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Case Report
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Laparoscopic Cholecystectomy in a Patient with Glenn Shunt-Aided with Erector Spine Block

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Abstract

The bidirectional (BD) Glenn shunt or hemi-Fontan procedure has been used to temporarily improve cardiac function in patients with severe structural heart disease which feature single ventricular physiology. Subsequently, more of these patients present for noncardiac surgical interventions, which present as an anaesthetic challenge. Erector spinae block (ESP) is an effective analgesic modality used in various thoraco abdominal surgeries, which can also be given safely in such patients. A case of a 17-year-old female patient with complex congenital heart disease (CHD) who underwent BD Glenn shunting with main pulmonary artery ligation in childhood, presently admitted for laparoscopic cholecystectomy done under general anaesthesia. With detailed preoperative workups, close haemodynamic monitoring and use of ESP for analgesia during perioperative period, the patient had successful outcome. We outline the anaesthetic management and the concerns of laparoscopy in such patients. A comprehensive understanding of physiology of Glenn's shunt and implications of the proposed surgical procedure is necessary to plan the anaesthetic and analgesic agents, cardiovascular drugs and ventilation strategies in patients with CHD with shunt procedure done.

Keywords: Congenital heart disease, BD Glenn shunt, anaesthetic management, laparoscopy, erector spinae block

Introduction

Patients with congenital heart disease (CHD) have attained improved survival due to advancement in the medical and surgical field. Subsequently, more of these patients present for noncardiac surgical interventions. They have an increased risk of perioperative morbidity and mortality compared with a matched control cohort. So, a clear understanding of each patient's anatomy is imperative for quality perioperative care.

The bidirectional (BD) Glenn shunt or hemi-Fontan is a procedure to improve cardiac function temporarily in patients with structural heart disease highlighting single ventricular physiology. The technique involves redirecting of the blood from superior venacava into the right pulmonary artery aiming at direct drainage of deoxygenated blood from head and upper body to the pulmonary arteries for oxygenation via lungs, thus reducing ventricular workload to some extent.[1,2]

Despite the documented advantages of laparoscopic surgery,[3] the pneumoperitoneum and positional changes during the surgery can be concerning for patients with CHD because of the resultant cardiovascular and respiratory changes. Alterations in pulmonary vascular resistance (PVR) and systemic vascular resistance (SVR) due to anaesthetic and analgesic agents can lead to hypotension, hypoxaemia and hemodynamic derangements, especially during the perioperative period. Erector spinae block (ESP) is a new advancing block with effective pain relief in various thoraco abdominal surgeries, which is easy to perform, has opioid sparing effect and can be given safely in such patients with coagulopathy without causing any haemodynamic instability.[4] Therefore, the risks and benefits of analgesic and anaesthetic modalities for patients with CHD must be carefully considered.

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Here is a case of the patient with CHD with BD Glenn shunting performed in childhood and now underwent laparoscopic cholecystectomy under general anaesthesia with ESP. This highlights the concerns of laparoscopy, anaesthetic challenges and use of ESP block for pain management in patients with complex congenital cardiac defects.

Case Report

A 17-year-old female weighing 41 kg was scheduled for laparoscopic cholecystectomy under general anaesthesia. At birth, she was diagnosed to have CHD (tricuspid atresia, non-restrictive secundum atrial septal defect (ASD) and ventricular septal defect (VSD), right to left shunt and severe pulmonary stenosis). A BD Glenn's shunt with MPA ligation was performed at 8 months of age, and the child had the history of restricted physical activity. Patient also had history of bilateral deep vein thrombosis 2 years back for which Inferior Vena Cava (IVC) filter was placed and she was on Tab. warfarin 2 mg at night, since then. Patient presented to emergency with complaints of right upper abdomen pain associated with nausea and vomiting. There was no history of associated fever, radiation of pain to back, loose stools or blood in stools. No other bladder bowel complaints were there. Ultrasound (USG) abdomen showed cholelithiasis. Endoscopic retrograde cholangiopancreaticography was done under sedation after 5 days of development of symptoms—common bile duct stone was extracted, stent placed and sphincterotomy was done. Patient was further planned for laparoscopic cholecystectomy after 2 days. Preoperative investigation revealed—haemoglobin 12.8 gm%, platelet count 1.55 lacs, packed cell volume—39.8%. The coagulation profile showed prothrombin time 13.9/11.4 seconds, activated partial thromboplastin time 39/30.9 second and INR-1.21. Renal and liver functions were normal. Preoperative echocardiography revealed a normally functioning patent BD Glenn's shunt, normal ventricular and valvular function and normal IVC flow was present. USG venous Doppler of lower limbs had no evidence of deep venous thrombosis.

