(Print pagebreak 549)

CHAPTER 7.5

Hepatic Surgery

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Hepatic Resection

Surgical Considerations

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Description: Liver resections usually are performed to remove primary tumors or metastatic tumors to the liver. The most common malignant primary liver tumor is hepatocellular carcinoma (HCC), usually caused by chronic hepatitis B or C, and cirrhosis due to chronic alcohol abuse. Liver resection is also performed for an enlarging hepatic adenoma, which is a benign primary tumor that is susceptible to rupture. The most common secondary tumors removed are metastases from colorectal cancer. In rare cases, it may be necessary to resect a devitalized area of the liver following trauma. The mortality and morbidity following liver resection depends on the extent of the surgery, experience of the surgeon, and the patient's hepatic function. In general, the risk of resection is higher in patients with primary HCC where the uninvolved part of the liver frequently is cirrhotic or diseased from chronic hepatitis B or C. Cirrhotic patients with Plt counts < 80,000, portal HTN with varices, ascites, albumin < 3.5 g/L, and prolonged INR are generally unsuitable candidates for major liver resection because of the high risk of postop liver failure.

Intraop blood loss is the most important predictor of short-term survival. Bleeding is largely from intrahepatic branches of portal and hepatic veins injured during the dissection, potentially leading to massive blood loss within minutes. Liver resection performed by experienced liver surgeon using modern dissection tools often can be performed successfully without the need for blood transfusions (Cell Saver should not be used when operating on cancer patients). The mortality rate of liver resection should be < 2–5%. Most patients do not require postop ICU care and are usually discharged within 4–5 d. Improved outcomes result from better surgical exposure and mobilization of the liver combined with the standard adoption of new dissection tools to minimize the risk of blood loss. These include new ablation devices to coagulate along the planned line of a resection (such as InLine) combined with the use of dissectors using high-pressure water jet (Hydrojet) or ultrasonic pulses (CUSA) to expose the intrahepatic vessels and bile ducts. Intraop ultrasound is very helpful for two reasons: (a) in planning the line of resection and mapping out its relationship with the large intrahepatic portal and hepatic veins and (b) in surveying the entire liver to look for multifocal lesions.

Anatomic vs nonanatomic liver resection: Until the last decade, most liver surgeons performed **anatomic liver resections** in which the porta hepatitis is dissected and the corresponding extrahepatic branches of the hepatic artery, portal vein, bile duct, and hepatic vein are mobilized and ligated before resection of the liver parenchyma (Fig. 7.5-1). In **nonanatomic liver resections**, only the tumor with a margin of 1–2 cm is removed instead of the entire anatomic lobe or segment. This approach is particularly appropriate in patients with cirrhosis or chronic hepatitis, in whom removing too much of the liver will predispose them to hepatic decompensation, and in patients with liver metastases where the risk of recurrence remains high. When nonanatomic resection is performed, dissection of the porta hepatis is unnecessary. Instead, branches of the vessels and hepatic ducts are ligated and resected as they are encountered during the resection of the liver parenchyma. All patients undergoing liver resection should also be grounded with the appropriate pads prior to draping for possible radiofrequency ablation of lesions found not to be suitable for resection.

Temporary occlusion of the hepaticoduodenal ligament that contains the main portal vein, hepatic artery, and common bile duct (**Pringle maneuver**) can be used in resection to minimize blood loss. Most patients will tolerate this maneuver for 15–20 min. In some patients, it may be necessary to repeat the maneuver twice to complete a major resection. However, with good surgical exposure and standard adoption of new dissection tools to minimize blood loss, the Pringle maneuver is rarely necessary.

