HEPATIC RESECTION
ANESTHETIC PROTOCOL
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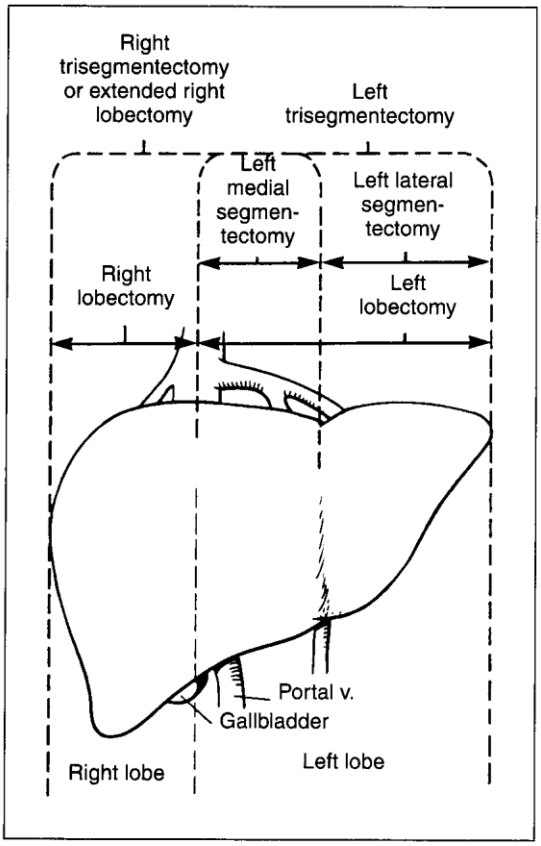

Description: Liver resections are usually performed to remove primary tumors or metastatic tumors to the liver. The most common malignant primary liver tumor is hepatocellular carcinoma (HCC), usually caused by chronic hepatitis B or C. Liver resection is also performed for hepatic adenomas and hemangiomas. Surgical risks are higher in patients with primary HCC, where the uninvolved part of the liver is frequently 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 PT (increased INR) are generally unsuitable candidates for major liver resection because the risk of postop liver failure is high.

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 can be performed without blood transfusions (Cell Saver should not be used when operating on cancer patients). We usually use Acute Normovolemic Hemodilution (ANH) to decrease blood transfusions.

The procedure can be grouped into three categories according to amount of liver removed and potential blood loss—From most to least--

1. **Right /Left Lobectomy /Trisegmentectomy (EBL—100-800 or more)**
2. **Partial Right Lobectomy (EBL—100-500)**
3. **Left Lateral Segmentectomy (EBL—100-300)**

Pre-operative evaluation—

Thorough H&P with Chem 7, LFT's, CBC, PT, PTT, INR, Type and Cross 4 units.

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

Hepatic-Liver function may be entirely normal in these patients. HCC is associated with chronic active hepatitis B and cirrhosis.

Hematologic- The liver produces all clotting factors except VIII and Von Willebrand factor; the degree of hepatic insufficiency determines the severity of coagulopathy.
Respiratory- Respiratory function is typically normal; however, patients with ascites may have respiratory compromise.
Cardiovascular- Patients may be hypovolemic, and volume status should be carefully assessed before induction--Tumors may surround major vascular structures.

Premedication

Standard premedication. Consider administering vitamin K (10 mg iv) if PT is prolonged. (Beneficial results from vitamin K usually occur within 24 h. Consider FFP for rapid correction of PT.)

Monitoring

- Standard ASA monitors
- UOP
- CVP
- Arterial line +/- FloTrack (Stroke volume variation monitor)

Blood and Fluid Requirements

- Anticipate large blood loss.
- IV: 14-16 ga x 2
- Normal Saline
- 5% Albumin
- Fluid warmer
- Acute Normovolemic Hemodilution (ANH).

Blood loss can be significant; stay 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., for every 10 units PRBC, give 2 or more units of FFP + 1 unit Plt). If procedure does not involve cancer, blood salvage devices can be used.

Anesthetic technique:

- ABX-- Ancef 1 gm IV—If allergic—Cipro 400 mg IV
- **Induction--** Standard induction. Restore intravascular volume before induction. Patients with ascites require rapid-sequence induction. After induction OG tube is placed which is usually removed at the end of the procedure
- **Maintenance--**Standard maintenance; N_20 should be avoided due to bowel distention IV fluids should be slowed and CVP should be decreased (<10) during liver division and the patient is placed in T-berg position to decrease venous bleeding. Venous air embolism is a possible complication. NTG gtt together with a NorEpi gtt may be needed to balance decreased CVP with appropriate SVR. After major resections, significant hemodynamic changes occur. CO and HR increase, and systemic vascular resistance decreases.
- **Emergence—**Most patients are extubated and go to the PACU. For major hepatic resections, the patient will be best cared for in an ICU. After major blood loss, consider keeping the patient mechanically ventilated.