Main Points

- Patients with complicated CHD presenting for noncardiac surgery require detailed preoperative workups and an understanding of their complex physiology for successful perioperative care.
- Anaesthetic goals include maintaining adequate preload, sinus rhythm, ventricular contractility and filling, low PVR and reduction in afterload.
- Ventilatory management should promote maximal pulmonary flow by minimising peak airway pressures.
- Use of USG guided ESP block for perioperative analgesia is a good option for effective pain relief without any alterations in haemodynamics in such patients.

Preoperatively the child was active. Heart rate was 78 min^{-1}, regular with good volume, blood pressure (BP)—100/54 mmHg and room air saturation was 84–86%. No dilated veins were evident on any part of the body. The child was taken for surgery under moderate risk. Tab warfarin was stopped 5 days prior to procedure and switched over to intravenous (IV) heparin (100 IU mL^{-1}) @ 5.4 mL h^{-1}. Six hours prior to surgery, heparin infusion was stopped. The child was brought to the operation theatre with IV line already *in situ*. Standard monitoring included electrocardiography, pulse oximetry and non-invasive BP and baseline values were recorded. Prior to induction, an arterial catheter was inserted in the right radial artery for beat to beat monitoring under local anaesthesia. Patient was premedicated with 0.5 mg IV midazolam and 100 μg fentanyl. Anaesthesia induced with etomidate 10 and 4 mg vecuronium was administered as neuromuscular blocker. Airway was secured with 6.5 mm internal diameter cuffed endotracheal tube. Volume control ventilation was utilised with tidal volume 300 mL resulting in peak pressures around 16–24 cm of H_2O with inspiratory-to-expiratory ratio of 1:3 and end tidal CO_2 varied between 30 and 32. Following induction, a central venous catheter was inserted in right internal jugular vien under USG guidance. Furthermore, patient was turned to left lateral position and using a high frequency linear probe (in sagittal orientation), transverse process of T6 vertebra was identified. A 23G spinal needle was inserted in an "inplane direction" between the transverse process and the erector spinae muscle under USG guidance under all aseptic precautions. After confirming the placement of needle with hydrodissection, 10 mL of 0.2% ropivacaine with 2 mg dexamethasone was injected on each side after negative aspiration to avoid intravascular injection and the spread of the drug was observed. Anaesthesia was maintained with 50% O_2 and 50% air with sevoflurane (1–2%). Dexmedotomidine infusion (4 mcg mL^{-1}) @ 4-6 mL h^{-1} infusion was started, and 600 mg paracetamol IV was given for pain relief. During pneumoperitoneum, carbon dioxide was insufflated slowly at a rate of 2–3 L min^{-1} and maximum limit of intrabdominal pressure was kept at 8 mmHg. The procedure lasted for approximately 120 minutes. The patient remained stable throughout the procedure. The pulse rate ranged from 70 to 90 min^{-1}, blood pressure varied between 100 and 130 mmHg systolic and 70 and 90 mmHg diastolic and SpO_2 from 86 to 92%. Central venous pressure was maintained at 15–20 cm H_2O. Total 500–600 mL of crystalloids was given during whole procedure. The total urine output was 120 mL, and estimated blood loss was 50 mL. Once, the surgery was completed, neuromuscular blockade was reversed and she was extubated. Post-operative analgesia was provided with only injection paracetamol, and patient was totally pain free. The child was taken to intensive care unit (ICU) where she was closely monitored. The post-operative course was uneventful. Tab warfarin was restarted on day-2. She was eventually discharged home on postoperative day 3.

Discussion

Patients with complicated congenital heart defects presenting for noncardiac surgery are more susceptible to perioperative complications, especially in the presence of risk factors like baseline cyanosis, features of congestive heart failure and poor general health.[5] Therefore, these patients require detailed preoperative workups, an understanding of their complex physiology and necessitate a multidisciplinary care team for successful perioperative care.

We outline a case of a patient with CHD (tricuspid atresia, non-restrictive secundum ASD and VSD, right to left shunt and severe pulmonary stenosis) and underwent a BD shunt with MPA ligation in childhood. Patient was admitted for laparoscopic cholecystectomy which was done under general anaesthesia with successful use of ESP block for optimal pain control without any haemodynamic alterations. The operation required creation of pneumoperitoneum and head-up position, which might have led to haemodynamic instability but the case was completed without any complications and managed successfully.

Complete preoperative evaluation and optimisation of the patient are important to reduce perioperative complications and improve outcome. Preoperative workup is directed by the general condition of the patient and the type of surgical procedure. However, a cardiology evaluation prior to the procedure is a must with a recent ECG and ECHO in order to assess the ventricular function and patency of shunt.[6] Further cardiac interventional procedures may be indicated in patients with decreased ventricular function to determine the cause and optimisation before elective surgeries.

