Fever and autologous blood retransfusion after total knee arthroplasty

A prospective study of 40 autotransfusion events in 21 patients

Tore Dalén[1], Kjell G Nilsson[1] and K Gunnar Engström[2]

Departments of [1]Orthopaedic Surgery and [2]Cardiothoracic Surgery, Umeå University Hospital, SE-901 85 Umeå, Sweden. E-mail: tore.dalen@orthop.umu.se
Submitted 00-06-23. Accepted 01-11-18

ABSTRACT – The commonest adverse reaction of autotransfusion of drain blood is an increase in temperature, probably due to a cytokine-mediated inflammatory reaction. We recorded body temperature in 21 patients operated on with a total knee prosthesis prospectively during the first 18 postoperative hours. The patients had been given an autotransfusion of autologous filtered drain blood (40 events) within the first 8–9 hours. They all had hypothermia at the end of operation, with a continuous increase in temperature during the first 12 hours whereafter the temperature slowly fell. No additional increase in temperature was seen during the first 2 hours after an autologous retransfusion. Autotransfusion of filtered drain blood within the first 8 postoperative hours after arthroplasty thus did not seem to cause an additional increase in temperature above that due to spontaneous recovery after postoperative hypothermia and surgical trauma.

Autotransfusion of wound drain blood is an established method for reducing the need for homologous transfusion of blood during surgery. An increase in temperature is the commonest reported side-effect after autotransfusion of drain blood, with an incidence of up to 22% (Table 1). Shed drain blood may be retransfused after washing or filtering. A maximum time limit of 6 hours has been proposed by the American Association of Blood Banks (1996), but autotransfusion after the 6-hour limit has also been evaluated (Martin et al. 1992, Dalén et al. 1995b, Schmidt et al. 1997). A disadvantage of the filter technique, however, is that it does not eliminate free hemoglobin, cytokines, degradation products, or wound debris, products that have been thought to cause an inflammatory reaction with a rise in body temperature (Heddle et al. 1993). Blood washing is a method to eliminate pro-inflammatory side-products from activated cells (Bengtson et al. 1990, Clements et al. 1992), but the process damages the erythrocytes, which, together with lost blood cells in the machine, reduce the recovery rate.

We studied body temperature following autotransfusion of autologous filtered drain blood after routine total knee arthroplasties.

Table 1. Febrile reactions reported after the transfusion event

Authors	Number of patients observed	Reactions within 0–6(8) h (%)
Bengtson et al. 1990	13	0
Faris et al. 1991	99	2
Faris et al. 1991	44	22 [a]
Clements et al. 1992	16	6
Martin et al. 1992	197	2
Blevins et al. 1993	26	0
Healy et al. 1994	84	0
Dalén et al 1995	32	0
Dalén et al. 1996	58	3

[a] Reactions within 6–12 h (%)

Patients and methods

Patients

24 patients (5 men, mean age (SEM) 71 (1.4) years) with osteoarthrosis were operated on with total knee arthroplasty. They all received 5000 units of low molecular weight heparin subcutaneously (Fragmin, Pharmacia, Stockholm, Sweden) as thrombo-prophylaxis. It was given daily starting on the evening before the operation. Immediately prior to surgery, the leg was exsanguinated with an Esmarch rubber roller before inflating a tourniquet. The tourniquet was released after wound closure. All operations were performed under a combination of epidural and spinal anesthesia. The epidural was maintained the first night for relief of postoperative pain. Drain blood was sampled for analysis at 2 hours and 5 hours after surgery with a total sample volume of 150 mL, as part of two parallel studies on drain blood quality, resulting in a lower amount of retransfused blood.

