

Title: A COMPARISON OF THE EFFECTS OF THREE METHODS FOR INTRAOPERATIVE BLOOD CONSERVATION ON SYSTEMIC HEMODYNAMICS AND BLOOD REPLACEMENT

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Introduction. Recent apprehension concerning the potential dangers of homologous blood transfusion as well as the increasing frequency of complex surgical procedures have prompted the increasing use of techniques aimed at diminishing the requirements for homologous transfusions. The present study examined the hemodynamic effects and blood replacement of three techniques, preoperative normovolemic hemodilution, intraoperative deliberate hypotension, and combined use of hemodilution and hypotension, in patients undergoing similar operative procedures.

Methods. The study was approved by the Subcommittee on Human Studies. Thirty patients were randomly assigned to three groups: Group 1 (n=10) had preoperative normovolemic hemodilution, Group 2 (n=10) had intraoperative deliberate hypotension, and Group 3 (n=10) had both techniques utilized. Patients were scheduled for resection of bone (femoral) tumors with allograft replacement. The groups were matched with respect to age, sex, and weight. Preoperative hemodilution (Groups 1 and 3) was performed by collecting blood in ACD-containing bags from an arterial catheter while lactated Ringer's solution (volume was equal to three times that of shed blood) was infused simultaneously into a peripheral vein. Deliberate hypotension (Groups 2 and 3) was produced by intravenous infusion of nitroprusside (0.01% solution) after a stable level of general anesthesia was achieved. Radial artery and central venous pressure catheters were inserted for hemodynamic measurements and blood sampling. Measurements were obtained before, during, and after completion of hemodilution (Groups 1 and 3); before and 30, 60, and 120 min after induction of general anesthesia (Group 1) or deliberate hypotension (Groups 2 and 3); and at termination of operation (all groups). Hemodynamic measurements included cardiac output (dye dilution), systemic and right atrial pressures (transduced), and pulse rate (ECG). Simultaneous measurements of arterial blood gases were performed. Anesthesia was induced with thiopental (5 mg/kg), and intubation facilitated with succinylcholine (1 mg/kg). Maintenance was with enflurane (1-2% inspired), F_{iO_2} (3:2 L/min), and curare. Intraoperative blood loss was determined by weighing sponges, measuring suction losses and estimating the blood losses on the drapes.

Results. Hemodynamic data: Preoperative normovolemic hemodilution was associated with a significant ($P<0.01$) increase in cardiac output (CO), and a significant decrease in systemic vascular resistance (SVR); mean arterial pressure (MAP) was not changed. General anesthesia in hemodiluted patients (Groups 1 and 3) was associated with a decrease in CO and SVR. Deliberate hypotension alone (Group 2) produced a small significant increase in CO and a decrease in

SVR and MAP. However, deliberate hypotension in the hemodiluted patients (Group 3) was accompanied by an unchanged cardiac output, provided MAP was maintained at or above 65 mmHg. A sudden significant decrease in CO was observed with MAPs below 65 mmHg. SVR was significantly decreased prior to deliberate hypotension, and decreased further with nitroprusside infusion (Group 3).

Blood replacement: With preoperative hemodilution alone, Group 1 patients received 220 ± 65 (mean \pm SE) ml of autologous (collected preoperatively) and 750 ± 25 ml of homologous blood. Group 2 patients received 1225 ± 85 ml of homologous blood. When both hemodilution and deliberate hypotension were combined, 800 ± 40 ml of autologous and 450 ± 30 ml of homologous blood was transfused. Intraoperative PaO_2 decreased with deliberate hypotension only.

Discussion. This study demonstrates that the combined use of preoperative hemodilution and deliberate hypotension decreased significantly the requirements for blood transfusion when compared with either technique alone in patients undergoing similar operative procedures. Blood loss, and thus blood replacement, was significantly lower than that reported during normotensive anesthesia without hemodilution in a similar group of patients.

The hemodynamic effects of normovolemic hemodilution, i.e. increased CO and decreased SVR, are presumably related to diminished blood viscosity, an important contributor in control of SVR. A decreased SVR is probably responsible for the increased sensitivity of the hemodiluted patient to the vasodilator effects of nitroprusside. Our results have stressed this hemodynamic phenomenon. Furthermore, the dose requirements for nitroprusside were significantly lower in hemodiluted patients (Group 3) than in Group 2 patients (no hemodilution). Farber-Bohm et al have reported that deliberate hypotension alone decreased blood loss significantly when compared with normovolemic hemodilution during total hip replacement. Normovolemic hemodilution alone had eliminated the need for homologous blood replacement in total hip arthroplasty.

These techniques should be popularized in an attempt to diminish the current apprehension concerning the potential hazards of homologous blood transfusion. Combined use of preoperative hemodilution and deliberate hypotension is a useful approach to diminishing the need for homologous blood transfusion.

References

1. Farber-Bohm et al: Br J Anaesth 52:1039-1043, 1980.