

CASE REPORT

Use of Airvo™ in Critically Ill Pediatric Patients During Procedural Sedation: A Case Report

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ABSTRACT

Central venous cannulations in pediatric patients require procedural sedation. Chances of desaturation are increased with anesthesia and maneuvers reducing functional residual capacity, especially in critically ill patients. Airvo™ is a device which can provide oxygen at very high flows with accurate and titratable FiO₂. We present a case where Airvo™ was instituted while securing central venous access in a patient with nephrotic syndrome with ascites.

Keywords: Airvo, Critically ill, Central venous cannulation, High flow nasal oxygenation.

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INTRODUCTION

Central venous cannulations (CVCs) have become an indispensable tool for the management of critically ill pediatric patients. In contrast with adults, where CVCs are possible solely under local anesthesia, the cannulation of neck veins in children is difficult without the administration of deep sedation.¹ The Trendelenburg position has a positive effect on neck vein diameter and thus improves the success rate of CVCs. It also reduces the risk of venous air embolism. For the same reasons, it is most commonly employed position for central venous cannulation, especially in hypovolemic and spontaneously breathing patients.² However, the use of sedative medications and instituting Trendelenburg position reduces functional residual capacity (FRC) and increases the risk of hypoxia.^{3,4} Presence of ascites with huge abdominal distension complicates this condition

further and increases the risk of hypoxia multiple folds.⁵ Airvo™ and Optiflow™ nasal cannula (Fisher and Paykel Healthcare Limited, Panmure, Auckland, New Zealand) are commercially available high-flow nasal oxygenation (HFNO) devices. We present a case with nephrotic syndrome with tense ascites where HFNO was instituted while securing central venous access. HFNO might have a role in preventing hypoxia in these kinds of scenarios. For describing this technique consent was obtained from the patient's parents.

CASE REPORT

A 4-year-old female child, weighing 18 kg a relapsed case of nephrotic syndrome presented with breathlessness, generalized, and abdominal distension. She was irritable and had severe respiratory distress (respiratory rate 60/minute) with the saturation of 93% on 6 L/minute of oxygen on Hudson's mask in sitting position. Auscultation revealed reduced air entry on either side in the lower zone. Point of care ultrasound revealed free fluid in the abdomen with collapsed inferior vena cava indicating severe hypovolemia. The child was scheduled for emergency central venous cannulation and diagnostic ascitic tap. The patient was induced in a 45° propped up position, with Airvo™ delivering 100% oxygen at the rate of 16 L/minute (Fig. 1). Since the patient was agitated we could apply Optiflow™ nasal cannula only after administration of injection (inj) propofol 10 mg IV. Saturations



Fig. 1: At the beginning of the procedure, Airvo™ application in propped up position

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Fig. 2: Patient's position after the procedure with 100% saturation in Trendelenburg position

immediately improved to 100%. After that, gradually the child was made supine and then was given Trendelenburg position (Fig. 2). Supplemental local anesthesia was given at cannulation site. Ultraguided CVC was successful in the first attempt.

Repeated and titrated doses of propofol-ketamine combination (total propofol 150 mg and ketamine 100 mg throughout 20 minutes) were used to avoid patient movement during the procedure. After CVC she underwent ascitic tap in the supine position. The patient maintained 100% saturation throughout the procedure. The patient was shifted to the pediatric intensive care unit, post procedure and continued on Airvo™ support and received albumin therapy with repeated paracentesis. She was gradually weaned off in next 2 days and was discharged home on the 7th day with nephrology follow-up.

DISCUSSION

Pathophysiological consequences of nephrotic syndrome as hypovolemia, acute renal failure, hypercoagulation, generalized, and infections need to be treated symptomatically.⁶ Central venous access may be an indispensable tool in these patients to maintain long-term venous access, guide fluid therapy, administer vasoactive agents and antibiotics, apart from its other common indications. Femoral venous cannulation can impose technical difficulties in the presence of ascites.⁷ Also the maintenance related complications of thrombus formation and infections are higher compared to the internal jugular and the subclavian venous access.⁸ Peripherally inserted central venous catheter placement was not possible in our case because of generalized body edema obscuring the peripheral veins, leaving only the neck veins for the possible venous access. Internal jugular and subclavian veins are poorly distended in case of hypovolemia.⁹ Trendelenburg

position allow gravity to enhance central venous filling and increase the diameter of internal jugular vein and subclavian vein.^{2,10} This creates a larger target for venipuncture and minimize the risk of venous air embolism.⁹ After the administration of anesthetic agents, there is a loss of muscle tone and dose-dependent decrease in minute ventilation. Simultaneously, there is a fall in FRC leading to alveolar collapse and an increase in intrapulmonary shunting.¹¹ Therefore, procedural sedation, Trendelenburg position along with cephalad displacement of the diaphragm by ascitic fluid not only reduces FRC but also alters the respiratory mechanics increasing the risk of hypoxia.³⁻⁵

Our patient was already hypoxic with the saturation of 94% on the oxygen mask. To compensate for the ill effects of anesthesia, position, and abdominal distension, we used 45° propped up position for induction. In cases of agitated patients, it might be necessary to give a small dose of sedative medication before applying Optiflow™ nasal cannula. The unique feature of Airvo™ is to provide oxygen at very high flows with accurate and titratable FiO₂. This combines the benefits of 'classical' apnoeic oxygenation with continuous positive airway pressure and gaseous exchange through flow-dependent deadspace flushing.¹² Ritchie et al. proposed that hypopharyngeal pressure is increased in proportion to increasing gas flow rate.¹³ The supra-atmospheric hypopharyngeal pressures created by this technique might have transmitted to distal airways without much change. This might have helped in increasing FRC, improving respiratory mechanics and preventing upper airway obstruction. Ability to provide 100% FiO₂ with this equipment might be an important factor in maintaining saturations throughout the procedure.

Since the Airvo™ equipment is not able to provide inhalation agents its use is currently limited to patients having functioning intravascular/intraosseous access *in situ*.

Our case demonstrates the usefulness of the Optiflow™/Airvo™ and its application to new paradigms. We believe that the administration of high-flow nasal oxygen can be a useful tool for such interventions.

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