Revision total hip arthroplasty without blood transfusion

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CASE REPORT

A 71-year-old woman, weighing 70 kg, presented for surgery to revise first the right and then the left femoral and acetabular cemented prostheses with uncemented hydroxy-apatite ceramic coated Furlong® components (Joint Replacement Instrumentation, London). Her medical history was of essential hypertension, stable angina pectoris and an uncomplicated myocardial infarction 5 years previously. There was no evidence of cardiac failure or cerebrovascular disease. Medications included metoprolol, glyceryl trinitrate spray and oral ferrous sulphate for 2 months before surgery. On examination her blood pressure was 130/70 mmHg with no signs of cardiac failure and no carotid bruits. Electrocardiogram revealed a left bundle–branch block, and the chest radiograph showed unfolding of the aorta with a normal cardiac shadow and lung fields. Urea and electrolytes were within normal limits and haemoglobin (Hb) was 141 g/litre (operation 1) and 140 g/litre (operation 2). The patient expressed a desire not to receive any blood or blood-related products at any time, and completed the requisite Jehovah's Witness documentation. It was agreed that she would undergo preoperative isovolaemic haemodilution and intraoperative salvage of red blood cells, maintaining continuity with her circulation at all times.

On both occasions the patient was premedicated with oral temazepam 20 mg and a 5 mg glyceryl trinitrate skin patch. After inserting a radial arterial line, a total of 700 ml of blood was venesected into bags containing citrate for anticoagulation and kept in continuity with the patient's circulation. Blood pressure was maintained during venesection using two 3 mg ephedrine boluses before volume replacement with 1000 ml of Gelofusine® (Braun, Melsungen) was commenced. Anaesthesia was induced with thiopentone 200 mg and maintained with isoflurane and nitrous oxide in 40% oxygen. Muscle relaxation was achieved using vecuronium and the patient intubated after receiving alfentanil 0.5 mg. Her lungs were mechanically ventilated to an end tidal $PaCO_2$ of 4.8–5.0 kPa. Intraoperative and postoperative analgesia was achieved on both occasions with a lumbar epidural catheter inserted at L1/2 interspace, using a continuous infusion of bupivacaine 1 mg/ml and fentanyl 2 μg/ml. Standard intraoperative monitoring included invasive blood pressure, central venous pressure and oesophageal temperature. A urethral catheter was inserted and body temperature maintained around 36°C using intravenous fluid warmers and a Warm Touch® (Gaymar, Hamburg). Intraoperative red blood cell salvage was achieved with a Haemonetics Cell Saver®5 (Haemonetics Corporation, Massachusetts), set up with a continuous circuit from the surgical sucker, through the filtration and reservoir units to an intravenous line in the patient using normal saline as a primer.

Intraoperative systolic blood pressure was maintained between 90–100 mmHg. Surgery involved meticulous removal of all cement using cement splitting and extracting instruments under image intensifier control. Finally granulation tissue between cement and bone was curetted away to expose bleeding cancellous bone. There were no unexpected surgical complications. Intraoperative blood loss totalled 1250 ml (operation 1), and 1100 ml (operation 2). A total of 2000 ml of colloid was infused after isovolaemic haemodilution and before the completion of surgery, at which time an arterial blood gas sample revealed no significant metabolic acidosis on either occasion. After wound closure a total of 500 ml of Cell Saver®5 infusate with an estimated haematocrit of 0.55 was transfused. Finally the two 350 ml bags of autologous blood were infused slowly over the next few hours.

Following extubation the patient was transferred to intensive care for overnight monitoring and continuous postoperative epidural analgesia. Investigations included full blood count, urea and electrolytes, coagulation profile, and arterial blood gases. Serial 12-lead electrocardiograms and cardiac enzymes revealed no evidence of myocardial ischaemia or infarction on either occasion. Demonstrable postoperative blood losses totalled approximately 500 ml for each operation. The lowest recorded Hb was 80 g/litre (operation 1), and 89 g/litre (operation 2), measured intraoperatively before infusing the Cell Saver®5 infusate. ***Figure 1*** shows the Hb levels from the preoperative day through to discharge for both procedures. Aside from a 37% prolongation of prothrombin time and 27% prolongation of activated partial thromboplastin time on the first postoperative night, coagulation rapidly returned to normal values.

The patient recovered uneventfully and despite persistent anaemia (***Figure 1***), was discharged home after 1 week on both occasions. Two-year follow-up confirms successful revision arthroplasties.

