U test) (fig 1). The corrected drop in Hb level at 48 hours in the delayed release group was 0.17 g less than in the immediate release group, although this was not statistically significant. The total number of units transfused in group A was 78 units compared to 66 units in Group B. Forty nine of the 78 units transfused in group A were given in the first 48 hours compared to 37 of the 66 transfused in Group B.

There were no statistical significant differences between length of stay (average duration of 13 days in both groups), bruising around the knee, oozing or blister formation (table I). Average time to regain 80 degrees flexion was 11.5 days in the delayed group and 14.3 days in the immediate group. Three patients required mobilisation under anaesthesia (MUA) and one patient did not regain 80° flexion in the delayed group compared to one patient requiring MUA and two patients not regaining 80° flexion in the other group ; however these differences were not statistically significant.

There were three cases of DVT in Group A (one of which had a PE), and two cases of DVT in Group B.

DISCUSSION

Serious consideration should be taken to avoid transfusion following joint replacement. Bleeding

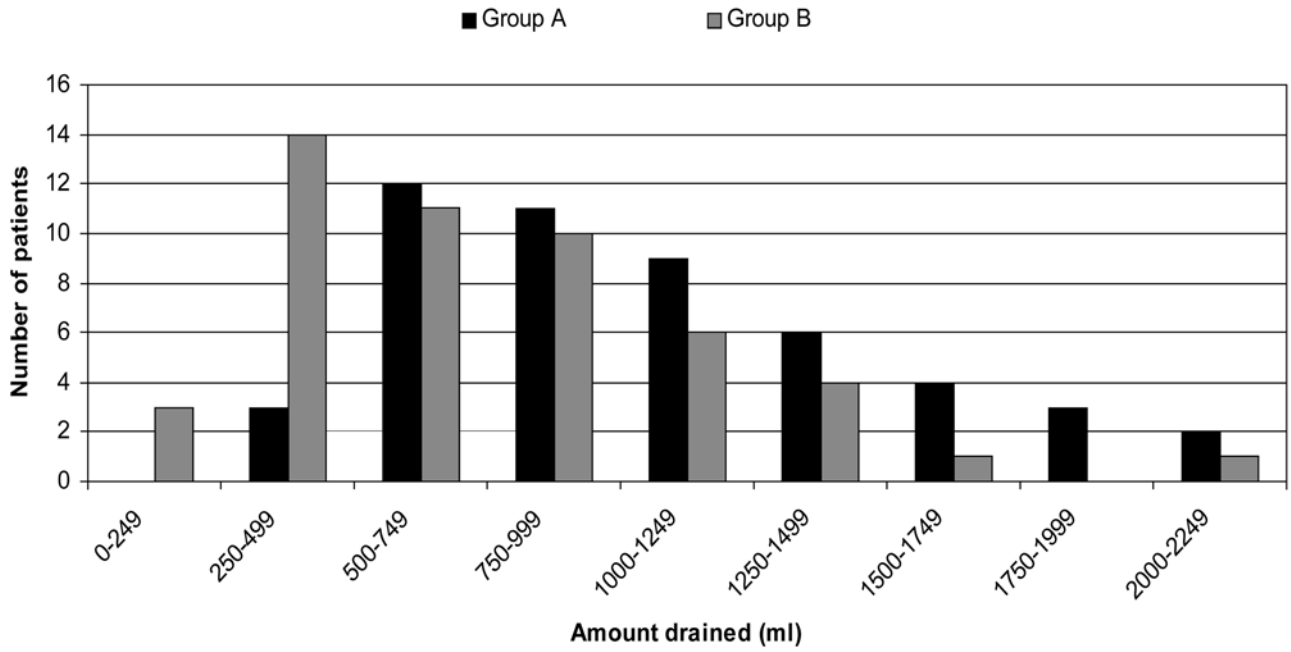

Fig. 1. — Graph to compare number of patients in each group with amounts drained in millilitres

Table I. — Wound complications. There was no statistical difference in these numbers between the two groups

	IMMEDIATE Group A	DELAYED Group B
Minor bruising	25	30
Major bruising	2	2
Serous discharge	7	8
Bloody discharge	7	6
Blister formation	6	11
Dressing reinforcement	3	3
Superficial infection	0	1
Deep infection	0	0

following TKA may well exceed 1000 ml, and various methods have been tried to reduce this blood loss.

