Why gastric perforation occurs in patients with isolated esophageal atresia: more vulnerable stomach?

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SUMMARY: Acer T, Karnak İ, Yalçın Ş, Şenocak ME. Why gastric perforation occurs in patients with isolated esophageal atresia: more vulnerable stomach? Turk J Pediatr 2012; 54: 312-316.

Gastric perforation (GP) in patients with isolated esophageal atresia (EA) is seen more than expected. The etiology of the perforation may be vulnerability of these immature stomachs. Gastrostomy operation should be performed by gentle handling. The volume of gastrostomy feedings should be increased incrementally. The early diagnosis of perforation is only possible with a high index of suspicion. The stomach should be visualized by gastrography with soluble contrast material as soon as the perforation is suspected.

Key words: esophageal atresia, isolated, gastric perforation, gastrostomy.

The incidence of gastric perforation (GP) due to positive pressure ventilation in patients with esophageal atresia (EA) with tracheoesophageal fistula (TEF) has been reported to be 1%[1]. Positive pressure ventilation, prematurity and hyaline membrane disease have been suggested to be predisposing factors in this group of patients.

Gastric perforation (GP) after primary repair of EA + TEF and after gastrostomy tube insertion has been reported in two cases among 19 GP patients[2]. Iatrogenic GP has also been reported following gastrostomy tube insertion in a newborn with EA + TEF[3].

Gastric perforation (GP) after gastrostomy has been reported in a patient with isolated EA[4]. The incidence of GP following gastrostomy in patients with isolated EA has been reported as 22%, which is quite striking[5]. Three isolated EA and GP cases following gastrostomy, among 31 isolated EA patients who underwent gastrostomy from 1970 to 2010, drew our attention to this special group of tracheoesophageal malformation.

Herein, the authors report three cases of isolated EA in which GP developed, following gastrostomy and feeding through gastrostomy tube, to emphasize the high likelihood of GP in this special group of tracheoesophageal malformation.

Case Reports

Case 1

A 2950 g baby boy was born to a healthy woman by cesarean section (C/S). He required endotracheal intubation because of respiratory arrest in the 2nd hour of life. Physical examination revealed a shallow abdomen, micropenis and polydactyly. Plain erect babygram showed no gas in the abdomen, feeding tube could not be propelled through the esophagus, and pouchogram demonstrated isolated EA. He was treated with continuous aspiration of the upper esophagus, broad spectrum antibiotics and parenteral nutrition. The course was complicated by renal failure and sepsis after extubation. Renal ultrasonography (US) was normal and patent foramen ovale (PFO) was detected by echocardiography. Cranial US showed nonspecific calcification in the thalamus.

Stamm-type gastrostomy was performed on the 7th day of life after improvement in his general condition. Patency of the gastric outlet and integrity of the stomach were checked by isotonic saline injection through the gastrostomy tube.

His general condition deteriorated in the first postoperative day. Gastrostomy feeding was started on postoperative day 2 after confirming absence of residue. The patient's condition

deteriorated obviously with acute renal failure and sepsis in the following four days. The feeding was stopped. Plain abdominal X-ray showed no specific finding. Purulent peritonitis was diagnosed after placement of a dialysis catheter. The patient succumbed following cardiac arrest. Postmortem examination revealed GP located on the posterior wall of the fundus.

Case 2

A 2000 g baby girl was born to a 30-year-old woman by C/S after preterm labor. She was resuscitated because of cyanosis and ineffective respiration. She had cleft palate and respiratory sounds were rough. Blood biochemical test results were in normal range; however, blood gas analyses revealed acidosis and hypercapnia.

Apneic convulsion was treated with phenytoin, and she required endotracheal intubation and mechanical ventilation under midazolam infusion because of ongoing apneic spells. The isolated EA was diagnosed on the 6th day of life through findings of gasless abdomen on plain abdominal X-ray, inability to propel the feeding catheter through the upper esophagus and visualization of the atretic end of the esophagus at the level of T4-5 on the pouchogram. PFO was diagnosed by echocardiography. Renal US examination was normal.

Stamm-type gastrostomy was performed on the 11th day of life. The course was complicated by abdominal distention, hypotonicity and inadequate circulation. The treatment of sepsis was started again. Plain erect abdominal X-ray was normal. Gastrography by giving water-soluble contrast material through the gastrostomy tube revealed leakage into the peritoneal cavity.

