Anesthesia Management in Neonates with Esophageal Atresia and Tracheoesophageal Fistula Repair: A Case Report

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KEYWORDS

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ABSTRACT:

Introduction: Esophageal atresia with tracheoesophageal fistula (EA-TEF) requires complex anesthesia management due to challenges in airway control and the risk of complications. This study reports an 11-day-old neonate with distal EA-TEF which would conduct the repair surger.

Case presentation: This study reports on an 11-day-old neonate, weighing 2.4 kg, admitted to Dr. Soetomo General Hospital due to continuous drooling shortly after birth. The initial examination indicated an inability to pass an orogastric tube, with no evidence of fever, respiratory distress, or hematin present. A diagnosis of esophageal atresia with tracheoesophageal fistula, associated with VACTERL abnormalities, was confirmed through radiological imaging showing respiratory distress syndrome and dilated bowel gas. This condition supported with increasing white blood cells level. General anesthesia was administered for surgical repair, and the patient's hemodynamics and oxygen level remained unstable during the procedure.

Discussion: Esophageal atresia with tracheoesophageal fistula (EA-TEF) requires timely surgical correction, but delays can lead to complications like aspiration pneumonia, as seen in this 11-day-old neonate with associated VACTERL abnormalities. General anesthesia was used with close monitoring to prevent gastric distension and maintain oxygenation. Hemodynamic instability and fluctuating oxygen saturation posed challenges during surgery, but the patient was successfully stabilized postoperatively, emphasizing the importance of precise anesthetic and surgical management in neonates with EA-TEF.

Conclusion: Repairing AE-TEF presents challenges in airway management, hemodynamics, and oxygenation. Careful preoperative assessment, correct endotracheal tube placement, and controlled ventilation are essential for positive outcomes and minimizing complications in neonates undergoing TEF repair.

1. Introduction

Esophageal atresia is a congenital condition characterised by an impairment in the continuity of the oesophagus, which may occur with or without the presence of a tracheoesophageal fistula (TEF) [1], [2], [3]. The prevalence of esophageal atresia (EA) accompanied by tracheoesophageal fistula is approximated to be 1 in every 3000 to 5000 live births [4]. Esophageal atresia–tracheoesophageal fistula (EA-TEF) represents a prevalent anomaly within the realms of digestive and respiratory systems, with an incidence ranging from 1 in 2,400 to 4,500 live births globally [5]. Esophageal atresia is suspected antenatally due to polyhydramnios, at birth through profuse salivation and foamy oral secretions, and by the inability to insert a nasogastric tube (NGT) into the stomach [6]. A definitive diagnosis is confirmed by the observation of nasogastric tube coiling in the chest and the absence of a gastric bubble on a chest X-ray (CXR) [4], [7].

Surgical repair is the definitive treatment [8], often performed urgently depending on the patient's condition. These anomalies are frequently associated with other abnormalities, such as those seen in the VACTERL spectrum [9], [10], requiring thorough preoperative evaluation [11]. Anesthesia management in EA with TEF repair is particularly complex due to the need for precise airway control and careful intraoperative ventilation to prevent gastric insufflation and maintain oxygenation [12], [13]. Ensuring airway patency, maintaining hemodynamic stability, and mitigating possible postoperative consequences, including respiratory distress or anastomotic leaks, are essential concerns [14], [15].

We present a case of an 11-day-old neonate diagnosed with oesophageal atresia accompanied by a distal type tracheoesophageal fistula. A thorough examination of the patient's clinical history, diagnostic assessment, and management strategy will be articulated, emphasising the complexities inherent in this case. This report aims to convey experiences for anaesthetic care of a newborn undergoing esophageal atresia and TEF repair which offering insights to enhance results in analogous instances.

2. Case Presentation

This study presents a case involving an 11-day-old newborn weighing 2.4 kg which was admitted to Dr. Soetomo General Hospital with a main complain drooling continuously shortly after birth. An orogastric tube was inserted into a patient's mouth, but it returned. The patient has been fasting since birth, and there is no fever, respiratory distress, retraction, or hematin. Based on the history taking, there was no allergy and the last medication were ampicillin, gentamycin, and midazolam. VACTERL association in this patient were small patent ductus arteriosus, trachea fistula, and esophageal atresia. On physical examination, vital signs were normal; however, rhonchi and murmur were found on auscultation. A complete blood count showed elevated white blood cell levels. Serum electrolyte analysis indicated an increase in calcium levels, while albumin levels were found to be decreased. As supplementary preoperative tests, babygram with umbilical catheter was performed, which confirmed the diagnosis (fig. 1). It showed respiratory distress syndrome (RDS) grade II, with a cardio-thoracic ratio (CTR) < 50%, and dilated bowel gas shadows mixed with faecal material in the abdominal cavity distributed to the pelvic cavity.

