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Hemodilution does not cause ischemia in rabbits

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colloids, liver, stomach, isovolemic, hemodilution, ischemia, ischaemia

Comments

This paper adds to the body of evidence that even extreme hemodilution is well tolerated if normovolemia is maintained, at least in terms of organ ischemia. It is interesting that the more complex starch molecules showed an increase in plasma lactate as these solutions are specifically marketed for intensive care unit patients.

Introduction

There are many strategies available to clinicians to reduce the quantity of allogenic blood transfusion. Hemodilution is one attractive technique which, based on mathematical models, should be able to obviate the need for transfusion even with blood loss of 5-10 l. Isovolemic dilution of blood hemoglobin of concentrations to 5 g/dl is well tolerated. Whether or not extreme isovolemic hemodilution affects regional oxygen supply, it is not known whether the fluid used to achieve dilution is important.

Aims

To determine what degree of hemodilution causes tissue ischemia and injury in rabbits and to assess whether this was related to the fluid used to achieve hemodilution.

Methods

Fasted male rabbits were anaesthetised and subsequently underwent tracheostomy. Mean arterial pressure (MAP) was monitored by a right femoral arterial catheter. Central venous pressure (CVP) and

heart rate (HR) were also monitored. Experimental fluids were administered via the right internal jugular vein.

Isovolemic hemodilution was performed as follows animals were given a solution of either 5% human albumin in normal saline ($n = 8$), 6% hetastarch ($n = 9$), 6% pentastarch ($n = 8$) or lactated Ringers solution (sham group, $n = 8$). Transfusions involved simultaneous infusion of the test solution (25% of the blood volume) with removal of an equal volume of blood. This process was performed four times in total, at intervals of 1 h. Prior to each transfusion, 4.5 ml arterial blood was taken for biochemical and physiochemical analysis. Following the experiment, tissue biopsy specimens were taken from the stomach, duodenum and liver for analysis of histologic injury and wet-to-dry weight ratio.

Results

Analysis of the starch solutions indicated a significantly greater in vitro colloid oncotic pressure when compared to the albumin solution. MAP was significantly reduced in the groups receiving albumin and pentastarch following the third and fourth hemodilution respectively, but there were no significant differences in CVP and HR between the groups. Hematocrit (Hct) values were significantly reduced in the groups receiving isovolemic hemodilution, compared to the sham group. Plasma protein was reduced in the groups receiving pentastarch and hetastarch after each hemodilution and plasma colloid oncotic pressure was significantly increased in the albumin and hetastarch groups after the second, third and fourth hemodilutions. Arterial pH, PaCO₂ and PaO₂ remained constant in each and between groups throughout the experiments, although HCO₃⁻ was significantly greater in the albumin group after the fourth hemodilution. Lactate levels remained constant in the groups until after the fourth hemodilution, when the hetastarch group showed a significant increase in lactate concentration (Hct level approximately 5%). Arterial ketone body ratio (AKBR) remained constant between the groups, despite hemodilution of the Hct to 5%. Acetoacetate and β-hydroxybutyrate were significantly greater in the sham group compared to the pentastarch and hetastarch group after the fourth hemodilution.

Analysis of the stomach, duodenum and liver following experiments revealed no differences in histologic injury or tissue wet-to-dry weight ratio between the groups.

Discussion

The findings of this study agree with other published results which suggest hemodilution to an Hct of 15% is not associated with increases in plasma lactate and ischemia. Furthermore, isovolemic dilution from Hct 33% to Hct 5% did not produce histological tissue damage. Overall, these data demonstrate that hepatoenteric ischemia and injury did not occur at extremely low Hct. At an Hct of 5% more ischemia was demonstrated by the group receiving hetastarch solutions in terms of plasma lactate but arterial ketone body ratio was not significantly reduced. Although not statistically significant, there was a trend to increasing lactate with albumin being least, then pentastarch and greatest with hetastarch. This

may be explained by the increasing viscosities of these solutions. Overall however, colloid solutions would not produce significant ischemia, be less expensive and potentially safer to use for haemodilution.

References

1. Nielsen VG, Baird M, Brix A, Matalon S: Extreme, progressive isovolemic hemodilution with 5% human albumin, pentalyte, or hexend does not cause hepatic ischaemia or histologic injury in rabbits. *Anesthesiology*. 1999, 90: 1428-1435.