Reviews

Characteristics of postoperative complications and their role in the evolution of esophageal atresia in children.

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Abstract

Caracteristica complicațiilor postoperatorii și rolul lor în evoluția atreziei de esofag la copii

Autorii ilustrează varietatea și gravitatea complicațiilor postoperatorii ce se dezvoltă după tratamentul chirurgical primar al atreziei congenitale de esofag, inclusiv dehiscențele anastomotice, recurența fistulei traheoesofagiene, disfuncția coardelor vocale, dismotilitatea postoperatorie, stricturile anastomotice. Se atrage atenția la indicii sporiți de morbiditate și mortalitate în aceste complicații, fiind descrise unele dificultăți diagnostice și opțiuni de tratament. Autorii conchid, că fiecare din potențialele complicații survenite în atrezia de esofag reprezintă o problemă semnificativă și o provocare de gestionare a acestei malformații grave la copii, impunându-se necesitatea elaborării a noi măsuri de prevenire și metode de tratament.

Cuvinte-cheie: atrezia de esofag, fistulă traheoesofagiană, complicații, copii

Abstract

The authors illustrate the variety and severity of postoperative complications that develop after primary surgical treatment of congenital esophageal atresia, including: anastomotic dehiscence, recurrence of tracheoesophageal fistula, vocal cord dysfunction, postoperative dysmotility, anastomotic strictures. Attention is drawn to the increased rates of morbidity and mortality in these complications, describing some diagnostic difficulties and treatment options. The authors conclude that each of the potential complications of esophageal atresia is a significant problem and a challenge in the management of this serious malformation in children, requiring the development of new prevention measures and treatment methods.

Keywords: esophageal atresia, tracheoesophageal fistula, complication, child

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Actuality. Esophageal atresia (EA) is a severe congenital malformation found in the neonatal period, characterized by impaired esophageal continuity, without or with a pathological connection to the trachea, resulting in a tracheoesophageal fistula that has several configurations [17, 82]. The incidence of EA is about 1 in 2500-4500 live births [53].

Documented for the first time in 1670 by William Durston, and the first one-stage operation being successfully performed in 1941 by Cameron Haight [62], this malformation continues to present a challenge for the pediatric surgeon both in regarding the surgical technical procedure, as well as the management of postoperative morbidity [11, 43, 76]. Although postoperative mortality in this malformation has decreased significantly, the literature indicates an increased incidence of postoperative morbidity caused by both anastomotic complications [111, 113] and respiratory and gastrointestinal problems, some of which persist throughout life [37, 45]. Some studies have indicated that the incidence of postoperative complications varies between 20% and 60% [112]. Anastomotic fistulas and strictures, dysphagia, gastroesophageal reflux, motility disorders, epithelial metaplasia, tracheomalacia are frequently documented radiological, scintigraphic and endoscopic [51, 81]. In this context, there is a need for complex prospective histopathological studies in order to describe more details in the pathogenesis of these postoperative consequences, in the literature being described few reports on the histopathology of esophageal atresia with eso-tracheal fistula [1, 30, 45].

Esophageal atresia is a severe problem of pediatric surgery both by the correction of this structural malformation and by the management of its sequelae [20, 101]. Despite the remarkable results obtained in the surgical treatment of esophageal atresia, the incidence of postoperative morbidity remains increased, being identified several factors that influence the prognosis of these patients [65, 71, 111]. According to some studies, respiratory problems (about 37%), anastomotic stenosis (22% - 40%), dysphagia (15% -100%), gastroesophageal reflux requiring antireflux surgery (12%), recurrent fistulas (4% -17%) are quite common. etc. [27, 42, 51, 80].

Anastomotic dehiscence after repair of esophageal atresia continues to encounter difficulties and challenges in management, being characterized by significant mortality and morbidity, caused by the risk of infection, stricture formation, respiratory distress and delayed onset of feeding [44, 61, 74]. Anastomotic dehiscence remains the most serious postoperative complication [23], registering an incidence of 4-36% of patients operated with congenital esophageal atresia [18, 38, 110], the mortality rate being 60-80% in developing countries and up to 25% in developed countries [38, 103].

