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Reinfusion of drained blood as an alternative to homologous blood transfusion after total knee replacement

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Abstract In patients undergoing total knee replacement we carried out a longitudinal cohort study to determine the efficacy and safety of a postoperative autologous blood reinfusion system, as an alternative to homologous, banked blood transfusions. Fifty patients received reinfusion of unwashed, filtered, shed blood, supplemented with banked blood transfusions as required. A control group of 50 patients in whom standard suction drains were used received homologous blood transfusions as required. In the study group, the homologous blood requirement was reduced by 80%. There was no significant difference in the postoperative haemoglobin values between the two groups. None of the patients developed any adverse reactions after reinfusion.

Résumé Chez des patients opérés par arthroplastie totale du genou nous avons fait une étude par cohorte longitudinale pour déterminer l'efficacité et la sécurité d'un système de réinfusion du sang de drainage postopératoire, comme une alternative aux transfusions de sang homologue. Cinquante patients ont eu une reinfusion du sang autologue filtré, complété par des transfusions de sang homologue selon les besoins. Un groupe témoin de 50 patients avec drainage standard a reçu des transfusions de sang homologue comme nécessaire. Dans le groupe de l'étude, la nécessité de sang homologue a été réduite de 80%. Il n'y avait aucune différence notable des taux postopératoires d'hémoglobine entre les deux groupes. Aucun des malades n'a présenté d'effet secondaire après reinfusion.

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Introduction

The risks associated with homologous blood transfusion, which include transmission of HIV and hepatitis viruses [1], have led to an increasing interest in autologous blood transfusion methods. Although transfusion reactions are rarely serious, and usually consist of febrile reactions, haemolytic reactions due to ABO and Rh incompatibility occur in 0.01% of transfusions and are potentially fatal [9]. It has also been suggested that homologous blood has an immunosuppressive effect [5,8]. Recently, the theoretical risk of transmission of new-variant Creutzfeldt-Jakob disease through blood transfusion has also forced health trusts to look into options that provide an alternative to homologous blood transfusion. Techniques available include preoperative deposition, perioperative salvage, or postoperative wound drainage and reinfusion.

We designed a study to evaluate a postoperative wound drainage and reinfusion system, which has been in use for patients undergoing total knee replacement in our department. The aim of the study was to look at the volume of blood collected and reinfused, the safety of using this system, and whether it reduced the requirement of homologous blood.

Materials and methods

The Betatrans Autotransfusion system (Duxbury Scientific, Duxbury, Mass., USA) consists of a blood collection chamber with a 260-micron filter, a collection line, a portable suction unit, a Betatrans Duxbury connector valve, and pre-attached sterile blood bags attached to the blood collection chamber via the connector valve. Before closure of wound, two drainage tubes are inserted. The tubes are connected through a *Y*-connector to the Betatrans assembly. All connectors are kept shut for at least 5 min following deflation of the tourniquet to allow defibrinogenation to occur. The drainage is started in the recovery room and reinfusion of blood is started after 700 ml has been collected. Reinfusion is done using a standard transfusion set with a 40-micron filter. As soon as the first collection is transferred into the sterile blood bag for transfusion, collection is resumed. Reinfusion is stopped after 12 h. Fifty patients (cohort) who underwent total knee replace-

ment and had reinfusion of drained blood using the Betatrans system were followed longitudinally and data was collected prospectively. Ethical committee approval had been obtained for the use of this drain and all patients gave informed consent.

The operating theatre computer database, which holds details of all patients undergoing knee replacements, was used to generate a random sample of 50 patients to create the control group. These patients had undergone total knee replacement, concurrently with the patients in the study group. Wound drainage was done using standard suction drains (Redivac).

The two groups were matched with respect to patient age, sex, preoperative pathology and preoperative haemoglobin (Hb). The surgical procedures were similar in all patients, using identical implants. A tourniquet was used in all operations and this was released after the wound had been closed, and pressure dressings applied. All patients received three perioperative doses of Cefuroxime. The trigger for transfusing homologous blood was a post-operative Hb of less than 9.0 g/dl or clinical symptoms of anaemia. The transfusion policy was identical for both groups of patients throughout the duration of the study.

The following data were obtained in both groups: preoperative haemoglobin and haematocrit levels, postoperative haemoglobin and haematocrit levels on the first, third and seventh postoperative days, total volume of blood collected in the drains in both groups, volume of blood reinfused in the study group, and number of homologous blood units transfused in both groups. Both groups were monitored for clinical incidents such as fever, wound problems, deep vein thrombosis or any other complications. Statistical analysis was done using Student's *t*-test or chi-square test for paired data.

