

Blood loss associated with Ring uncemented total knee replacement: comparison between continuous and intermittent suction drainage¹

F W Wittmann MB FFARCS

P A Ring MS FRCS

New East Surrey Hospital, Redhill, Surrey

Summary: In a retrospective comparison of blood loss following uncemented total knee replacement, in which either continuous or intermittent suction drainage was used, measured blood loss was significantly greater with continuous drainage. However, a method of calculating actual blood loss demonstrated no significant difference. With intermittent drainage, more blood remains undetected around the knee joint; this technique should therefore be abandoned in favour of continuous suction drainage.

Introduction

During uncemented total knee replacement (TKR) (Ring 1979), two Redivac drains are inserted at the operation site and attached to a graduated vacuum bottle. The operation is performed under arterial tourniquet control. At completion of the operation compressive dressings are applied to the knee and the tourniquet is then released. This is quickly followed by the accumulation of considerable amounts of blood in the suction drainage bottle. The main cause of this post-tourniquet haemorrhage is reactive hyperaemia, which is the result of prolonged ischaemia. Another factor is a pronounced rise in the fibrinolytic activity for at least fifteen minutes after the release of an arterial tourniquet (Nakahara & Sakasashi 1967, Klenerman *et al.* 1977). It is also due, in part, to the action of the suction drainage in preventing the venous sinuses in the cut bone ends from clotting, thus resulting in substantial bleeding.

In an effort to prevent this, it was decided to abandon continuous suction drainage and replace it with intermittent suction drainage. The regime used was to drain the wound for 2 minutes and to clamp the suction drains for 8 minutes in every 10 minutes. This was continued for 12 hours or until drainage of blood ceased. A strong clinical impression was formed that blood loss, using intermittent drainage, was much reduced. Blood transfusion required to maintain haemoglobin levels, however, appeared to be similar in the two groups.

This paper reports a retrospective study of the blood loss comparing the two methods.

Method

As intermittent drainage appeared to result in rather less blood loss than continuous drainage, it was decided to undertake a retrospective study to see if this could be confirmed. Blood loss in the last 25 cases of TKR using continuous suction drainage were compared with the first 25 cases using intermittent suction drainage. In all 50 cases, uncemented TKRs (Ring 1979) were performed by PAR and all were anaesthetized by FWW. Two Redivac drains were inserted at the time of operation and the tourniquet was released after the application of compressive dressings at the end of the operation. The blood loss following operation was measured in the graduated bottles and recorded. There was of course no operative loss.

In each group there were 18 women and 7 men. The average age was 67.92 years in the continuous drainage group and 66.2 years in the intermittent group. In the continuous

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group the average Hb was 13.28 g/dl preoperatively and 11.83 g/dl postoperatively; they were transfused an average of 3.9 units of whole blood. In the intermittent group, average preoperative Hb was 12.48 g/dl and postoperative Hb was 12.11 g/dl; they were transfused an average of 4.4 units of blood.

Results

In the intermittent suction drainage group, the blood loss, as measured in the Redivac bottle, ranged from 150 to 1800 ml, with an average of 788.8 ml. In the continuous drainage group, blood loss ranged from 685 to 2370 ml, with an average of 1390.7 ml. Variance analysis, using Student's *t* test, showed a significant difference ($P < 0.001$).

This measured blood loss, however, was only a small part of the actual blood loss, which was calculated as follows: assuming that 1 unit of whole blood raises Hb 1 g/dl, and 1 unit of whole blood contains 450 ml, then actual blood loss = (preoperative Hb \pm postoperative Hb + units transfused) \times 450 ml.

For example:

$$\begin{aligned} \text{Actual blood loss} &= (14 \text{ g} - 12 \text{ g} + 3 \text{ units}) \times 450 \\ &= (2 + 3) \times 450 \\ &= 5 \times 450 \\ &= 2250 \text{ ml} \end{aligned}$$

In the above example, the measured blood loss was only 760 ml.

Using this calculation, the actual blood loss in the continuous group ranged from 1170 to 4455 ml (average 2399.4 ml), and in the intermittent group ranged from 1215 to 3690 ml (average 2149.2 ml). Variance analysis of these figures showed no significant difference ($P > 0.1$).

The operations lasted from 28 to 70 minutes, with an average of 43 minutes. Blood loss was related to operating time in a linear fashion – the longer the operation, the greater the blood loss. Thirty-four patients had osteoarthritis and 16 had rheumatoid arthritis. There was no statistical difference in blood loss between these two groups.

Discussion

It has been demonstrated that in TKR a tourniquet can safely be left in place until after wound closure and application of pressure dressings (Newman *et al.* 1979). Blood loss is no greater than if the tourniquet is released before wound closure, with diathermy to control the bleeding points.

Nevertheless, bleeding is brisk and considerable after release of the tourniquet. It appeared that if the volume of blood collected in the graduated Redivac suction drainage bottle was used as the criterion of blood loss, then changing from continuous to intermittent suction drainage might reduce it. This indeed proved to be the case. However, we felt that measured loss was only a small fraction of the actual loss. Actual loss was better reflected by the change in preoperative and postoperative haemoglobin, linked to blood transfusion. When calculated by the method described, actual blood loss was much greater than measured loss and was not significantly different in the two drainage groups.

The validity of this method of calculating actual blood loss requires the following assumptions:

(1) It must be accepted that a drop in Hb is due to operative blood loss. This has been questioned by Pattison *et al.* (1973) who believed that, following Shiers or MacIntosh knee replacements, the drop in Hb was greater than could be accounted for by blood loss alone. They postulated haemolysis or red cell sequestration as an alternative mechanism. It has, however, since been confirmed that blood loss at total knee replacement is the explanation for this fall in Hb concentration (Erskine *et al.* 1981).

(2) A small amount of blood loss is due to venepuncture for postoperative investigations. We have not included these amounts in our estimations, but assumed they would be similar in the two groups. Nor have we investigated for other possible causes of blood loss. Erskine

et al. (1981), for example, found small amounts of blood loss from the gastrointestinal tract in 4 out of 5 patients studied with rheumatoid arthritis, probably due to analgesic therapy. It is very unlikely that any such factor would significantly alter our results.

(3) It must also be accepted that one unit of whole blood will raise the haemoglobin by 1 g/dl (James 1970) and that laboratory estimation of Hb is reliable. Hb was measured 2 days preoperatively and 10–14 days postoperatively, just before discharge. The methods used were either Counter Model S (Coulter Electronics Ltd, Northwell Drive, Luton) or Ortho Elt 800 (Ortho Diagnostic Ltd, Denmark House, Denmark Street, High Wycombe), both of which are said to be very accurate.

(4) Finally, it must be agreed that one unit of whole blood contains 450 ml as stated on the blood bag.

It is certain that simply measuring the volume of blood in the suction bottle gives a false low reading. Newman *et al.* (1979) stated that there was a serous discharge or resolving haematoma present in a few of their cases, and similar findings occurred in this series. Such blood loss is clearly not included in the recorded blood loss in the drainage bottle.

Thus if the actual blood loss is compared, there is no statistical difference between continuous and intermittent suction drainage in the amount lost. With intermittent drainage, more blood simply remains undetected around the operation site. As this is undesirable, intermittent suction drainage should be abandoned. Actual blood loss also gives a much better indication of blood transfusion needs. If measured loss is the criterion for blood transfusion, the patients are likely to be significantly anaemic following total knee replacement.

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