Several factors significantly involved in the mechanism of development of anastomotic dehiscences are described, such as: friable lower atretic segment, ischemia of esophageal segments, sepsis, excessive mobilization of atretic segments, imperfect suturing technique, type of suture, excessive tension of the anastomotic area, gestational age and birth weight having an impact on survival, but not on healing of anastomosis [5, 38]. Postoperative elective ventilatory support has been shown to be of paramount importance in reducing anastomotic complications by decreasing the tension of the anastomosis area [99].

In cases of anastomotic dehiscence in children with esophageal atresia, management depends largely on the degree of dehiscence and the clinical condition of the child. Anastomotic dehiscences exceeding ¼ from the circumference of the esophagus are considered major [100]. Most anastomotic leaks are found on a routine radiological examination performed 5-7 days postoperatively. The development of this complication can be suspected in cases when some elimination occur through the placed thoracic tube, in such situations it is necessary to perform radiological examination with a water-soluble contrast agent [65].

Anastomotic dehiscence can be solved by conservative methods with placement of the thoracic drainage tube, administration of broad-spectrum antibiotics and proton pump inhibitors, pareneteral nutritional support and oral aspirations [29, 100, 110] or surgically, resorting to an early thoracotomy with reconstruction of the anastomosis [110]. In some cases it may be necessary to apply cervical esophagostomy and gastrostomy with pleural lavage and reanastomosis after a certain period of time, repair with the pleura or pericardium, use of intercostal muscle patches, or gastric transposition or colonic interposition [56, 65, 100].

Chilothorax is a rare complication in children undergoing surgical treatment with esophageal atresia, with an incidence of 3%. This complication develops secondary to thoracic duct lesions following repair of esophageal atresia [26, 65]. Usually, the duct lesion produced above the level of the fifth thoracic vertebra develops in the left chilotorax, while the lesions below this level can develop a chilotorax on the right side [65].

Some pathological conditions such as anastomotic leakage or reflux of gastric contents into the thoracic cavity may mimic a chylothorax after surgery for esophageal atresia, in these cases for the purpose of differential diagnosis, being necessary to perform pleural fluid analysis, with a predominance of lymphocytes and triglycerides (> 110 mg / dl) [73].

Usually, conservative treatment is quite effective in resolving post-traumatic chylothorax (80% of cases) and includes: cessation of enteral feeding or administration of medium-chain triglycerides with or without parenteral nutrition, aimed at reducing lymph flow in the thoracic

duct. In some cases, intravenous administration of somatostatin or octreotide, repeated thoracentesis or, if necessary, the application of thoracic drainage is used. In cases of inefficiency of conservative methods, as a possible alternative stage before surgery may be the use of pharmacological pleurodesis with the instillation of various substances in the pleural space iodopovidone, bleomycin, tetracycline, etc. [86]. Some authors resort to embolization of the thoracic duct with various substances, including Lipiodol or N-butyl cyanoacrylate tissue adhesive [22]. Surgical options for resolving posttraumatic chylothorax include: thoracic duct ligation, surgical pleurodesis, mediastinal electrocoagulation, application of pleuroperitoneal shunts [65].

Recurrent tracheoesophageal fistula (TEFr) is a fairly common postoperative complication in the surgical treatment of esophageal atresia, with an incidence of 5% -10%. In 4% of patients with primary repair of EA / FTE, leaky fistulas can be found, which manifest shortly after surgery [24, 34, 91].

It is considered that in addition to improper ligation, recurrent tracheoesophageal fistula develops as a result of an abscess-shaped anastomotic dehiscence, which subsequently opens into the trachea on the suture line, which is a point with weaker resistance. In this context, some authors indicate that almost 75% of patients successfully treated for an anastomotic discharge subsequently developed tracheoesophageal fistula [34, 49]. Some authors indicate that esophageal strictures, which require force dilation, may contribute to the development of this complication [7].

