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Innovative Surgery Treatment for Multiple Giant Esophageal Diverticula: a Case Report and Literature Review

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Abstract: *Multiple Esophageal diverticulum is a rare condition in thoracic diseases which manifests as respiratory infections, coughing during eating or drinking, hemoptysis, and sometimes fatal complications and seriously affecting the quality of life. Herein, we successfully performed surgery using innovative treatment method, a video-assisted thoracoscopic surgery (VATS) diverticulectomy using a carbon dioxide (CO_2) artificial pneumothorax on a patient with multiple giant esophageal diverticula and associated symptoms. The patient, a 59-year-old male, presented to our hospital with an 8-month history of postprandial vomiting and acid reflux. Esophagography and upper gastrointestinal endoscopy revealed multiple giant diverticula in the lower esophagus. After preoperative assessments, including electrocardiography, cardiac ultrasonography, and relevant laboratory tests, were conducted to assess the patient's condition for surgery, the patient underwent CO_2 artificial pneumothorax-assisted thoracoscopic diverticulectomy. The patient exhibited a favorable postoperative recovery. Follow-up evaluations conducted at 1 month, 3 months, and 1 year postoperatively revealed no complications, including laryngeal nerve palsy, pneumonia, or anastomotic fistula.*

Keywords: *CO_2 Artificial Pneumothorax, Multiple Esophageal Diverticula, Surgery*

1. Introduction

Esophageal diverticulum(ED) is an uncommon condition that often remains asymptomatic in its early stages. However, as the diverticulum enlarges, it may lead to symptoms such as dysphagia, acid reflux, retrosternal tightness, and other related manifestations[1]. Typically, patients experience no symptoms and may go undiagnosed until they develop challenges with swallowing, which can be problematic. The primary symptom observed is dysphagia, and the difficulty in swallowing is influenced by the size of the diverticula, their placement, and the severity of associated diffuse esophageal motility disorders[2]. Various related symptoms can occur, including regurgitation, weight loss, and certain metabolic effects[3]. The clinical manifestations of complications from ED commonly include cough resulting from food being trapped in the diverticular sac, which may lead to aspiration phenomena and even aspiration pneumonia, particularly following episodes of nocturnal regurgitation[4]. Other possible complications involve hemorrhaging at the diverticular site and esophagitis resulting from food fermentation occurring within the diverticula[5]. In cases involving the cervical region, patients often report an unpleasant sensation of a lump in the throat during the initial stages, particularly after consuming solid and dry foods[6]. As time progresses, the perception of incomplete swallowing inadvertently triggers a reflexive behavior of repeated swallowing, leading to an urgent need for liquids to resolve the swallowing challenge. Patients, particularly the elderly, typically endure this symptomatology for extended periods—sometimes spanning months or years—without seeking medical assistance[7]. It is not unusual for those diagnosed with a Zenker diverticulum to recount a prolonged history of difficulties related to swallowing[8, 9]. As the dysphagia escalates, it results from the growing size of the diverticulum, which becomes plunging and descends along the cervical esophagus. This condition obstructs the digestive passage, compromising oral nutrition and leading to

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malnutrition. Signs of food stagnation, characteristic of the diverticular sac's presence, also advance gradually over time[10]. In rare cases, acute food blockage leading to an inability to swallow is noted as the initial symptom of the disease. One early indicator of food stagnation in a pharyngeal diverticulum is the emergence of hydro-aerial sounds during fluid intake[11]. It is generally recognized that diverticula exceeding 5cm in size transition into a retentive state[12]. However, with epiphrenic diverticula, no direct relation is observed between the size and the retentive characteristic. Following this, sialorrhea may occur as a response to the challenges faced in evacuating digestive contents through the pharyngoesophageal tract. Following the development of a retentive pharyngeal-ED, spontaneous regurgitations commence, featuring undigested food consumed hours prior, which disrupts the feeding process. Patients may start to experience fetor oris, or foul breath, resulting from the breakdown of food stasis due to bacterial activity. Occasionally, cervical stasis can be observed through asymmetrical cervical regions, which are affected by variable swelling and are accompanied by hydroaerial sounds upon palpation (Boyce's sign) found in the lower section of the sternocleidomastoid muscle. Some individuals often induce the emptying of their diverticular sac through manual pressure applied to the cervical swelling, leading to regurgitation, rumination, and a subsequent return to swallowing[13]. Regarding diverticula of the esophageal body, pulmonary complications are reported in 24-45% of cases, and in 25% of instances, this is the sole manifestation of the condition[14, 15]. The occurrence of symptoms among patients with epiphrenic diverticulum ranges from 37% to 63%40. Fasano et al. discovered that all individuals with epiphrenic diverticulum larger than 5 cm exhibit symptoms, in contrast to just 41% of those with diverticula measuring less than 5 cm[16]. The diagnosis of esophageal cancer typically follows a history of symptoms lasting at least 15 years for achalasia and 10 years for epiphrenic diverticulum[17]. In other word, When the diverticulum larger than 5 cm with obvious symptoms or these symptoms become particularly severe, surgical intervention is often required.