Epidural anaesthesia aims to reduce blood loss by inducing hypotension through sympathetic blockade (*11*). Akizuki *et al* reported a reduction in bleeding by infusing 50 ml of saline containing tranexamic acid and carbazochrome into the joint, after release of the tourniquet, and clamping the drain for 30 minutes (*2*). Benoni and Fredin reported the same with intravenous tranexamic acid (*4*). Akizuki *et al* and Levy et *al* have both, independently, shown fibrin tissue adhesive to be effective in reducing drainage in cementless TKA (*2, 8*). In addition Ryu *et al* reported a reduction in bleeding following TKA by injecting epinephrine in the knee post-operatively, however increased blood pressure and skin necrosis were found to be potential problems (*11*). Interestingly releasing the tourniquet following operation and gaining surgical haemostasis has not been shown to be effective in reducing post-operative bleeding (*13*).

TKA is different from other orthopaedic operations as it involves a large non-collapsible dead space. Not draining TKA results in continuous bleeding into the dead space, leading to increased bruising and soakage of dressings, which may predispose to infection (*7*). Despite this a number of studies have recommended not using drains post-operatively in TKA (*1, 3, 7, 9*). On the other hand using a drain abolishes the tamponade effect, which may in turn increase drainage from the dead space (*11*).

Average bleeding into the drain in TKA ranges from 500 ml to 1000 ml. However Ritter *et al* showed no difference in drop in Hb or haematocrit between those drained compared to those who were

not (*10*). This would suggest that the $^1/_2$ to 1 litre of blood, which would normally be collected in the drain, extravasates into the wound and surrounding tissues leading to bruising of the limb and leakage from the wound. Conversely, Reilly *et al* found that in the absence of a postoperative drain there was less of a drop in Hb and haematocrit, suggesting that absence of drainage reduces extravasation (*9*). This is presumably due to the tamponade effect. However, neither of these studies took into account the number of units of blood transfused, when calculating the drop in Hb levels. We have taken this into account and found that the patients bled less, resulting in a smaller drop in Hb levels when release of the drain was delayed. This is a phenomenon also noted by Akizuki *et al* when they combined drain clamping with the injection of haemostatic drugs (*2*), and is more in keeping with Reilly *et al*'s findings. Kiely *et al* performed a similar study to ours releasing the drain after two hours in the delayed group and found no benefit in delaying release of the drain (*6*). They did however have a large disparity in numbers within the two groups, with 45 patients having immediate release and 31 delayed release of their drains. They accept this as a shortfall and attribute this to a shortcoming in the randomisation process. Our power calculations when designing our study dictated the need for at least 40 patients in each group (and we actually achieved 50 in each group) ; thus the differences in findings between our two studies may be the result of a type 2 error.

One potential problem with clamping or avoiding drains is the development of wound complications. Holt *et al* noted that 40% of patients in a non-drained group required reinforcement of dressing compared with 0% those in a drained group, and 69% of those without a drain had significant ecchymosis compared to 39% of those drained (*5*). Similarly Kim *et al* noted that 61% of patients required dressing reinforcement due to soaked dressings and a similar number had significant bruising following TKA without postoperative drainage compared to 10% when drained (*7*). In addition 4 patients had skin edge necrosis and 2 patients had deep infection in the knees that did not have any drain. However there was no significant difference in the other parameters evaluated. Beer *et al* however, evaluated 38 patients undergoing bilateral TKA and found no increase in wound problems in the non-drained side (*3*), similar to Ritter *et al* (*10*). In our study there was increased blister formation in the delayed group but bruising was similar in the two groups. Other wound parameters were the same in both groups (table I).

Another concern with clamping drains and especially abandoning drains is that it may increase the chances of developing a deep infection following the TKA (*7*). Fortunately the number of deep infections following TKA is so low that a very large prospective randomised trial would be needed to make any conclusive finding on the effect that drainage or non-drainage might have on infection rates. In our patients there were no deep infections. One patient in the delayed group did grow *Staphylococcus* in enrichment media, following a wound swab for suspected infection, but is currently performing satisfactorily.

This study aimed to see if a compromise could be reached between the reduction of blood loss by allowing tamponade, yet avoiding the problems associated with abandoning the use of drains altogether. We believe that our results confirm that this is the case, and that delaying the release of the drain by one hour following TKR is a simple technique, without any adverse effect, that results in a significant reduction in blood loss.

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