Autotransfusion

We used the ConstaVac (Stryker, Kalamazoo, MI 49001, USA) postoperative autotransfusion drain system which has an 800 mL plastic container. The blood first passed a 260 μm filter before entering the container. No anticoagulant was added. The container had a constant suction pressure of 30–70 mmHg. When emptying the container, the final top layer of 100 mL always remained in the container and was not reinfused. Reinfusion of the drain blood was started 2 h after surgery, if the collected blood exceeded 200 mL, or when the blood volume in the container exceeded 500 mL, whichever occurred first. During reinfusion, the blood passed through an additional 40 μm filter. Autotransfusion was not done if the blood had been collected more than 8–9 hours after surgery. However, the drain remained active about 24–30 hours postoperatively. Homologous blood transfusion was given only if the patient had obvious clinical signs of anemia or if the blood hemoglobin was lower than 90 g/L, but always well after finishing all autotransfusions of shed blood.

Measurements and samples

The body temperature was measured orally the morning before operation. The patients were observed in a postoperative care unit the first night after the operation. Body temperature was continuously determined during the first 18 (9–21) postoperative hours with a rectal probe connected to an analogue temperature recorder. In 1 patient, the recording was interrupted at 9 hours because of technical difficulties. The recorder was checked for accuracy by calibration at 0 °C and 40 °C at the beginning of the observation period. The temperature measurements were compared with oral measurements by a digital thermistor thermometer between 4 to 8 times in each patient during the registration period. The temperature recorder was disconnected the next morning when the patients were transferred to the ward. Body temperature was recorded twice daily at 6 a.m. and 1 p.m., using an oral digital thermometer, until the patients were discharged from the hospital.

Samples of venous blood were taken preoperatively for hemoglobin, erythrocyte count, erythrocyte volume fraction, erythrocyte-mean cell volume, leukocyte count and platelet count. The blood cell measurements were done according to standard Coulter counter technique.

Statistics

Data are presented as mean and standard errors (SEM). For statistical differences Wilcoxon's rank sum test (SPSS-exact routine) was used for matched analysis.

Results

Bleedings and transfusions

All patients had normal preoperative blood findings. On average, they had a total postoperative bleeding of 1047 (80) mL of which 538 (88) mL was autotransfused. The blood recovery rate was therefore 66% of the total postoperative bleeding with correction for the blood sampling. 21 of the 24 patients received autologous blood, but 2 were given no blood and 1 received only allogeneic blood. These 3 patients were excluded from further calculations. 4 of the 21 patients received allogeneic blood, some time after finishing the autologous retransfusion. Of the 21 patients receiving autotransfusion, 6 were retransfused once, 11 twice, and 4 were retransfused three times. This

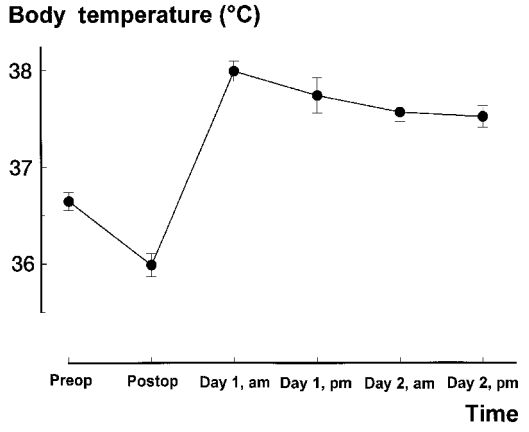

Figure 1. Pre- and postoperative temperature. 21 patients underwent a total knee arthroplasty. Body temperatures were recorded preoperatively, immediately after surgery and twice daily during the first two postoperative days. Mean (SEM).

