

Methodology Article

Emergency Aorto-Pulmonary Shunt Using Two IV Cannulas Technique: A Rapid Stabilization Technique for Cyanotic Spells in Tetralogy of Fallot Before Cardiopulmonary Bypass

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Abstract

Perioperative cyanotic spells in Tetralogy of Fallot (TOF) patients during the initiation of surgery can lead to profound desaturation & hemodynamic instability. These spells are characterized by acute desaturation due to increased right-to-left shunting, often triggered by anesthesia induction, stress, or changes in vascular resistance. In severe cases, standard medical management—including fluid boluses, vasopressors, and beta-blockers—may fail, necessitating urgent intervention to restore pulmonary blood flow or put patient immediately on cardiopulmonary bypass (CPB). We encountered such a scenario in a 5-year-old child scheduled for total correction of TOF. Preoperative imaging had revealed good-sized branch pulmonary arteries but significant right ventricular outflow tract (RVOT) obstruction at valvular level. Two large major aortopulmonary collateral arteries (MAPCAs) had been coiled preoperatively. During anesthesia induction, the child developed a severe cyanotic spell perioperatively, with saturations progressively dropping below 20%. Despite aggressive conventional management, including oxygenation, deep sedation, and vasoactive support, the spell remained refractory, and the patient's condition deteriorated rapidly. These measures failed to improve oxygenation, and decision was taken to immediately put patient on CPB. *Recognizing the urgency, we immediately performed an emergency sternotomy to put patient on CPB, but as setting up CPB would take several minutes, meanwhile we also tried to stabilise the child by rapidly restore pulmonary circulation with our innovative novel Two IV Cannula technique: inserting a 14F IV cannula into the ascending aorta and another 14F IV cannula into the distal pulmonary artery, then connecting them with a standard IV tubing connector. This setup created a temporary aorto-pulmonary shunt within few seconds, functionally resembling a Blalock-Taussig-Thomas (BTT) shunt, allowing blood to bypass the obstructed outflow tract and directly perfuse the pulmonary circulation. This simple yet life-saving maneuver resulted in an immediate and dramatic improvement in oxygenation/saturation within few seconds, providing crucial time for controlled CPB initiation.* Within seconds, the patient's oxygen saturation improved dramatically from 20% to 70%, and hemodynamic stability was restored and allowing a controlled transition to CPB. This rapid stabilization technique using IV cannula in perioperative spelling child provided crucial time for CPB initiation under controlled conditions. The IV cannulas were then removed, and the total correction was successfully performed with a transannular patch. *This simple, easily replicable & innovative Two IV cannulas technique offers a life-saving bridge to CPB in cases of refractory cyanotic spells. It is easy to implement, requires minimal equipment, achieved in few seconds and can be performed by an assistant while the primary surgeon continues with CPB cannulation. This approach may be especially useful in resource-limited settings & serves as an effective interim measure to stabilize the patient until bypass is established.*

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Keywords

Tetralogy of Fallot, Cyanotic Spell, Emergency Aorto-pulmonary Shunt, IV Cannula Technique, Pediatric Cardiac Surgery

1. Introduction

Tetralogy of Fallot (TOF) is the most common cyanotic congenital heart disease, characterized by right ventricular outflow tract (RVOT) obstruction, ventricular septal defect, overriding aorta, and right ventricular hypertrophy [1, 2]. Perioperative cyanotic spells can be triggered by multiple factors, including anesthetic induction, hypovolemia, stress responses, or increased catecholamine release [3, 4]. In such situations, there is an acute increase in right-to-left shunting across the ventricular septal defect (VSD), resulting in profound systemic desaturation.

Cyanotic spells are usually managed with fluid resuscitation, increasing systemic vascular resistance (phenylephrine), reducing pulmonary vascular resistance (oxygenation), and decreasing myocardial contractility/heart rate (beta-blockers like propranolol or esmolol) [5, 6]. However, in severe cases, these standard measures may fail, leading to life-threatening hypoxia. In such scenarios, immediate restoration of pulmonary blood flow is critical to prevent life threatening desaturation & cardiac arrest [7] or to go immediately on CPB.

