

ORIGINAL ARTICLE

DRAIN CLAMPING IN KNEE ARTHROPLASTY,
A RANDOMIZED CONTROLLED TRIALEDEN RALEIGH,* CAROLINE B. HING,† ANDREW S. HANUSIEWICZ,§
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Background: The purpose of this study was to determine whether repeated clamping of a suction drainage system will result in less external blood loss, blood transfusion and no increase in complications compared to a routine continuous suction drainage system. This was a randomized prospective study on patients undergoing total knee arthroplasty.

Methods: Group A patients' drains were left clamped for all but 5 min (or 100 mL drainage) every 2 h for the first 6 h, then at 12-h and 24-h periods, when the drains were removed. Group B patients had continuous suction drainage. The amount of external blood loss, transfusion requirements and complications were compared between the two groups. The study group comprised 66 patients.

Results: The mean external blood loss in the clamped drain group was 296.67 mL (standard deviation 160.28 mL) with a mean drain *in situ* time of 32 h, significantly less ($P < 0.05$) than the continuous drain group that had a mean external blood loss of 796 mL (standard deviation 250.34 mL) with a mean drain *in situ* time of 34 h. There was no difference in the requirements for transfusion between the two groups.

Conclusion: We conclude that clamping drains intermittently in hybrid total knee arthroplasty results in significantly less external blood loss with no change in morbidity or mortality. This study was a level 1 therapeutic study (i.e. with level of evidence randomized control trial with a significant difference).

Key words: arthroplasty, blood loss, drain, transfusion.

Abbreviation: hb, haemoglobin.

INTRODUCTION

The use of drains in knee arthroplasty remains controversial with no consensus on whether drains are effective in minimizing blood loss and complications.^{1–3} Where drains are used, it has been accepted that they should be removed as soon as possible because 85% of the total volume of blood drained after knee arthroplasty is drained in the first 24 h and leaving drains for 48 h significantly increases the number of drain tips colonized (25%).⁴ Despite the clear lack of evidence for the beneficial use of drains in knee arthroplasty, a survey of members of the British Orthopaedic Association showed 69% of respondents kept drains *in situ* for more than 24 h.⁵

There are various treatment regimen for the management of suction drains in knee arthroplasty, including immediate clamping, 24-h clamping, free drainage and variations on these themes.^{6–8} In this randomized controlled study we compared intermittent clamping to continuous drainage to determine whether external blood loss was less with drain clamping.

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PATIENTS AND METHODS

Patient characteristics

Between 2002 and 2004, 87 consecutive patients (45 women, 42 men) of ages 48–87 years who underwent unilateral total knee arthroplasty at the North West Regional Hospital, Tasmania were invited to participate in the study. Informed consent was obtained in all cases and the study was approved by the North West Regional Hospital ethics committee.

Methods

Patients were randomized into two groups using sealed envelopes. Group A had drains clamped for 115 min and released for 5 min every 2 h until 6 h postoperatively. The drains were then only unclamped for the last 5 min at 12 and 24 h (unless drainage was over 100 mL, where it was then clamped) Group B patients had their drains placed on suction drainage until the 24 h. Medical staff (ward registrars and nurses) were asked to complete a form recording external blood loss, transfusion requirements and complications. Transfusion trigger was haemoglobin (hb) being less than 70 g/L or symptomatic anaemia.

Surgical technique

The type of prosthesis (including cementing), surgeon details, age of patient and premorbid conditions, the type and number of

drains used were similar in both groups. This information was verified using the Orthopaedic Unit Hospital database system to ensure that all complications were noted. Two surgeons carried out all the knee arthroplasties using Nexgen (Zimmer, Warsaw, IN, USA) and LCS (DePuy, Warsaw, IN, USA). A combination of general anaesthesia and spinal anaesthesia was used for all patients. A tourniquet was used in all cases and released before closure. Two Survac low-pressure suction drains (Mepro, Germany) were inserted into the knee joint. The drains were not part of a reinfusion system. All prostheses were hybrid (cemented tibial components, cementless femoral components and seven prostheses contained only Polyethylene (All Poly, Nexgen; Zimmer)). In all patients the knee was splinted extended for 24 h postoperatively before mobilizing and elastic stockings were used with Clexane (Sanofi-Aventis, Paris, France) 40 mg daily for thromboprophylaxis beginning on the first postoperative day and continuing until discharge. Postoperative hb was measured on the second postoperative day.

