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CASE REPORT

Anaesthetic Challenges in Minimally Invasive Gastric Pull-up for Oesophageal Atresia With Significant Proximal-Distal Oesophageal Discrepancy in an Infant - A Comprehensive Case Report

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Abstract

A unique subset of infants diagnosed with oesophageal atresia (EA) with tracheooesophageal fistula (TEF) are those born with pure long-gap oesophageal atresia (LGEA), constituting around 10 % of oesophageal atresia. Several procedures have been developed for oesophageal reconstruction and gastric pull-up has demonstrated promising outcomes. Anaesthetic management for the gastric pull-up surgery is challenging with a high risk of respiratory distress and a high incidence of perioperative tachyarrhythmias. Case of infant diagnosed with LGEA, marked by a significant proximal-distal oesophageal discrepancy, initially underwent cervical oesophagostomy and feeding gastrostomy in the neonatal period is presented. Anaesthetic challenges were faced both intraoperatively and postoperatively.

Key words: Anaesthesia; Complications; Oesophageal atresia; Tracheoesophageal fistula; Gastric pull-up.

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Introduction

A unique subset of infants diagnosed with oesophageal atresia (EA) with tracheooesophageal fistula (TEF) are those born with pure long-gap oesophageal atresia (LGEA), constituting around 10 % of oesophageal atresia.[1-3] "Long gap" oesophageal atresia is defined as a distance of more than 3 cm between the proximal and distal oesophageal remnants. Though the native oesophagus is the best conduit, in such circumstances, the proximal and distal segments of the oesophagus are too far apart to enable primary anastomosis and thus require a conduit. Managing these cases presents significant challenges for anaesthesiologists, as patients face a high risk of both immediate and long-term respiratory complications. Following initial treatment with cervical oesophagostomy, a common issue is the gradual narrowing of the oesophageal fistula, often resulting in recurrent aspirations leading to pneumonia. Anaesthetic management is particularly complex, as patients are prone to intraoperative tachyarrhythmias due to vagal disruption, as well as ventilation difficulties arising from reduced intrathoracic space. The latter is often exacerbated by pneumomediastinum, which develops during the laparoscopic gastric pull-up procedure; placing the gastric conduit

into the mediastinum further increases thoracic pressure, complicating respiratory management. The colon was the most commonly used conduit in the past. However, due to significant complications and conduit loss, gastric transposition is now preferred.

This case report discusses a complete laparoscopic oesophageal transposition using a gastric conduit in an infant with long-gap oesophageal atresia, with a focus on the anaesthetic strategies employed to manage critical respiratory and hemodynamic challenges. By detailing the perioperative considerations and potential complications, aim of this study was to provide valuable guidance for anaesthesiologists facing similar complex cases in the future.

Case history

A 1-year-old male child weighing 9 kg, diagnosed with long-gap EA with TEF, was posted for total laparoscopic gastric pull-up surgery as a definitive procedure using gastric conduit. The child underwent cervical oesophagostomy and feeding gastrostomy on second day of life.

On the initial clinical assessment, the child was non-syndromic, haemodynamically stable and had achieved age-appropriate milestones. Weight gain and other preoperative evaluations were unremarkable.

Parental written informed consent was secured and the ASA standard fasting protocols were followed. Blood and blood products were arranged in advance. Proper hydration was maintained by administering intravenous fluids the night prior to the surgery.

The child was premedicated with intravenous 40 µg/kg midazolam and 4 µg/kg glycopyrrolate in the preoperative room after documentation of vitals. Upon arrival in the operation theatre, standard ASA monitoring was applied, which included electrocardiography, pulse oximetry, non-invasive blood pressure, end-tidal carbon dioxide ($ETCO_2$) measurement and a peripheral temperature sensor were attached.

While continuing para-oxygenation, anaesthesia was induced with intravenous fentanyl at 2 µg/kg, propofol at 2 mg/kg and atracurium at 0.5 mg/kg. The airway was secured with a 4 mm uncuffed endotracheal tube (ETT). To facilitate continuous blood pressure monitoring and blood sampling, the right radial artery was cannulated. Additionally, a 4.5 French (Fr), 20 cm triple lumen central venous catheter was placed in the right femoral vein.

