Southern African Journal of Anaesthesia and Analgesia 2018; 24(3)(Supplement 1)

South Afr J Anaesth Analg
ISSN 2220-1181 EISSN 2220-1173

FCA 2 REFRESHER COURSE

Liver resection and anaesthesia

L Gilliland

Department of Anaesthesia, Chris Hani Baragwanath Academic Hospital, University of the Witwatersrand
Correspondence to: lizilg@gmail.com

Introduction

The liver is a truly unique organ due to the fact that after tissue resection, hepatocytes can replicate within 24 hours. The dual blood supply adds to this uniqueness in that 25% of the average adult cardiac output oxygenates the liver via the hepatic artery and portal vein.[1] Knowledge of these physiological traits has significantly reduced operative risks during liver resections.[2]

Anatomy

Known as the body's largest solid organ, the liver is divided into eight functional segments. Each segment is based on the blood supply from the portal vein and hepatic artery, the venous drainage from the hepatic vein, and the biliary drainage. Resection of the liver can be anatomic and include segments or it can be non-anatomical, resecting only metastases and therefore sparing liver parenchyme.[3]

The hepatic artery contributes only 30% of the liver's total blood flow while the portal vein supplies 70%. The hepatic artery has some degree of autoregulation, but in the portal vein flow is linearly related to pressure. The hepatic arterial buffer system will see a decrease in hepatic arterial resistance, therefore increasing flow when there is reduced portal venous flow.[4]

Indications

Resection of hepatic metastases in colorectal cancer patients can increase survival in certain patients, therefore it remains a very common indication. Other indications include malignant and benign hepato-biliary tumours, living donor liver transplantation and trauma.[1,5]

Anaesthesia

Preoperative concerns

The preoperative assessment is based on the patient's pathology and planned surgery, comorbidities, and baseline liver function. Healthy patients will have routine blood tests done including a full blood count, electrolytes, renal function, and a liver function test with a coagulation profile. Any evidence of hepatic impairment places the patient at increased risk for developing complications including cardiac, respiratory and renal failure as well as bleeding requiring blood transfusion. Necessary investigations may include lung function testing, arterial blood gas analysis and echocardiography. Patients who received neoadjuvant chemotherapy need special mentioning as their cardiovascular reserve may be reduced. The risk of postoperative liver and renal failure is high in these patients but also in the elderly, diabetics and patients with preoperative steatosis and cirrhosis.[1,2]

Post hepatectomy liver failure (PHLF) is a serious complication that leads to morbidity and mortality and emphasis should be placed on identifying the patients at risk pre-emptively. MRI or CT based volumetric analysis can be useful in predicting the future liver remnant (FLR). Indocyanine green clearance, retention and plasma disappearance rate is a newer noninvasive technique used to predict PHLF. High risk factors for developing PHLF include a predicted FLR ≤ 25%, splenomegaly, Prothrombin activity < 70%, Hyaluronic acid ≥ 200 ng/mL, a platelet count < 100 000/μL, and hyperbilirubinemia.[6]

Intraoperative ultrasound is imperative to detect smaller tumours and possibly alter the resection, thereby sparing liver parenchyme.[3]

Intraoperative concerns

Anaesthesia and Monitoring

Monitoring should be in line with the SASA practice guidelines essential list. Special monitoring includes invasive arterial and CVP as well as a cardiac output monitor. Depending on expertise and availability this may be a noninvasive arterial waveform monitor or a transoesophageal echocardiography. As rapid blood loss remains a possibility, care should be taken to prepare for this via large bore intravenous access and availability of a rapid infuser. Blood and blood products should be on standby and intraoperative cell salvage utilized.[7] Temperature management is crucial and forced air blankets and fluid warmers should be employed. Arterial blood gas analysis including haemoglobin and glucose levels should be monitored, as well as the coagulation profile.[1]