Surgical exploration revealed a 4-5 cm diameter perforation site on the anterior wall of the gastric corpus. Ischemic edges surrounding the perforation were excised, and the defect was closed in two layers. The gastrostomy tube was replaced and a Penrose drain was left in the area. Pathologic examination of the excision specimen showed necrosis of the stomach wall and clusters of gram-positive cocci. *Enterococcus faucium* grew in the microbiological culture of intraabdominal fluid. Antibiotherapy was given according to antibiogram results.

The postoperative course was uneventful and the patient improved well. The patient was on gastrostomy feeding, and primary anastomosis was performed at the age of 4.5 months. Cleft palate repair was performed at eight months of age. She is currently four years old with no gastrointestinal complaint.

Case 3

A 2920 g premature male was born to a 31-year-old woman by C/S. The mother was on medication for thrombosis and Hashimoto thyroiditis and was using enoxaparin, acetylsalicylic acid, tinzaparin, vitamin supplements, and L-thyroxin. He had cyanosis soon after birth and improved later without requiring endotracheal intubation. Plain erect babygram showed no gas in the abdomen, feeding tube could not be passed to the stomach, and pouchogram confirmed isolated EA. The echocardiographic examination revealed a defect in the atrial septum.

Stamm-type gastrostomy was performed on the 4th day of life. Gastrostomy feeding was initiated on the 3rd postoperative day after checking residual volume. Abdominal distention occurred the next day. Plain abdominal X-ray was normal. Gastrography showed leak of contrast material from the stomach on the 5th postoperative day.

Laparotomy showed a perforation site on the fundus located on the great curvature. Ischemic wound edges were excised and the defect was closed in two layers. Gastrostomy was revised and a tube jejunostomy was performed. A Penrose drain was left in the area. Histopathological examination of the excision material revealed edema, inflammation and fibrin deposits, and congestion in the mucosa and submucosa layers associated with hemorrhagic and necrotic regions.

The postoperative period was complicated by cardiac insufficiency and disseminated intravascular coagulation (DIC) presenting with hemorrhage from an intraabdominal drain hole on the 6th postoperative day. Broad spectrum antibiotherapy and mechanical ventilator support were initiated. The clinical picture was further complicated by acute renal failure. Extubation could be done on the 13th postoperative day. Jejunostomy feeding was started the following day. The renal function

returned to normal level. Gastrography showed an intact but small stomach, and gastrostomy feeding could be started in the 2nd postoperative month. Primary repair of the esophagus was performed successfully later.

The patient underwent an augmentation gastroplasty with a modified Hunt-Lawrence jejunal patch gastroplasty because of intolerance of normal volume feedings. He is four years of age currently, in good health and tolerates full oral feeding.

Discussion

Gastric perforation (GP) is a rare event in the newborn and the attributed predisposing factors are prematurity[6-14], hypoxia[2,4,8,11,12,15], TEF[1,4,16,17], congenital muscular defect [18], ventilation with mask or nasal continuous positive airway pressure (CPAP)[14], intestinal obstruction distal to the stomach[6,14] and orogastric tube[19]. These factors give clues about the perforation mechanism.

The hypoxia may lead to weakening of the gastric tissue and decrease its strength against pressure. On the other hand, it has also been proposed that it is not a predisposing factor since the GP and necrotizing enterocolitis (NEC) association is not that strong[6,8]. Although all patients had a history of hypoxia, and sepsis was present in two of them, the gastric wall was normal in appearance at the time of gastrostomy tube insertion in the present cases. Therefore, hypoxia may not have been a predisposing factor in our patients. However, it may be a cofactor since most authors define a history of hypoxic condition accompanying other factors[2,4,8,11,12,15].

Congenital muscular defect in the stomach wall has been proposed as an etiologic factor for perforation because of the absence of muscle layer at the edges of the perforation [18]. However, this has not been supported by animal study findings[20]. The muscle tissue was absent at the edges of experimental GP created by acute distention in a normal dog stomach. This experiment emphasizes the importance of increased intragastric pressure in the development of GP but not the congenital muscle defect. Perforation was found located on the anterior wall of the stomach in that experimental study[20]. This finding is clearly in accord with the findings of previously reported patients[2,3,6-8,12-14,21].

