Autologous blood transfusion in revision hip arthroplasty

A prospective, controlled study of 30 patients

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In a prospective, randomized study of the efficacy and effects of autologous blood transfusion in revision hip arthroplasty, 30 patients were randomly allocated into two groups. The Control Group received homologous blood transfusion. The Study Group deposited 2–3 units of blood preoperatively, intraoperative blood salvage was used, and no homologous blood was transfused intraoperatively. There was a smaller postoperative blood loss in the Study Group. The preoperative hemoglobin values were lower in the Study Group, but one week postoperatively they were higher than in the Control Group. The decrease in the values of AT III and protein C was lower in the Study Group.

The combination of preoperative blood donation and intraoperative blood salvage reduced blood loss and homologous blood transfusion in revision hip arthroplasty.

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The present study focuses on the combination of predonation and salvation of autologous blood in major surgery with increased demand of blood.

Patients and methods

30 patients undergoing revision hip arthroplasty were randomly allocated to receive autologous (Study Group) or homologous (Control Group) blood with 15 patients in each group. The study was approved by the Ethics Committee of Lund University. The patient's consent was obtained.

All patients had revision hip arthroplasty in the supine position with trochanteric osteotomy. Epidural anesthesia with continuous access for 24 hours was used for all patients except for one in the autologous group who received general anesthesia. 7 patients in the Study Group and 8 in the Control Group were operated on using a non-cemented acetabular component. Revision of the acetabular component of the prosthesis alone was done in 2 patients, one in each group. One study patient had only the femoral component revised. All the operations were done by the same group of surgeons who used the same operative technique and methods of hemostasis.

Study Group

There were 9 women and 6 men with a mean age of 63 (45–80) years. 14 patients deposited three units of blood 2–3 weeks before the operation with a 1 week interval between each donation. The blood was stored at 6–8 °C in a liquid state using Sagman additive solution with 877 mg sodium chloride, 819 mg anhydrous dextrose, 16.9 mg adenine, 525 mg mannitol in 100 mL distilled water. The blood was labeled "for autologous use only". The last patient deposited only two units because of a short preoperative period. Iron supplementation was given to the patients in the form of iron sulfate 100 mg three times daily, starting at the first donation.

Intraoperative blood salvage during the operation was performed using an autotransfusion device (Electromedics-Autotrans AT-1000 autotransfusion system®, Englewood, Colorado).

Blood was retrieved from the operation field with a double-lumen suction catheter and immediately anticoagulated with sodium citrate. Larger debris, such as fat, bone and cement particles, were removed by a 240 micron filter in the cardiotomy reservoir. The filtered blood was pumped to a bowl centrifuge, centrifuged and washed with 1500 mL of saline. The supernatant was discarded, the erythrocyte concentrate was pumped to the reinfusion bag and then given back to the patient.

Control Group

7 women and 8 men, with a mean age of 64 (45–83) years received only homologous bank blood during or after the operation.

Hematology studies

Blood samples were obtained from all patients preoperatively, at the end of the operation, after 24 hours and at 1 week postoperatively.

The hemoglobin concentration, hematocrit and red blood cell count were determined with an automated flow cytometry blood cell analyzer (H*1, Technicon Instr., U.S.A.). In EDTA-anticoagulated blood, the fraction of carboxyhemoglobin was assessed with a spectrophotometric method (OSM 3 Hemoximeter, Radiometer, Copenhagen, Denmark). The concentration of haptoglobin and free hemoglobin was determined in EDTA plasma with an immunologic and spectrophotometric method, respectively. In addition, the concentration of creatinine and potassium in serum, platelet count, hemoglobin and urobilinogen in urine were determined with the standard methods used in the clinical chemistry laboratory.