General anaesthesia with controlled ventilation via an endotracheal tube is most commonly employed.[1] Anaesthetic agents with minimal impact on liver blood flow should be used for maintenance although no optimal agent has been identified. Favourite inhalational agents remain isoflurane, sevoflurane and desflurane with cisatracurium or atracurium as the neuromuscular blocker of choice.[2] Known hepatotoxins should be avoided.[1]

Surgery and Haemodynamics

Hepatic resection outcome depends greatly on the intraoperative blood loss and need for transfusion.[3,7] Different hepatic vascular occlusion techniques are available and it is of utmost importance that the haemodynamic consequences are understood (Table I). Inflow vascular occlusion techniques include hepatic pedicle occlusion known as the Pringle manoeuvre that can be applied continuously or intermittently. Selective inflow occlusion includes hemihepatic and segmental vascular clamping that is reserved for high risk cirrhotic patients as it is technically demanding.[5] All four of the aforementioned techniques share the same haemodynamic management and do not prevent backflow bleeding from the hepatic veins.[2]

Inflow and outflow vascular occlusion is essentially applying the Pringle manoeuvre with two additional clamps placed across the infrahepatic and suprahepatic IVC, obtaining total hepatic vascular exclusion (THVE). In selective hepatic vascular exclusion (SHVE) caval flow is not disrupted and there is extraparenchymal control of the hepatic veins with minimal haemodynamic compromise.[5]

As displayed in Table I haemodynamic intolerance to THVE is common and should therefore only be used in carefully selected cases. Vasoactive agents may be needed together with volume loading prior to clamping.

Fluids

Limiting intravenous fluids while maintaining blood pressure and urine output can aid in maintaining a low central venous pressure (CVP) < 5 mmHg during inflow vascular occlusion. This reduces blood loss from backflow bleeding via the hepatic veins.[2,4] If fluid restriction is ineffective, drugs like nitroglycerine, diuretics or inhalational agents can be used. Reverse Trendelenburg position, normovolaemic haemodilution and minimising positive end expiratory pressures can also aid in reducing the CVP.[7,8] There appears to be no difference in efficacy and safety when comparing fluid restriction with using inhalational agents or nitroglycerine to lower CVP.[9] Complications of a low CVP technique include inadequate organ perfusion and possible venous air embolism. Vasopressors should be used to maintain mean arterial pressures within 20% of the patient's baseline.[4,7,8]

If a low CVP technique is not feasible or achieved, SHVE should be utilized.[2]

Using the CVP as a monitor remains a very contentious issue since there is no association between the CVP and the volume of circulation. Evidence suggests that performing liver resections without CVP monitoring does not negatively affect blood loss or outcome.[10] The use of stroke volume variance (SVV) as a predictor of low CVP (< 5 mmHg) seems to be more accurate when the SVV > 10%.[7,9]

During the resection some units accept a SVV of up to 20% while maintaining blood pressure and cardiac index. Post resection fluids should be given in an individualised goal-directed manner to maintain euvolaemia. The optimal choice of fluid remains unknown but acetate-buffered solutions result in better biochemical and haematological outcomes than lactate buffered solutions.[7]

Analgesia

Liver resection with a subcostal incision extending midline has historically been associated with poor pain control.[11] Thoracic epidural analgesia (EA) has well known benefits of decreasing postoperative pulmonary complications and duration of ileus. When functioning optimally it provides good analgesia and blunts the surgical stress response.[12,13] Concerns in liver surgery are rapid fluid shifts with hypotension intraoperatively, increased risk of transfusion and epidural haematoma if postoperative coagulation issues arise.[5,11] The timing of epidural catheter removal needs to be individualised, especially in patients with cirrhosis, where apart from prior INR and platelet count tests, thromboelastography should be considered.[13]

Alternatives to EA are single shot intrathecal morphine, opioid patient controlled analgesia and local anaesthetic at the time of surgery continued with wound catheter infiltration postoperatively.[5,12] Intrathecal morphine has gained popularity since patients have less intraoperative hypotension and therefore require less fluid with rapid mobilisation and shorter hospitalisation.[12] Evidence is emerging that comparable pain scores to EA can be achieved with a transabdominal plane and rectus sheath block with continuous wound infiltration.[13]

Analgesia following liver surgery remains a very controversial topic and each case should be individualised based on the liver pathology and subsequent patient profile.

