Autotransfusion of drainage blood in arthroplasty

A prospective, controlled study of 31 operations

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56 consecutive patients who had primary arthroplasties of the hip or the knee were randomly selected for either autologous or homologous blood transfusion. For autologous transfusion, the Solcotrans Orthopaedic® device was used. Patients who received autologous transfusion had 65 percent of the postoperatively drained blood reinfused; compared to the control group the number of bank blood transfusions decreased in the hip group from 2.3 to 0.6 units, and in the knee group from 3.3 to 0.3 units.

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The first reinfusion of autologous blood was given with success during an exarticulation of the hip by Miller (1886). Because of severe complications including air and fat embolism and disturbances in the coagulation mechanism, the method was not accepted (Duncan et al. 1974a, b). The development of a micropore filter, as well as increasing worry about transmission of HIV and hepatitis virus during homologous transfusion, in spite of screening the donor blood, has given the method a renaissance. In 1988, an autotransfusion device was produced for orthopedic use (Solcotrans Orthopaedic®). This drainage system collects drainage blood from the patient into a blood-compatible bag, using wall suction. Reinfusion is performed through a 40 micron micropore filter. We report results of reinfusion of postoperatively drained whole blood in 31 arthroplasty cases with 25 control patients.

Patients and methods

Well informed about the investigation and giving their consent, 56 consecutive patients of whom 34 had total hip replacement and 22 total knee replacement were studied. All were elective primary arthroplasties. Patients were excluded from the study if they had received homologous blood transfusion preoperatively, or if infection or malignancy was suspected. Preoperatively, the patients were randomly selected to receive either autologous reinfusion or homologous donor blood during the postoperative period.

All arthroplasty operations were done in operating rooms with laminar air flow, and all patients received antibiotic prophylaxis. During arthroplasty of the hip, a noncemented acetabular component and a cemented femoral stem were inserted. One subfascial and one subcutaneous drain were used and in the reinfusion group they were connected to a common drainage bottle. The knee arthroplasty was done under tourniquet and without the use of cement. The tourniquet was released and hemostasis carried out before the insertion of two drains intraarticularly and one subcutaneously. In the reinfusion group the deep drains were connected to a common drainage bottle.

For autologous reinfusion, Solcotrans Orthopaedic® (Solco Basle (UK) Ltd.) was used. This drainage system consists of a semi-rigid plastic bottle containing a thin plastic blood-compatible bag, with a capacity of 500 mL. The drains from the patient were connected to the unit via a 260 micron filter. Before blood collection, 50 mL of 3.8 percent sodium citrate was added to the drainage bag, and by use of 80 mm Hg aspiration suction pressure, blood was led into the drainage bag. Reinfusion was performed either when the drainage bag was full, or after 6 hours of collection time if a minimum of 300 mL of blood was present in the drainage bag. It was effected by disconnecting the drains and the suction, and connecting the outlet through a 40 micron micropore filter to a preapplied intravenous infusion set. Postoperatively, all patients were observed for 24 hours in the intensive care ward where reinfusion was carried out. Low doses of heparin (5,000 IE × 2) as thrombosis prophylaxis were given to all patients until mobilization. In order to detect discrete organic damage and to unmask biochemical signs of potentially dangerous side-effects from autologous transfusions, blood specimens were obtained from all patients preoperatively as well as 24 and 72 hours postoperatively. Hemoglobin, creatinine, biliru-

Table 1. Per- and postoperative bleeding; amount of blood reinfused and units of homologous blood transfusions in the homologous and autologous groups. All figures show average with range in brackets

	Number	Age	Peroperative bleeding mL	Postoperative bleeding mL	Reinfusion mL	Homologous blood units
Autologous						
Hip	18	68 (18–84)	745 (100–1700)	1060 (480–1900)	650 (300–1350)	0.61 (0–2)
Knee	13	65 (46–86)	250 (50–650)	1350 (800–2375)	920 (350–1900)	0.31 (0–2)
Homologous						
Hip	16	66 (50–81)	735 (200–2500)	950 (210–2800)	0	2.25 (0–8)
Knee	9	71 (61–81)	270 (100–600)	1730 (1050–2900)	0	3.25 (0–6)