For coagulation studies, venous blood samples from all patients were obtained preoperatively, at the end of the operation and at 24 hours postoperatively. The following tests were performed: fibrinogen and P&P (factors II, VII, X) determined as previously described by Nilsson (1974). Plasminogen was determined amidolytically (Friberger 1983), protein C by immunoradiometric assay (Malm et al. 1988) and antithrombin III (AT III) and antiplasmin by amidolytic assay using S-2238 and S-2251 (Kabi, Stockholm, Sweden), respectively. Fibrin/fibrinogen degradation products (FDP) were assayed with a latex agglutination inhibition test (Nilsson 1974).

Blood transfusion

The intraoperative blood loss was assessed in the autologous group by measuring the amount of blood collected in the autotransfusion device and the estimated amount of blood in the sponges and operation drapes, while in the homologous group the blood collected in the suction container as well as in the operation drapes and sponges was measured. Postoperatively, blood loss was assessed in both groups by measuring the amount of blood collected in the drainage systems during the first postoperative 48 hours.

The indication for blood transfusion was the same in both groups. Intraoperatively, blood transfusion was given according to the anesthetist's decision. Postoperatively, transfusion was given if the hemoglobin was less than 85 g/L or there were frank symptoms of anemia (Grindon et al. 1985).

Thromboprophylaxis was given to all patients using dextran 70 (Macrodex® 6 percent in saline, Kabi-Pharmacia, Sweden) as 500 mL during the operation, another 500 mL during the rest of the operation day, and 500 mL on postoperative days 1, 3, and 5. An additional 500 mL was given on the second postoperative day if the operative blood loss exceeded 2000 mL.

Table 1. Patient data, blood loss, and transfusion requirements in the Study Group (n 15) and the Control Group (n 15). Mean (range)

	Study Group		Control Group		*P*-value
Age	63	(45–80)	64	(45–83)	
Women	9		6		
Men	7		8		
Operative time (min)	209	(130–290)	215	(140–310)	
Hospital stay (days)	13	(9–18)	15	(12–18)	
Bleeding (L)					
Operative	2.1	(0.9–3.5)	2.1	(0.9–4.3)	
Postoperative	0.83	(0.43–2.7)	1.3	(0.58–2.5)	0.002
Total	3.0	(1.5–5.7)	3.4	(1.8–6.8)	
Transfusion (L)					
Operative					
Intraoperative salvage	0.72	(0–1.6)	0		
Predeposited autologous	0.58	(0–0.9)	0		
Homologous	0		1.3	(0.6–3.0)	0.0001
Postoperative					
Predeposited autologous	0.17	(0–0.6)	0		
Homologous	0.18	(0–0.6)	0.56	(0–1.3)	0.001
Total transfusion of autologous and homologous	1.7	(0.9–3.1)	1.8	(0.6–3.3)	

Table 2. Coagulation and hematologic parameters of the patients, preoperatively and postoperatively. Mean *SD*

