

On-table Extubation Following Off-pump Bidirectional Cavopulmonary Anastomosis: Two Sides of the Coin

There has been a constant emphasis on minimizing the duration of postoperative ventilation facilitating an early discharge from the Intensive Care Unit in the cardiac surgical arena. Although much more challenging compared to the adult counterpart, the present-day pediatric cardiac surgical practice is witnessing a gradual transition from early extubation to on-table extubation.

Bidirectional cavopulmonary anastomosis (BDCPA) or the Glenn shunt was introduced by Azzolina *et al.* and is a commonly performed palliative procedure contemplated in complex cyanotic congenital heart disease of varying etiology.^[1] BDCPA is characterized by an anastomosis between the superior vena cava (SVC) and the right pulmonary artery, thereby augmenting the pulmonary blood flow (PBF) without increasing the ventricular volume overload. The ongoing technical advancements and improved surgical expertise have resulted in a substantial number of BDCPA being performed on an off-pump basis.

BDCPA presents a peculiar postoperative physiology wherein the PBF is passively supplied by the upper body systemic venous return without complete dependence on a subpulmonary ventricle. Postoperatively, SVC pressure needs to be maintained at higher than normal values (15–20 mmHg) so as to overcome the downstream pulmonary vascular resistance (PVR) in order to maintain a nonpulsatile PBF. However, inadvertently, high SVC pressures (>20 mmHg) following the BDCPA can also lead to opening up of small veno-venous collateral connections contributing to significant arterial desaturation.^[2] The appropriate preoperative selection of patients with low PVR as BDCPA candidates minimizes the risk of complications resulting from the elevation in the SVC pressure.

The underlying physiological premise proposes a postoperative ventilatory strategy which prevents persistently high SVC pressures, maintaining an adequate

PBF at the same time. A negative intrathoracic pressure associated with a spontaneously breathing patient is associated with an increased PBF in a BDCPA circulation, in addition to avoiding the detrimental effects of a positive end-expiratory pressure and high airway pressures on PVR.^[3] Therefore, patients with BDCPA are expected to benefit from return to spontaneous ventilation as early as their clinical state allows.

A meticulous anesthetic plan of management can expedite the postoperative recovery of the cohort of these patients thereby facilitating an on-table extubation. In addition to the physiological advantages of augmenting PBF, an on-table extubation strategy can result in reduction in the duration of the ICU and hospital stay and an early initiation of feeding. There are various factors involved in rendering an on-table extubation feasible in this subset of patients. The avoidance of hemodynamic and inflammatory consequences of cardiopulmonary bypass (CPB) by contemplating an off-pump procedure constitutes a major factor. However, the duration of intraoperative clamping of SVC should be minimized so as to reduce the risk of cerebral and airway edema. Interestingly, the anatomical presence of a left SVC favors uninterrupted cerebral venous drainage in spite of contralateral (right) SVC being clamped. A unique aspect of the BDCPA physiology is that a moderate degree of postoperative hypercapnia improves the PBF due to the cerebral vasodilation in spite of the vasoconstricting effects on the pulmonary circulation.^[4] Considering all these factors together, a plan of an on-table extubation in these patients who are all trained against hypoxia stands a strong clinical ground.

On the other side of the coin, longer duration of SVC clamp times in certain cases increases the risk of cerebral as well as airway edema, precluding fast tracking of anesthesia. The need for atrial septectomy in addition to BDCPA

necessitates the use of CPB that might compound the situation. Moreover, the intraoperative preservation of an antegrade pulmonary flow necessitates the maintenance of higher SVC pressures to promote downstream flow through the BDCPA. The need of higher SVC pressures in this subset of patients increases the risk of pleural effusion and chylothorax in the postoperative period causing respiratory compromise. At the same time, on-table extubation may lead to atelectasis and hypoxia-related increases in PVR.^[3] These factors complicate the decision with regard to the ideal time of extubating these patients.

Joshi *et al.* identified various factors such as weight <5 kg, age <1 year, CPB time >120 min, and presence of associated noncardiac structural anomalies as the important determinants of a successful extubation in the operating room (OR).^[5] Harris *et al.* demonstrated preoperative mechanical ventilation, weight ≤5 kg, bypass time >140 min, circulatory arrest time >7 min, postoperative inotrope, PaO₂ <80 mmHg, age ≤30 days, and male sex as predictors of delayed extubation.^[6] Most of the studies evaluating the feasibility of on-table extubation in pediatric cardiac surgical patients have demonstrated a considerably high success rate in patients undergoing BDCPA. Harris *et al.* could extubate 89% of the BDCPA patients in the OR and 100% within 24 h.^[6]

A sound perioperative anesthetic management using ultrashort-acting anesthetics, anti-inflammatory drugs to reduce airway edema, monitoring depth of anesthesia using bispectral index, and an effective analgesic regimen can improve the feasibility of on-table extubation. However, decision regarding an OR extubation should be individualized as per the index case. The proponents of on-table extubation consider the advantages of favorable postoperative cardiopulmonary interactions with an early reinstatement of spontaneous ventilation, whereas a second school of thought exists proposing a more watchful yet early extubation, ruling out any inadvertent increase in SVC pressures or risk of bleeding or respiratory compromise in the immediate postoperative period.

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References

1. Azzolina G, Eufate S, Pensa P. Tricuspid atresia: Experience in surgical management with a modified cavopulmonary anastomosis. *Thorax* 1972;27:111-5.
2. Filippini LH, Ovaert C, Nykanen DG, Freedom RM. Reopening of persistent left superior caval vein after bidirectional cavopulmonary connections. *Heart* 1998;79:509-12.
3. Al-Eyadhy A. Mechanical ventilation strategy following Glenn and Fontan surgeries: On going challenge! *J Saudi Heart Assoc* 2009;21:153-7.
4. Li J, Hoskote A, Hickey C, Stephens D, Bohn D, Holtby H, *et al.* Effect of carbon dioxide on systemic oxygenation, oxygen consumption, and blood lactate levels after bidirectional superior cavopulmonary anastomosis. *Crit Care Med* 2005;33:984-9.
5. Joshi RK, Aggarwal N, Agarwal M, Dinand V, Joshi R. Assessment of risk factors for a sustainable "On-table extubation" program in pediatric congenital cardiac surgery: 5-year experience. *J Cardiothorac Vasc Anesth* 2016;30:1530-8.
6. Harris KC, Holowachuk S, Pitfield S, Sanatani S, Froese N, Potts JE, *et al.* Should early extubation be the goal for children after congenital cardiac surgery? *J Thorac Cardiovasc Surg* 2014;148:2642-7.

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