

COMBINATION OF ACUTE NORMOVOLLEMIC HAEMODILUTION AND DELIBERATE HYPOTENSION IN ORDER TO AVOID ALLOGENEIC BLOOD TRANSFUSION IN THE MANAGEMENT OF LARGE BLOOD LOSS IN SPINAL TRAUMA SURGERY. CASE REPORT

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A b s t r a c t

We report the case of a 35-year-old patient with a displaced fracture of the fourth lumbar vertebra in whom normovolemic haemodilution and deliberate hypotension were used as techniques for avoiding allogeneic blood transfusion during spinal surgery. After starting general anaesthesia, 2000 g of the whole blood was removed and circulation was restored with 1500 ml of colloids and 2000 ml of crystalloids. Retransfusion was started when the blood loss reached 900 ml (transfusion trigger, haematocrit value of 0.25). In the course of anaesthesia, deliberate hypotension (systolic blood pressure, 90 mmHg) was induced and maintained for three hours by continuous application of nitroprusside sodium. The total blood loss was 3500 ml during the 8-hour operation and additional 880 ml postoperatively in 48 h. During the operation we administered a total of 2000 ml of colloids, 6000 ml of crystalloids and 2000 g of blood obtained from acute normovolemic haemodilution. The patient was haemodynamically stable for the whole time, with a final haematocrit value of 0.32. We did not have to use allogeneic blood transfusion.

Key words

Spinal surgery, Large blood loss, Acute normovolemic haemodilution, Deliberate hypotension

Abbreviations used

ANH, acute normovolemic haemodilution; DH, deliberate hypotension; ASA, American Society of Anesthesiologists; ECG, electrocardiogram; SaO₂, oxygen saturation; EtCO₂, end tidal carbon dioxide; Hct, haematocrit

INTRODUCTION

The therapeutic use of allogeneic blood involves rare but potentially fatal complications. In addition to some well known infectious and haemolytic transfusion complications, clinical evidence shows that blood transfusion can also have serious immunological effects. These well-documented risks have stimulated a re-evaluation of the current transfusion practice (1). One of the primary goals in spinal surgery, as well as in other surgical specialties, is to

minimise blood loss, and this implies the need for allogeneic blood transfusion (2). Because it is impossible to use an autotransfusion device at the time of operation, we resorted to ANH supported by DH as a combination of two blood sparing techniques to avoid administration of allogeneic blood in a patient with spinal injury.

CASE REPORT AND METHODS

A 35-year-old male patient weighing 100 kg, without medical history (ASA classification I), with a displaced fracture of the fourth lumbar vertebra was admitted to our hospital two days after he suffered this trauma following a fall with a parachute. After application of low molecular weight heparin, he received intramuscular premedication with 1 mg atropin and 100 mg promethazin. General anaesthesia was started by administration of 10 mg pancuronium, 2 mg flunitrazepam, 20 mg etomidate and 0.2 mg fentanyl followed by inhalation of 2% sevoflurane in a mixture of N₂O and O₂, with additional doses of 2 mg pancuronium and 0.1 mg fentanyl. A cannula was inserted in a vein of each upper extremity, the right jugular vein was punctured with a three-way catheter and the left radial artery was prepared for invasive blood pressure monitoring and collection of blood for haemodilution. ECG, SaO₂, EtCO₂, central venous pressure and urine output were monitored continually. After induction of anaesthesia, a blood volume of 2 000 g was collected into four transfusion bags, each containing 70 ml of CPDA-1 solution, and circulation was restored with a volume of 1500 ml of colloids and 2000 ml of crystalloids. The amount of blood to be taken was calculated in advance according to the formula:

$$\text{Haemodilution volume (in ml)} = (\text{Hs} - \text{Hr}) \times \text{TBBV}/\text{Hs}$$

where Hs is starting haematocrit, Hr is required haematocrit and TBBV (total body blood volume) equals 6500 ml.

After intubation, in the course of ANH (40 min), systolic blood pressure was maintained above 100 mmHg. The blood loss was compensated by a supply of crystalloid and colloid solutions. Retransfusion was started when the blood loss was 900 ml (calculated transfusion trigger at Hct = 0.25). The collected blood was returned to circulation in a volume equal to that of the subsequent blood loss. The values of haemoglobin and haematocrit were checked every hour. During surgical manipulation with the spine, DH (systolic blood pressure, 90 mmHg) was maintained for three hours by continuous application of nitroprusside sodium.

