Case Report

Anaesthesia for patients with Glenn shunt for ophthalmic procedures

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ABSTRACT

Patients with single ventricular physiology (SVP) have a single chamber for systemic and pulmonary venous return. Bidirectional Glenn shunt (BDG) or superior cavopulmonary anastomosis diverts blood from superior vena cava to the pulmonary artery. Patients with this stage of palliation may present for non-cardiac procedures including ophthalmic surgery. They are characterized with low SpO2 and cyanosis as blood from the inferior vena cava is returned to the systemic circulation without oxygenation. Ophthalmic procedures have certain advantages in being less invasive, absence of major fluid shifts, but many occur in ambulatory centres. The circulatory and ventilator goals in managing patients with BDG shunt for ocular surgery is described.

Key words: Bidirectional Glenn shunt, single ventricular physiology, ophthalmic anaesthesia

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Introduction

Patients with single ventricular physiology (SVP) have a single chamber for systemic and pulmonary venous return. Bidirectional Glenn (BDG) shunt is done as the first or second stage of palliative surgery in these patients.

Case description

We present anaesthesia management of four patients between 3 and 24 years of age with bidirectional Glenn shunt (BDG) who presented for various ophthalmic procedures.

All patients had good ventricular function of the single ventricle and smooth unobstructed flow through the BDG. One child was operated twice; first for squint surgery and after 8 months for ptosis correction. The case details are listed in Table 1 and the echocardiographic findings are highlighted in Table 2.

They were allowed clear fluids orally until 2 hours prior to surgery to avoid dehydration. They also received maintenance fluid therapy with Ringer lactate intra-operatively. Post -operatively, all were allowed orally within an hour except the one with post-operative vomiting after squint surgery. All patients were discharged home on the first post-operative day.

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Table 1: Patient's demographic and anaesthesia details

Case	Age/sex/ weight	History and clinical findings	Preoperative medications	Room air SpO2	Surgery	Anaesthesia	Anaesthesia details	Definitive airway	SpO2/FiO2
1a	13year/ male/ 30 kg	No effort intolerance,	Aspirin, Levetirecetam	83%	Squint	GA	Fentanyl 60μg, Propofol 60mg, Atracurium 15mg	ETT	90% / 0.6
1b		Epilepsy			Ptosis correction			Ambu LMA #2.5	
2	3year/ male/ 12 kg	Normal developmental milestones	Aspirin	71%	Squint	GA	Fentanyl 25μg, Propofol 20mg, Atracurium.6mg Controlled Ventilation Air/O2/Sevoflurane POV in PACU maintenance intravenous fluids for 6 hours in PACU	Ambu LMA #2	92% / 0.5
3	24 year/ female/ 40 kg	Dyspnea NYHA Class 2/ no orthopnea	Aspirin	73%	Scleral buckling and PPV with silicon oil insertion	PBB	Fentanyl 50μg Midazolam 2mg	Nasal prong	90% / 3l/min O2
4	10 year/ Male/ 25 kg	No effort intolerance	Aspirin, Enalapril Propranolol	81%	Lensectomy and anterior vitrectomy for a subluxated lens	GA	Fentanyl 50μg, Midazolam 1 mg, Ketamine 25 mg, Atracurium 10mg Controlled Ventilation Air/O2/Sevoflurane	Ambu LMA#2.5	94%/0.6

GA: General anaesthesia; PBB: Peribulbar block, CV: controlled ventilation; PPV: pars plana vitrectomy, POV: post-operative vomiting; ETT: endotracheal tube; LMA: laryngeal mask airway

Table 2: Echocardiographic findings

Case	Primary Diagnosis	Ventricular size	Ventricular function	Septum	Valves	Age at which BDG shunt surgery was done
1	Pulmonary atresia	Hypoplastic RV	Good	IVS intact; nonrestrictive ASD, tiny PDA	PV atretic, others normal	8 months
2	Tricuspid atresia	Hypoplastic RV	Good	Nonrestrictive VSD Nonrestrictive ASD	TV atretic Mvprolapsing, AV, PV normal	One month
3	DORV Malposed great arteries	LV normal RV muscle bound	Good	Large VSD Intact IAS	PV stenotic, rest Normal	7 years
4	DORV	LV hypoplastic RV dilated	Good	Large VSD Large ASD Common complete unbalanced AVSD	Common AV valve with moderate regurgitation, severe PS, doming PV, AV normal	21 days