Clinical symptoms include the presence of a persistent cough caused by salivary aspiration, dyspnea or apnea during feeding, recurrent pneumonia and chronic lung damage. Injection of the contrast agent under pressure through a nasogastric tube that is gradually withdrawn is a fairly sensitive diagnostic method. The diagnosis is confirmed by bronchoscopy or esophagoscopy, which occasionally requires the use of methylene blue [7, 16, 96].

Management of children with TEFr is quite difficult, the endoscopic option of solving evolving as an alternative approach [69]. Endoscopic treatment can be performed by both bronchoscopy and esophagoscopy and includes:

- Injection of an adhesive (eg fibrin or histoacryl adhesive) into the fistula or submucosal tract [32, 107].
- Deepithelialization of the fistula tract by various methods, including: cauterization, chemocauterization, sclerosis, etc. [54, 65].
- The combined method [39].

Surgical treatment of TEFr is quite difficult due to the adhesion process and mediastinal fibrosis, and the failure rate is quite high, the incidence of refistularization being about 21% and a mortality of 3% -10% [14, 91].

Vocal cord dysfunction (VCD) is a complication found in patients with esophageal atresia (unilateral or bilateral) that develops as a result of congenital or iatrogenic dysfunction of the laryngeal nerve or vagus nerve from which the laryngeal nerve originates, this complication having an incidence of 4% -50% [50, 65, 70].

More commonly, VCD is found in cases of isolated closed tracheoesophageal fistula by surgical approach [108]. The use of diathermy can cause transient or permanent damage to the vagus nerve or laryngeal nerve fibers, especially in cases where these nerves have not been clearly identified [68]. In this context, the use of thoracoscopy offers several advantages [104].

The diagnosis of VCD is made by flexible laryngoscopy or by direct laryngoscopy on spontaneous breathing [70], the identification of congenital forms requiring a preoperative laryngoscopy [66].

VCD is usually transient in most cases. The main concern in case of VCD is to ensure airway permeability. The multidisciplinary approach with the involvement of the otorhinolaryngologist is extremely important for the proper management of children with this complication, being available several treatment options, including: temporary intubation pending recovery of laryngeal nerve function, various laryngoplasty and renervation and tracheostomy. [47, 88]. Given that the most common manifestation of VCD is aspiration, these patients require some changes in diet, including thickening of the diet or the use of feeding tubes [35].

Postoperative dysmotility. Esophageal dysfunction is considered a common finding in children diagnosed and treated surgically for various forms of esophageal atresia, motility disorders being detected in 75-10 %% cases [105], their etiology remaining controversial [12, 21].

PD of the esophagus in children with esophageal atresia and eso-tracheal fistula are widely described in the literature, there are some controversies about their secondary multifactorial origin, caused by: abnormal development of vagus nerve and Auerbach plexus, vaginal nerve trauma, surgical mobilization and tauma, ischemia or major traction on the lower end of the esophagus during surgery or due to congenital architectural abnormalities [1, 90].

The dysfunction of the motor activity of the distal esophagus by anastomosis in patients with esophageal atresia with tracheoesophageal fistula was first described in 1957 by Haight, and several etiological factors were discussed, including: the presence of abnormal ganglion cells in the Auerbach plexus of muscles in the fistulous segment, the presence of tracheobronchial cartilaginous reminiscences [30], these changes being documented by us [8]. We note that impaired esophageal motility has also been found in cases of congenital esophageal stenosis

[46]. In the 70s and 90s of the twentieth century, some experimental studies have shown that esophageal peristalsis is a complex process involving both extrinsic and intrinsic innervation, experimentally demonstrating that the myogenic control system of the esophagus is able to produce contractions with a speed of propagation similar to normal esophageal peristalsis independently. This system can be modulated by extrinsic and intrinsic nerves [67, 85]. Thus, the myogenic mechanism that activates in accordance with the neural mechanisms would represent an additional level of control of the esophageal motor [77].