Figure 1. Radiological examination showing RDS grade II and dilated bowel gas shadows mixed with faecal material

Monitoring in the operating room was conducted using non-invasive blood pressure, pulse oximetry (SpO2), and EKG, showing favourable outcomes with OGT that produced thick, clear mucus. General anesthesia was conducted for this patient. Induction was performed with sedation which was achieved by using 2.5% sevoflurane and atracurium 0,5 mg/kgBB. Fentanyl 3 mcg also administered via venous access. The patient has an endotracheal tube (ETT) with a size of 3.5 mm installed with correctly positioned, as verified by capnography and pulmonary auscultation, initiating volume-controlled ventilation with a tidal volume of 8 ml kg−1 and a respiratory rate of 16 to 20 breaths per minute. The depth of anaesthesia was maintained 2.5% sevoflurane, and fentanyl at a dosage of 0.25 mcg/kg body weight administered intermittently every 45-60 minutes, along with atracurium at 0.1 mg/kg body weight given intermittently every 30-45 minutes, following the closure of the fistula.
During the surgical process, the patient's hemodynamics were not stable, with a heart rate ranging from 130 to 160 beats per minute, a systolic blood pressure between 40 and 60 mmHg, and diastolic blood pressure between 22 and 40 mmHg. The respiratory system maintained SpO2 levels between 88% and 100%, which unexpectedly increased to nearly 100% following the complete repair of esophageal atresia and ligation of the fistula. The surgery lasted 4 hours, with 39 cc urine production, 10 cc bleeding that replaced with 113 crystalloids which were administered, and there was no requirement for blood product transfusions. Following the surgical procedure, the patient was moved to the neonatal intensive care unit (NICU), which was intubated, and mechanically ventilated, without any complications. The Babygram post-operation was conducted (fig. 2). The findings indicated pneumonia, with a cardio-thoracic ratio (CTR) of less than 50%. ETT had its distal tip located at thoracic vertebrae level 3 (VTh 3), the central venous catheter (CVC) had its distal tip at thoracic vertebrae level 8 (VTh 8), and the gastric tube's tip was positioned at lumbar vertebrae level 4 (VL 4) on the left side. Additionally, there was a shadow of intestinal gas interspersed with faecal material in the abdominal cavity, which was normally distributed towards the pelvic cavity.

Figure 2. Post-operation radiological examination showing pneumonia and faecal material in the abdominal cavity which normally distributed

3. Discussion

Atresia oesophagus with tracheoesophageal fistula is a congenital anomaly which has to be surgically repaired [16]. The surgical correction of tracheoesophageal fistula can be conducted within the first days of life [17], [18]. Nevertheless, it is frequently observed that surgical correction is postponed from 3 days to 2 weeks following delivery [12], [19]. The findings from the pre-operative babygram assessment of this patient revealed infiltrates within the lung fields, suggesting the presence of pneumonia. This occurrence is probable as the repair procedure on this patient was conducted at 11 days after delivery. An longer duration of conservative therapy is more commonly linked to aspiration pneumonia and sepsis [19]. This condition is further supported by an elevation in white blood cell count, signifying the presence of an infection [20]. Untreated recurring infections or frequent aspiration can cause bronchiectasis and ongoing atelectasis, therefore causing permanent lung damage [21]. Furthermore, antibiotics and acid-suppressive drugs must be administered at least 24 hours prior to surgery when aspiration pneumonia is suspected [22].

In patients with type C TEF, special care must be taken to the intubation technique because the fistula lies just above the carina [23], and the tip of the ETT tube can easily enter into the fistula. Also, the presence of blood or secretions in the endotracheal tube may lead to airway obstruction [24], necessitating regular tracheal suctioning. Surgical airway manipulation and upper lung collapse resulting from retractor use may lead to episodes of hypoxemia. Preoperative constant suctioning decreases secretion accumulation [12]. Also, additional precautions must be considered during intubation, as the fistula is located directly above the carina, and the tube's tip may inadvertently enter the fistula during the surgical procedure [25]. Regarding the patient's respiratory compromise due to aspiration pneumonia, early extubation must be considered [22].

Anaesthetic management is contingent upon patient comorbidities, the classification of EA with or without TEF, and standard hospital protocols [26]. Preoperative assessment of comorbidities associated with oesophageal atresia is essential for evaluating surgical risk and the potential for concurrent surgical interventions. Echocardiography must be conducted prior to surgery to identify potential cardiac or vascular anomalies [12]. The results of the preoperative evaluation showed other VACTERL abnormalities, such as presents with atrial septal defect (ASD) [27]. ASD, as a cardiac defect, can complicate the perioperative and long-term management of TEF by affecting hemodynamic stability, oxygenation, and increasing the risk of comorbidities [28]. Identifying and managing these anomalies early is critical for optimizing outcomes [29].