Several theories were established to explain the increase in the intragastric pressure. Severe distention may cause changes at the angles of the esophagogastric junction and duodenum, resulting in entrapment of air in the stomach and increase in intragastric pressure. This kind of air entrapment is not likely since the length of the abdominal esophagus is short in the newborn. However, incoordinated vomiting reflex may precipitate obstruction at the esophagogastric junction because of immaturity of coordination of the esophageal and gastric contractile function in the newborn[7]. This finding could explain why neonatal GPs are mostly seen in the first week of life, when gastric motility is irregular. Further, it is known that prematurity increases the risk of GP as the coordination between the stomach and esophagus is also immature in premature newborns[3,6-14,20,21]. The esophageal end of the gastric chamber is congenitally closed in isolated EA. The intragastric pressure increases if gastric emptying is slow or the stomach is overloaded by high volume of feedings in patients with isolated EA.

Interstitial Cajal cells, which have regulatory function on the gastrointestinal motility, have been found decreased in the perforated stomach of newborns[21]. A decreased amount of Cajal cells may cause motility dysfunction and impair gastric drainage, which leads to gastric over-distention[21].

A GP rate of 22% (2 of 9 patients) following gastrostomy in patients with isolated EA is interesting[5]. Three isolated EA and GP cases following gastrostomy drew our attention to this special group of tracheoesophageal malformation. Our previous experimental study in rabbit fetuses revealed that prevention of amnion fluid deglutition causes smaller and vulnerable stomachs and decreased levels of intestinal lactase. It has been found that gastric weight and gastric weight/total body weight were lower than in controls, and significant histological changes, which consisted of erosive gastritis, were found in the gastric tissues[22]. Similar findings were also reported by others[5,23]. Since gastrin levels were lower in patients with isolated EA[24], vulnerability of the stomach cannot be attributed to gastrin, but it can be due to lack of amniotic trophic factors. The result is impaired development

and maturation of the gastric tissue, and this may cause weakening of the gastric wall. Also, the hypoplastic nature of the stomach may result in technical difficulty during gastrostomy operation and increased risk of GP in patients with isolated EA. Similarly, Kimble et al.[5] also indicated that absence of amniotic trophic factors may be the cause of high gastric complication rates (total of 78%) in isolated EA patients.

Gastric perforation (GP) developed after starting feeding through the gastrostomy tube. The volume of feeding may exceed the capacity of the small vulnerable stomach in these patients. Additionally, inappropriate digestion due to deficiency of intestinal enzymes may cause delay in gastric emptying and may increase gastric distention. Gastric outlet obstruction was excluded by perioperative saline injection, low residual volumes during intermittent openings following 6 to 12 hours of gastrostomy tube closure, and gastrography, in all cases in the present series. In summary, neither pyloric obstruction nor primary motility defect could be the reason for GP in isolated EA cases.

We think that prompt diagnosis of GP could have been made only with a high index of suspicion in those cases. Gastrography with water soluble contrast material given through the gastrostomy tube should be done without delay to detect leakage.

Primary repair with or without partial or total gastrectomy was recommended in many reports[1-3,6-10,13,16,17,20]. The gastrostomy tube was also replaced in most cases[1,2,6,7,9,12,16,17]. Needle aspiration may be preferred in cases with acutely developing respiratory distress due to pneumoperitoneum[2,7,10,11]. The surgeon should be very gentle with respect to this vulnerable stomach during surgery. Primary repair with gastrostomy could be done in two of our cases. Feeding jejunostomy was also added in Case 3 to start enteral feeding early in the postoperative period.

Necrosis was detected in the pathologic specimens of two of our patients. No necrotic areas were found in cases that were operated within the 4th hour of perforation, but necrosis could be detected in cases operated in the 8th hour of perforation[6]. Although it is not clear whether necrosis is the cause or result, it seems the earlier the operation, the more likely it is to not find necrosis.

The mortality rate was reported as 0-62% in GP cases[2,10]. The most important factors affecting mortality are prematurity and delay in treatment[6,8,14,20]. The mortality rate was 33% in the present series.

Gastric perforation (GP) can be seen in isolated EA patients following gastrostomy and feeding through the gastrostomy tube. The cause of perforation may be vulnerability of these immature stomachs with small volume and underdeveloped or disintegrated structure. Gastrostomy operation should be performed with gentle handling of the vulnerable stomach. The amount of gastric feed should be increased incrementally and residual volume should be checked intermittently. The clinical picture of GP may be silent, and the most important clue to diagnose perforation earlier is a high index of suspicion. The stomach should be visualized by gastrography with soluble contrast material as soon as the perforation is suspected.

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