We present a novel, rapid-response Two IV Cannulas technique using two IV cannulas to create a temporary aorto-pulmonary shunt similar to BTT Shunt, allowing for immediate oxygenation/saturation improvement in a TOF patient experiencing a refractory cyanotic spell. This can be done by assistant also & main surgeon can continue in process of establishing CPB.

2. Case Report

A 5-year-old female child with Tetralogy of Fallot was scheduled for elective total correction. Preoperative echocardiography and CT angiography revealed good-sized branch pulmonary arteries but significant RVOT obstruction at valvular level in main pulmonary artery, necessitating a transannular patch. Additionally, two large major aortopulmonary collateral arteries (MAPCAs) had been coiled preoperatively.

Following routine induction of anesthesia, the patient developed progressive hypoxia with fluctuating saturations, eventually dropping below 20% despite aggressive standard spell management. The anesthesia team attempted fluid resuscitation, 100% oxygenation, deep sedation, and vasoactive support, but the spell persisted, and the patient's condition deteriorated rapidly.

Recognizing the urgency, the decision was made to proceed with an emergency sternotomy & to put patient on CPB. Time was critical, as CPB setup in a beginner's hands would take several minutes, and the risk of cardiac arrest was imminent.

Innovative Rescue Approach-Two IV cannulas technique: upon opening the pericardium, the heart was found to be severely cyanotic and underfilled main pulmonary artery, confirming that pulmonary blood flow was critically compromised. To immediately restore pulmonary circulation, an innovative approach was employed:

1. A 14F IV cannula was inserted into the ascending aorta.
2. Another 14F IV cannula was placed into the distal main pulmonary artery.
3. The two cannulas were connected using a standard IV tubing connector, allowing oxygenated blood from the aorta to flow directly into the pulmonary circulation (Figures 1-3).

This can be done by assistant also & main surgeon can continue in process of establishing CPB. Within seconds, oxygen saturation increased from 20% to 70%, and the patient's hemodynamics stabilized. This rapid stabilization provided crucial time for CPB initiation under controlled conditions. Once CPB was established, the IV cannulas were removed, and total correction was successfully performed with a transannular patch.

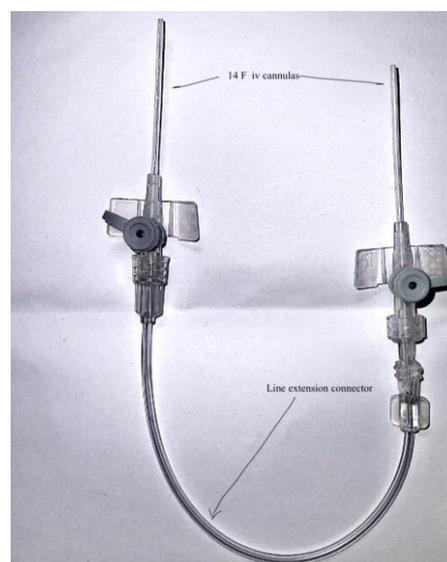


Figure 1. 14F IV cannulas with connector.