INTRODUCTION

Mean perioperative blood loss during revision total hip arthroplasty (THA) with uncemented components is 2000 ml (Semkiw et al, 1989). Blood loss of this volume mandates replacement with either allogeneic or preoperatively donated and stored autologous blood. Both of these options are unacceptable to Jehovah's Witnesses, making revision THA a high risk procedure in these patients. Acceptance of haemodilution techniques and intraoperative red blood cell salvage by Jehovah's Witnesses (Ridley, 1990) now makes revision THA viable in these patients.

DISCUSSION

Management of a Jehovah's Witness for elective surgery of this severity requires planning. Ethical issues must be considered and appropriate documentation completed for a clear and unambiguous picture of acceptable perioperative management techniques (Royal College of Surgeons of England, 1996).

Preoperative optimization

Haemoglobin (Hb) levels must be maximized, and while this patient received oral iron for 2 months before

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surgery, there is evidence of the limited efficacy of oral iron therapy, mainly because of poor absorption (Brown et al, 1958). In an anaemic patient, however, reticulocytes peak after 12 days of oral iron therapy and will raise Hb by 1 g/dl after 15 days (Brown et al, 1958). Intravenous iron is more effective but its use is limited by side-effects and the need for inpatient care.

In multicentre trials, 14-day preoperative treatment with erythropoietin has demonstrated a reduced need for allogeneic blood transfusion postoperatively after orthopaedic surgery (Faris et al, 1996). Cases are described where a combination of oral iron and erythropoietin therapy have been used to 'supranormally' elevate preoperative haematocrit (Hct), thereby enabling preoperative haemodilution and autologous postoperative transfusion without the need for allogeneic blood (Rothstein et al, 1990).

Normovolaemic haemodilution

The amount of blood that can safely be venesected is a factor of the final Hct and the patient's clinical condition. Volumes of 15 ml/kg have been used but these patients did not have ischaemic heart disease (Boldt et al, 1999). Using the following formula to estimate final Hct (Stehling and Zauser, 1991), we venesected 10 ml/kg preoperatively:

$V = EBV \times (Ho - Hf) / Hav$

where V is the blood volume to be venesected, EBV is the patient's estimated blood volume, Ho is the initial Hct, Hf is the desired final Hct, and Hav is the average of the two Hcts.

Intraoperative management

This focuses on minimizing operative blood losses and maintaining adequate oxygen delivery (DO_2) to the tissues. Factors which influence blood loss include intraoperative arterial and venous blood pressure (Sauercracker et al, 1987), and surgical technique. To ensure bony bonding to the hydroxy apatite ceramic coated (HAC) implants it is essential that all existing cement be removed to expose bleeding (ideally cancellous) bone. This process can take time, resulting in prolonged oozing of blood from bone.

Complications such as femoral shaft fracture can increase blood loss significantly. Techniques to reduce blood loss focus on patient positioning to reduce venous blood pressure, controlled systemic hypotension, regional anaesthesia, meticulous surgical technique with use of diathermy, and even selective arterial embolization (Sculco and Ranawat, 1975). Both spinal and epidural anaesthesia have demonstrated significant reductions in operative blood losses (Modig and Karlstrom, 1987).

The dangers of controlled hypotension include vital organ damage, especially brain and myocardium, and the limits of hypotension in an individual patient are never certain (Lindop, 1975). Moderate hypotension was used in this patient because of the presence of ischaemic heart disease and a previous myocardial infarction. In addition, the risk of concurrent anaemia and reduced arterial oxygen content needed to be considered.

The maintenance of DO_2 during isovolaemic haemodilution and controlled hypotension poses difficulties. Normally, DO_2 is maintained by an increase in cardiac output (CO), redistribution of that CO, improved oxygen extraction, and decreased Hb–O_2 affinity. DO_2 peaks at 110% of pre-anaemic values when the Hct is 30%, and decreases as Hct approaches 25% (Messmer, 1991). Oxygen consumption (VO_2) has been described in a Jehovah's Witness to have decreased only after severe acute haemodilution to an Hct below 12% (Van Woerkens et al, 1992). This, however, is entirely dependant on the maintenance of normovolaemia, and the ability to increase CO. Coronary artery disease significantly limits tolerance of haemodilution, and cardiac vulnerability rises as Hct falls (Kettler, 1994). Patients with Hct below 28% have shown significantly increased postoperative cardiac morbidity (Nelson et al, 1993). Anaesthesia has a dual effect on the tolerance of haemodilution as it decreases oxygen demand, but also affects the normal physiological response to haemodilution by decreasing CO. The combination of haemodilution and controlled hypotension can lead to unexpected reductions in DO_2 to vital organs (Crystal et al, 1988).