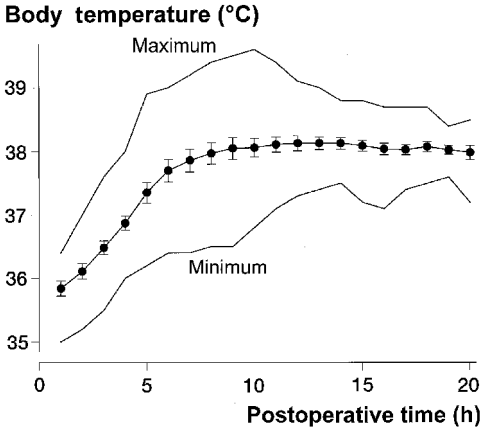

Figure 2. Body temperature as a function of time. The temperature was recorded continuously and during the first 20 postoperative hours. Mean (SEM), maximum and minimum recordings are shown.

accounts for a total of 40 autologous autotransfusion events that were recorded during the first 21 postoperative hours. In most cases, the transfusions were completed within 30–40 minutes.

Temperature recordings

Autotransfusion was started 3.3 (0.5) hours postoperatively. Their preoperative body temperature was 36.6 (0.1) °C. The first postoperative measurement at an average of 66 (30–190) minutes after release of the tourniquet showed a temperature of 36.0 (0.1) °C (Figure 1). Extrapolation of the curve to time zero (tourniquet release) yielded a calculated minimum postoperative temperature of about 35.5 °C. (Figure 2). The temperature rose to a maximum of 38.1 (0.1) °C 12 hours after surgery. It then slowly fell to 38.0 (0.1) °C at the end of the continuous recording period (Figure 2). During hospital stay, a body temperature exceeding 38.0 °C at any time was recorded in 11 patients and above 39.0 °C in 1. The first oral temperature, day 1, was identical to the last recorded with the continuous method, 38.0 (0.1) °C. The last recording on day 2 showed a fall in temperature to 37.5 (0.1) °C (Figure 1).

For each of the 40 autotransfusion events, the change in temperature within 60 minutes immediately before the event was compared with the corresponding change in temperature during the 120 minutes after the event (Table 2 and Figure 3).

Table 2. Temperature slope reactions before and after the transfusion event

Time intervals	Temperature slope (°C/h)
–60→0 min (before the event)	0.35 (0.06)
0→120 min (after the event)	0.30 (0.04)
–60→120 min	0.31 (0.04)
0→120 min / –60→0 min	0.30/0.35 = 0.86

The slope was calculated for the febrile reaction 60 min before the autotransfusion event (set to 0) to 120 min after. The slopes are expressed as mean (SEM), n 40.

There were no differences in the slope of the temperature before and after any of the autotransfusion events ($p = 0.6$).

Clinical complications

One patient had a short shivering episode 6 hours after surgery, 2.3 hours after the drain blood autotransfusion had been started, but no rise in temperature.

Discussion

Autotransfusion did not increase body temperature above the normal postoperative reaction after the surgical trauma. It seems possible that the immediate postoperative hypothermia may trigger a temperature overshoot. Intraoperative hypother-

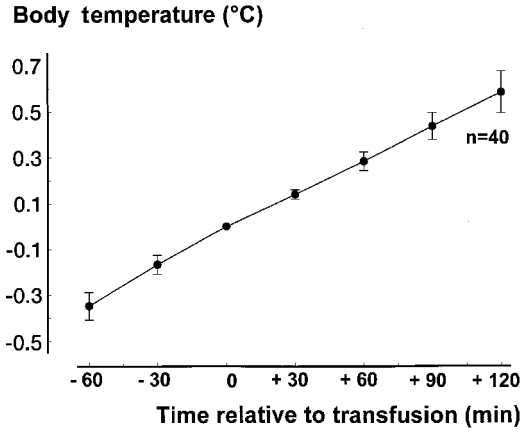

Figure 3. Temperature slope as a function of time and autotransfusion. Temperature reactions extracted from/ around the autotransfusion events, starting 1 hour before to 2 hours after the transfusion. The temperature at the autotransfusion is set to zero. Mean (SEM) of 40 wound blood autotransfusions are shown.

mia is known to cause shivering after surgery and increase the number of postoperative complications (Kurz 1997, Rosenberg and Sessler 1999).