Postoperative concerns

Liver resections are characterised by rates of postoperative morbidity up to 25% and mortality of up to 5% despite technological advances.[7,14,15] Patients having undergone liver

Table I. Hepatic vascular occlusion techniques: Impact on haemodynamics [2,5]

	Technique	Heart rate	Mean arterial pressure	Systemic vascular resistance	Cardiac output
Inflow and outflow occlusion	**THVE**	↑↑↑(50%)	↓↓↓	↑↑↑ (80%)	↓↓↓ (60%)
	SHVE	↑ (2-5%)	↑	↑	↓
Inflow occlusion		↑ ↑	↑↑ (15%)	↑↑ (40%)	↓ (10%)

resection need to be nursed in an intensive care unit following surgery.

Postoperative fever can have numerous causes as seen in Table II. Postoperative bleeding occurs in 4–10% of cases and usually originates from the residual liver surface, or due to incomplete intraoperative haemostasis. Coagulopathy needs to be ruled out with special investigations and treated appropriately. Bleeding can also occur from the gastrointestinal and biliary tracts. Incidence of bile leakage ranges from 4–17%.[15]

PHLF is defined as acquired deterioration in the liver's synthetic, excretory and detoxifying abilities. It presents with hyperbilirubinaemia and an increased INR on or after day 5 postoperatively.[6]

Table II. Postoperative pyrexia etiology[15]

Venous catheter infection
Pleural effusion
Wound infection
Pulmonary atelectasis/infection
Ascites
Subphrenic infection
Urinary tract infection

Maintaining euvolaemia to preserve renal function and prevent ascites while limiting weight gain to less than 5% of preoperative weight should be the goal in postoperative fluid management.[16]

Glucose and electrolyte imbalances are frequently encountered post liver resection. Hypophosphataemia has been linked to increased postoperative complications following liver resection. Phosphate is needed during liver regeneration therefore supplementation should be given, but care should be taken not to cause hyperphosphataemia, since this can lead to further complications.[16]

ERAS

Enhanced recovery after surgery (ERAS) is a bundle of care pathways aimed at improving patient recovery and reducing medical complications after major surgery. The ERAS society strongly recommends the following ERAS items for liver surgery supported by moderate to high level of evidence:[14]

Preoperatively

- Dedicated preoperative counselling.
- Attention to perioperative nutrition especially if BMI < 18, albumin < 30 g/dl and weight loss > 10–15%. Depending on severity, supplement for 7–14 days preoperatively.
- Adhere to fasting guidelines, 6 hours for solids and 2 hours for liquids.
- Avoid long acting pre-medication.
- Anti-thrombotic prophylaxis should be used.

Intraoperatively

- Antimicrobial prophylaxis before skin incision and skin preparation with chlorhexidine 2% are recommended.
- Incision type at surgeon's discretion, but avoid Mercedes type incision.
- Minimally invasive approach if performed by a skilled surgeon.
- Routine prophylactic nasogastric tube not indicated.
- Prevent intraoperative hypothermia.
- Routine thoracic EA cannot be recommended; wound infusion catheters or intrathecal opioids can be used alternatively combined with multimodal analgesia.
- Preventing postoperative nausea and vomiting with a multimodal approach.
- Maintaining CVP < 5 mmHg preferring balanced crystalloid over saline or colloids to maintain intravascular volume.

Postoperatively

- Early postoperative oral intake.
- Maintain normoglycaemia postoperatively with insulin therapy.
- Prevention of delayed gastric emptying by an omental flap after left sided hepatectomy.
- Stimulation of bowel movement not indicated postoperatively.