Ventilation was managed with a 40:60 mixture of oxygen and air, using a tidal volume of 6 mL/kg and a respiratory rate of 30 breaths per minute. Due to reduced pulmonary compliance and increased intra-abdominal pressure during the laparoscopic procedure, to maintain adequate tidal volume and oxygenation, peak inspiratory pressure (PIP) was maintained between 20 and 25 cm H_2O, with a positive end-expiratory pressure (PEEP) of 3 cm H_2O. Anaesthesia was maintained with isoflurane and atracurium was infused continuously at a dosage of 0.5 mg/kg per hour.

Surgery began with laparoscopic dissection and mobilisation of the stomach and distal oesophagus (Figure 1). During posterior mediastinal tunnelling, the patient developed sudden bradycardia below 30, due vagal stimulation which resolved after pausing the dissection and notifying the surgeon (Figure 2). The critical phase involved carefully threading and positioning the gastric conduit through a peritoneal tunnel into the posterior mediastinum (Figure 3). During this phase, the patient experienced multiple desaturation episodes, managed with increased PEEP, alveolar recruitment manoeuvres and 100 % FiO_2. These episodes persisted intermittently until the complete mobilisation of the oesophagus and transposition of the gastric conduit into the posterior mediastinum. Cervical anastomosis was performed and