Parameters (ref. values)	Group	Preoperatively		End operation		24 h postoperatively		7 days postoperatively	
Antithrombin III	A	0.87	*0.1*	0.8	*0.1*	0.9	*0.1*[a]		
(0.8–1.3 IE/mL)	H	0.85	*0.06*	0.8	*0.1*	0.79	*0.1*		
Plasminogen	A	94	*18*	83	*17*	89	*13*		
(70–150 percent)	H	90	*18*	80	*17*	81	*12*		
Protein C	A	80	*26*	78	*9*	86	*11*[a]		
(70–130 percent)	H	78	*19*	76	*8*	78	*10*		
FDP	A	< 10		< 10		< 10			
(< 10 mg/L)	H	< 10		< 10		10–40			
Fibrinogen	A	3	*0.5*	2.7	*0.4*	3.5	*0.9*		
(2–4.5 g/L)	H	3	*0.5*	2.6	*0.5*	3.3	*0.4*		
Hb	A	118	*5*	98	*8*	106	*13*	120	*11*[a]
(g/L)	H	131	*7*[b]	101	*7*	105	*5*	112	*8*
Hct	A	35	*2*	30	*2*	32	*2*	35	*2*[a]
(percent)	H	38	*5*	30	*2*	31	*2*	33	*2*
Thrombocytes	A	232	*52*	178	*62*	202	*42*	296	*49*
(10^9/L)	H	246	*61*	176	*58*	198	*56*	274	*54*
MCV	A	93	*3*	92	*3*	91	*3*	93	*2*
(fL)	H	92	*3*	91	*3*	90	*2*	92	*2*
Plasma hemoglobin	A	0.03	*0.02*	0.04	*0.03*	0.03	*0.02*	0.05	*0.08*
(g/L)	H	0.03	*0.01*	0.04	*0.07*	0.05	*0.02*	0.06	*0.08*
Carboxyhemoglobin	A	1	*0.7*	0.9	*0.5*	1.2	*0.5*	0.8	*0.2*
(percent)	H	0.8	*0.5*	1.2	*0.5*	1.2	*0.5*	1.1	*0.6*
Haptoglobin	A	2.1	*0.4*	1.2	*0.5*	1.3	*0.4*	2.4	*0.6*
(g/L)	H	1.9	*0.5*	1.1	*0.6*	1.4	*0.6*	2.3	*0.5*

A autologous group, H homologous group. [a] $P < 0.05$, [b] $P < 0.001$

Analysis of variance (ANOVA) and the Mann-Whitney test or Student's *t*-test were used.

Results

No complications such as thromboembolism, wound hematoma or infection were encountered.

In the Study Group none received homologous blood during the operation, 5 patients each received 1–2 units of homologous blood postoperatively. In 9 patients only two units of their three deposited units were used. In the Control Group, an average of 1262 mL of homologous blood was used intraoperatively and 562 mL postoperatively.

The postoperative blood loss was less in the Study Group (Table 1). The coagulation parameters of the patients in the two groups showed no difference between the groups, except for AT III and protein C with slightly higher values in the Study Group on the first postoperative day (Table 2).

The preoperative hemoglobin value was lower in the Study Group. However, at 1 week postoperatively this value was lower in the Control Group. No difference between groups was observed in the other parameters studied (Table 2). No evidence of intravascular hemolysis was observed in the two groups. Furthermore, there was no sign of renal impairment, as evidenced by normal creatinine levels in all the patients for up to 1 week postoperatively.

Discussion

Since revision hip arthroplasty is usually associated with a substantial blood loss, which cannot be replaced by intraoperative autotransfusion alone, especially during the postoperative period, the deposition of three units was used to enhance the effectiveness. This combination led to the complete elimination of homologous blood transfusion intraoperatively; approximately 90 percent of the total transfusion requirements were met by autologous blood. In a study by Law and Wiedel (1989), 72 percent of the transfusion requirements were accounted for by autologous blood. Wilson (1989) reported a 42 percent reduction of homologous blood transfusion in hip arthroplasty by using intraoperative blood transfusion only.

The explanation for the lower postoperative blood loss in the Study Group may be an effect of the preoperative phlebotomy in stimulating the hematopoetic system; the patients arrive at the operation in a state of optimal bone marrow stimulation. This was supported by the finding that hemoglobin levels at one week postoperatively were significantly higher, confirming our previous report on predonation of blood (Elawad et al. 1991a).

The presence of free hemoglobin in plasma of the autotransfused blood has been reported earlier to be higher than in homologous blood (Brener et al. 1973, Elawad et al. 1991b). In the present study, the concentration of haptoglobin decreased on the first postoperative day in both groups. Since this decrease was the same in both groups, it is unlikely that it was due to the infusion of free hemoglobin. A more reasonable explanation would be a dilutional effect from the dextran and other fluids used during the operation and in the early postoperative period.

The levels of antithrombin III and protein C were decreased in the early postoperative period in both groups; therefore it is unlikely that the decrease in these factors was related to the type of transfusion.

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