Fundamentally, the direct connection between the existence of the diverticular sac and its clinical manifestations, alongside the consideration of particular complications, is crucial for formulating treatment strategies, which can range significantly from observation and monitoring to more invasive methods, with the associated morbidity and potential mortality being hard to overlook. The treatment strategy has two primary goals: (I) Performing a subdiverticular myotomy to address the etiological deficit underlying the diverticular problem; (II) Addressing the diverticular sac to resolve the particular diverticular issue[18]. Up to day, various methods were reported and had been recommend for the therapy of ED[19]. The treatment of the diverticular sac includes options such as diverticulectomy, diverticulopexy, or invagination (inversion), often in conjunction with subdiverticular myotomy. For the surgery therapy of multiple giant esophageal diverticula with, skilled cooperation with the anesthesiologist is necessary. However, in some resource-limited settings, there may be a shortage of skilled anesthesiologists, posing a challenge. A video-assisted thoracoscopic surgery (VATS) diverticulectomy using a carbon dioxide (CO2) was a novel technique which was has become the standard approach for some normal thoracic diseases such as minimally invasive lung resections. The concept of CO2 artificial pneumothorax was first introduced in 2006 by Palanivelu[20] et al and used in minimally invasive resection of esophageal cancer. Compared to traditional open thoracotomy, VATS is associated with less postoperative pain and a shorter recovery period[21]. Nevertheless, CO2-MP-VATS has rarely been reported in the therapy of multiple giant ED. Thus, in the present study, we successfully performed a video-assisted thoracoscopic surgery (VATS) diverticulectomy using a carbon dioxide (CO_2) induced artificial pneumothorax in a patient with multiple giant esophageal diverticula.

2. Case Report

A 59-year-old male patient presented to our hospital with an 8-month history of intermittent vomiting and acid reflux. The patient had been in good health and had no significant medical history, although he had a 40-year history of smoking. A physical examination revealed no significant abnormalities. Upon admission, upper abdominal computed tomography (CT) and upper gastrointestinal tractography revealed two large diverticula in the lower esophagus with signs of infection (Fig.1 A-B).

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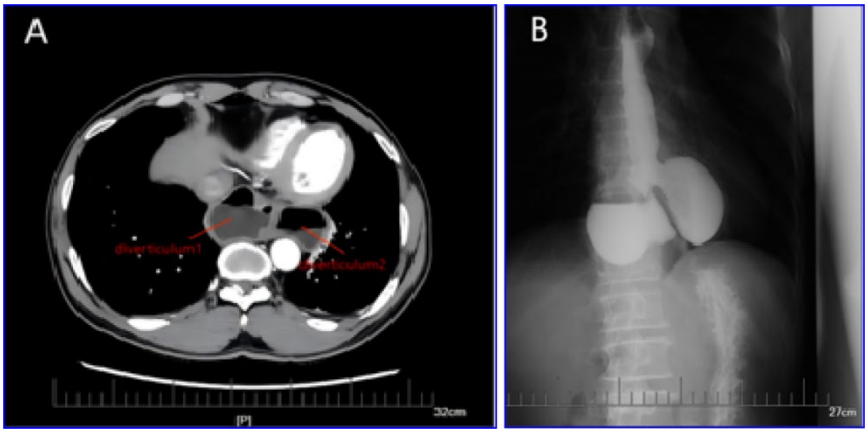

Figure 1 (A) CT and angiography; (B) showed multiple giant diverticula in the lower oesophagus, measuring about 69 x 73 mm and 50 x 37 mm respectively.

