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VENO-VENOUS BYPASS WITHOUT SYSTEMIC ANTICOAGULATION IN CANINE AND HUMAN LIVER TRANSPLANTATION

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Previous attempts to perform liver transplantation during veno-venous bypass with systemic anticoagulation (heparin) in 12 patients at this medical center resulted in excessive blood loss in six and at least one fatality. The purpose of this study was to test the plausibility and consequences of using a veno-venous circuit without systemic anticoagulation during liver transplantation.

MATERIALS AND METHODS

Orthotopic liver transplantation was performed in ten mongrel dogs (20 to 25 kg) while using the bypass circuit without systemic heparin. Results of hematologic profiles, hemodynamic measurements, and postmortem examination were compared with those in three dogs in which no bypass was used. These three control transplants employed the “cuff” technique described by Cooperman et al (1). Bypass was initiated with drainage from the divided portal vein and proximally occluded infrahepatic vena cava with return to an external jugular vein. The circuit consisted of a centrifugal pump and flow probe with 3/8-inch Tygon tubing coated with 5% albumin and primed with a physiologic electrolyte solution. Appropriately sized Bahnson caval cannulas were used for the jugular vein and cava, while a fenestrated stainless-steel ventricular vent with 1/4-inch Silastic tubing drained the portal vein. Bypass continued for two to four hours at rates of flow between 400 and 1,500 mL/min. In the clinical trial, caval drainage was obtained through 7-mm Gott tubing introduced via the right common femoral vein advanced to the iliac vein; the same size was used for the portal vein, and a 9-mm piece provided venous return to the patient’s left axillary vein. The remainder of the circuit was unchanged.

RESULTS

The use of bypass avoided low cardiac output and portal venous congestion usually associated with caval and portal vein occlusion. Hematologic profiles were not significantly different between groups and indicated a slight decrease in RBCs (5.67 to 5.16 × 10^6/mm^3), WBCs (13.8 to 9.8 × 10^3/mm^3), platelets (145 to 117.5 × 10^3/mm^3), and fibrinogen (145 to 80 mg%/dL) associated with the bypass. Fibrin split products and monomers were moderately elevated (staph clumping 1 to 128, ethanol gel 1 to 4+). Fibrin threads were seen on the support struts of the pump housing in two studies in which the flow rate decreased below 800 mL/min. Gross and microscopic examination of the lungs failed to show intravascular thrombus. In the clinical trial, PT, PTT, and fibrin monomers increased slightly during bypass, whereas fibrin split products remained unchanged and fibrinogen levels decreased. The patient developed a fatal aspiration pneumonia during the first postoperative week. At postmortem examination, no intravascular thrombus was found at the cannulation sites or in the lung.

DISCUSSION

The use of a bypass circuit in liver transplantation provides several advantages by avoiding severe cardiovascular derangements, particularly hypotension, often associated with caval clamping prior to hepatectomy. At completion of the infrahepatic vena caval and portal anastomoses, blood rich in potassium and hydrogen ions is returned to the systemic circulation from the previously stagnant capillary beds of the lower body and splanchnic circulations. A bypass circuit that decompresses the portal vein and the cava below the liver could prevent the accumulation of potassium and acid which might cause cardiac arrhythmias. Azpeitia et al used several different shunts (without a pump) during liver transplantation in dogs (2). Partial cardiopulmonary bypass provided hemodynamic stability during human liver transplantations performed by Calne et al (3). All of these investigators used heparin systemically. In this experiment, veno-venous bypass without systemic anticoagulation preserved the physiologic state during liver transplantation without imposing significant coagulopathy or thromboembolism and served to stimulate a clinical trial in which bypass cannulas were heparin bonded. The use of this system in one patient was associated with normal cardiac output, portal decompression, and no significant change in coagulation factors, platelet count, fibrin split products and monomers, or thromboelastogram. This study has demonstrated the feasibility of veno-venous bypass without systemic anticoagulation. The experimental and early clinical success has prompted plans for routine clinical use in human liver transplantation.

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