Predonation autologous blood in hip arthroplasty

Awad A. R. Elawad[1], Svante Jonsson[2], Martin Laurell[3] and Hans Fredin[1]

In a prospective randomized study of elderly patients, a total of 130 units of blood were donated by 45 patients prior to a total hip arthroplasty. Fifteen patients served as controls (no phlebotomy). The average age was 71 (60–82) years. No major complication occurred with phlebotomy. All the patients were able to maintain their hematologic and chemical parameters within the normal range throughout the donation period. The autologous blood covered all the peroperative transfusion needs and 97 percent of the total transfusion requirements. There was less postoperative blood loss, as well as total blood loss, in the autologous groups compared with the control group. There was no difference in the rate of postoperative complications between the groups.

The use of predeposited autologous blood in elective orthopedics, regardless of patient age, is feasible, cost effective, and avoids the risks associated with homologous blood transfusion.

Lund University Departments of [1]Orthopedics, [2]Transfusion Medicine and [3]Clinical Chemistry at Malmö General Hospital, S-214 01 Malmö, Sweden
Submitted 90-05-01. Accepted 90-07-26

Autologous blood transfusion signifies recycling of the patient's own blood. Different methods are in use: predeposit phlebotomy, preoperative hemodilution, and intraoperative salvage. The use of autologous blood eliminates the risks encountered with homologous blood, such as hepatitis, AIDS, isoimmunization, and febrile hemolytic and anaphylactic reactions (Conrad et al. 1981, Widell et al. 1987, Ward et al. 1988).

The use of autologous banked blood is well documented in the literature (Mallory and Kennedy 1976, Cowell and Swichard 1974, Marmor et al. 1977, Eckardt et al. 1978, Blaise and Jackmuth 1979, Cain 1979, Mann et al. 1983, Greenwalt 1987). In 1968, Turner presented his experiences with autologous blood. Cowell and Swichard (1974) reported the use of autologous blood in pediatric orthopedics. However, the literature is still scarce as regards the use of predeposit phlebotomy in elderly patients undergoing a total hip replacement (Marmor et al. 1977, Cain 1979). Cain presented his experiences with preoperative phlebotomy in 23 patients with hip or knee arthroplasty. He concluded that preoperative phlebotomy in the elderly is safe, well tolerated, and cost effective. However, in all the reported studies, the patient material or the operation type was not homogeneous.

We report our experiences with predeposited autologous blood in patients aged 60 years or more undergoing a primary total hip replacement.

Patients and methods

Sixty patients underwent a preoperative blood donation prior to a total hip arthroplasty. The patients were randomly separated into four equal groups: Group A served as a control (no phlebotomy), and Groups B, C, and D donated blood. Group B received no supplementation, whereas Group C received iron supplementation as ferrous sulfate (Kabi, Sweden) 100 mg three times daily; finally, Group D received, besides iron, folate (Folacin®, Kabi Sweden) 5 mg three times daily, starting after the first phlebotomy. The total blood donation was obtained on an average of 34 (31–40) days before the operation, with an average interval of 11 (9–16) days between each phlebotomy. Data in the four groups are presented in Table 1. The patients were studied regarding their hematologic and biochemical responses after blood donation and hip arthroplasty. The following tests were done on each blood sample taken at the time of donation, on the morning of the operation day, and 10 days and 6 weeks postoperatively: S (serum)-Hb, S-Hct, Eryth-MCV, Eryth-MCHC, S-RBC, S-WBC, S-platelets, S-TIBC, S-Fe, S-ferritin, S-Na, S-K, S-creatinine, S-ALB, S-ESR, and S-CRP. All the patients had a total hip replacement under epidural anesthesia in the supine position according to the Charnley procedure with trochanteric osteotomy. The operations were performed by several surgeons with ordinary surgical techniques as regards hemostasis.

Table 1. Data in the four groups

	Group				
	A	B	C	D	Total
Age, mean	71	71	71	70	71
max	81	79	82	81	82
Sex M	9	9	8	7	33
F	6	6	7	8	27
No. of units deposited	0	45	43	42	130
Diagnosis					
Arthrosis	14	15	14	14	57
Postfracture	1	0	1	1	3
Operation time (min)					
Mean	125	116	116	109	117
SD	*18*	*19*	*26*	*20*	*26*

A Homologous transfusion.
B Autologous transfusion with no supplementation.
C Autologous transfusion with iron supplementation.
D Autologous transfusion with iron and folic acid supplementation.

