Anaesthetic Management of a Child with Fontan Circulation Posted for Laparoscopic Continuous Ambulatory Peritoneal Dialysis Insertion

Sir,

In Fontan physiology, the venous return from the superior vena cava (SVC) and inferior vena cava (IVC) are bypassed from the right heart to the pulmonary circulation and once oxygenated, the blood enters the left atrium and then to the single ventricle and finally to the systemic circulation. The pressure difference between the caval veins and pulmonary artery has to be maintained for adequate pulmonary blood flow. Elevated systemic venous pressures and decreased cardiac output due to absent sub-pulmonary ventricle are the most common causes for widespread systemic organ dysfunction in Fontan patients.[1,2] Anaesthesiologists must be well aware of Fontan physiology as peri-operative management of such patients is challenging. Patients with Fontan circulation undergoing laparoscopic procedures are at a potential risk of haemodynamic perturbations; hence, vigilant monitoring is prioritised. There is limited literature regarding laparoscopic surgery in a child with a Fontan physiology. We, hereby, discuss the successful management of a child with Fontan physiology undergoing laparoscopic continuous ambulatory peritoneal dialysis (CAPD) insertion.

The patient was a 12-year male child (weighing 40 kg) with a solitary kidney associated with chronic kidney disease Stage 5, undergoing haemodialysis for one year. He was planned for laparoscopic CAPD insertion. He had a history of congenital heart disease (hypoplastic right ventricle, ventricle septal defect, large atrial septal defect, pulmonary atresia, and tricuspid atresia) and underwent a bidirectional Glenn procedure 10 years back and Fontan procedure 8 years back. He had no symptoms of impaired cardiac output, hypoxaemia or venous congestion prior to the surgery. Echocardiography findings were normal Fontan circulation with normal systemic ventricular function of 60%. He was on tablets amlodipine, darbepoetin, and unfractionated heparin. The child was taken to the operation theatre and standard monitors were placed. Oxygen saturation on room air was 97%, blood pressure was 120/90 mmHg, and the heart rate was 98 beats/min. He was intubated with injection etomidate (0.4 mg/kg) in titrated doses along with fentanyl (4 µg/kg) and atracurium (0.5 mg/kg). An arterial line was placed. Maintenance of anaesthesia was done with sevoflurane (0.2-0.5%), fentanyl (1 mg/kg/hr), and atracurium. Pneumoperitoneum was created with intra-abdominal pressures <10 mmHg. Airway pressure was 17 cmH_2O and minute ventilation was adjusted to end tidal CO_2 of 33-36 mmHg. The saturation dropped to 89%, blood pressure to 90/60 mmHg, and the heart rate to 82 beats/min. Boluses of phenylephrine were given, but the blood pressure did not improve, and saturation remained 89% (with FiO_2 of 0.8). At the end of the procedure, the saturation improved to 96% with FiO_2 0.8. The child was extubated and shifted to the post-anaesthesia care unit.

In this era of advanced surgical techniques and improved perioperative care, there is a high survival rate in postoperative cases of congenital heart diseases. These children are likely to get posted for non-cardiac surgeries and hence perioperative preparedness is one of the major concerns. Laparoscopic surgeries have less postoperative pain, less pulmonary complications, and lesser hospital stay. Although these factors add advantage to cardiac patients, complications associated with CO_2 insufflation such as impaired venous return, decreased pulmonary compliance, diaphragmatic splinting, and hypercarbia might increase pulmonary vascular resistance (PVR) and reduce cardiac output which may be deleterious in Fontan patients.[3] This might be one of the reasons of decreased blood pressure (from 120/90 to 90/60 mmHg) after creation of pneumoperitoneum in this case, which did not respond to bolus doses of phenylephrine. We preferred etomidate (which is a more cardio-stable medicine) as compared to propofol (to avoid transient vasodilatation) for induction of anaesthesia. We kept sevoflurane at low concentration (0.2-0.5%) for maintenance of anaesthesia to avoid further fall in systemic vascular resistance (SVR). It was supplemented with fentanyl infusion (1 mg/kg/hr).

Table I: Factors affecting Fontan circulation.

Patient factors
• Chronic lung disease
• Severe ventricular systolic or diastolic dysfunction
• Recalcitrant pulmonary vein stenosis
• Older age
• Pregnant patients
Anaesthesia factors
• Systemic venous pressure
• Pulmonary vascular resistance
• Atrioventricular valve function
• Cardiac rhythm
• Pulmonary artery pressure
• Drugs with negative ionotropic effects (e.g.: β-blockers)
Surgical factors
• Laparoscopic surgeries
• Major surgeries
• Prolonged duration
• Multiple surgeries

The decreased oxygen saturation (from 97 to 89%) in this case might be due to increased right-to-left shunting through a fenestration or intrapulmonary shunt mainly due to impaired pulmonary blood flow and ventilation-perfusion mismatch, which might be due to decreased vascular volume or increased PVR.[4] Therefore, risk-benefit ratio should be analysed by keeping in mind the factors affecting Fontan circulation (Table I). In the case of elective surgeries, planning and assessment should be done well in advance and adequate time for preoperative optimisation should be considered.[5]

COMPETING INTEREST:
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AUTHORS' CONTRIBUTION:
MK: Concept and design of the work.
SN: Analysis and interpretation of the data.
SM: Final approval.
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