Hemostasis and Hepatic Surgery

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KEYWORDS

• Liver resection • Blood loss • Blood transfusion • Hemostasis • Vascular occlusion
• Parenchymal transection • Topical hemostatic agents • Low central venous pressure

KEY POINTS

- Operative blood loss and allogeneic transfusions are independently associated with worse perioperative and long-term outcomes following hepatectomy.
- Restrictive transfusion protocols are safe and effective at minimizing exposure to allogeneic blood in surgical patients.
- Maintenance of low intraoperative central venous pressure is associated with decreased operative blood loss.
- Vascular inflow occlusion is well tolerated and can decrease blood loss during hepatectomy.
- Topical hemostatic agents may decrease intraoperative blood loss from the remnant surface.

INTRODUCTION

The liver hosts the most complex vascular anatomy of any human organ. Liver resection was once deemed an impossible feat largely because of its propensity for hemorrhage, but is now the mainstay for the treatment of primary and secondary tumors of the liver.

Significant progress in anatomic approaches, surgical technique, diagnostic imaging, and perioperative care has led to vast improvements in outcomes of patients undergoing hepatic resection. In the 1970s, operative mortality from hepatic resection occurred in approximately 20 to 30% of patients.[1] Contemporary series now report rates of major morbidity and mortality in high-volume centers to be less than 40% and 5%, respectively.[2,3] Despite these improvements, bleeding continues to be a major source of morbidity for patients and remains a pervasive challenge to hepatic surgeons. Intraoperative blood loss averages between 200 and 2000 mL for major

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hepatic resection, and perioperative blood transfusions are used in 20% to 50% of patients.[2,4,5] Operative blood loss and exposure to allogeneic blood are independently associated with worse perioperative and long-term outcomes in patients undergoing hepatic resection.[2,3,6,7] These observations highlight the paramount importance of minimizing blood loss and blood transfusion in hepatic surgery. This review discusses strategies to minimize blood loss and the utilization of blood transfusion pertaining to oncologic hepatic surgery.

ALLOGENEIC RED BLOOD CELL TRANSFUSION IN HEPATIC RESECTION

The development of modern blood banking has contributed significantly to the improvements in outcomes in hepatic surgery and greatly expanded what is technically feasible for hepatic surgeons. Allogeneic blood transfusion is necessary in cases of severe hemorrhage to maintain hemodynamic stability and end-organ perfusion. However, blood transfusions carry risks of infectious disease transmission, transfusion reaction, and immune suppression and contribute notable economic costs. Furthermore, immunosuppression attributable to allogeneic transfusion has been strongly linked to increases in postoperative infectious complications and cancer recurrence.[3,6,8,9]

The evolution of surgical techniques has led to a reduction in blood loss and transfusion requirements, but paradigm shifts in transfusion strategies have further contributed to these trends. Randomized controlled trials have demonstrated that restrictive transfusion strategies are at least equivalent if not superior for patients who are critically ill, undergoing major elective surgery, or suffering from acute hemorrhage.[10–12] Specific transfusion triggers in surgical patients remain somewhat elusive, although consensus guidelines generally suggest consideration of transfusion in asymptomatic, hemodynamically stable patients with a hemoglobin lower than 6 to 8 g/dL.[13,14] Our institutional practice is to transfuse for a hemoglobin less than 7 g/dL in the asymptomatic nonbleeding patient. Considerable reductions in unnecessary blood transfusion are achievable through implementation of institutional transfusion policies.[15]

NONOPERATIVE TECHNIQUES TO MINIMIZE BLOOD LOSS DURING HEPATIC RESECTION

Improvements in outcomes of hepatectomy are not solely attributable to refinements in surgical techniques. Anesthetic and perioperative care have made substantial contributions to the progress of hepatic surgery.

Low Central Venous Pressure Anesthesia

The strategy of maintaining a low central venous pressure (CVP) during liver resection is based on the premise that blood loss during hepatectomy is derived largely from backflow from the vena cava and hepatic veins. As such, blood loss is exacerbated by normovolemic or hypervolemic states that result from aggressive fluid resuscitation. Decreased blood loss, transfusion requirements, and perioperative morbidity have been demonstrated with the use of low CVP anesthesia.[16–19] With the strategy of low CVP anesthesia, the procedure is divided into the (1) pretransection phase and the (2) posttransection phase.[16] During the pretransection phase, a low CVP (<5 mm Hg) is accomplished primarily through volume restriction. Intravenous fluids are limited (<1 mL/kg per hour) and marginal urine output (25 mL/h) is accepted. Trendelenburg positioning (15°) is used to increase venous return to the heart while decreasing CVP in the inferior vena cava.

A number of pharmacologic adjuncts may assist achieving a low CVP, including loop diuretics, intravenous nitroglycerin, and morphine, although with judicious fluid