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A Case Report And Literature Review Of Anesthetic Considerations In Laparoscopic Hepatectomy

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Abstract
Laparoscopic liver resection poses a tough challenge to anesthesiologists. Through this case report and review of literature, we present the first ever performed laparoscopic hepatectomy in the sub-Himalayan region and the elements of anesthesia care which provide outstanding perioperative outcomes.

Keywords: Laparoscopic hepatectomy, pringles mauver, central venous pressure, anesthesia consideration

Introduction

Major hepatectomies are known to cause numerous complications. Laparoscopic hepatectomy is considered one of the safest and feasible treatment option for liver tumors. It is considered to be less invasive procedure than open liver surgery. Laparoscopic hepatectomy was performed for the first time in Sub Himalayan region with favorable result.

Case Study

40 years old female detected with mass in the left lobe of the liver, planned for laparoscopic partial hepatectomy left liver lobe. She visited hospital with history of pain in the hypochondriac region , loss of appetite and weight loss for two months. At preanesthetic evaluation patient is thin built, with weight 42 kg, height 153 cm and BMI of 17.9 Patient had past history of tubal ligation 20 years back done under subarachnoid block which was uneventful There was no history of any other chronic medical illness including viral hepatitis, renal disease, anemia. Patient was independent in routine household chores and had a metabolic equivalent of task >= 4. she is a not a smoker and alcoholic. her general physical and systemic examinations were unyielding, patient is categorized as American Society of Anesthesiologists class II. Routine preoperative investigations were done which included complete hemogram, liver function tests, renal function tests, echocardiogram, chest x-ray, which showed normal results when USG abdomen and pelvis revealed a mass of 8x5 cm in left lobe of the liver high degree of suspicion was kept in view of neoplastic growth and USG guided FNAC was advised. USG guided FNAC from liver mass showed scanty material with few atypical cells.

One night prior to surgery, patient was kept Nil orally 6 hr for solids and 2 hrs for clear liquids and Tab: Ranitidine 150 mg and Tab: alprazolam 0.25 mg were prescribed.

In operation theatre all monitors attached and intravenous line with 18 G cannula secured. An

Epidural catheter was inserted in T11 -T12 level and confirmation done with Lignocaine 2 % with Adrenaline 3 ml IV. Morphine 2 mg IV diluted with Normal saline 6 ml given for intra operative and post-operative pain management. Then patient was premedicated with Fentanyl 100 mcg IV, Propofol 100 mg IV, and intubated with endotracheal tube 7 .5 mm size after Succinylcholine 100 mg IV . Anesthesia is maintained on Sevoflurane, Air and O2. Tidal volume 7 mL/kg ideal body weight was set, fraction of inspired oxygen ($fi0_2$) 0.6 with air, inspiratory: expiratory ratio 1:2, and inspiratory fresh gas flow 2 L/min. were set. ETCO2 pressure of 30–45 mmHg was maintained by adjusting respiratory rate 8-18 breaths/min. Right Internal jugular venous catheter was placed using ultrasound guidance and continuous CVP monitoring was done. Incipiently CVP pressure is 12 mm hg and it is continued at 4-6mmhg of H2o. throughout the surgery. Intermittent bolus doses of Nitroglycerin 50 mg were given in case of central pressure greater than 6 mm hg and epidural infusion dose of ropivacaine was titrated . Invasive blood pressure monitoring was done by securing 20 G radial cannula in left radial artery. Hourly urine output monitoring and intraoperative blood loss monitoring was done. Throughout the surgery patient was started on infusion Ropivacaine 0.2 % + Fentanyl 2 ml via epidural catheter. Total duration of surgery was about 6 and half hours. Total amount of fluid intake was 1450 ml along with one unit of packed red cells and 2 units of red blood cells. with urine output of 350 ml and blood loss of 300 ml. Patient was extubated hassle free after reversal of neuro muscular blockade with injection : Neostigmine 2.5 mg and Injection Glycopyrolate.4 mg Iv. Patient was ambulated after 8 hours, infusion with ropivacaine was carried out for 24 hours and Patient was discharged on 7th postoperative day.

Fig1. Intraoperatively parinet was placed in reverse trendelenburg position ,invasive and central venous pressure monitoring done along with clinical and routine monitoring.

Discussion

Major anesthetic concerns in hepatectomy are hemodynamic control while handling the vascular pedicle and choice of anesthetic agents. Preanesthetic evaluation of patient, type of anesthesia, intraoperative blood loss, risk of air embolism are some of the other concerns associated with patient undergoing hepatectomy.