Usual preop diagnosis: Benign and malignant primary or metastatic tumors of the liver

Summary of Procedures

	Right/Left Lobectomy/Trisegmentectomy	Partial Right Lobectomy	Left Lateral Segmentectomy
Position	Supine		
Incision	Upper midline, extending to right subcostal (Lexus incision)		Upper midline
Special instrumentation	Thompson liver retractor; InLine, Helix Hydro-jet or CUSA; TissueLink dissecting sealer; argon beam laser; tumor ablation device; intraop ultrasound		
Unique considerations	Maintain normal core Temp. Most intrahepatic bleeding can be controlled temporarily by compression. Note the duration of Pringle maneuver, if applied. Give mannitol furosemide for hemoglobinuria associated with extensive radiofrequency ablation of the liver to reduce the risk of postoperative acute tubular necrosis		
Antibiotics	Vancomycin/cefazolin 1 g iv preop		
Surgical time	3–8 h	4–6 h	< 3 h
Closing considerations	Secure meticulous hemostasis; place two perihepatic Jackson Pratt flat bulb suction drains.		
EBL	Variable (50–800 mL)	100–500 mL	100–300 mL
Postop care	PACU → ward		
Mortality	< 2–5%		< 1%
Morbidity	Ascites: 20–30% Wound infection: 5–10% Liver failure: < 5% Bile leak: < 5% Postop bleeding: < 2–5%	10–20% < 2–5%	< 10% < 2%
Pain score	7–8	7–8	7

(Print pagebreak 551)

Patient Population Characteristics

Age range	19–85 yr
Male:Female	4:1 in primary HCC 2:1 in liver metastases
Incidence	Metastatic colorectal cancer is the most common disease treated with liver resection in the United States. The incidence of primary HCC is rising 2° the prevalence of chronic hepatitis C; however, because of delayed Dx and associated hepatitis C cirrhosis, many are not suitable resection candidates. Primary

	HCC is a common cancer in Asian Americans because of the high incidence of chronic hepatitis B. Many young Asians (30–50 yr) with HCC 2° chronic hepatitis B may not have cirrhosis.
Associated conditions	Cirrhosis; chronic hepatitis; and, rarely, hemochromatosis; Hx of colorectal surgery in patients with liver metastases

(Print pagebreak 552)

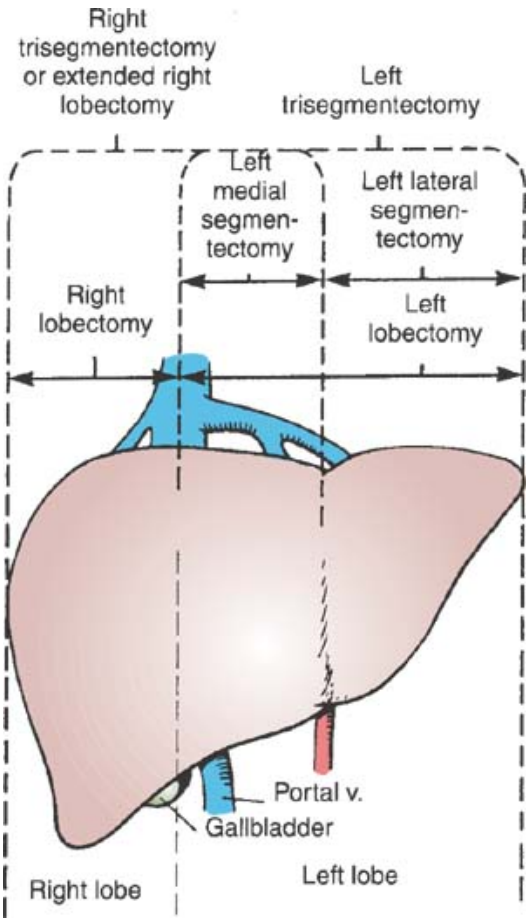

Figure 7.5-1. 1. Types of liver resection. (Reproduced with permission from Hardy JD: *Hardy's Textbook of Surgery,* 2nd edition. JB Lippincott, Philadelphia: 1988.)

Anesthetic Considerations

See Anesthetic Considerations following Hepatorrhaphy, p. 553.

Suggested Readings

1. D'angelica M, Fung Y: The liver. In *Sabiston's Textbook of Surgery,* 18th edition. Townsend CM, et al, eds. Sanders Elsevier, Philadelphia: 2007, 1463–523.