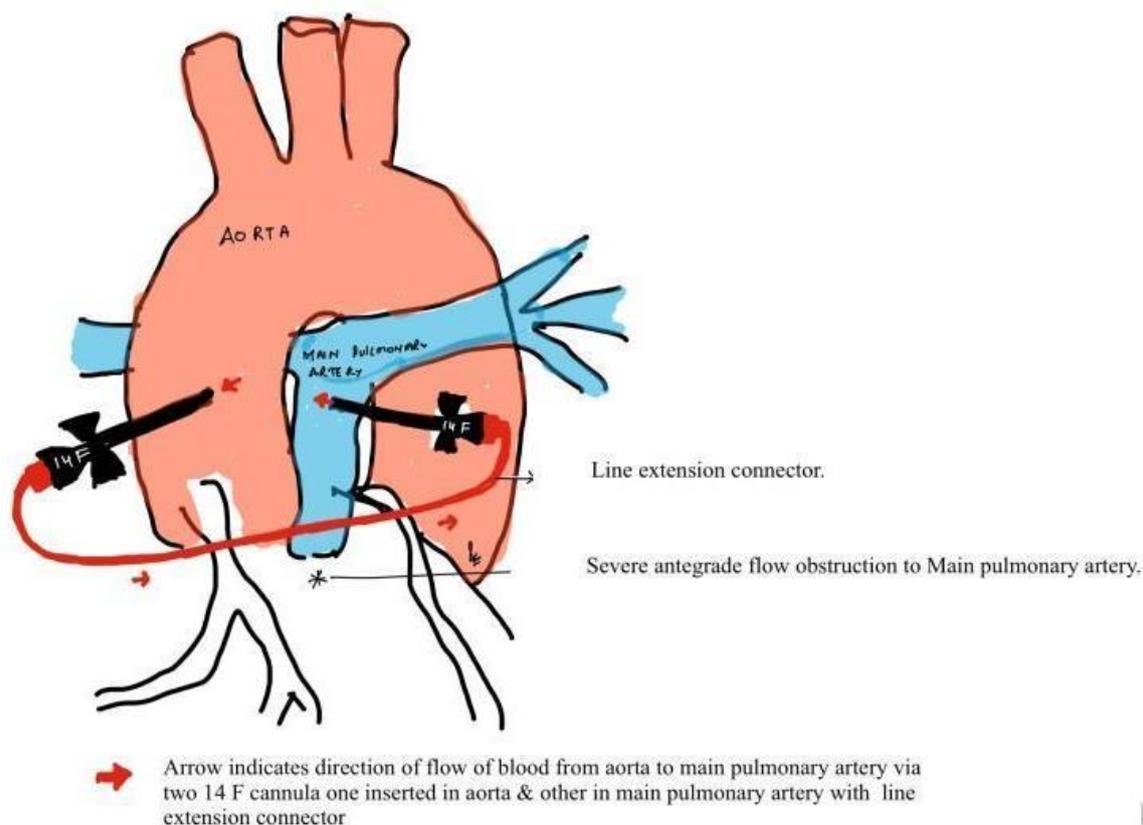


Figure 2. Schematic image representation of increasing pulmonary blood flow in case of intraoperative on table spelling child during induction of anesthesia before going on CPB using two cannulas with connector (Two IV Cannulas Technique). Note red arrow indicate direction of blood flow.



Figure 3. Intraoperative image showing surgeon (second assistant) quickly inserting two IV cannulas in intraoperative spelling child while main surgeon continues in establishing CPB.

3. Discussion

Perioperative cyanotic spells are life-threatening emergencies in TOF, particularly in cases with severe fixed RVOT obstruction. Conventional spell management is often

effective, but in rare situations where the response is inadequate, immediate intervention to restore pulmonary blood flow is critical [8, 9].

The IV cannula-based aorto-pulmonary shunt mimics the physiology of a modified Blalock-Taussig-Thomas (BTT) shunt, providing an immediate and temporary systemic-to-pulmonary connection [10, 11].

The main advantages of this technique (Comparison With Other Interventions in Table 1)

include:

- Speed: Takes few seconds to establish, compared to CPB initiation which takes several minutes.
- Simplicity: Uses only two IV cannulas and a connector, requiring no specialized vascular grafts or anastomoses. This can be done by assistant also & main surgeon can continue in process of establishing CPB.
- Universality: Can be performed in any center, even in resource-limited settings where rapid CPB initiation may not be feasible [12-16].
- Reversibility: The shunt can be easily disconnected and removed once CPB is established.