Our patient had no other known medical illness or any complication arising from liver pathologies. Patients who are planned for hepatectomies should undergo through pre-operative evaluation. As

Volume 6, Issue 2; March-April 2023; Page No 950-957

pathologies involving liver are known to cause derangements in other organ systems.Subjects with liver ailments are at substantial risk of multi-organ breakdown, including cardiac failure due to low cardiac reserve, disabled gas exchange, Porto-pulmonary hypertension, bleeding, coagulopathy and hepato-renal syndromes so to validate in-depth assessment with aids like lung function tests, blood gas analysis, and echocardiography may be required. In subjects with metastases and recipients of neoadjuvant chemo therapy particularly have reduced cardiac reserve which may require further cardiac optimization and risk evaluation.

In a patient with hypoxemia resulting due to pleural effusion in relation to ascites or by intra pulmonary vasodilation, the administration of 100% oxygen to the patient the improvement of hypoxemia will give an idea about degree of shunt and whether reversal from mechanical ventilation will be possible (1).

Beta blockers are known to reduce portal hypertension and decrease cardiac workload, they should be continued in patients who have CHD in relation to CLD. Due precautions should be taken while administering anaesthesia to patients with decompensated cirrhosis. The indication and necessity of major liver surgery should be intensely discussed upon(2).

In our case, procedure was performed under general anaesthesia supplemented by regional anaesthesia for peri-operative pain management and patient was kept on controlled mechanical ventilation after tracheal intubation.

Regional anaesthesia is known to reduce surgical stress . which involve, raised corticosteroid and catecholamine levels (3) which also depress immune system**.** Thoracic epidural anaesthesia (TEA) induce superlative pain relief and helps in reducing postoperative mortality. In case of coagulopathy epidural catheter should be avoided and other modalities like patient-controlled analgesia can be used in pain management post operatively.

Mallard C, et al in their study found that using combined epidural and general anaesthesia in patients undergoing hepatectomy surgeries had advantages such as reduced demand for crystalloid, colloid, or blood component administration during surgery, reduces the total IV opioid dose and excellent analgesia. Therefore, intraoperative epidural anaesthesia combined with general anaesthesia is considered better option in these patients(4)

Another study conducted by Poozar-Lukonorvvic, N et al, concluded that epidural analgesia accompanied with general anaesthesia improved oxygen delivery to liver by improving splanchnic perfusion(5). Thus, regular anaesthesia with epidural analgesia is justified and could be endorsed in liver surgery and abdominal surgeries for pain management intra and post operatively. In our case Bupivacaine in doses of 0.125% 12 ml was given through epidural during resection as it is known to decrease blood pressure and CVP pressure as well as ameliorate splanchnic circulation. Followed which continuous infusion of Ropivacaine 0.2 % plus Fentanyl 100 mcg was continued throughout the surgery and in post operative period for 24 hours. Antibiotic coverage with Cefuroxime and Metronidazole can be given routinely in such cases. cytochrome P450 enzymes alters the metabolism due to which there is, decreased biliary excretion and decreased concentration of plasma proteins after resection causes prolonged action time of drugs. Due to the risk of embolism nitrous oxide should be avoided. Halothane should not be administered due to its well-known hepatotoxicity. Propofol it is the safe drug in patients with hepatic disease because of its short half-life (6). Long-acting opioids and sedatives should be used in prolonged surgeries. Narcotic agents like Sufentanil, Fentanyl, and sedative agents like Lorazepam, Oxazepam, along some volatile anaesthetics like Sevoflurane are permissible(7).

Laviolle et al. advocated the early protective effect of propofol in setting of hepatic injury(8). Substantial reduction in blood flow , metabolic and excretory functions of the liver as well as diminished excretion by kidneys decreases the clearance of drugs like Pancuronium and leads to their prolonged action. Atracurium , vecuronium have an advantage because their metabolism is independent of liver. Cis-atracurium is the agent of choice as it is eliminated by Hoffman's degradation and does not cause release of histamine (9) a study by Gatecel C, et al established that isoflurane cause vasoconstriction of hepatic arterioles when studied using doppler when compared to halothane that causes vasoconstriction.(10).

Volume 6, Issue 2; March-April 2023; Page No 950-957

A randomized controlled trial conducted by BeckSchimmer et al determined that sevoflurane when used for ischemic preconditioning before the inflow occlusion minimised the hepatic dysfunction postoperatively

(11).

Ko et al. in their study established that when desflurane and sevoflurane are used in equal doses of MAC 1 desflurane provided better postoperative kidney and liver function tests compared to sevoflurane. after hepatic resection in donors.(12) sevoflurane decreases hepatic artery blood flow but increases blood flow to portal vein (13) Desflurane may cause less liver injury as it is metabolised limitedly (14).

For laparoscopic hepatectomy patients are positioned in the reverse Trendelenburg position with a left tilt. In reverse Trendelenburg position reduces preload on the heart by decreased venous return. Improves pulmonary function as there is downward movement of viscera, tidal volume increases due to decrease in the pressure on the diaphragm. (15) Blood stasis in the lower extremities makes the patient susceptible to deep vein thrombosis (DVT).