Two randomised controlled trials that measured enhanced recovery after liver resection demonstrated a significant reduction in length of hospital stay and medical complications.[17]

Conclusion

Liver resection remains a major abdominal surgical procedure with its associated complications. A multidisciplinary team approach with appropriate preoperative planning and communication is of paramount importance. Adequate analgesia and fluid management with avoidance of major intraoperative blood loss and transfusion will reduce the physiological stress and lead to fewer postoperative complications.

References

1. Hartog A, Mills G. Anaesthesia for hepatic resection surgery. Oxford Journals. 2009;9(1):5.
2. Tympa A, Theodoraki K, Tsaroucha A, Arkadopoulos N, Vassiliou I, Smyrniotis V. Anesthetic Considerations in Hepatectomies under Hepatic Vascular Control. HPB Surgery. 2012;2012:12.
3. Aragon RJ, Solomon NL. Techniques of hepatic resection. J Gastrointest Oncol. 2012;3(1):28-40.
4. Bonofiglio FC. Anesthesia in Liver Resections: Review. J Anesth Crit cCare: Open Access. 2017;8(5):00318.
5. Page AJ, Kooby DA. Perioperative management of hepatic resection. J Gastrointest Oncol. 2012;3(1):19-27.
6. Kauffmann R, Fong Y. Post-hepatectomy liver failure. Hepatobiliary Surg Nutr. 2014;3(5):238-46.
7. Yoshino O, Perini MV, Christophi C, Weinberg L. Perioperative fluid management in major hepatic resection: an integrative review. Hepatobiliary Pancreat Dis Int: HBPD INT. 2017;16(5):458-69.
8. Maurer CA, Walensi M, Käser SA, Künzli BM, Lötscher R, Zuse A. Liver resections can be performed safely without Pringle maneuver: A prospective study. World J Hepatol. 2016;8(24):1038-46.
9. Zatloukal J, Pradl R, Kletecka J, Skalicky T, Liska V, Benes J. Comparison of absolute fluid restriction versus relative volume redistribution strategy in low central venous pressure anesthesia in liver resection surgery: a randomized controlled trial. Minerva Anestesiol. 2017;83(10):1051-60.
10. Wax DB, Zerillo J, Tabrizian P, Schwartz M, Hill B, Lin HM, et al. A retrospective analysis of liver resection performed without central venous pressure monitoring. Eur J Surg Oncol: the journal of the European Society of Surgical Oncology and the British Association of Surgical Oncology. 2016;42(10):1608-13.

11. Amini N, Kim Y, Hyder O, Spolverato G, Wu CL, Page AJ, et al. A nationwide analysis of the use and outcomes of perioperative epidural analgesia in patients undergoing hepatic and pancreatic surgery. Am J Surg. 2015;210(3):483-91.
12. Tzimas P, Prout J, Papadopoulos G, Mallett SV. Epidural anaesthesia and analgesia for liver resection. Anaesthesia. 2013;68(6):628-35.
13. Siniscalchi A, Gamberini L, Bardi T, Laici C, Gamberini E, Francorsi L, et al. Role of epidural anesthesia in a fast track liver resection protocol for cirrhotic patients - results after three years of practice. World J Hepatol. 2016;8(26):1097-104.
14. Melloul E, Hubner M, Scott M, Snowden C, Prentis J, Dejong CH, et al. Guidelines for Perioperative Care for Liver Surgery: Enhanced Recovery After Surgery (ERAS) Society Recommendations. World J Surg. 2016;40(10):2425-40.
15. Jin S, Fu Q, Wuyun G, Wuyun T. Management of post-hepatectomy complications. World J Gastroenterol : WJG. 2013;19(44):7983-91.
16. Warner SG, Jutric Z, Nisimova L, Fong Y. Early recovery pathway for hepatectomy: data-driven liver resection care and recovery. Hepatobiliary Surg Nutr. 2017;6(5):297-311.
17. Kelliher LJS, Jones CN, Fawcett WJ. Enhanced recovery for gastrointestinal surgery. BJA Education. 2015;15(6):305-10.