Anesthesia for major hepatobiliary and pancreatic malignancies

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5 Preoperative Considerations

5.1 Anesthesia for Major Hepatobiliary and Pancreatic Malignancies

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Introduction

The incidence and severity of hepatic damage during anesthesia cannot as yet be precisely monitored. However, liver function may be impaired by several factors during anesthesia (Strunin and Davies 1983), arising from anesthetic management, the surgery itself and the underlying disease.

Preoperative Assessment

Well-planned anesthesia is based upon good preoperative assessment. The outcome of the operation is determined to a great extent by the patient's physical fitness. Every effort to improve the state of health before the operation must be made. In patients undergoing major hepatobiliary surgery, the normal preoperative evaluation includes not only assessment of cardio-pulmonary and renal function, but also investigations related to the liver. The most important factors are the patient's physical and mental state, liver function reserve and clotting status. Questions regarding the patient's medical history, previous incidences of jaundice or hepatitis, increased bleeding tendency, reactions to previous anesthesia, current drug therapy, alcohol and drug abuse should be made. It is only in the advanced stages of liver disease that significant abnormalities are found in the patient's physical and mental condition. Indeed, in this situation several organ systems may be involved, such as the brain, kidneys and vascular system.

Essential laboratory tests includes liver function tests, plasma protein levels, clotting profile, hemoglobin, hematocrit, electrolytes, creatinine and urea (Chopra and Griffin 1985). Patients scheduled for major hepatic bile surgery may have normal liver function tests. In the case of preoperative extrahepatic obstruction, an endoprosthesis can be placed to improve bile drainage. In cirrhotic patients, liver damage is largely irreversible. Severe liver disease is always accompanied by disturbed liver function tests.

To grade the severity of liver disease, Pugh et al. (1973) described a classification system based on three laboratory tests (bilirubin, albumin and prothrombin) and two clinical observations (encephalopathy grade and ascites). Each of these parameters may score 1, 2 or 3 points for increasing abnormality. Patients with a low score (5–6 points) are considered to have a good level of operation risk and patients with high scores (10–15 points) have a poor level of operation risk.

Coagulation

Hemostatic abnormalities are common in liver disease. For this reason it is important to be informed about the patient's clotting status. In liver failure, there is a deficiency of the coagulation factors fibrinogen and vitamin K-dependent factors II, VII, IX and X. Clotting defects may be aggravated by thrombocytopenia and qualitative platelet disturbances. Antithrombin III synthesis is also lowered, and this leads to increased fibrinolysis. Vitamin K deficiency is common in biliary obstruction, and the synthesis of vitamin K-dependent clotting factors is reduced.

Because bleeding is the most frequent complication in liver surgery, efforts must be made to correct or improve any clotting deficiency. Preoperative treatment can be started with vitamin K, 2×10 mg daily. Sometimes two or three days are needed for correction. In emergency situations, correction can be achieved by means of fresh frozen plasma or clotting-factor concentration (II, VII, IX, X), and if necessary with concentrated platelet transfusion.

Preoperative Visit

The preoperative visit is an essential part of good patient care. Patients faced with this type of operation can be very ill. Most of them are aware of the seriousness of the operation and know about the postoperative intensive care period. The anesthetist plays an important role in reducing the patient's anxiety by dealing with his fears and anxieties for the coming operation and anesthesia. Explanations of what anesthesia means and some information about the postoperative period, to the extent that the patient is interested and able to understand, may not only reduce preoperative anxiety but are also important for postoperative well-being.

Visiting the patient gives the anesthetist the opportunity to obtain information about venous accessibility. Good running venous lines can be lifesaving during the operation. Central lines are important, as they can be used not only for cardiac monitoring but also become crucial in case of massive transfusions. Putting in these lines the day before saves time on the day of operation. If an epidural block is planned, the anatomy of the patient's spine is also important. Anatomical disorders may hinder an epidural block. Advance information about possible problems reduces problems on the day of the operation.

Anesthetic Considerations

Liver Blood Flow and Anesthesia

The liver belongs to the splanchnic organs along with the gallbladder, spleen, pancreas and digestive tract. The blood flow through these organs is the splanchnic blood flow, which is directly related to perfusion pressure and inversely proportional to the resistance in the splanchnic area (Strunin and Davies 1986). Total liver blood flow is about 25 % of the cardiac output. The portal vein supplies 70 % of liver blood flow, but can supply only half of the oxygen demand. The other 50 % of oxygen comes from the hepatic artery, which supplies 30 % of the liver perfusion. Blood drains from the liver via the hepatic veins into the inferior vena cava.