Carbon dioxide id usually used to insufflate and create pneumoperitoneum (abdominal pressure was kept 12mmHg) this leads to increase in the CVP , increase in the arterial resistance but also reduces the preload on heart (15). The cardiac rhythm can be disturbed by parasympathetic stimulation caused by stretching of the peritoneum and sympathetic stimulation due to reduced venous return and to some extent by acidosis and hypercarbia. These consequences can be avoided by maintaining the abdominal pressure of 10 -12 mmHg and monitoring the end-tidal CO_2 and adequate hydration. (16)

As liver is a highly vascular organ a sudden and large amounts of blood loss is possible so intraoperative bleeding should be watched for. Recurrence and survival after resection in setting of carcinomas can be predicted by blood loss alone [17].Bleeding from the liver is controlled by clamping the hepato-duodenal ligament which interrupting the through hepatic artery and portal vein the blood. This method is called the Pringle manoeuvre and used regularly for heamostasis during laparoscopic hepatectomy(18).

Better communication between anaesthetist and surgeon can alleviate the problem of bleeding. During hepatic inflow occlusion, reverse flow via the hepatic veins is main cause of haemorrhage. To reduce the blood loss controlling the central and thus hepatic venous pressure is needed. Intravascular volume should be expanded for a power margin anticipating blood loss. But, this also can be a cause for raised CVP and distended central veins resulting in difficulty to stop blood loss from the major hepatic veins. Bleeding prolongs time of occlusion , and increases the hepatic ischaemia-reperfusion injury(19). Measurement of CVP is thus one of the important modalities to keep a track of volume of blood that is lost and need for blood transfusions . In addition, to invasive blood pressure monitoring, the CVP monitoring allows for better hemodynamic control (20).

After induction as well as with epidural analgesia hypotension is commonly seen .primary resuscitation with Trendelenburg position phenylephrine infusion or low-dose dobutamine 3 mg kg/min(21) in the case of persistent hypotension(21). Momentary compression of the inferior vena cava (IVC) during surgery, can lead to severe reduction in blood pressure.

Fluids when used to treat such episodes will result in raised CVP and in turn will promote bleeding. Hence fluids should be managed cautiously and close communication with surgeon is necessary (21). Application of PEEP (positive end expiratory pressure) during liver resection though helps in recruiting the alveoli is known to cause elevated (22).

Aprotinin a bovine pancreatic trypsin inhibitor have been used in liver resection with reports showing reduced use need for blood transfusions. But it is also notorious to cause life threatening allergic reactions along with its poor renal safety and thrombotic potential Aprotinin compared with other antifibrinolytics is believed to cause 1.5 times raised mortality rates where are latter have also shown to reduce Blood transfusions.

Intra-venous access preferably of wide bore should be secured. In addition to invasive a blood pressure monitoring , monitoring the cardiac output ,In Patients with cardiac disease necessitates advanced cardiac monitoring .

Volume 6, Issue 2; March-April 2023; Page No 950-957

Hypoglycemia specifically during vascular occluding maneuverers and after specimen resection , should be promptly identified and corrected. Enteral feeding and stomach drainage should be done by naso-gastric tubes.

Whenever possible core body temperature should be monitored. warmed fluids and forced warm air blankets warmed helps in achieving normothermia and also avoiding vasoconstriction and coagulopathy. Monitoring Neuromuscular block should be done throughout the surgery. Coagulation profile should be assessed intraoperatively during the surgery especially in a prolonged surgery in patients with preoperative cirrhosis, steatosis, and history of chemotherapy and optimization to be done. (22) Perioperative techniques should be employed to aim for the mean blood loss to 300–900 ml, as massive blood transfusions are known to develop major post operative complications(21,23,24). Coagulopathy can be augmented hypocalcaemia, which should be monitored and corrected. Mortality rate after major hepatic resection is 30 % (25). Acute liver failures begin around 72 hours postoperatively. coagulopathy stands as a principal cause of death in these patients. previous cirrhosis or obstructive in in biliary tract, have incidence of fatal liver failure up to 32%.incidence (25).Even if the blood loss occurring due to resection can be promptly managed by this multimodal approach , ischemia -reperfusion(IR) injury acts as a benefactor to postoperative hepatic dysfunction(26).