Table 2. The average values of hemoglobin, creatinine and haptoglobin measured preoperatively, 24 and 72 hours postoperatively, with range in brackets

	Time of lab test day	Hemoglobin g/dL	Creatinine µmol/L	Haptoglobin g/L
Autologous				
Hip	0	14.2 (11.8–16.1)	83 (60–126)	2.35 (0.75–4.27)
	1	...	77 (54–118)	1.29 (0.30–2.18)
	3	10.5 (8.7–12.6)	80 (43–117)	3.24 (1.35–4.37)
Knee	0	13.2 (11.4–15.1)	78 (59–102)	2.86 (0.93–5.60)
	1	...	69 (48–114)	2.23 (0.51–4.51)
	3	10.5 (9.0–13.0)	70 (49–103)	3.71 (1.96–6.97)
Homologous				
Hip	0	13.5 (10.0–15.5)	94 (69–137)	2.10 (0.72–2.81)
	1	...	83 (67–104)	1.60 (0.54–3.06)
	3	10.0 (8.5–12.6)	86 (69–114)	3.29 (2.28–4.96)
Knee	0	13.5 (12.1–14.7)	92 (65–132)	2.00 (0.75–3.33)
	1	...	77 (59–102)	1.61 (0.64–2.48)
	3	10.9 (9.2–12.1)	83 (52–121)	2.92 (1.78–3.80)

bin and haptoglobin were quantified in each sample, while the quantities of complement split product C3d, fibrin split product D-dimer and antithrombin III were collectively analyzed. The criterion for giving homologous blood transfusion was clinical judgement, taking into account the hemodiluting effect of parenteral solutions given intraoperatively to maintain normovolemia. The critical hemoglobin level for administering homologous blood was 8.5 g/dL.

The patients were placed in 4 groups: Hip autologous, Hip homologous, Knee autologous and Knee homologous groups. There were no age differences in the 4 groups. The average bleeding within 4 days postoperatively was 1.0 L for the hip patients and 1.5 L for the knee patients, with no difference between experiment and control groups (Table 1).

Results

In both hip and knee patients who received autologous blood, 65 percent of the postoperatively drained blood was reinfused (Table 1), and all reinfusions were performed during the first 24 hours postoperatively. For both hip and knee patients who received reinfusion, the number of homologous blood transfusions per patient was lower than for the patients receiving homologous blood exclusively. For the hip patients, there was a decrease from 2.3 to 0.6 units, and for the knee patients from 3.3 to 0.3 units. Of the patients receiving autologous transfusion, 6 hip patients and 3 knee patients additionally received between 1 and 2 units of homologous blood.

The hemoglobin value in the hip and knee patients measured preoperatively and 72 hours postoperatively, when either homologous bank blood transfusion or reinfusion of autologous blood was completed, showed equal decreases (Table 2). Creatinine, hapto-

Table 3. The average values of complement and coagulation factors measured preoperatively, 24 and 72 hours postoperatively with range in brackets. C3d, antithrombin III and D-dimer were analyzed collectively in one laboratory kit

	Time of lab test day	C3d µ/L	Antithrombin III µ/L	Bilirubin µmol/L	Fibrin split product D-dimer µ/L
Autologous					
Hip	0	31 (23–40)	1.04 (0.89–1.18)	10 (4–18)	0.60 (0.12–1.20)
	1	23 (17–31)	0.81 (0.57–1.03)	15 (8–32)	6.35 (0.50–22.7)
	3	32 (22–41)	0.91 (0.83–1.07)	10 (5–18)	1.59 (0.42–4.75)
Knee	0	33 (22–40)	1.15 (0.99–1.25)	7 (3–12)	1.25 (0.18–4.60)
	1	25 (14–33)	0.92 (0.79–1.04)	11 (6–16)	3.95 (0.27–12.2)
	3	34 (23–41)	0.92 (0.79–1.14)	7 (4–11)	0.89 (0.21–2.65)
Homologous					
Hip	0	30 (22–41)	0.95 (0.89–1.01)	13 (9–18)	0.28 (0.17–0.43)
	1	21 (18–29)	0.76 (0.66–0.97)	19 (12–30)	0.96 (0.17–1.64)
	3	33 (25–49)	0.81 (0.72–0.97)	14 (9–19)	0.55 (0.42–0.88)
Knee	0	34 (25–41)	1.12 (0.99–1.26)	7 (5–9)	0.38 (0.20–0.65)
	1	24 (19–29)	0.82 (0.73–1.00)	13 (9–17)	0.70 (0.07–1.64)
	3	30 (23–36)	0.87 (0.79–1.04)	8 (6–11)	0.35 (0.15–0.67)