Table 1. Comparison with BTT shunt & CPB.

| Intervention | Time to Effect | Equipment Required | Feasibility in Emergency |
|--|----------------|---------------------------|--|
| IV Cannula Aorto-Pulmonary Shunt (Two IV Cannulas Technique) | Few seconds | 2 IV cannulas & connector | Highly feasible. This can done by assistant also while main surgeon can continue in process of establishing CPB. |
| Blalock-Taussig-Thomas (BTT) Shunt | 30–60 minutes | Graft, sutures | An emergency measure but take time. |
| CPB Initiation | 5–10 minutes | CPB machine, cannulation | Time-consuming in beginners' hands. |

This technique is particularly valuable for surgeons-in-training, where CPB initiation may take longer, increasing the risk of hypoxic injury or cardiac arrest in such critical situations.

4. Conclusion

This case highlights an innovative, simple, and life-saving Two IV Cannulas technique for managing refractory perioperative cyanotic spells in TOF patients. As it will take some time to put patient on CPB, meanwhile we can manage the child by this novel innovative Two IV Cannulas

technique to increase pulmonary blood flow. This novel innovative technique serves as an effective interim measure to stabilize the patient until bypass is established. The IV cannula-based aorto-pulmonary shunt offers an *effective bridge to CPB*, ensuring patient stabilization and preventing fatal hypoxia.

This technique is easily adaptable, achieved in few seconds & can done by assistant also while main surgeon can continue in process of establishing CPB. This should be considered in emergency scenarios where immediate pulmonary blood flow restoration is required.

Management of Refractory Perioperative Cyanotic Spells in TOF Using the Two IV Cannula Technique

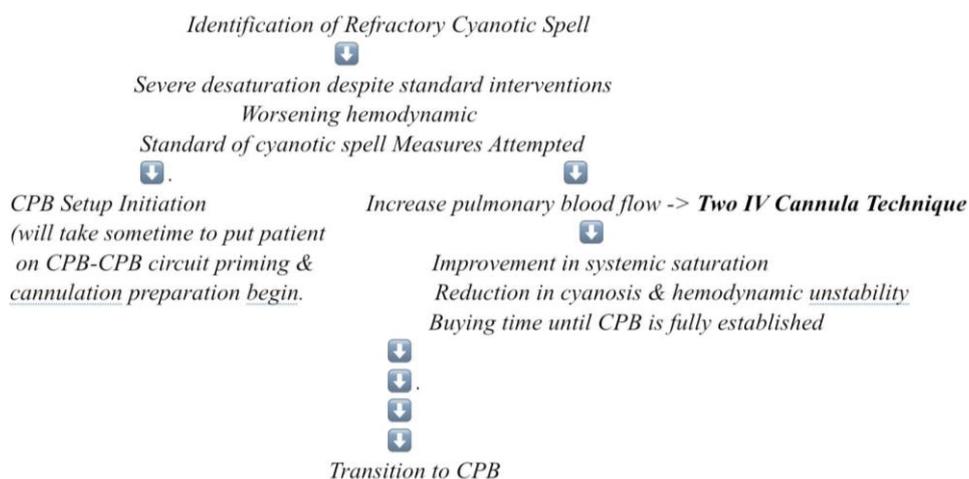


Figure 4. Flowchart of management of Refractory Perioperative Cyanotic Spells in TOF Using the Two IV Cannula Technique.

RVOT Right Ventricular Outflow Tract

Abbreviations

- CPB Cardio Pulmonary Bypass
- IV Intravenous Cannula
- MAPCAs Major Aorta Pulmonary Collaterals
- TOF Tetralogy of Fallot
- VSD Ventricular Septal Defect

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Author Contributions

Ajit Singh: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

Puneet Sharma: Supervision, Validation, Writing – review & editing

Vinay Malhotra: Validation

Vishesh Sharma: Validation

Ethical Approval

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Human Rights

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Conflicts of Interest

The authors declare no conflicts of interest.

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