RESULTS

The duration of surgery, involving the first part from the anterior approach (Harms instrumentation) and the second step in the prone position (Daniaux), was eight hours. The total blood loss was 3200 ml. After ANH, we recorded a decrease in central venous pressure from + 8 to + 4 cmH₂O, a reduction in haematocrit value from 0.42 to 0.29 and a decline in haemoglobin value from 142 to 98 g/l. During the operation, a total volume of 2 000 ml of colloids and 6000 ml of crystalloids and 2 000 g blood obtained from ANH were supplied. After surgery, the patient was extubated without complications and transferred to a postoperative unit. Because of a drop in AT III value to 56%, 1000 units of AT III were administered postoperatively. The blood loss was 600 ml at 1 day and 280 ml at 2 days due to drain suction after the procedure. We did not have to use

allogeneic blood because the patient was haemodynamically stable and haematocrit values, including a coagulogram, were normal both during the operation and after it. The main values corresponding to mathematical calculations are shown in *Table 1*.

Table 1

Blood count values during the surgical treatment of spinal injury

Time	Preoperative	After ANH	Before retransfusion	Postoperative
Haemoglobin (g/l)	142	98	86	106
Haematocrit (%)	42	29	0,24	32

DISCUSSION

Bloodless medicine and surgery programmes have been developed mainly to meet the needs of Jehovah's Witnesses, but they can also be used in other patients who desire to avoid or minimise their exposure to allogeneic blood products (1). Preoperative autologous blood donation, application of erythropoietin, intraoperative blood salvage and ANH are routine methods used to avoid allogeneic blood transfusions. ANH is a technique involving collection of whole blood from the patient and subsequent restoration of a circulating blood volume with acellular fluid shortly before an anticipated serious blood loss. According to some authors, ANH, as an autologous blood procurement strategy, can replace preoperative autologous blood donation because it is less costly and equally effective (3,4). The haemoglobin level that can be tolerated depends on many factors. Oxygen delivery to tissues is influenced by the respiratory system, blood (the oxygen-carrying system) and the cardiovascular system. Anaemia results in a decrease in blood viscosity, with reduction of peripheral vascular resistance (5). Compensatory mechanisms include both an increase in cardiac index and an increase in oxygen extraction (6,7). Another approach by which the use of allogeneic blood can be minimised is intraoperative DH. The mean arterial blood pressure is intentionally lowered by peripheral vasodilators, such as sodium nitroprusside, or by inhaled volatile anaesthetic agents (1). Many studies have shown that hypotensive anaesthesia can effectively reduce intraoperative blood loss. However, patients to be treated by this approach should be carefully selected; contraindications include coronary artery disease, congestive heart failure, poorly controlled hypertension and cerebrovascular disease (8).

In conclusion, this case of a patient with a major blood loss during the operation of spinal injury without administration of allogeneic blood

demonstrates the efficiency of two cheaper blood-sparing methods and no necessity to use expensive devices. Some surgical blood loss is inevitable, but a reduction in blood loss is vital to the avoidance of anaemia and reduction of morbidity and mortality in surgical patients (9). Awareness of complications that can increase bleeding, and skilful surgery combined with blood saving methods and a careful management of blood coagulation can reduce the perioperative blood loss. Each strategy is valuable, but they give the best results when used in combination (10).

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KOMBINACE AKUTNÍ NORMOVOLEMICKÉ HEMODILUCE A ŘÍZENÉ HYPOTENZE K VYLOUČENÍ TRANSFÚZE ALLOGENNÍ KRVE PŘI VELKÉ KREVŇÍ ZTRÁTĚ BĚHEM OPERACE TRAUMATU PÁTEŘE

S o u h r n

Je popsán případ 35letého pacienta s dislokovanou frakturou čtvrtého bederního bratle, u kterého byly během operačního výkonu na páteři použity techniky akutní normovolemické hemodiluce a řízené hypotenze k vyloučení transfúze allogenní krve. Po úvodu do celkové anestézie bylo odebráno 2 000 g plné krve a náhrzeno infúzí 1 500 ml koloidních a 2 000 ml krystaloidních roztoků. Retransfúze byla zahájena po krevní ztrátě 900 ml (transfúzní trigger, hodnota hematokritu 0,25). V průběhu operace byla kontinuálním podáním nitroprusidu sodného po dobu tří hodin zavedena řízená hypotenze (90 mmHg systolického krevního tlaku). Krevní ztráta dosáhla 3 500 ml během 8 hodin operace a dalších 880 ml v následných 48 hodinách po výkonu. Celkem bylo podáno 2 000 ml koloidů, 6 000 ml krystaloidů a 2 000 g krve získané akutní normovolemickou hemodilucí. Protože pacient byl po celou dobu hemodynamicky stabilní, s konečnou hodnotou hematokritu 0,32, nemusela být použita allogenní krev.

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