Results

In the study group, 45 patients received reinfusion of drained blood (Table 1). Forty patients in this group required no further blood transfusion. Five patients required additional homologous blood transfusion because they had clinical signs of anaemia and the post-operative Hb was below the trigger value (9 g/dl), after they had received reinfusion of drained blood. One of these patients had melaena on the third post-operative day and required 4 units of homologous blood in addition to reinfused blood. Three patients had only homologous blood because there was insufficient collection in the Betatrans drain (mean: 72.5 ml). Two patients did not have reinfusion of blood due to insufficient collection, but did not require any homologous transfusions, either.

Forty-four patients, in the control group, required homologous blood transfusion. Eighty-one units of blood were transfused in this group.

Eight patients in the study group required homologous transfusion, compared to 44 patients in the control group ($P<0.001$). Sixteen units of homologous banked blood were used in the study group, compared to 81 units that were transfused in the control group ($P<0.001$). The mean volume drained in the study group was 768.4 ml of which a volume of 566.2 ml was reinfused. The volume drained in the control group was approximately 836.4 ml.

There was no significant statistical difference in the post-operative Hb and haematocrit values (Table 1).

Discussion

In this study, the use of Betatrans Autotransfusion system enabled a significant proportion of the collected blood to be reinfused, and this substantially reduced the need for banked blood postoperatively.

The mean volume of blood collected in the Betatrans drain was approximately 768.4 ml, of which 566.2 ml (74% of the blood drained into the Betatrans drain) could be reinfused. This is the equivalent of 2 units of banked blood. In comparison, most patients in the control group required two or more units of banked blood. The volumes of collection and reinfusion were more than previously reported in literature [4,7]. The higher volumes drained into Redivac drains could be due to the fact that a higher suction pressure can be applied with this drain.

Sixteen units of bank blood were transfused in the study group compared to 81 units in the control group, an overall saving of homologous bank blood of 80%. The cost incurred per patient in the study group was £90.76 whereas the average cost per patient in the control group was £161.26. Thus this system was cost effective, as 2 units of banked blood cost nearly £70 more than a single Betatrans unit, which produces a turnover of the equivalent of 2 units of blood.

Several studies previously have shown that unwashed and filtered blood is of satisfactory quality and is safe to reinfuse [2, 3,6]. Definite clinical advantages have also been shown with the use of autologous blood using a reinfusion system [6]. The important difference between the previously used reinfusion systems and the Betatrans unit is that there is no anticoagulant in the latter. Hence the drain should be opened only after 5 min after release of tourniquet. This allows defibrinogenation of blood to occur so that the effect of clotting factors is eliminated. In our hospital, recovery room nurses start drainage of

Table 1 Summary of findings in the two groups

Findings	Study group (*n*=50) (Betatrans drain)	Control group (*n*=50) (Redivac drain)
Preoperative Hb (means + SD)	12.8+1.8 g/dl	13.2+1.4 g/dl
Postoperative Hb (day 7)	10.4+1.4 g/dl	10.8+1.2 g/dl
Postoperative haematocrit (day 7)	30.2+0.3	32.8+0.5
Volume drained (means + SD)	768.4+106.3 ml	836.4+103.7 ml
Volume reinfused from Betatrans	566.2+68.4 ml	0
Number of patients needing homologous blood	8	44
Total units of banked blood transfused	16 units	81 units
Median (range) units of banked blood	0 (0–4)	2 (0–4)

blood. Subsequently, trained ward nurses carry out collection and reinfusion. There have been no problems relating to this practice. None of the patients had clinical evidence of coagulopathy, deep vein thrombosis or impaired renal function. Minor wound problems were seen in three patients, which resolved spontaneously. Our study therefore confirmed that this drain was safe to use. There are several methods of collecting and transfusing autologous blood. Preoperative deposit is unsuitable for most elderly patients undergoing elective operations. Intraoperative salvage is suitable for large volumes but it involves the use of complicated and cumbersome equipment and high capital costs. Compared to these methods, reinfusion of shed blood is relatively simple, safe and also relatively inexpensive.

Some studies in the past have reported disappointing results with the collection and reinfusion method, because of the low volumes collected, and therefore do not advocate the routine utilisation of this for unilateral knee replacement [7]. Previous studies have also shown that the haematocrit values of shed blood are lower than that of banked blood [3,7]. We did not measure haematocrit values of either the shed blood or the homologous blood. However, the postoperative haemoglobin as well as the haematocrit values in both groups of patients was comparable, regardless of whether they received shed blood or homologous blood. This finding is in agreement with previous studies [7].

Therefore, we would like to emphasise that the main benefit of using this system was that we were able to reduce banked blood utilisation without compromising patient safety. We continue to use it for patients undergoing total knee replacement. We believe that, in operations like total knee replacements where a tourniquet is used intraoperatively and collection drains are used postoperatively, almost universally, reinfusion of drained blood would appear to be the most appropriate method of autologous transfusion. We would also strongly recommend that wider use of this method of autotransfusion should be considered, especially in operations like revision hip replacement where a substantial blood loss is anticipated.

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