Statistical analysis

A power study was carried out using sample size formulae for the primary outcome measure. Previous studies have shown a standard deviation (SD) of blood loss with immediate and delayed drain clamping of ~500 mL.^{6,9} We therefore chose an SD of 600 mL for external blood loss. A SD of 15 g/L in postoperative hb was chosen again based on a previous study.⁶ For the primary outcome measure of blood loss, assuming a significant difference between the two groups of 500 mL blood with a SD of 600 mL would require 23 patients per group to have an 80% power with a two-sided *P*-value of 0.05.

Independent statistical analysis was carried out using SPSS version 11.5 (SPSS, Chicago, IL, USA). A Student's unpaired *t*-test was used to compare the blood loss and transfusion requirements between the clamped and free-drainage groups to determine whether there was a significant difference (*P* < 0.05) between the two groups.

RESULTS

Seventy-two out of 87 patients agreed to our study. This is was a response rate of 87%. Seventy patients were required as calculated from our power analysis; however, out of the 72 patients recruited, 6 were removed from the study because of either inadequate data collection (2) or devacuated drains (4). Of the 66 patients who remained in the study, the type of prosthesis used and the surgeon carrying out the procedure had no significant difference (*P* < 0.05) on external blood loss or transfusion requirements.

There was no significant difference (*P* = 0.96) in preoperative hb between the clamped group 137.42 g/L (SD 12.6 g/L) and continuous drain groups 137.60 g/L (SD 15.2 g/L). There was a significant difference (*P* < 0.05) comparing postoperative to preoperative hb in both groups. There was a significant difference (*P* = 0.01) in postoperative hb between the clamped group with a hb of 110.61 (SD 14.52) and the continuous drain group with a hb of 101.17 (SD 12.68), but no significant difference (*P* = 0.071) in the amount of blood that patients from each group were transfused after surgery. There was also a significant reduction (*P* < 0.05) in total external blood loss in the clamped drain group of 296.67 mL (SD 160.28 mL) compared with 796.40 mL (SD 250.34 mL) in the continuous drainage group. External blood loss at all times sampled in the postoperative period was

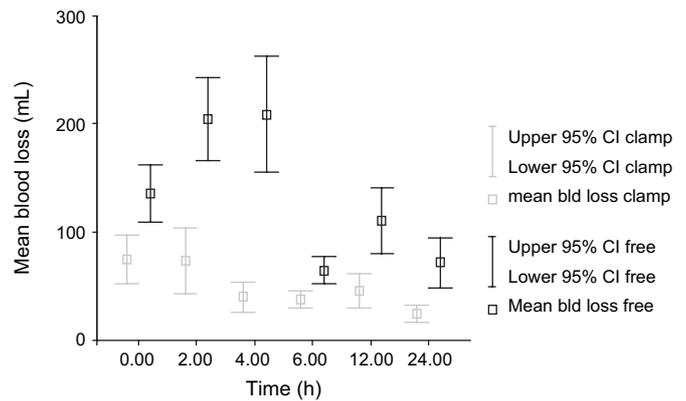


Fig. 1. Mean external blood loss in the clamped and free-drainage groups at 0, 2, 4, 6, 12 and 24 h illustrated with confidence intervals (CI).

significantly reduced (*P* < 0.05) (Fig. 1). There was no difference in dressing changes between the two groups in the postoperative period. There was also no difference (*P* > 0.05) in the complication rates and length of hospitalization was not significantly different: 8.4 days in the clamped group and 7.2 days in the free-drainage group (Table 1).