During the operation and anesthesia, a number of factors may influence liver blood flow. All anesthetic techniques (general or regional) decrease hepatic blood flow. During spinal and epidural anesthesia, the liver blood flow parallels the reduction in arterial blood pressure. The same is true when halothane, enflurane or isoflurane are used. Although studies in animals have shown an increase in hepatic artery blood flow during isoflurane anesthesia, the total hepatic blood flow (hepatic arterial flow plus portal flow) decreases. Positive pressure ventilation increases vascular resistance in the splanchnic area and thereby decreases liver blood flow. Oxygen and carbon dioxide are important; both hypoxia and hypercarbia may cause an increase in sympathetic nervous activity and a fall in splanchnic blood flow and liver perfusion. Normocapnic ventilation will probably cause the least interruption in hepatic blood flow.

All anesthetic agents influence liver blood flow. However, surgical intervention itself is often the most relevant factor producing a decrease in the liver blood flow (Gelman 1976).

Massive Blood Loss and Clotting Defects

During liver surgery, especially in liver resections, shunt operations or reinterventions, massive blood loss is common. The anesthetist is responsible for arranging large-bore intravenous cannulae. Autotransfusion equipment can be helpful. There must be a well-organized blood bank. Perioperative clotting defects, caused either by the preoperative condition of the patient or by massive blood loss, make it necessary for the anesthetist to be closely informed about the clotting status. Prompt laboratory service during the operation is essential.

Temperature

The patient's temperature during the operation may decrease considerably during prolonged surgery. This is a common problem during this type of operation because of the extent of the operation field, contact of the bowels and viscera with theater air, and massive intravenous fluid and blood administration. To solve this problem, it is essential that a heating mattress is used, that theater temperature is sufficiently increased, that the bowels are wrapped to prevent transpiration, and that the infusion fluids and blood are warmed to body temperature. In addition, warming and humidification of the inspired gases helps to prevent further cooling. The anesthetist must monitor body temperature. In spite of all these measures, it nevertheless sometimes happens that a decrease in body temperature cannot be prevented. Postoperative patient management should include the correction of temperature to normal values, this being one of

the contributing factors in postoperative controlled ventilation.

Hypotension

Hypotension may occur during anesthesia and operation for hepatobiliary surgery. Besides massive blood loss, other factors may be involved, such as:

- Surgical manipulations resulting in acute obstruction of the inferior vena cava blood flow. Temporary clamping of the inferior vena cava is sometimes unavoidable for surgical reasons.
- Apparent or insidious infection at the start of the operation may induce hypotension due either to septicemia or to circulating endotoxins.
- Resecting more than 30% of the liver parenchyma may result in a decrease of the portal outflow tract, causing transient portal hypertension and acute peripheral hypovolemia (Stone 1975, Stone et al. 1969).
- Unexpected hypotension may occur following air or tumor embolism. The anesthetist should be aware of this complication during incision and surgery of the inferior vena cava. Hiccuping at this stage of surgery can be fatal.

Impaired Liver Function and Drug Metabolism

Impaired liver function may influence the pharmacokinetics of anesthetic drugs. Elimination of anesthetics by the liver may be impaired by:

- the underlying preoperative liver disease
- deterioration of liver function perioperatively due to altered hepatic blood flow during anesthesia and surgery
- loss of liver parenchyma due to the surgical intervention (Zoli et al. 1986).

In addition, a low plasma protein level may result in an increased free fraction of the anesthetic drugs.

Hepatotoxicity of Anesthetic Agents

During major hepatobiliary surgery, drugs suspected of hepatotoxicity must be avoided. Most anesthetic drugs can be used safely. Nevertheless, some anesthetics are still controversial. The halogenated hydrocarbons halothane, enflurane and isoflurane have been administered to patients scheduled for this type of operation. From a theoretical point of view with regard to volatile anesthetics, isoflurane should be preferred, being the anesthetic with the lowest level ($< 1\%$) of biodegradation (Brown and Gandolfi 1987, Stricker and Spoelstra 1985). Harmful effects of the prolonged administration of nitrous oxide are questionable. Bowel distension during long operations might be another reason for avoiding nitrous oxide.

Perioperative Pain Management

Anesthesia for major hepatobiliary surgery should include the opioids fentanyl, sufentanil or alfentanil either by bolus injection or continuous infusion. Special attention has to be paid to patients with advanced stages of liver disease. Enhanced sensitivity and prolonged action may be expected.