PA: pulmonary artery; DORV: double outlet right ventricle; PA: pulmonary artery; RV: right ventricle; LV: left ventricle; AV atrioventricular; ASD: atrial septal defect; VSD: ventricular septal defect; AVSD: atrioventricular septal defect; IAS: interatrial septum; IVS: interventricular septum; MV: mitral valve; TV: tricuspid valve; AV: aortic valve; PV: pulmonary valve; BDG: bidirectional Glenn

Discussion

SVP is referred to a condition where the normal dual ventricle series circulation is impossible to achieve and a single ventricle is responsible for systemic outflow.[1] The other ventricle may be atretic or hypoplastic. Pulmonary circulation is maintained by passive flow from the superior vena cava (SVC) after BDG shunt. BDG shunt may be preceded by a Blalock taussig (Subclavian artery to pulmonary artery) shunt or PA banding depending on whether the pulmonary flow is low or high respectively. None of our four patients had undergone BT shunt or PA banding. BDG may be followed by the final stage of palliation when the inferior vena cava is a connected to the left pulmonary artery (total cavopulmonary connection-TCPC) to achieve a Fontan circulation.[2] Patients awaiting TCPC or in whom unfavourable anatomy or pressures preclude a Fontan's procedure may present for non-cardiac surgery.

BDG shunt is usually done at six months of age when pulmonary pressures are low enough for pulmonary flow to be maintained passively but may be done earlier. The room air SpO_2 in these patients is 75-85% as venous blood from the IVC does not pass through the pulmonary circulation. These patients are on antiplatelet agents or aspirin to prevent shunt thrombosis.[2]

All these patients fall into the high-risk category (White and Peyton classification) due to the presence of SVP, complex heart disease and cyanosis.[1]

During the pre-operative evaluation, it is necessary to understand the unique cardiac physiology of each patient, their stage of palliation and current cardiac status. A close liaison with the attending cardiologist is useful. A careful history regarding effort tolerance, developmental milestones, recent respiratory infection, bleeding diathesis, previous surgery and recovery is helpful. A review of cardiac catheterization data, if available gives valuable information about the various pressures and shunt patency. Complete blood count, coagulation profile, ECG, CXR and echocardiogram are indicated regardless of the nature of surgery. Recent respiratory infection increases the risk of respiratory events during anaesthesia. It is important to avoid anemia as hemoglobin is required to improve oxygen delivery. Polycythemia, increased viscosity and dehydration pose a risk for cerebral venous and shunt thrombosis. It is reasonable to avoid prolonged fasting and continue aspirin therapy in these patients. The presence of ventricular dysfunction, arrhythmias, protein losing enteropathy and thromboembolic episodes should alert the anaesthesiologist to a failing ventricle.[3]

All our patients were above two years, well compensated and posted for ophthalmic surgery which does not involve major fluid shifts, hemodynamic instability or prolonged surgery. Hence they were taken up at our free standing ophthalmology unit within a campus where immediate and specialty cardiac care is also available. No invasive lines were planned or used.

In the operating room, all cardiac, emergency and anaesthetic drugs need to be kept ready and their doses calculated according to body weight. Induction may be intravenous or inhalational. It is vital to avoid air bubbles in intravenous lines. Invasive lines may be planned depending on the nature of surgery and patency of veins.[4] Central line, if needed should be placed in the femoral vein.[2] The chief circulatory goals are to avoid dehydration, keep afterload low to maintain forward flow and maintain low pulmonary vascular resistance. Tachycardia and arrhythmias are poorly tolerated and Qp/Qs should be maintained between 0.7 and 1.5. Spontaneous ventilation keeps PVR low, improves cardiac output and pulmonary blood flow but controlled ventilation allows improved oxygenation and minute ventilation. Nitrous oxide is best avoided due to its tendency to increase PVR and risk of air expansion.

The SpO_2 usually increases after induction due to improved cardiac output and decreased peripheral oxygen extraction. Nevertheless, an SpO_2 >90% may also be suggestive of pulmonary over-circulation with the concomitant risk of pulmonary edema.[5] Infective endocarditis prophylaxis is indicated in these patients for procedures that cause bacteremia.[6]

Brown et al reported that 1.8% of patients with SVP undergoing non-cardiac surgery had an adverse anaesthesia event with 60.8% needing post-operative cardiac ICU care. The adverse events identified included hypotension, bradycardia, arrhythmias, ST-T changes and cardiac arrest.[7]

In conclusion, it may be said that patients with BDG shunt are considered high risk and are best managed in tertiary care centres with facilities for transfer to cardiac ICU, if required. A thorough understanding of the patient's cardiac physiology is crucial in managing anaesthesia for non-cardiac surgery.

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Conflicts of interest

There are no conflicts of interest.

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