Due to IR all cells in which electron transport chain occurs for their metabolism are involved (27).Ischemia leads to reduced aerobic metabolism due to lack adenosine triphosphate (ATP) production in liver cells, Kuppfer cells (28).This results in inflammation of the hepatocytes, and kuppfer cells and there by constricting the hepatic sinusoids. due to increase of intracellular Na^{+}. immediately after reperfusion, raised levels of reactive oxygen species (ROS) have been reported (28)

increased permeability of plasma membrane to Ca^{2} and release of Ca^{2} from the Endoplasmic Reticulum by activation of ryanodine and TRP channels. As a result of this the transmembrane potential of mitochondria is reduced due to increased Ca^{2+} concentration in the mitochondria.(29) As a consequence MPT (mitochondrial permeability transition) pores are formed (30). MPT pores cause permanent damage by depolarization of the mitochondria (31) Kupffer cells are activated by ROS which in turn leads to creation of more ROS and thereby setting vicious cycle (32).

Reduce sinusoidal blood flow due to reperfusion injury prolong further hypoxic insult if any. ischemic preconditioning by clamping 10–15 min causing ischaemia followed by 5 min of release for reperfusion have demonstrated practical protection from tissue damage.(33)

Endogenous anti-oxidants play a role in limiting oxygen-derived free radicals, but are also broken down after reperfusion. Hence there is need to administer the artificial antioxidants which can limit ischaemia–reperfusion injury in liver surgeries. N-acetylcysteine is such exogenous antioxidant regularly infused , from induction of anaesthesia till postoperative period, although proof of added advantage is vague.(34)

Postoperative management

Risk factors for postoperative complications include age, ASA grading, amount of liver resected, multiple blood transfusions, and cirrhosis. Up to 30% of liver resection patients face one of the significant complications like major blood loss, kidney or hepatic impairment, respiratory failure, infection and severe sepsis,

Preservation of appropriate fluid balance with optimal renal function is crucial, sodium restriction and diuretic therapy is recommended in patients who develop ascites postoperatively. Liver starts producing lactate instead of utilizing it instead of injury and stress

Watanabe, et al concluded that lactate is raised in the patients in immediate post op period with high mortality than the patients without mortality hence lactate containing solutions should be used judiciously *(35).* Increased phosphate uptake by regenerating hepatocytes often leads to hypo-phosphatemia.. this in turn hampers energy metabolism, leading to dysfunction in cells of major organs causing, cardiac arrhythmias, coagulation disorders respiratory failure , neuromuscular dysfunction, insulin resistance (36).

Volume 6, Issue 2; March-April 2023; Page No 950-957

In the post-hepatic resection period, the regenerating liver require higher levels of glucose and electrolytes leading to a catabolic state accompanied by glucose and electrolyte imbalances. Current evidence strongly supports nutritional support via central route unless otherwise contraindicated.

Improved nutrition and reduced prevalence of complications of cirrhosis, beneficial of patients for radio therapy, improved quality of life. Branched chain amino acids was associated with uneventful postoperative period in patients with pre-op liver cirrhosis. (38) Hyperglycaemia corrected by High-dose insulin therapy reduces postoperative liver damage due to cell damage and inflammation. (39)

Cirrhotic patients have drug aggregation due to decreased drug metabolism especially to opioids and benzodiazepines. impairment of opioid metabolism depends on the amount of liver resected., large resections cause greater impairment (40)

Risk of post-operative coagulopathy is highest from second to fifth postoperative day. Hence while removing epidural catheter around same time may require transfusion of platelets or fresh frozen plasma(41). Acetaminophen with maximum recommended dose of 2 g/day is in use. As NSAIDs are not advocated in post hepatectomy, cirrhotic patients, and in patients with poor renal function as they pose the risk of hepatorenal syndrome and bleeding (42) An Epidural catheter infusion of ropivacaine should be well titrated as increased plasma level are observed in patients post hepatectomy concentration no more than 0.25% or infusion for less than 2 days is acceptable. paravertebral infusion of local anaesthetic with PCA have been reported. For routine use of this further studies are required (43).

Appropriate sodium balance is necessary sodium restriction can cause hyponatremia and secondary hyper aldosteronism which [promotes sodium and water retention causing oedema should be looked for. (45) venous thrombotic embolism should be prevented by proper prophylaxis.(44).

Encephalopathy seen in a patient with deteriorating liver function and un-explained neurological symptoms. blood ammonia levels help in diagnosis. Ongoing hepatic ischaemia should be suspected in patients who have persistently raised levels of transaminases and alkaline phosphatase levels (46)

Conclusion:

Laparoscopic hepatectomy though a minimally invasive one is a major surgery with scope for major hemodynamic shifts. Prolonged duration, reverse trendelenburg position, complicates the procedure. Authors recommend a carefully designed plan of anaesthesia with meticulous fluid management and hemodynamic monitoring including CVP and invasive Blood Pressure monitoring. Preoperative optimization plays a significant role in attaining favourable post operative outcomes.

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Volume 6, Issue 2; March-April 2023; Page No 950-957

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Volume 6, Issue 2; March-April 2023; Page No 950-957

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Volume 6, Issue 2; March-April 2023; Page No 950-957