globin, C3d and antithrombin III values all showed a moderate but uniform decrease 24 hours after surgery, followed by an increase 48 hours later in all groups (Table 3). Bilirubin showed an average increase of 57 percent 24 hours postoperatively, with no difference between the patient groups. Preoperative levels were reached 72 hours after surgery. Fibrin split product D-dimer was increased 24 hours postoperatively, apparently with an additional elevation in the autologous patients ($0.05 < P < 0.10$). For all patients the value of D-dimer decreased within 72 hours.

Discussion

To reduce the number of homologous blood transfusions in orthopedic surgery, predeposit of blood prior to elective operation has been tried. Several studies have reported poor utilization of between 6 and 37 percent of predonated blood and several technical problems have been pointed out (Kruskall et al. 1986, Nicholls et al. 1986, Toy et al. 1987). Intraoperative use of the cell-saving technique has proved its efficiency in vascular and spine surgery, where the blood salvage has been up to 50 percent (Popovsky et al. 1985, Semkiw et al. 1989). For hip arthroplasty, the use of cell-saving techniques is expensive and unsuitable because of relatively little blood loss (Lampe 1988, Cone et al. 1990), whereas combined with postoperative utilization of drainage blood, the cell-saving technique has been shown effective (Semkiw et al. 1989). As concerns revision arthroplasties, the method has shown its usefulness (Cone et al. 1990).

A reduction in the use of homologous blood of 72 percent in hip arthroplasty and 91 percent in knee arthroplasty was achieved in our study. This reflected the effectiveness of the method, and the saving rate of homologous transfusion was better than in previous studies (Gannon et al. 1992, Majkowski et al. 1990, Martindale et al. 1989).

Drainage blood collected for autologous transfusion is of high quality regarding blood platelets as well as the oxygen carrying capacity of the erythrocytes when used for reinfusion within 4 to 6 hours (Fornasari et al. 1986, Clifford et al. 1987, Demeyere et al. 1988, Faris et al. 1988, Martindale et al. 1989, Duchateau et al. 1990). Complement activation as well as activated coagulation factors in the drainage blood have been shown, but not systemic activation after reinfusion (Howes et al. 1990, Bengtson et al. 1990, Husfeldt et al. 1990).

In our study, hemolysis was judged by haptoglobin and bilirubin. Haptoglobin decreased, but 72 hours later exceeded the original levels in all groups. Corresponding changes were found by Högman et al. (1983). This may reflect the role of haptoglobin as a phase reactant or the surgically induced hemolysis. Interestingly, 5 patients in our study receiving neither homologous nor autologous transfusion showed uniform changes in the haptoglobin level. In this way, at least no additional hemolysis is seen when blood loss is compensated for by using reinfusion of drainage blood instead of homologous blood transfusion.

Both C3d and creatinine showed a decrease in all groups, which we believe is attributable to a transient hemodilution in the patients.

During bleeding and collection of the extravasated blood through the drainage system, there is a risk that systemic coagulation may occur after reinfusion (Howes et al. 1990). We found a transient, moderate decrease in antithrombin III and increase in fibrin split

product D-dimer in all groups, with a tendency to a higher increase in the autologous groups. It is likely that the degradation of fibrin from surgically induced coagulation was the cause with the addition of fibrinous material from the infused autologous blood.

The price of one Solcotrans transfusion device, including the micropore filter, equals the price of one homologous blood unit.

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