Table 2. Data in the four groups for the frequency and amount of transfusion, blood loss, and units not used. Groups as in Table 1

	Group				
	A	B	C	D	Total
Units transfused					
≤ 1	2	1	1	2	6
2	12	11	13	12	48
> 2	1	3	1	1	6
No. of autologous units discarded	0	12	13	15	40
Blood loss (mL)					
Perop. Mean	1000	893	845	960	
SD	*453*	*363*	*319*	*568*	
Postop. Mean	1105	631	557	559	
SD	*558***	*262*	*365*	*252*	
Total. Mean	2105	1524	1409	1519	
SD	*877**	*499*	*415*	*558*	

*$P < 0.01$, **$P < 0.001$.

Blood transfusions were given according to regular anesthetic routine.

Peroperative blood loss was assessed by measuring the blood collected by suction, as well as by determination of the amount of blood in the towels/sponges.

Thromboprophylaxis was given as 6 percent dextran 70 in saline (Macrodex® Pharmacia AB, Sweden): 500 mL was administered during the operation and 500 mL more during the remainder of the operation day; further, 500 mL was given on postoperative Days 1, 3, and 5. Another 500 mL was given on the second postoperative day if the peroperative blood loss exceeded 2,000 mL. Pretreatment was given with 20 mL dextran (Promiten®, Pharmacia, Sweden) to prevent anaphylactic reactions (Renck et al. 1983).

Deep vein thrombosis was assessed either by fibrinogen uptake (Kakkar 1972) or thermography (Cooke and Pilcher 1974). If the results were positive, a phlebography was performed to confirm the diagnosis. The negative results of thermography and fibrinogen uptake were reevaluated by an independent observer without his knowing which group the patient belonged to.

The cost of one unit of autologous blood, as well as homologous blood, was calculated.

The statistical analysis comparing each group with the control was done using the Student's *t*-test.

Results

A total of 130 units of blood were donated by the 45 patients. All the patients started their donation with an average initial Hb and Hct above 130 g/L and 40 percent, respectively. Hemoglobin and serum iron values dropped in all the groups, but remained within the normal range after the phlebotomies, as well as postoperatively. The values rose again in the autologous groups, approaching the preoperative values 6 weeks postoperatively (Table 3). Other biochemical parameters studied were also within the normal range both preoperatively and postoperatively, except CRP and serum ferritin.

A total of 93 units of blood were transfused in the study group (45 patients): 90 autologous and three homologous. No patient in the autologous groups was transfused with homologous blood peroperatively.

The three homologous units were transfused postoperatively in 2 patients from Group B and in 1 patient from Group D who had already received all their autologous blood. One patient had a Hb of 80 g/L on the second postoperative day, but no symptoms. The other 2 patients were tired and dizzy upon mobilization on the fifth and sixth postoperative day, respectively. Their Hb values were 94 g/L and 96 g/L.

One patient in the control group and 2 patients in Group D (iron and folate) did not need a transfusion. Fifty-two units of autologous plasma were also transfused: 15 units in Group B, 20 units in Group C, and 17 units in Group D. Albumin was also given; 16 units were used, all by Group A (the homologous group). Fifty-four patients required two units of blood or less. Predeposited blood that was not used by the patients was discarded (40 units; Table 2).

Table 3. Hematologic data during the donation period and postoperatively in the autologous Group A and control Group C

	Hb (g/L)		HCT (percent)		S-Fe (Mmol/L)		S-Ferritin (µg/L)	
	C	A	C	A	C	A	C	A
1st	139	140	41	41	18	17	93	96
2nd	140	129	41	38	15	14	95	83
3rd phlebotomy	143	123	42	37	17	13	80	72
Preoperatively	141	127	41	38	17	13	85	64
Postoperatively, 10 days	111	109	33	32	10	11	175	124
6 weeks	122	129	36	38	12	12	123	113

Table 4. Incidence of deep vein thrombosis in the various groups as confirmed by phlebography

Patient group	Fibrinogen uptake thermography positive	Phlebography positive	Phlebography negative
A	6	2	4
B	7	2	5
C	5	0	5
D	6	2	4
Total	24	6	18

There was a reduction in the postoperative blood loss ($P < 0.001$), as well as in the total blood loss ($P < 0.01$), in Groups B, C, and D compared with the control Group A (Table 2).