2. Delman KA, Curley SA: Hepatic neoplasms. In *Greenfield's Surgery: Scientific Principles and Practice*, 4th edition. Mulholland MW, et al, eds. Lippincott Williams & Wilkens, Philadelphia: 2006, 956–77.

3. Jarnegan WR: Liver and portal venous system. In *Current Surgical Diagnosis and Treatment*, 12th edition. Doherty GM, ed. McGraw-Hill Medical, New York: 2006, 539–72.

Hepatorrhaphy

Surgical Considerations

Harry A. Oberhelman

Description: Although most liver lacerations have stopped bleeding by the time a surgeon sees them, others require suturing or partial liver resection to control bleeding. Various techniques are available to control hemorrhage, *(Print pagebreak 553)* including packing, suturing, inflow occlusion, and resection. Small lacerations that have stopped bleeding require no specific therapy other than possible drainage. Lacerations that continue to bleed usually can be sutured and drained. Extensive tears of the liver that are actively bleeding may require temporary occlusion of the porta hepatis, containing the hepatic artery, portal vein, and bile duct (**Pringle maneuver**) to excise deviated parenchyma and control bleeding with sutures, clips, coagulators, etc. Occasionally, the hepatic vein draining the involved lobe will require clamping to control back-bleeding. When the bleeding cannot be controlled, it is expedient to pack the wound, drain the abdomen, and close. The pack can be removed without much risk of rebleeding within 48–72 h.

Usual preop diagnosis: Trauma with CT evidence of hepatic laceration

Summary of Procedures

Position	Supine
Incision	Midline abdominal
Special instrumentation	Denier retractor
Antibiotics	Cefazolin l g iv
Surgical time	1–2 h
EBL	300–2000 mL
Mortality	1–2%
Morbidity	Continued bleeding: 2–3% Biliary fistula Perihepatic abscess Intrahepatic hematoma Arterioportal fistula Hepatic and renal failure
Pain score	7–9

Patient Population Characteristics

Age range	Variable
Male:Female	1:1
Incidence	Rare
Etiology	Trauma (blunt vs penetrating); surgical; hepatic adenomas; needle biopsies of liver

Anesthetic Considerations for Hepatic Procedures

(Procedures covered: hepatic resection; hepatorrhaphy)

Preoperative

Patients presenting for hepatic surgery may have primary or metastatic tumors from GI and other sources. Liver function may be

entirely normal in these patients. HCC is seen commonly in males > 50 yr, and is associated with chronic active hepatitis B and cirrhosis. The preop considerations listed below describe patients without cirrhosis. (See Preoperative Considerations for Surgery for Portal Hypertension, p. 434) for evaluation of patients with cirrhosis).

Respiratory	Respiratory function is typically normal; however, patients with ascites may have respiratory compromise. **Tests:** CXR; others as clinically indicated.
Cardiovascular	Patients may be hypovolemic, and volume status should be carefully assessed before induction of anesthesia (skin turgor, UO, orthostatic BP, HR, etc). Tumors may surround major vascular structures and impede venous return. Consider evaluation with CT/MRI scan.
Hepatic	Liver resection can be indicated for hemangiomas, hydatid cysts, and tumors. It is important to determine the size of the tumor and involvement of vascular structures preop so as to be adequately prepared for major intraop blood and fluid losses. **Tests:** LFTs; albumin; ultrasound/CT/MRI
Hematologic	The liver produces all clotting factors except VIII, and the degree of hepatic insufficiency determines the extent of any coagulopathy. T&C 4 U PRBCs. **Tests:** CBC; PT; PTT; Plt count; others as indicated from H&P.
Laboratory	* Tests as indicated from H&P. **NB:** For elective cases, if abnormal LFTs are present on preop labs, it is important to perform a complete medical workup. This can include reviewing old lab data, hepatitis serology, and an abdominal ultrasound to r/o cholestatic causes of liver dysfunction. Surgery and anesthesia in the presence of acute hepatitis is associated with a high mortality.
Premedication	Consider midazolam 1–2 mg iv (see B-1). Consider administering vitamin K (e.g., 10 mg iv/sc) if PT is prolonged. Beneficial results from vitamin K usually occur within 24 h. Consider FFP for rapid correction of PT.