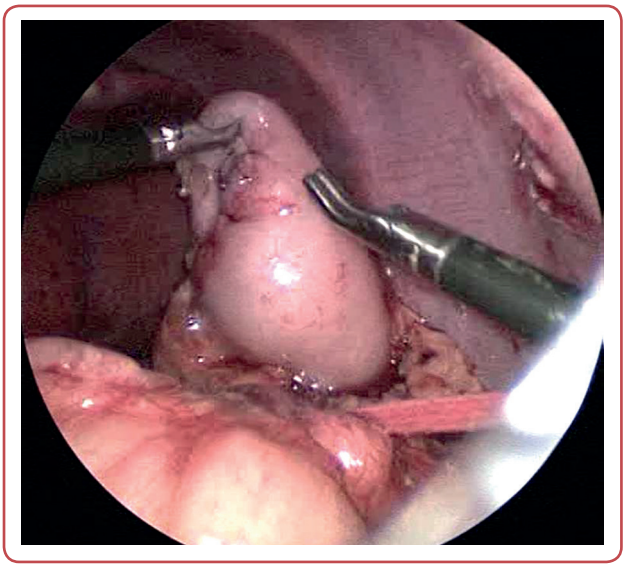

Figure 1: Gastrostomy closed and mobilizing lower oesophagus

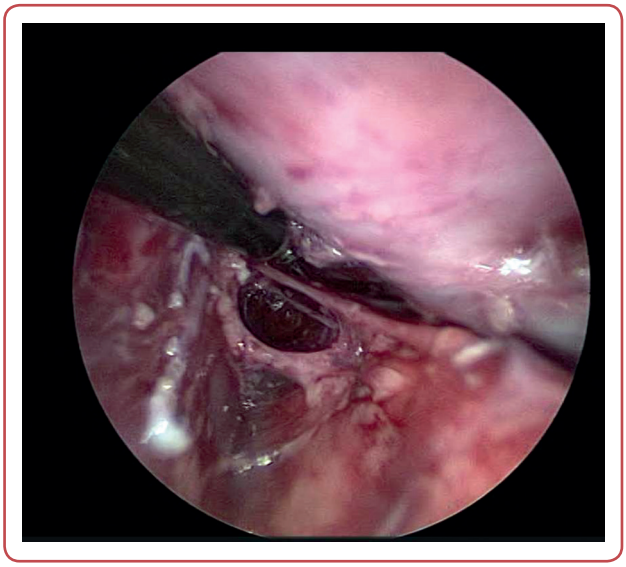

Figure 2: Posterior mediastinal tunnelling

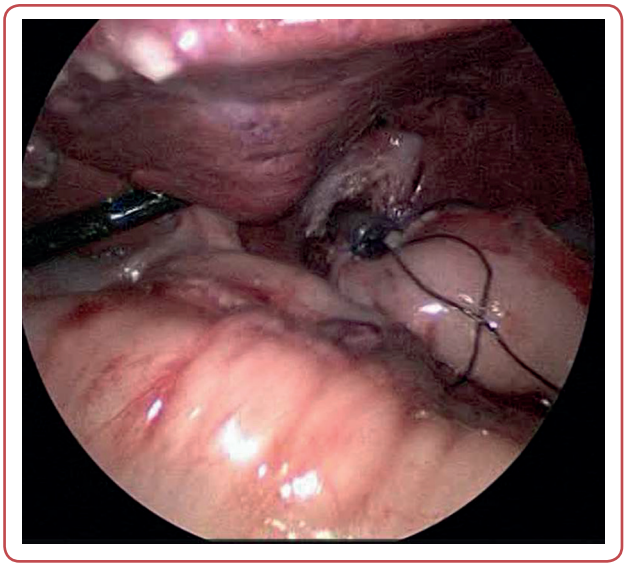

Figure 3: Mobilising oesophagus via posterior mediastinum

the hiatus was closed, although maintaining adequate ventilation remained challenging and was guided by frequent blood gas analyses.

Intraoperatively, the patient developed severe tachyarrhythmias, narrow complex (heart rate 180 to 200 bpm). Management involved administering an intravenous bolus of esmolol at 300 µg/kg/min over one minute, followed by a continuous infusion titrated between 25 to 50 µg/kg/min. A nasogastric tube was placed post-anastomosis to decompress the gastric conduit lying in the mediastinum, to facilitate postoperative contrast study and to commence the feeding.

Postoperatively the child was sedated and elec-

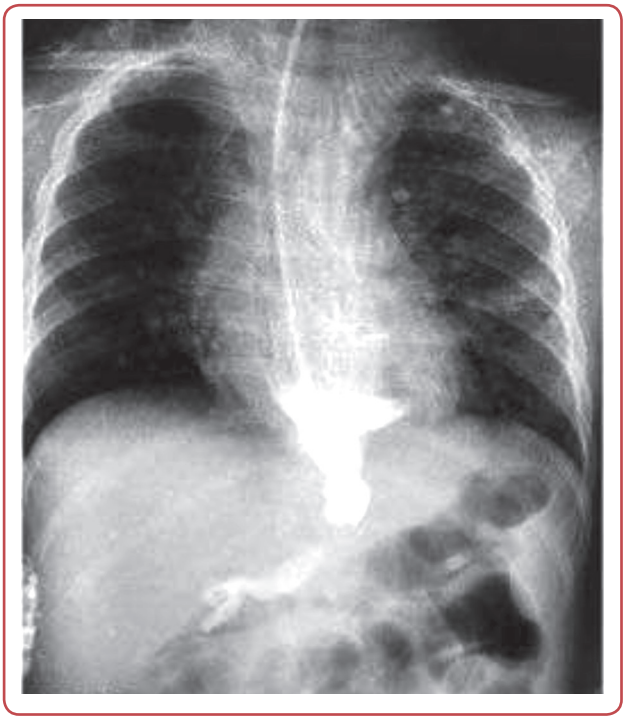

Figure 4: Barium swallow postoperative day 7

tively ventilated in the intensive care unit for 48 hours owing to high risk of respiratory distress, chances of anastomotic leak and potential airway oedema due to cervical dissection (Figure 4).[4] However, postoperatively persistent tachycardia 180 to 200 bpm was noted, managed by esmolol infusion (150 µg/kg/min) for next 24 hours and tapered thereafter. Extubation was done on postoperative day (POD) 3 and was uneventful. Post-extubation arterial blood gas analysis was normal and the recovery was good.

Discussion

The infants born with long gap proximal and distal oesophageal discrepancy represents around 10 % of all other types of oesophageal atresia with tracheoesophageal fistula cases.[1-3] The ultimate goal in managing an infant with LGEA is restoring continuity to enable oral feeding. Surgical repair involves either a primary repair, if possible, length of oesophagus present or reconstructing the oesophagus using an alternative autologous gastrointestinal segment. Gastric pull-up is a preferred surgery, mainly done for pure EA or corrosive strictures. To improve the standard of living of these children, this minimally invasive laparoscopic trans-hiatal approach offers a promising result. This approach necessitates

comprehensive preoperative evaluation and meticulous preparation due to its distinct anaesthetic challenges. Close and continuous monitoring is essential to identify and manage intraoperative complications like hypoxia, hypercarbia, lung atelectasis and tachyarrhythmias. These complications require prompt recognition and appropriate intervention.