Postoperatively, 6 patients (2 each in Groups A [controls], B, and D) had a deep vein thrombosis, as defined by signs of a thrombus on the venograph of the deep venous system of the lower extremity, as confirmed by phlebography (Table 4). Two patients, from Groups B and C had a pulmonary embolism that was suspected clinically and verified by radiography and perfusion-ventilation scintigraphy. No other complication was encountered. There were no differences in the length of hospitalization between the different groups.

The cost of one autologous unit of blood and the cost of the corresponding homologous unit of blood were respectively 600 and 460 Swedish kronor (SEK). The value of one unit of plasma was 250 SEK.

Discussion

Despite the efforts that have been made to ensure the safety of the homologous blood transfusion, it still carries definite risks for the patient (Conrad 1981, Ward et al. 1988); the incidence of post-transfusion hepatitis is 2.4 percent (Widell et al. 1987). HIV infections and hemolytic febrile and anaphylactic reactions are also an important threat to the patient (Messmer 1975, Ward et al. 1988). In this study, we have tried to minimize the need of homologous blood in total hip arthroplasty by using predeposited autologous blood. The organization of the predeposit program could be carried out within the regular organization, and it did not disturb the routine in the blood center. Only because the patients were less mobile, due to their hip disease, did they require more time at the blood center than young healthy donors.

The autologous blood in this series satisfied all the peroperative transfusion needs and 97 percent of the total transfusion requirement. This is a high percentage when compared with what has been reported by other authors: Haugen and Hill (1987) 91 percent, Toy et al. (1987) 88 percent, Rebulla et al. (1987) 45 percent, and Kruskall et al. (1986) 40 percent.

The three homologous units transfused in our series could have been avoided. On the second postoperative day, 1 asymptomatic patient was transfused by the surgeon on duty because the Hb was 80 g/L. This low Hb could have been due to the expected dilution effect of the dextran that was used as thromboprophylaxis. Grindon et al. (1985) recommended that a RBC transfusion should be used if the Hb is less than 80 g/L and the Hct is less than 24 percent, or if there are symptoms related to anaemia. The other 2 patients were given blood, although each one's Hb was well above 90 g/L, on the basis of subjective symptoms of feeling tired when they were being mobilized, which is also to be expected in such patients. Only 6 patients needed more than two units. Thus, we believe that with good surgical technique and hemostasis, the predeposition of two units before primary total hip replacement will satisfy the patients' needs for blood transfusion.

The postoperative and the total blood loss difference in the autologous groups when compared

with the homologous group could have been due to the effect of the phlebotomy on stimulating the donor's hemopoietic and coagulatory systems. Rebulla et al. (1987) mentioned that in their study some surgeons gave the impression that there was more oozing of blood in the autologous patients peroperatively; however, they did not measure the exact amount. Preoperative phlebotomy may induce a state of hemodilution and also enhance the peripheral circulation, which may help in the prevention of DVT (Messmer 1975). However, in this study, we did not find any difference in the incidence of DVT between the control and the autologous group.

Although there is a decrease in Hb values after blood donation, this decrease is still beneficial, because it results in priming of the hemopoietic precursors, which promote a rapid return to the normal postoperative hemoglobin level. The postoperative rise in both CRP and serum ferritin reflects only the postoperative inflammatory response. However, serum ferritin levels also represent the patient's iron stores.

The cost of the autologous blood is almost the same as that of the homologous blood. The only difference is that the elderly patients in our study required more time and help at the blood center due to their impaired mobility, and this may approximately increase the personnel costs twofold. These costs could be reduced if the program is introduced as a routine by scheduling the autologous donors separately from homologous donors. If we consider the cost of the extra plasma (one unit of plasma is obtained free of charge with predeposited autologous blood), the autologous blood will be less expensive per unit (SEK 600) than the homologous blood (SEK 710) even with doubled personnel costs. Without plasma, autologous blood is still less expensive because the autologous plasma can be used and is financially recoupable. The autologous units not used by the patients could be crossed over to other patients if the unit fulfilled the criteria for homologous blood. This will reduce the cost of autologous blood further. However, at the present time "cross over" is not allowed at our blood center.

We conclude that predonation autologous blood is safe, effective, and well tolerated by patients; and because it eliminates the risk of transfusion-related diseases and ensures the demand for blood, it should be encouraged in elective orthopedic operations requiring blood transfusion.