Acute Normovolemic Hemodilution (ANH):

Procedure:

- Blood is removed from the patient and replaced with an appropriate volume of crystalloid (3:1) or colloid (1:1), which dilutes the patient's blood without changing circulating blood volume. After hemodilution, each ml of blood contains fewer red blood cells than the patient's baseline undiluted blood; this will allow for maximal total blood loss with minimal RBC loss. At the end of the case, the undiluted, RBC-rich blood that was removed from the patient will be transfused back to the patient.
- The type of diluting replacement fluid for each case should be discussed with your attending preoperatively.
- Blood is collected in standard blood bags containing citrate-phosphate-dextrose. Each bag is designed to hold 450ml of blood. Blood can be extracted piecemeal off a central venous catheter using a large syringe for proper measurement.
- The blood is kept in the operating room and is maintained at room temperature to preserve platelet function. Frequent agitation is essential to avoid coagulation of blood.
- Blood is reinfused after major blood loss has ceased, or sooner if indicated.

Physiology:

- Decrease in arterial oxygen content, but oxygen delivery is usually unaffected—due to increase C.O.
- Increased cardiac output due to decreased viscosity.
- Increase in stroke volume is most important; heart rate does not ordinarily increase in the absence of hypovolemia.
- Hb decreases approximately 1 g/dL for each unit of blood removed
- Inappropriate to employ the technique when the Hb is less than 11 g/dL
- Patients with decreased renal function are not suitable candidates for ANH because excretion of diluent fluids may be impaired.
- Significant restrictive or obstructive pulmonary disease is a contraindication because decreased arterial oxygen content is inherent with ANH and tissue oxygenation may be inadequate.
- The minimal safe HCT depends on the patient's ability to compensate for the decreased arterial oxygen content.
- Myocardial ischemia and cerebral hypoxia are the major potential complications.
- Studies comparing dextran, albumin, and hydroxyethyl starch have demonstrated no significant differences among diluents. The advantage of crystalloid, in addition to cost, is that excess fluid can easily be excreted if a diuretic such as furosemide is administered before reinfusion of the blood.

Calculating Amount of Blood to Remove:

Calculating the amount of blood to remove from the patient to achieve a desired goal HCT can be accomplished by using of one of two variations of the "Maximum Allowable Blood Loss" formula, depending on when the colloid/crystalloid diluent is administered.

1. If all blood is removed en bloc before colloid/crystalloid diluent is given, the following equation is used. This technique will yield the most concentrated, RBC-rich blood for re-transfusion later. However, vasopressor support may be needed until volume is replaced.

$$MABL = EBV \times [(H_{start} - H_{final})/H_{start}]$$

2. If colloid/crystalloid diluent is administered <u>while</u> blood is being removed from the patient, then a slightly different equation is used. You will need to take off more blood to achieve a desired goal HCT (see sample calculations below), and the blood removed will be less concentrated.

$$MABL = EBV \times [(H_{start} - H_{final})/H_{AVG}]$$

MABL is the Maximum Allowable Blood Loss to achieve a desired HCT. EBV is the patient's Estimated Blood Volume (about 7% of ideal body weight), H_{start} is the starting HCT, H_{final} is the desired HCT after hemodilution. H_{AVG} is the average of H_{start} and H_{final}

Sample Calculations:

For a patient with an EBV of 5 L, a starting HCT of 45 percent, and a desired HCT of 30 percent after hemodilution:

If all blood is removed en bloc <u>before</u> colloid/crystalloid replacement, the approximate amount of blood to withdraw is calculated as:

$$MABL = EBV \times [(H_{start} - H_{final})/H_{start}]$$

$$MABL = 5\ L \times [(45 - 30)/45] = 1{,}600\ mL$$

If colloid/crystalloid diluent is administered <u>while</u> blood is being removed from the patient:

$$MABL = EBV \times [(H_{start} - H_{final})/H_{AVG}]$$

$$MABL = 5\ L \times [(45 - 30)/37.5] = 2{,}000\ mL$$

Notice the difference in total volume between the two equations and you will understand the importance of using the correct MABL formula. <u>Discuss with your attending preoperatively which method he/she prefers, and which crystalloid/colloid solution is preferred for hemodilution.</u>

The augmented cardiac output increases myocardial oxygen consumption while the oxygen content of blood supplying the myocardium is reduced. Tachycardia and decreased cardiac output resulting from hypovolemia can further impair myocardial oxygen supply-demand relationships. In the adult, tachycardia should be considered an indication of hypovolemia and should be corrected immediately.