Esophageal motility disorders are classified into primary, secondary and tertiary. The primary motor disorders characteristic of esophageal atresia are the main cause of abnormal development of the muscular and nervous system (intrinsic and extrinsic innervation) of the esophagus, these statements being partially supported by several histopathological studies [33]. Some authors believe that traumatic surgery may contribute to esophageal dysmotility in cases of esophageal atresia due to a neurological defect caused by partial esophageal denervation [6], while several studies have found that abnormal innervation and neuromuscular defect of the esophagus are present until surgery [114]. Several authors have found the association of esophageal atresia with tracheoesophageal fistula with neural crest developmental malformations, hence the origin and innervation of the esophagus [75]. Some experimental studies have shown significant changes in the intramural nerve components of the esophagus in laboratory animals with esophageal atresia and tracheoesophageal fistula [78]. Be an important factor contributing to esophageal dysmotility observed in esophageal atresia with tracheoesophageal fistula [12, 21]. There are also clinical studies that have concluded that the significantly low density of Cajal interstitial cells in esophageal atresia is an important factor in favor of the pathogenesis of esophageal dysmotility observed in these patients [64]. However, there is little information available that would reflect the particularities of the intramural nerve components of the human esophagus in cases of esophageal atresia with lower tracheoesophageal fistula [12].

Some authors believe that pathological changes found in the arthritic segments in case of esophageal atresia with eso-tracheal fistula, including muscle distortion by fibrosis, glandular and neuronal pathological changes, the presence of tracheobronchial cartilaginous reminiscences may contribute to dysmotility and surgery after surgery. The eso-tracheal fistula should be sectioned 3 mm distally from its origin in the trachea, the morphological changes in this area being suitable for primary anastomosis [1, 30]. In children, the heterotopic gastric mucosa in the normal esophagus can often be seen on endoscopic examination (up to 5.9%), presenting as a patch with sizes ranging from a few millimeters to a few centimeters, usually single or rarely ring-shaped, asymptomatic or causing dysphagia, odynophagia, esophageal strictures, bleeding and respiratory symptoms. The association of heterotopic gastric mucosa with esophageal atresia with eso-tracheal fistula is rarely described, most cases being found endoscopically after malformation repair [40, 98]. There are studies describing the presence of gastric epithelium in both the mucosa of the proximal esophageal and distal segments [31]. Some complex studies have found that the prevalence of Barrett's esophagus is 4 times higher in young adults treated with esophageal atresia, and the prevalence of esophageal carcinoma is 108 times higher than in the general population, these findings requiring an endoscopic follow-up evaluation. of life [102].

Esophageal dysmotility in children with esophageal atresia causes the development of gastroesophageal reflux, dysphagia, eating disorders, aspiration, these symptoms persisting into adulthood, negatively influencing the quality of life. Chronic exposure of the esophageal mucosa to the action of the acid environment can lead to Barrett's esophagus and esophageal carcinoma [33, 37, 59, 89, 102].

Anastomotic strictures (AS) of the esophagus are one of the major complications, affecting 9% -79% of children undergoing surgery for esophageal atresia [84]. Among the factors involved in the pathogenesis of this complication are: suturing technique and suturing material, anastomosis dehiscences, degree of tension of the anastomosis area, gastroesophageal reflux [57, 72, 92]. There is currently no consensus on the definition of AS in children, reducing the diameter of the lumen requiring a comparison with the lumen of a normal esophagus depending on age and weight [13]. Several studies have indicated that the long-term prophylactic use of H2 blockers can prevent anastomotic stricture after surgical treatment of esophageal atresia [68]. At the same time, some authors have a reserved attitude towards the efficacy of proton pump inhibitors in SE prophylaxis [25, 28]. Clinical symptoms of anastomotic strictures include difficulty eating and swallowing, regurgitation and vomiting, insignificant addition to body mass, respiratory symptoms (cough, aspiration, recurrent respiratory infections, oxygen desaturation during feeding) [94] .