DISCUSSION

The use of drains in knee arthroplasty is commonplace in orthopaedic surgery, but evidence is currently lacking as to whether this is effective practice, when drains should be removed and whether they should be clamped.^{3-5,7,8} Previous studies have shown that clamping of drains is useful for preventing immediate brisk blood loss, but has no other benefit in routine knee arthroplasty.⁶ However, a review of published work has shown that there are various regimens for the management of drains to reduce external blood loss in cemented, uncemented and hybrid knee arthroplasties.⁵⁻⁸

Our study looked at external blood loss. We did not calculate the total blood loss by determining intraoperative blood losses and weighing the dressings used in the immediate postoperative period, which is a weakness of our study because we had assumed that this would be similar in the two groups. We had nurses and registrars measuring postoperative blood loss and whereas this was a true reflection of orthopaedic practice in our unit, it may introduce interobserver error into our study. Our patient numbers were small, but sufficient for our primary aim of determining whether external blood loss was significantly reduced. To look at transfusion requirements infection rates, pain scores and range of movement, a larger number of patients would be required.

Table 1. Complications in the clamped and free-drainage groups

Complication	Clamped group	Free-drainage group
Superficial infection	0	1
Deep infection	0	0
Urinary/respiratory infection	5	6
Stiffness requiring manipulation under anaesthesia	2	2
Deep venous thrombosis	1	0

We have shown that clamping drains reduces external blood loss in hybrid total knee arthroplasties reflected in less of a postoperative hb reduction, but failed to show that transfusion rates significantly dropped. Postoperative hb levels and transfusion requirements are poor indicators of external postoperative blood loss because hb levels can fluctuate according to the hydration status of the patient in the immediate postoperative period and transfusion triggers are often subjective, with decisions varying between clinicians and patients based on symptoms. Our results concur with previous studies that have shown that drain clamping can reduce total external blood loss in total knee arthroplasty.^{6,8} If drain clamping reduces total external blood loss it may well reduce the total blood loss and transfusion requirements, but a larger study would be needed to investigate this. The use of tamponade, temperature and adrenaline infiltration in conjunction with wound drainage (high vacuum, low vacuum, reinfusion) in cemented, uncemented and hybrid knees may also have an effect on blood loss.^{3,4,6,8-10}

REFERENCES

1. Magee C, Rodeheaver GT, Golden GT, Fox J, Edgerton MT, Edlich RF. Potentiation of wound infection by surgical drains. *Am. J. Surg.* 1976; **131**: 547-9.
2. Sorensen AI, Sorensen TS. Bacterial growth on suction drain tips. Prospective study of 489 clean orthopaedic operations. *Acta Orthop. Scand.* 1991; **62**: 451-4.
3. Corpe RS, Gallentine JW, Young TR, Steflik DE, Rectinwald EJ, Kusuma S. Complications in total knee arthroplasty with and without surgical drainage. *J. South. Orthop. Assoc.* 2000; **9**: 207-12.
4. Willemen D, Paul J, White SH, Crook DW. Closed suction drainage following knee arthroplasty: effectiveness and risks. *Clin. Orthop. Relat. Res.* 1991; (**264**): 232-4.
5. Chandratreya A, Giannikas K, Livesly P. To drain or not drain: literature versus practice. *J. R. Coll. Surg. Edinb.* 1998; **43**: 404-6.
6. Kiely N, Hockings M, Gambhir A. Does temporary clamping of drains following knee arthroplasty reduce blood loss? A randomised controlled trial. *Knee* 2001; **8**: 325-7.
7. Canty SJ, Shephard GJ, Ryan WG, Banks AJ. Do we practice evidence based medicine with regard to drainage usage in knee arthroplasty? Results of a questionnaire of BASK members. *Knee* 2003; **10**: 385-7.
8. Parker MJ, Roberts C, Hay D. Closed suction drainage for hip and knee arthroplasty. A meta-analysis. *J. Bone Joint Surg. Br.* 2004; **86**: 1146-52.
9. Esler CAN, Blakeway C, Fiddian NJ. The use of a closed suction drain in total knee arthroplasty: a prospective randomised study. *J. Bone Joint Surg. Br.* 2003; **85**: 215-17.
10. Yamada K, Imaizumi T, Uemura M, Takada N, Kim Y. Comparison between 1-hour and 24-hour drain clamping using diluted epinephrine solution after total knee arthroplasty. *J. Arthroplasty* 2001; **16**: 458-62.