Postoperative management

Despite replacement of virtually all overt surgical blood loss, and the reinfusion of preoperatively venesected blood, this patient demonstrated a reproducible pattern of postoperative anaemia after both operations (*Figure 1*). Postoperative blood salvage poses ethical difficulties for Jehovah's Witnesses because of the loss of continuity with their circulation, and was not used in this patient.

By the 7th postoperative day, despite normal preoperative Hb values, and ongoing oral iron therapy, Hb was still only at 66% (operation 1) and 63% (operation 2) of preoperative values. This may be the result of covert blood loss into soft tissue spaces as mean postoperative blood loss in uncemented revision THA is reported as 1000 ml (Semkiw et al, 1989), potentially leaving 500 ml unaccounted for in this patient. There is also evidence of a 'lag phase' in Hb recovery, lasting up to 1 week, which can be prevented with preoperative erythropoietin therapy (Atabek et al, 1995), and which has been ascribed to postoperative inflammatory inhibition of erythropoiesis (Schilling, 1991).

The postoperative Hb values compare favourably with those reported from less complex primary uncemented THA in Jehovah's Witnesses (Whittmann and Whittmann, 1992). Although a clinically significant anaemia was not avoided there was no associated morbidity, demonstrating that even complex revision THA can safely be undertaken without allogeneic transfusion. The use of erythropoietin both pre- and postoperatively may well have a role in the management of these patients. HM

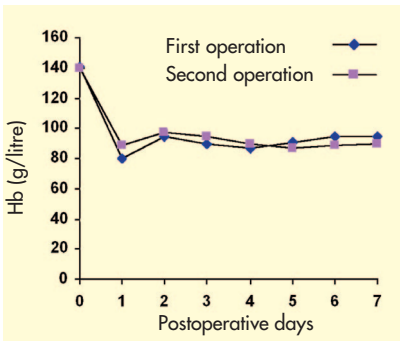

Figure 1. Haemoglobin values from before surgery to day 7 (before discharge).

Atabek U, Alvarez R, Pello MJ et al (1995) Erythropoietin accelerates hematocrit recovery in post-surgical anemia. *American Surgeon* **61:** 74–7
Boldt J, Weber A, Mailer K et al (1999) Acute normovolaemic haemodilution vs controlled hypotension for reducing the use of allogeneic blood in patients undergoing radical prostatectomy. *Br J Anaesth* **82(2):** 170–4
Brown EB, Dubach R, Moore CV (1958) Studies in iron transportation and metabolism. XI. Critical analysis of mucosal block by large doses of inorganic iron in human subjects. *J Labor Clin Med* **52:** 335–55
Crystal GJ, Rooney MW, Ramez Salem M (1988) Regional haemodynamics and oxygen supply during isovolaemic haemodilution alone and in combination with adenosine-induced controlled hypotension. *Anesth Analg* **67:** 211–18
Faris PM, Ritter MA, Abels RI (1996) The effects of recombinant erythropoietin on perioperative transfusion requirements in patients undergoing major orthopaedic surgery. *J Bone Joint Surg* **78(A):** 62–72
Kettler D (1994) 'Permissive anaemia' compared with blood transfusion in patients with cardiac disease: another point of view. *Curr Opin Anaesthesiol* **7:** 1–4
Lindop MJ (1975) Complications and morbidity of controlled hypotension. *Br J Anaesth* **47:** 799–803
Messmer KFW (1991) Blood rheology factors and capillary blood flow. In: Guttierrez G, Vincent JL, eds. *Tissue Oxygen Utilisation.* Berlin-Verlag, Berlin: 103–13
Modig J, Karlstrom G (1987) Intra and postoperative blood loss and haemodynamics in total hip replacement when performed under lumbar epidural *vs* general anaesthesia. *Eur J Anaesthesiol* **4:** 345–55
Nelson AH, Fleischer LA, Rosenbaum SH (1993) Relationship between postoperative anaemia and cardiac morbidity in high risk vascular patients in the intensive care unit. *Crit Care Med* **21:** 860–6
Ridley DT (1990) Accommodating Jehovah's Witnesses' choice of nonblood management. *Perspectives on Healthcare Risk Management* **10(1)**: 17–21
Rothstein P, Royle D, Verdisco L, Stern L (1990) Preoperative use of erythropoietin in an adolescent Jehovah's Witness. *Anesthesiology* **73:** 568–70
Royal College of Surgeons of England (1996) *Surgical Management of Jehovah's Witnesses.* Royal College of Surgeons of England, London
Sauercracker AJ, McCroskey BL, Moore EE et al (1987) Intraoperative hypogastric artery embolisation for life-threatening pelvic haemorrhage: a preliminary report. *J Trauma* **27**: 1127–9
Schilling RF (1991) Anaemia of chronic disorder: a misnomer? *Ann Intern Med* **115:** 572–3
Sculco TP, Ranawat C (1975) The use of spinal anaesthesia for total hip replacement arthroplasty. *J Bone Joint Surg* **57-A:** 173–7
Semkiw LB, Schurman DJ, Goodman SB, Woolson ST (1989) Postoperative blood salvage using the cell saver after total joint arthroplasty. *J Bone Joint Surg* **71-A:** 823–7
Stehling L, Zauser HL (1991) Acute normovolaemic haemodilution. *Transfusion* **31(9)**: 857–68
Van Woerkens ECSM, Trouwborst A, van Lanschott JJB (1992) Profound haemodilution: What is the critical level of haemodilution at which oxygen delivery-dependant oxygen consumption starts in anaesthetised humans? *Anesth Analg* **75:** 818–21
Whittmann PH, Whittmann FW (1992) Total hip replacement surgery without blood transfusion in Jehovah's witnesses. *Br J Anaesth* **68:** 306–7