Autotransfusion of blood during and after surgery has become more frequent to reduce the need for allogeneic blood products (Sculco 1995, Dalén and Engström 1996). Knowledge about the safety of autologous blood, however, is limited (Bengtson et al. 1990, Toy 1990, Sculco 1995). The shed blood is processed by washing or by simpler filtration before autotransfusion. Different methods of filtering are available with various designs and pore size of the filters, and efforts have been made to exclude specific fractions (e.g., fat) of the drain blood. Complications with autotransfusion of filtered drain blood occur in 0–22%, mainly febrile reactions, usually ascribed to pyrogens (Faris et al. 1991)—e.g., high concentrations of pyrogenic interleukin-6 (Fong et al. 1990, Kristiansson et al. 1995). Bacterial contamination has also been discussed (Clements et al. 1992, Harrap et al. 1992). Febrile reactions occur not only with autotransfusion, but also with non-hemolytic reactions after a transfusion with homologus blood in a frequency of 7% (Heddle et al. 1993), possibly because of accumulation of pyrogenic substances during homologous blood storage (Mangano et al. 1991). The frequency of postoperative pyrexia (> 39 °C) is thought to increase fourfold for each transfused unit of homologous blood after total knee arthroplasty (Kennedy et al. 1997). Febrile reactions usually occur within 30 minutes after homologous blood transfusions (Goodnough and Shuck 1990) and, in 70–85% of cases, leukocyte antibodies are found (Brubaker 1990).

The temperature patterns after wound-blood autotransfusions have not been described. Although several studies report febrile reactions after autologous transfusions (Faris et al. 1991, Clements et al. 1992, Martin et al. 1992, Dalén et al. 1996), none of them have shown a direct correlation to the autotransfusion per se. Because of these reactions, some authors recommend washing the drain blood before autotransfusion (Clements et al. 1992). Washing removes not only activated leukocytes, platelets, cytokines and free hemoglobin, but also important plasma proteins, such as clotting factors and immunologically-active proteins. In addition, some erythrocytes are lost or destroyed during washing. The recovery rate of erythrocytes after centrifuging and washing during peroperative use in orthopedic surgery may be as low as 50% (McMurray et al. 1990, Dalén et al. 1995a).

An operation causes an inflammatory response that is mediated by cytokines. These cytokines are thought to be associated with trauma, shock, and a rise in temperature after surgery. The reaction of the cytokines derived from the autotransfusion may be masked by other causes of febrile reactions after an operation. It is also possible that more dramatic febrile reactions are seen only after large-volume autotransfusions. However, in this study, we found no correlation between the volume of the autotransfusion and the maximum rise in temperature. Since we noted no relation between a specific temperature pattern and an autotransfusion event, we remain convinced that autotransfusion of filtered drain blood within the first 8 postoperative hours is a safe procedure for recycling blood after total knee arthroplasty.

No funds have been received to support this study.

American Association of Blood Banks. Standards for Blood Banks and Transfusion Services. The 1994-95 Standards Committee of the AABB. Bethesda, Maryland, 1996; 17th ed.

Bengtson J P, Backman L, Stenqvist O, Heideman M, Bengtsson A. Complement activation and reinfusion of wound drainage blood. Anesthesiology 1990; 73: 376-80.

Blevins F T, Shaw B, Valeri C R, Kasser J, Hall J. Reinfusion of shed blood after orthopaedic procedures in children and adolescents. J Bone Joint Surg (Am) 1993; 75: 363-71.

Brubaker D B. Clinical significance of white cell antibodies in febrile nonhemolytic transfusion reactions. Transfusion 1990; 30 (8): 733-7.

Clements D H, Sculco T P, Burke S W, Mayer K, Levine D B. Salvage and reinfusion of postoperative sanguineous drainage. A preliminary report. J Bone Joint Surg (Am) 1992; 74: 646-51.