General anesthesia is often used for TEF surgery [28]. Anesthetia induction may be delivered via intravenous methods, inhalation, or through a synergistic application of both techniques. The utilisation of inhalational anaesthetic induction is favoured for ensuring airway security during intubation while preserving spontaneous ventilation [19]. Anaesthetic management's main concerns for esophageal atresia with TEF is ensuring sufficient oxygenation despite the existence of a connection between the airway and the oesophagus, with potential desaturation episodes occurring during both induction and anaesthetic maintenance [26], [30]. Techniques involve awake intubation, the avoidance of muscle relaxants, and the minimization of excessive positive pressure ventilation until the fistula is repaired [25]. Induction in these patients was conducted using sevoflurane and oxygen, adhering to the neonatal dosage guidelines for this agent. The depth of anaesthesia was sustained through the administration of O_2, compressed air, sevoflurane, and fentanyl at a dosage of 0.25 mcg/kg body weight intermittently every 45-60 minutes. Paediatric induction of anaesthesia is favoured over inhalational agents due to the elevated minute ventilation, which enhances drug distribution and facilitates a more rapid clearance period. Sevoflurane was selected due to its lack of effect on airway secretion production, which minimises the risk of aspiration [12], [31], [32].

Gastrostomy was not conducted in this patient. The primary issue with general anaesthesia is positioning the distal end of the endotracheal tube beyond the fistula yet above the carina, while also preventing gastric distension [33]. Large fistulas may lead to gastric distension during ventilation, potentially causing respiratory compromise [34]. Newborns with TEF face an elevated risk of stomach distension, which may lead to pneumoperitoneum, a risk that can be worsened by the initiation of mechanical breathing with positive pressure [26]. Gastrostomy is typically conducted during the staged repair of tracheoesophageal fistula (TEF) [35] to mitigate air inflow through the fistula during positive pressure ventilation, which can lead to excessive stomach distension and hinder diaphragmatic movement. Gastrostomy is not essential, as it can prevent complications like gastric rupture; however, it may lead to low-pressure leaks through broncho-cutaneous fistulas, resulting in ineffective ventilation [19]. In line with this condition, verification of endotracheal tube placement through physical examination, ensuring audible breath sounds in both lungs, alongside continuous perioperative monitoring of oxygen saturation [36], [37].

The patient's hemodynamic instability during the operation presented a challenge with a heart rate ranging from 130 to 160 beats per minute, a systolic blood pressure between 40 and 60 mmHg, and diastolic blood pressure between 22 and 40 mmHg. Multiple causes make hemodynamic instability during tracheoesophageal fistula (TEF) closure a major problem. These include intrathoracic pressure changes, poor breathing, and surgical stress-related cardiovascular reactions. Airway and oesophageal manipulation can cause vagal stimulation, bradycardia, and hypotension. Inadequate breathing during the surgery might cause hypoxemia, hypercapnia, and acidosis, worsening instability [38].

In addition, during the operation, SpO_2 levels were between 88% and 100%. Unstable oxygen saturation (Sp_{O2}) during tracheoesophageal fistula (TEF) repair arises from several mechanisms, primarily linked to airway and ventilation challenges. The abnormal connection between the trachea and esophagus allows air to escape into the gastrointestinal tract, reducing effective ventilation and leading to hypoxia [31]. Surgical manipulation may temporarily obstruct airflow or worsen air leaks, further compromising oxygenation. Positive-pressure ventilation can exacerbate the issue by insufflating the stomach through the fistula, reducing lung compliance and causing ventilation-perfusion mismatch. Proper endotracheal tube placement, ensuring its tip is positioned distal to the fistula. Also, anesthetic strategies involving controlled ventilation with low tidal volumes help prevent gastric insufflation while maintaining oxygenation [39].
Aspiration pneumonia is the most prevalent complication observed in neonates with EA-TEF, which is a result of delayed treatment. Sepsis, anastomotic hemorrhage, esophageal stricture, and respiratory failure are potential postoperative complications. Delayed intervention may result in persistent gastroesophageal reflux, which is one of the potential long-term complications. Furthermore, esophageal dysmotility, which can result in esophageal obstruction and failure to thrive, may also occur. Tracheomalacia is a less common complication that can significantly influence the long-term results of TOF/OA repair. Stridor, apnea, or recurrent pneumonia may be the result of tracheomalacia, which can lead to the collapse of the airway [40].

4. Conclusion

In conclusion, the repair of tracheoesophageal fistula (TEF) presents challenges in managing airway, hemodynamics, and oxygenation, especially when surgery is delayed. Prompt intervention is critical to reduce complications like pneumonia and infection. Comorbidities such as atrial septal defect (ASD) require careful preoperative assessment and monitoring. Anesthesia management must focus on correct endotracheal tube placement, controlled ventilation, and continuous monitoring to avoid complications like gastric distension. With careful planning and a multidisciplinary approach, positive outcomes can be achieved in neonates undergoing TEF repair, ensuring optimal recovery and minimizing long-term effects.

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