IN THE PUBLIC'S VIEW...

2001: Back to the future

Whether you celebrated the millennium at the end of 1999 or the end of 2000, the parties are now over. Those at the end of 1999 were bigger; those at the end of 2000 more exclusive. I went for 1999, on the grounds that the change from 1999 to 2000 is more digits than the change from 2000 to 2001.

There was plenty in the public's view as we either packed away the first year or mopped up the last. NICE changed its mind about zanamivir (Relenza), advising GPs to prescribe it to the vulnerable. *Drugs and Therapeutics Bulletin* (December 2000, p 96) disagreed. At its inception, NICE warned that doctors not complying with its guidelines would be wise to record their reasons in patients' notes. What, now, will NICE do about a collective body — the Bulletin just happens to be published by the Consumers' Association — that is ignoring its guidelines?

NICE has been further tasked by Secretary of State Alan Milburn to review treatments for in-vitro fertilization. In his public statements, Milburn suggested that IVF was next in line now that the first priorities of heart disease and cancer had been sorted out. Amid the hollow laughter, I hear the shuffling of feet from patients awaiting hip replacements.

The government announced 20 000 new nurses (Oh, sorry! Didn't we say that most of those will be part-time?). The Pay Review Bodies made their recommendations: higher than inflation (well, there is an election coming), but only for some. The initial news broadcasts suggested almost blanket 8% rises, but it was not to be. The *Guardian* starkly compared the £195 pay rise for a low-grade nurse with the £4200 due to a consultant with a top merit award.

Perhaps because of a lack of medical malpractice towards the end of the year, some of the tabloids tracked down Harold Shipman's wife, publishing photographs of her new home, and berating her for standing by her husband. In that story we see the full depths of the popular press.

The Commons debated therapeutic cloning. Research on embryonic stem cells became the key to future human happiness and freedom from disease, or an abomination that degraded all that it meant to be human. A speaker on Radio 4's 'Thought for the day' wondered at what stage the fertilized, dividing cells acquired their soul.

Perhaps a black obelisk had something to do with it. In 1984, we looked to George Orwell, and were mostly reassured. In 2001, we look to Stanley Kubrick, whose film of Arthur C Clarke's novel '2001' was one of the archetypal films of the 60s.

Was that possibly how man developed from the apes, via the intervention of a mysterious black obelisk? What to make of the third encounter with the obelisk: the psychedelic trip through the stargate, and the apparent re-birth of the surviving astronaut as a star-fetus, looking down on the planet Earth? A pretentious load of hooey? It seemed more than that in the Mauldeth Road Odeon in 1967.

The world is not like that, in the real year 2001. There are no permanent American and Russian settlements on the moon, and you could carry a computer with the power of Hal in a briefcase, if not in a pocket.

Nevertheless, I greet the year 2001 with just an undercurrent of anticipation. I shall watch the skies a little more closely. Perhaps that's where our extra 7000 doctors are coming from. **HM**

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