Postoperatively, especially after upper abdominal surgery, patients may suffer from severe pain. Pain relief is necessary not only for humanitarian but also for therapeutic reasons. Abdominal wounds tend to impair respiration by inhibition of deep breathing, coughing and sputum clearance. Atelectasis, perfusion inequality, shunting of venous blood, and a decrease of functional residual capacity can occur. Following insufficient postoperative pain relief, pulmonary complications are therefore likely to occur.

Anesthetic technique can be an important factor in preventing postoperative pain. The anesthetist has to plan his dosage scheme during the operation, avoiding the administration of opioid antagonists on the one hand, and on the other, respiratory depression caused by the opioids themselves. Postoperative controlled ventilation should sometimes be preferred to the more unstable condition of early extubation. Good preoperative information can decrease the analgesic demand postoperatively. Neither drugs nor regional anesthetic techniques can relieve postoperative pain without the attention from doctors and nurses which the operated patient requires. Opioids should be administered intramuscularly or intravenously in adequate doses and at suitable intervals. Respiratory parameters should be controlled intensively. Continuous administration of opioids either in the recovery room, in intensive care or in the general ward, where close observation and monitoring is assured, should be considered.

"Combined anesthesia", general and epidural with catheter, is an elegant technique for major hepatobiliary surgery. The segmental spread of 4–8 ml bupivacaine 0.25–0.5% with adrenalin 1 : 200000, instilled epidurally at one spinal level below the center of incision (e.g. T 7–8 for subcostal incision) results in pain relief with little sympathetic or motor block (Torda 1983). During anesthesia, the patient's need for opioids and relaxation is less, and after the operation, pain relief can be achieved by epidurally administered local anesthetics, opioids, or a mixture of both. This results in early extubation and mobilization of a pain-free patient. Instilling epidural opioids demands close observation of respiratory parameters, and parenteral administration of opioids is forbidden. Of course, coagulation defects may occur perioperatively, and careful consideration of this

must be taken into account when an epidural block is thought to be of value. Each patient should be considered individually.

Hypnotics

Impaired liver function may result in prolonged action of hypnotics. Benzodiazepines (diazepam or midazolam), barbiturates (thiopentone or methohexitone), etomidate or propofol can be used safely as the induction agent, taking into account the considerations mentioned above.

To prevent prolonged administration of nitrous oxide, a continuous infusion of hypnotics might be preferred. Benzodiazepines and barbiturates could accumulate, however, resulting in a prolongation of the recovery period. Etomidate decreases cortisol levels during continuous administration for a longer period. Applications for the promising new hypnotic drug propofol during anesthesia for major hepatobiliary surgery are not yet known.

Relaxation

Dundee and Gray (1953) described "resistence to curare" in patients with liver disease. This phenomenon has also been described for other nondepolarizing neuromuscular blocking drugs, such as pancuronium. Increased distribution volume may be an explanation. Westra et al. (1981) observed a delay in the onset of paralysis. Total clearance of pancuronium is particularly decreased in obstructive jaundice. Larger doses of pancuronium are therefore needed to achieve an effective blood concentration. However, this results in a longer duration of action. Vecuronium is also mainly cleared from the plasma by the liver, and relies on biliary excretion, so that its effects are possibly prolonged in liver disease (Miller 1986).

Atracurium is metabolized in a completely different way (Ward and Neil 1983). A non-enzymatic breakdown in plasma by the Hofmann reaction makes its metabolism independent of liver and renal function. From a theoretical point of view, atracurium seems to be the muscle relaxant of choice in patients with liver disease, although the toxic effects of its metabolites have not been fully determined (Chapple et al. 1987).

Monitoring

As major bleeding is one of the main problems during this type of operation, intensive cardiovascular monitoring is essential. Besides routine measurement of heart rate, arterial blood pressure and electrocardiogram, central venous pressure monitoring is recommended. Indeed, in case of severe cardiac or pulmonary disease, it is necessary to use a pulmonary artery catheter to obtain information about pulmonary arterial pressure, pulmonary capillary wedge pressure and cardiac output. Furthermore, the central venous pressure or pulmonary artery pressure line can be used for the aspiration of air should embolism occur. An indwelling arterial catheter allows continuous arterial blood pressure measurement and regular arterial blood sampling. Blood gases, acid-base balance, hemoglobin, hematocrit, serum electrolytes, blood glucose and clotting status can thus be finely controlled.

For optimal ventilation, end tidal expiratory carbon dioxide measurement is necessary. Pulse oximetry is now recommended for continuous measurement of oxygen saturation. During anesthesia, proper measurement of muscle relaxation should be performed using a relaxograph. For temperature control, a thermistor probe is placed in the esophagus via the nasal route. Urine production should be controlled, and bladder catheterization is necessary.

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