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Complications in pediatric enteral and vascular access

James S. Farrelly, MD, David H. Stitelman, MD*

Division of Pediatric General and Thoracic Surgery, Yale Children's Hospital, Yale University School of Medicine, PO Box 208062, New Haven, Connecticut 06520-8062

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ABSTRACT

Obtaining reliable enteral and vascular access constitutes a significant fraction of a pediatric surgeon's job. Multiple approaches are available. Given the complicated nature of this patient population multiple complications can also occur. This article discusses the various techniques and potential complications associated with short- and long-term enteral and vascular access.

Introduction

Pediatric surgeons are actively involved in the placement of enteral and vascular access for several purposes outlined below. It is our duty to make sure that the correct access is placed in the safest manner and cared for in the optimal way. These cases, though often straightforward, can become extraordinarily complicated both intraoperatively and postoperatively.

Enteral access

It is generally accepted that enteral nutrition is superior to parenteral nutrition for pediatric patients who cannot achieve adequate calories or medications by mouth. Most surgeons follow the dictum "if the gut works, use it." Enteral nutrition is generally less expensive and easier to manage compared to total parenteral nutrition (TPN), and enteral access also eliminates the well-documented risks of liver injury and bloodstream infections associated with TPN and the central venous catheters required for its administration. Enteral access also gives caregivers the ability to ensure compliance with vital medications and to decompress the alimentary tract in cases of chronic mechanical or functional obstruction. Given the existence of multiple enteral access devices and different techniques for placement, physicians need to understand the specific risks and benefits associated with each type of enteral access and how they relate to individual patients. One must determine the appropriate type of enteral access after taking into account the unique anatomy of the patient, the underlying pathology treated, and the estimated duration of use. Unfortunately, guidelines for enteral access decision-making, if they exist, are usually based upon meager data or expert opinion alone.

Nasoenteric tubes

Orogastric and nasogastric tubes

For most patients, the first choice for short-term enteral access is a nasogastric, orogastric, or postpyloric nasoenteric tube. A recent survey revealed that approximately 24% of neonatal inpatients have an enteral access tube in place at any one time.[1] The choice of tube varies by indication, age, and size of the patient. Nasogastric tubes are used often in cases where aspiration of gastric contents and decompression are needed. The standard 2-lumen nasogastric tube (i.e., Salem sump) is more appropriate for larger, older pediatric patients because it has side ports that will extend up into the esophagus of a small infant or neonate. In contrast, the Replogle tube, with its lumen ports located only at the tip of the tube, is usually a more appropriate choice for small infants and neonates.

When a patient is not mechanically or functionally obstructed but needs enteral nutrition, the choice of gastric versus postpyloric tubes remains controversial. Large reviews have shown similar risks of aspiration and only minor differences in feeding capacity between intragastric and postpyloric feeding.[2] Compared to postpyloric intubation, nasogastric intubation is often less challenging, allows for physiologically "normal" bolus feeding, and does not always require radiographic confirmation.[3] In patients with conditions associated with severe reflux, including congenital diaphragmatic hernia or gastroschisis, the clinician may need to place a postpyloric tube, as these patients may not tolerate gastric feeding.

* Corresponding author.
E-mail address: david.stitelman@yale.edu (D.H. Stitelman).

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While nasoenteric tube placement might seem simple compared to surgical enteral access, nasogastric tube placement can prove to be quite difficult in pediatric patients, especially in premature and extremely low-weight neonates. It is well known that premature and low birthweight neonates are at increased risk of pharyngoesophageal and gastric perforation during nasogastric tube placement, and the rate of pharyngoesophageal perforation can be as high as 4% for neonates weighing less than 750 g.[4]

To avoid injury, small soft tubes (e.g., 5, 6, or 8 Fr) should be used for nasogastric intubation in infants and neonates, but even with these relatively small-caliber tubes, excessive force can result in injury of the posterior oropharynx or esophagus. Practitioners should use caution while inserting nasogastric tubes in neonates with halting and repositioning of the tube whenever any resistance is encountered; the position should be confirmed with a radiographic study with or without a small amount of water-soluble contrast. The most common area of injury depends on the age of the patient, as neonates tend to have high pharyngoesophageal perforations while older children are more likely to have injuries to the thoracic esophagus. This difference in location of perforation is attributed to the focal narrowing of the neonatal esophagus at the cricopharyngeus muscle and a relatively underdeveloped fragile esophagus. A high thoracic injury is more likely to perforate into the posterior mediastinum, while a distal esophageal injury results more often in a right-sided pneumothorax with or without an associated pleural effusion or empyema.[5] Though mortality in adults with esophageal perforation might range from 25% to 50%, pediatric patients generally recover better, with a reported mortality as low as 4% in one series.[6]