Dalén T, Engström K G. Blodåtervinning inom ortopedin i Sverige. Sårblodsåtervinning vanligaste metoden. Läkartidningen 1996; 48: 4448-52 (In Swedish).

Dalén T, Broström L Å, Engström K G. Quality of peroperative collected blood using Haemocell 350® blood washing system. Transactions of the 51st Annual Meeting, Swedish Orthopaedic Society, Stockholm, May 17-19, 1995a: 57.

Dalén T, Broström L Å, Engström K G. Cell quality of salvaged blood after total knee arthroplasty. Acta Orthop Scand 1995b; 66: 329-33.

Dalén T, Skak S, Thorsen K, Fredin H. The efficiacy and safety of blood reinfusion in avoiding homologous transfusion after total knee arthroplasty. Am J Knee Surg 1996; 9: 117-20.

Faris P M, Ritter M A, Keating E M, Valeri C R. Unwashed filtered shed blood collected after knee and hip arthroplasties. J Bone Joint Surg (Am) 1991; 73: 1169-78.

Fong Y, Moldaver L L, Shires G T, Lowry S F. The biologic characteristics of cytokines and their implication in surgical injury. Surg Gynecol Obstet 1990; 170: 363-78.

Goodnough L T, Shuck J M. Risks, options and informed consent for blood transfusion in elective surgery. Am J Surg 1990; 59: 602-7.

Harrap R S J, Whyte G S, Farrugia A, Jones C. Some characteristics of blood shed into the Solcotrans postoperative orthopaedic drainage/reinfusion system. Med J Aust 1992; 157: 95-6

Healy W L, Pfeifer B A, Kurtz S R, Johnson C, Johnson W, Johnston R, Sanders D, Karpman R, Hallack G N, Valeri C R. Evaluation of autologous shed blood for autotransfusion after orthopaedic surgery. Clin Orthop 1994; 299: 53-9.

Heddle N M, Klama L N, Griffith L, Roberts R, Shukia G, Kelton J G. A prospective study to identify the risk factors associated with acute reactions to platelet and red cell transfusions. Transfusion 1993; 33: 794-7.

Kennedy J G, Rodgers W B, Zurakowski D, Sullivan R, Griffin D, Beardsley W, Sheehan L. Pyrexia after total knee replacement. A cause for concern? Am J Orthop 1997; 26 (8): 549-52.

Kristiansson M, Soop M, Saraste L, Sundqvist K G, Suontaka A M, Blombäck M. Cytokine and coagulation characteristics of retrieved blood after arthroplasty. Intensive Care Med 1995; 21: 989-95.

Kurz A. Intraoperative hypothermia: pathophysiology and clinical sequelae. Wien Klin Wochenschr 1997; 109 (8): 261-9.

Mangano N M, Chamers L A, Kruskall M S. Limited efficacy of leukopoor platelets for prevention of febrile transfusion reactions. Am J Clin Pathol 1991; 95: 733-8.

Martin J W, Whiteside L A, Milliano M T, Reedy M E. Postoperative blood retrieval and transfusion in cementless total knee arthroplasty. J Arthroplasty 1992; 7 (2): 205-10.

McMurray M R, Birnbaum M A, Walter N E. Intraoperative autologous transfusion in primary and revision total hip arthroplasty. J Arthroplasty 1990; 5 (1): 61-5.

Rosenberg J, Sessler D I. Mild intraoperative hypothermia. Another risk factor for postoperative complications. Ugeskr Laeger 1999; 161 (20): 2935-8.

Schmidt H, Følsgaard S, Mortensen P E, Jensen E. Impact of autotransfusion after coronary artery bypass grafting on oxygen transport. Acta Anesthesiol Scand 1997; 41: 995-1001.

Sculco T P. Blood management in orthopedic surgery. Am J Surg 1995; 6A: 60S-3S.

Toy P T C Y, eds: The use of autologous blood. The National Blood Resource Education Program Expert Panel. JAMA 1990; 263: 414-7.