(Print pagebreak 554)

Intraoperative

Anesthetic technique: GETA. For major liver resections, the surgeon may attempt to reduce blood loss by applying intermittent vascular inflow occlusion or total vascular exclusion. As the result of ischemia induced by vascular occlusion and the loss of liver mass during resection, liver function may be significantly abnormal in the postop period. Coagulation abnormalities may exist; consequently, an epidural catheter for postop pain relief may be associated with ↑ risk of hematoma formation.

Induction	Standard induction (see B-2). Restore intravascular volume before induction. Trauma patients or those with ascites require rapid-sequence induction (see B-5) with cricoid pressure until intubation has been confirmed. If patient is hemodynamically unstable, consider etomidate (0.2–0.4 mg/kg) or ketamine (1–3 mg/kg) in place of propofol.
Maintenance	Standard maintenance (p. B-2); N_2O can be used if bowel distention will not impede surgical exposure/closure. If total vascular occlusion is used, elevate CVP to at least 12 mmHg by rapid fluid administration before cross-clamping. Have Neo-Synephrine and epinephrine infusions ready to treat ↓ BP. After major resections, significant hemodynamic changes occur. CO and HR increase, and systemic vascular resistance decreases.
Emergence	For major hepatic resections, the patient will be best cared for in an ICU. After major blood loss, consider keeping the patient mechanically ventilated.

Blood and fluid requirements	Anticipate large blood loss. IV: 14–16 ga × 2 NS/LR @ 10–20 mL/kg/h Fluid warmer Humidify gases Consider utilizing rapid-transfusion device.	Blood loss can be significant; keep at least 2 U PRBC ahead. Lobectomies often are associated with more blood loss than wedge resections. Massive transfusions may be required and appropriate blood products should be available (e.g., 2 FFPs + 6 Plt per 10 U PRBC). If procedure does not involve cancer, blood salvage devices may be used.
Control of blood loss	Surgical control Pringle maneuver Total vascular exclusion	Surgical occlusion of the main blood vessels entering the hilar area (Pringle maneuver), or total vascular occlusion. Total vascular exclusion is accomplished by complete occlusion of liver inflow and outflow.
Monitoring	Standard monitors (see B-1) UO CVP Arterial line ± TEE	Others as clinically indicated. If the extent of the resection is not known at the beginning of surgery, appropriate monitoring (CVP, arterial line, additional iv's) should be established prior to beginning resection. Forced-air warmer.
Positioning	and pad pressure points eyes	
Complications	Massive hemorrhage	Ensure adequate vascular access. Consider rapid-transfusion device.

(Print pagebreak 555)

Postoperative

Complications	liver function Hemorrhage Electrolyte imbalance Hypoglycemia Hypothermia, shivering DIC Pulmonary insufficiency	Patients with normal liver function preop may have significant postop impairment of liver function 2° loss of liver mass or ischemic injury induced by vascular occlusion.
		> 90% of patients will develop some form of respiratory complication (atelectasis, effusion, pneumonia).
Pain management	PCA (see C-3)	Patient should be recovered in ICU or hospital ward that is accustomed to treating the side effects of opiates (e.g., respiratory depression, breakthrough pain, nausea, pruritus).
Tests	ABG; CXR; others as clinically indicated.	

Suggested Readings

1. Kaufman BS, Roccoforte JD: Anesthesia and the liver. In *Clinical Anesthesia*, 5th edition. Barash PG, Cullen BF, Stoelting RK, eds, Lippincott Williams & Wilkins, Philadelphia: 2006, 1072–111.

2. Niemann CU, Roberts JP, Ascher NL, et al: Intraoperative hemodynamics and liver function in adult to adult living liver donors. *Liver Transpl* 2002; 8:1126–32.

3. Redai I, Emond J, Brentjens T: Anesthetic considerations during liver surgery. *Surg Clin North Am* 2004; 84(2):401–11.

4. Suman A, Carey W: Assessing the risk of surgery in patients with liver disease. *Cleve Clin J Med* 2006; 73(4):398–404.