Symptoms of iatrogenic pharyngoesophageal perforation may present in a delayed fashion and can appear clinically similar to esophageal atresia as the sump tube meets resistance and cannot pass into the stomach. Neonates with esophageal perforation can have any combination of drooling, choking, vomiting, cyanosis, and/or respiratory distress. A chest radiograph might show pneumothorax, pneumomediastinum, pleural effusion, submucosal contrast collection parallel to the esophagus, or a hypopharyngeal or esophageal "pseudodiverticulum."[7]

In contrast to the more aggressive management of adult esophageal injuries, the current standard of care for pediatric esophageal injuries is selective nonoperative management with broad-spectrum antibiotics, nothing by mouth, and parenteral nutrition.[8,9] If there is free perforation of the thoracic esophagus with pneumothorax, pleural effusion, empyema, or mediastinitis, the patient might require drainage, primary closure of the injury, or resection with diversion. This can be accomplished using an open thoracotomy or a video-assisted thoracoscopic approach.[10] Likewise, if the injury is high, then operative drainage of the neck might be indicated. If the injury is minor and the patient shows no evidence of sepsis or other complications, they can usually resume an age-appropriate diet within several days after the initial traumatic event.[11]

In older children and adolescents, nasoenteric tubes can cause a sudden, life-threatening bilateral vocal cord paralysis, a condition known as "nasogastric tube syndrome." The etiology is thought to be due to paresis of the posterior cricoarytenoid muscles due to ulceration and infection over the posterior lamina of the cricoid.[12] Management of nasogastric tube syndrome involves emergent esophagoscopy and laryngoscopy, removal of the nasoenteric tube, and appropriate measures to protect the airway (i.e., endotracheal intubation, tracheostomy, etc).

In extremely rare cases with other complicating factors, nasogastric tubes have been misplaced into the brain, pericardial space, liver, spleen, and the urinary bladder.

Nasojejunal tubes

Some physicians prefer postpyloric feeding to intragastric feeding because of a theoretical reduction in the risk of aspiration, but there is a dearth of good evidence in support of the routine use of postpyloric feeding over nasogastric feeding for patients with adequate gastric emptying. In large studies that analyzed postpyloric feeding in adults and children, no true reduction in aspiration events, aspiration pneumonia, or other complications were appreciated. In the critically ill pediatric population, however, it seems that postpyloric feeding might allow for higher caloric intake overall due to its continuous nature and bypass of the pylorus in patients with gastric dysmotility.[13] Multiple studies since the 1970s have suggested that nasojejunal tubes, perhaps due to hardening of the tube material over time, can cause perforation of the duodenum or jejunum resulting in small bowel fistulas or peritonitis.[14] These perforations can be missed due to a depressed neurological status of the patient and confusion with other adverse effects of enteric tube feeds, such as bloating, cramping, and ileus. Management of small bowel perforations caused by a nasoenteric tube requires abdominal exploration.

Other complications associated with nasoenteric tube placement are epistaxis, sinusitis, and necrosis of the nasal ala.[15] Epistaxis occurs due to erosion of the nasoenteric tube through the nasal mucosa. Though it is usually mild and can be treated with pressure with or without packing, nasoenteric tube-related epistaxis in adults can be both dramatic and life-threatening if a named vessel is involved, sometimes requiring angioembolization of the feeding artery.[16] Multiple recent studies have confirmed the presence of nasoenteric tubes as a risk factor for nosocomial sinusitis, especially in the pediatric ICU setting. Cases of sinusitis in the pediatric ICU are usually identified by a CT scan of the head and face; middle meatus culture can be performed in cases of high suspicion.[17] Management of nosocomial sinusitis includes removal of all nasal tubing, decongestants, broad-spectrum antibiotics, or middle meatus culture for targeted antibiotics.[18] Necrosis of nasal alar tissue, though not life threatening, can be cosmetically devastating and is entirely preventable with appropriate tube positioning to minimize pressure between the tube and the nasal skin. Nasogastric tubes should exit the nares caudally and be taped in a gentle curve to either side and attached to the upper lip and cheek. Patients who have necrosis of the septum, ala, or other tissue may require reconstructive surgery to repair the cosmetic or functional defect. This complication is entirely preventable with attention to detail.

Gastrostomy tubes

Patients who likely require enteral feeding support for more than 4 weeks should be evaluated for a surgical, endoscopical, or radiological placement of feeding tube.[19] Pediatric patients needing enteral access for more than 4 weeks may have a primary inability to swallow, severe gastroesophageal reflux, chronic aspiration, difficult oral medication regimen, or general failure to thrive. Despite the plethora of enteral access literature available, there remains a lack of strong guidelines or algorithms for clinicians to follow when making the decision about which type of enteral access to place, and these decisions are still made on an individual basis. Early postoperative complication rates and health care resource usage remain unacceptably high for all gastrostomy procedures, with 30-day emergency room visit and readmission rates as high as 8.6% and 3.9%, respectively.[20]