Acknowledgement

The authors wish to thank Carin Holmberg for assisting in preparing the manuscript, nurse Bodil Wiklund for helping in the patient selection, and the staff of Ward 2, Department of Orthopedics, for their help in obtaining the blood samples.

References

Blaise G, Jackmuth R. Preoperative autotransfusion for total hip protheses. *Acta Anaesthesiol Belg* 1979; 30 (3): 175–82.

Cain J L. Autologous transfusions in elderly total joint replacement patients. A review of blood replacement methods. *J Fla Med Assoc* 1979; 66 (1): 35–8.

Conrad M E. Diseases transmissible by blood transfusion: viral hepatitis and other infectious disorders. *Semin Hematol* 1981; 18 (2): 122–46.

Cooke E D, Picher M F. Deep vein thrombosis: preclinical diagnosis by thermography. *Br J Surg* 1974; 61 (12): 971–8.

Cowell H R, Swickard J W. Autotransfusion in children's orthopaedics. *J Bone Joint Surg* (Am) 1974; 56 (5): 908 12.

Eckardt J J, Gossett T C, Amstutz H C. Autologous transfusion and total hip arthroplasty. *Clin Orthop* 1978; 132: 39–45.

Greenwalt T J. Autologous and aged blood donors (editorial). *JAMA* 1987; 257 (9): 1220 1.

Grindon A J, Tomasulo P A, Bergin J J, Klein H G, Miller J D, Mintz P D. The hospital transfusion committee. Guidelines for improving practice. *JAMA* 1985; 253 (4): 540–3.

Haugen R K, Hill G E. A large scale autologous blood program in a community hospital. A contribution to the community's blood supply. *JAMA* 1987; 257 (9): 1211–4.

Kakkar W. The diagnosis of deep vein thrombosis using the 125 I fibrinogen test. *Arch Surg* 1972; 104: 152–9.

Kruskall M S, Glazer E E, Leonard S S, Willson S C, Pacini D G, Donovan L M, Ransil B J. Utilization and effectiveness of a hospital autologous preoperative blood donor program. *Transfusion* 1986; 26 (4): 335–40.

Mallory T H, Kennedy M. The use of banked autologous blood in total hip replacement surgery. *Clin Orthop* 1976; 117: 254–7.

Mann M, Sacks H J, Goldfinger D. Safety of autologous blood donation prior to elective surgery for a variety of potentially "high risk" patients. *Transfusion* 1983; 23 (3): 229–32.

Marmor L, Berkus D, Robertson J D, Wilson J, Meeske K A. Banked autologous blood in total hip replacement. *Surg Gynecol Obstet* 1977; 145 (1): 63–4.

McCurdy P R. Oral and parenteral iron therapy. *JAMA* 1965; 191: 859–62.

Messmer K. Hemodilution. *Surg Clin North Am* 1975; 55: 659.

Rebulla P, Giovanetti A M, Mercuriali F, Sirchia G. Autologous blood predeposit for elective surgery: an Italian experience. *World J Surg* 1987; 11 (1): 47–52.

Renck H, Ljungström K G, Hedin H, Richter W. Prevention of dextran induced anaphylactic reactions by hapten inhibition. III. A Scandinavian multicenter study on the effects of 20 ml dextran 1, 15%, administered before dextran 70 or dextran 40. *Acta Chir Scand* 1983; 149 (4): 355–60.

Toy P T, Strauss R G, Stehling L C, Sears R, Price T H, Rossi E C, Collins M L, Crowley J P, Eisenstaedt R S, Goodnough L T, et al. Predeposited autologous blood for elective surgery. A national multicenter study. *N Engl J Med* 1987; 316 (9): 517–20.

Turner R S. Autologous blood for surgical autotransfusion. *J Bone Joint Surg* (Am) 1968; 50: 834.

Ward J W, Holmberg S D, Allen J R, Cohn D L, Critchley S E, Kleinman S H, Lenes B A, Ravenholt O, Davis J R, Quinn M G, et al. Transmission of human immunodeficiency virus (HIV) by blood transfusions screened as negative for HIV antibody. *N Engl J Med* 1988; 318 (8): 473–8.

Widell A, Sundström G, Hansson B G, Fex G, Moestrup T, Nordenfelt E. Post transfusion hepatitis type non A, non B in southern Sweden: occurrence and clinical significance. *Scand J Infect Dis* 1987; 19 (6): 603 10.