Infants and young children are especially prone to hypoxia and hypercarbia due to mismatched ventilation and blood flow. The anaesthetic strategy focuses on minimising airway reactivity, preventing ventilation-perfusion imbalance and maintaining stable haemodynamics. This is achieved through continuous monitoring of arterial blood pressure, central venous access and frequent arterial blood gas analysis to ensure adequate gas exchange.[4]

On transposing the oesophagus into the mediastinum, hypotension may arise from cardiac compression and insufficient hydration. Yet, rectifying dehydration hastily can precipitate overhydration, potentially causing postoperative pulmonary congestion. Additional complications, such as atelectasis and pleural effusion, have been documented as consequences of trauma and inflammation resulting from mediastinal dissection.[5]

A commonly observed and significant complication is sinus tachycardia following the transposition of the stomach into the mediastinum. Timely intervention is imperative to prevent its progression into potentially devastating tachyarrhythmia.[6] The occurrence of these events may be linked to autonomic instability, which arises from the proximity of the vagal and sympathetic nerves to the repositioned stomach in the posterior mediastinum. Other contributing factors include direct manipulation of the atrium or pericardium during mediastinal dissection and increased adrenergic activity in the postoperative period.[5]

Sinus tachyarrhythmia may also result from potential vagolysis. It is important to exclude other contributing factors such as pain, insufficient muscle relaxation, inadequate depth of anaesthesia, hyperthermia and hypovolemia. In presented case, pain was managed intraoperatively by intravenous fentanyl 1 µg /kg and a continuous infusion of 0.125 % bupivacaine at a dose of 0.2 to 0.3 mg/kg/hour, delivered through a caudal epidural catheter, which was also continued postoperatively. Suspecting vagolysis as the likely contributor, an intravenous loading dose of esmolol was administered in case, resulting in a positive response. Few authors proposed the use of oral beta-blockers three days before surgery to regulate intraoperative heart rate and also the use of intravenous labetalol if tachycardia with hypertension is seen.[7]

Additionally, the patient may develop bronchospasm or pneumothorax. Also postoperatively, respiratory distress in children with TEF can stem from various factors, including the dynamic collapse of the airway and altered mucociliary clearance. When utilising the stomach as a conduit, which occupies a significant space in the infant's mediastinum, continuous decompression through a nasogastric tube is essential.[8, 9] There can be a risk of gastric reflux and aspiration postoperatively due to vagotomy for which pyloromyotomy is done.[10]

An uncommon yet noteworthy cause of respiratory distress is compression by the innominate artery, which crosses in front of the trachea above the carina.[11] During cervical dissection and anastomosis, there is a risk of tracheal oedema, which can lead to compression by the artery, resulting in complications such as chest infections and upper lobe collapse.

Conclusion

Gastric pull-up surgery for long-gap oesophageal atresia presents significant anaesthetic and surgical challenges, with a high incidence of perioperative complications such as tachyarrhythmias, pneumothorax, severe airway oedema, post-extubation stridor and respiratory distress. Invasive haemodynamic monitoring, including arterial blood pressure measurement and central venous access, is strongly recommended to facilitate precise fluid management, early identification of haemodynamic instability and safe administration of vasoactive agents. The risk of anastomotic leak and prolonged intubation further complicates recovery, as patients often struggle with secretion clearance, increasing the likelihood of respiratory compromise. Successful outcomes in these cases depend on the anaesthesiologist's close monitoring, proactive management of haemodynamic and respiratory risks, along with the surgeon's expertise.

Ethics

Our institution does not require ethics approval for reporting individual cases or case series. A written informed consent for anonymised patient information to be published in this article was obtained from the patient legal guardians (parents).

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Conflicts of interest

The authors declare that there is no conflict of interest.

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Data access

The data that support the findings of this study are available from the corresponding author upon reasonable individual request.

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