These patients have increased bleeding tendency because of increased systemic venous pressures, coagulation abnormalities[7] and typically higher haematocrit due to chronic hypoxaemia. Though no preset guidelines have been defined, one should have a higher transfusion threshold in order to ensure optimal delivery of oxygen to the tissues. Therefore, one unit of blood was arranged preemptively in this case.

Having not undergone a Fontan operation, our patient relied on a BD shunt to maintain blood flow from the systemic system to the pulmonary system (PA). As a result of the mixing between the systemic and pulmonary circulations, her baseline oxygen saturation and target for the perioperative period was 80–85%. Higher saturations might indicate excessive pulmonary flow, risking pulmonary oedema and respiratory decline. Our patient had associated septal defects in both atrium and the ventricle, so the level of oxygen was comparatively maintained.

Our anaesthetic goals included maintaining adequate preload, sinus rhythm, ventricular contractility and filling, low PVR and adequate pulmonary blood flow and reduction in afterload. To assist anaesthetic management, the degree of invasive monitoring should be according to the patient' s clinical status and the type of surgical procedure. Laproscopic cholecystectomy involves creation of pneumoperitoneum and head-up position, both of which might be associated with respiratory and haemodynamic alterations, since head-up position can decrease preload and lower cardiac output, a decision was taken to monitor both CVP and intra-arterial blood pressure. However, placement can be technically difficult on account of anatomical abnormalities and surgical repairs. In turn, the provider must have a precise understanding prior to placing central venous or PA catheters. One should be aware that central venous cannulation involves a risk of trauma to the anastomosis site and also increased the risk of thrombus formation in patients with a prior BDG shunt.[8] The magnitude of the right internal jugular vein in patients with this shunt do not change with head low position, valsalva manoeuvre or liver compression.[9] Transoesophageal echocardiography (TEE) helps to determine cardiac performance and fluid status but due to short duration of surgery and the patient being haemodynamically stable TEE was not opted. IV line filters should be applied to prevent paradoxical air embolism as in our case it was already placed as patient was a known case of DVT. Factors which tend to increase PVR would cause reduction in pulmonary flow which would result in increase in the flow across the shunts resulting in hypotension and desaturation.[8] Therefore, factors which elevate PVR like hypoxaemia, hypercarbia, acidosis, positive pressure ventilation were taken care of to maintain adequate pulmonary flow and prevent arterial desaturation. N_2O is not an absolute contraindication; however, it may lead to an increase in PVR, atelectasis and dimensions of gaseous emboli.[6] Therefore, taking these concerns into consideration the use of N_2O was avoided in this case.

Ventilatory management should promote maximal pulmonary flow by minimising peak airway pressures. As pulmonary blood flow occurs predominantly during exhalation, ventilatory strategies include prolonged expiratory phase with low mean airway pressure (inspiratory-to-expiratory ratio 1:3) and adequate tidal volume.[10] Similar ventilation settings were followed in this case to maintain adequate pulmonary flow.

Inadequate anaesthesia or suboptimal pain control can increase SVR, exacerbating left to right shunting as blood is directed away from the systemic circulation. As a result, cardiac output would be compromised. Similarly, decreased cardiac output can occur following declines in venous return from systemic hypotension or elevated intrathoracic pressures.[11] Hence, in our case, we used ultrasound guided ESP block for perioperative analgesia to avoid Non steroidal anti inflammatory drugs (NSAIDS) and the significant adverse effects associated with opioids including respiratory depression, sedation, nausea, vomiting, delayed mobilisation and it appears to provide both somatic and visceral analgesia.[12]

ESP block is one of the novel truncal interfacial plane blocks which has gained popularity for treating both acute and chronic pain in thoracic and abdominal surgeries. One of the main advantage of this block is the site of injection is away from the major blood vessels and with the application of ultrasound its use is considered safe even if the patient is on anticoagulants. Our patient was a known case of deep vein thrombosis (DVT) and was on long-term anticoagulants; therefore, it had added advantage in our case undergoing abdominal surgery. Post-operatively, warfarin must be restarted as soon as possible and these patients should be managed in ICU with continued meticulous attention to haemodynamics as done in this case.

Conclusion

This was a challenging case of a patient with a complex CHD who underwent laparoscopic cholecystectomy. A growing number of patients with CHD are presenting for similar interventions. These patients can experience successful surgical outcome with comprehensive understanding of physiology of Glenn's shunt and anaesthetic implications of the surgical procedure. They necessitate intricate preoperative workup, meticulous perioperative haemodynamic monitoring, optimal pain relief and vigilant post-operative management.

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