The diagnosis of anastomotic strictures includes contrast radiography of the esophagus and endoscopic examination. Radiological images allow highlighting the morphology of the esophagus and the detection of associated abnormalities, lung diseases, while endoscopy allows a proper diagnosis and combined treatment [94]. In order to quantify the severity of the stricture and monitor the effectiveness of the treatment, the anastomotic stricture index was described. Some authors have proposed that this index (SI) be calculated according to the formula:

SI = (D - d) / D x100, where D - is the diameter of the esophagus below the stricture, and d - the diameter of the stricture. Usually, patients became symptomatic in cases when SI> 50% before the onset of dilatations [9, 83]. The symptomatic structure may respond to a single dilation or may become refractory or recurrent. Anastomotic stricture is considered refractory in cases when SI> 10% after 5 sessions, recurrent stricture being considered in cases of recurrence of symptoms or SI> 50% after 4 weeks after obtaining an SI <10% [9].

It has been proposed that the esophageal anastomotic stricture index (EASI) be used as a predictor of the development and severity of anastomotic stricture after repair of esophageal atresia, this index being generated after radiological evaluation of the upper gastrointestinal tract in the early postoperative period (5- 10 days postoperatively) and represents a ratio between the diameter of the stricture and the diameter of the upper segment (U-EASI) and lower (L-EASI): EASI = (lateral d / D + d / D anteroposterior) / 2, where D is the diameter of the esophageal segment upper or lower and d is the diameter of the stricture [93].

Currently, the treatment of choice in SE is the endoscopic one, which includes several methods, the main point being the exercise of an expandable force in the lumen of the stricture and obtaining the increase of the diameter of the esophageal lumen. For this purpose, the basic methods used are expansion with spark plug or balloon catheter with radial expansion, the success rate being 58% -96% [25, 55, 87]. To improve dysphagia and maintain adequate oral nutrition in cases of SE, between 1 and 15 dilations are required [55], the frequency of dilation procedures after reconstructive operations being higher in the first 2 years of life [92]. Endoscopic evaluation is recommended after each dilation, with the aim of guiding decision making [25]. The perforation rate in case of SE endoscopic dilatations is 0.9% -8% [94, 97]. Some studies indicate that the use of balloon expansion is more effective, has fewer technical failures, and requires fewer expansion procedures compared to Savary-Gilliard-type expansion [36].

In refractory or recurrent forms of SE, it is preferable to resort to a conservative approach, before resorting to surgery, different adjuvant methods being proposed [63]. There is currently a growing interest in the use of intralesional corticosteroid injection [2, 95], a method proposed in the 1970s [4]. More frequently intralesional triamcinolone acetate, acetonides, betamethasone and dexamethasone are used [48, 109].

Some authors recommend using systemic corticosteroid therapy concomitantly with dilation procedures [41, 106].

The use of Mitomycin C, which is an antitumor antibiotic produced by *Streptomyces caespitosus* and isolated in 1958 [55], is based on the properties of inhibiting wound healing by regulating gene expression of extracellular matrix proteins, acting as an agent antiproliferative by decreasing fibroblast activity, collagen synthesis and scar formation [9]. Topical use or intralesional injection of this preparation concomitantly with SE dilation has been shown to be quite beneficial in the treatment of recurrent or refractory strictures [10, 19, 52, 58, 79]. Mitomycin C concentrations recommended in the treatment of SE range from 0.1 mg/ml to 1 mg / ml [25]. Several authors point to the usefulness of endoscopic electrocautery in the treatment of esophageal stenoses in adults [15]. Despite numerous reports of the use of this method in children, there is currently insufficient evidence to support endoscopic cauterization as an effective treatment in SE after esophageal atresia [9, 60]. In patients with strict dilatation-refractory, the temporary placement of a recoverable stent may be considered [3]. Some authors propose as an alternative the placement of the biliary stent as an effective, accessible and minimally invasive method in the treatment of refractory esophageal strictures after primary anastomosis applied in cases of esophageal atresia [36].

The inefficiency of conservative treatment in resolving refractory or recurrent esophageal stricture is found in 3% -7% of patients [9, 49]. Strict resection with esophageal reanastomosis is the most common surgical procedure performed in cases of refractory SE, segmental or total esophageal substitution being rarely used [94]. Most patients undergoing reanastomosis require postoperative dilation again, and some complications are observed, including: pseudodiverticula formation, anastomotic dehiscence, recurrent strictures [9].

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