The patient was placed on fasting and underwent an upper gastrointestinal endoscopy, which identified two large diverticula in the lower esophagus, located 41 and 45 cm from the incisors. Upon irrigation of the diverticula, an indentation measuring approximately 0.8 cm was observed in the left diverticulum. Histopathological examination of the biopsy specimens confirmed the absence of malignancy. A duodenal tube was then inserted to facilitate gastrointestinal decompression and administer enteral nutritional support. Preoperative assessments, including electrocardiography, cardiac ultrasonography, and relevant laboratory tests, were conducted to assess the patient's condition for surgery.

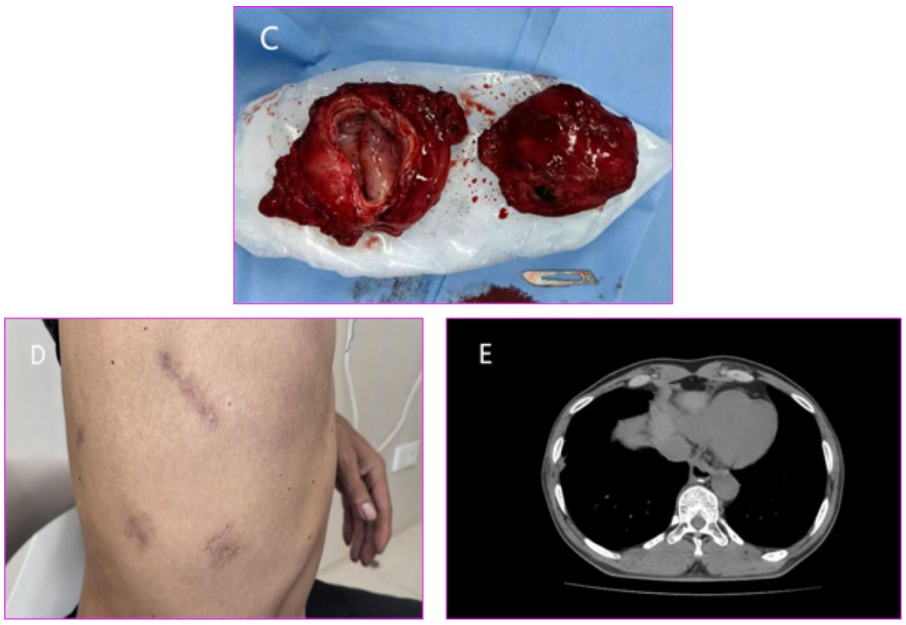

Figure 2 (C)Two surgically removed oesophageal diverticulum specimens; (D)Patient's wound healing and CT; (E) performance one year later

After preoperative preparation, we performed thoracoscopic surgery on the patient. The patient was positioned in the left lateral recumbent position with a 30° forward tilt. A 1.2 cm surgical incision was made in the right posterior axillary line at the 8th intercostal space to serve as the thoracoscopic observation port. A second incision measuring 0.5 cm was made along the anterior axillary line at the right 8th intercostal space. Moreover, a 1.2 cm incision was made at the mid-axillary line of the 5th intercostal space, and another 1.2 cm incision was performed between the posterior axillary line of the 7th intercostal space and the scapular line. The incisions served as operative ports through which trocars were inserted. One of the trocars was connected to a pneumoperitoneum machine, facilitating the insufflation of CO_2 into the thoracic cavity at a flow rate of 2 L/min. This maintained intrathoracic pressure at 8 mmHg and induced rapid lung atrophy. We then released the right lung adhesion, opened the mediastinal pleura, separated it, and mobilized the lower and middle esophagus. Two large diverticula were observed on the right and left sides of the lower and middle esophagus, which were

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resected and sutured using the Ethicon II60 cutter. The partial lower esophagus was incised to the cardia low esophageal sphincter muscle, followed by the placement of interrupted sutures and embedded edges. A gastric tube was placed in the lower and middle esophagus, and it was clamped near the cardia. No evidence of abnormal leakage from the wound was observed following the injection of 100 mL of Methylene Blue and normal saline into the gastric tube. After adequate hemostasis was achieved, we retained the gastric and duodenal nutritional tubes, placed a chest drainage tube, and closed the chest wall incision. We then measured the size of the two esophageal diverticula, which were approximately 5.5 × 3.5 × 3.4 cm and 5.8*4.2*3.9 cm (Fig. C).

The patient exhibited a favorable postoperative recovery. Follow-up evaluations conducted at 1 month, 3 months, and 1 year postoperatively revealed no complications, including laryngeal nerve palsy, pneumonia, or anastomotic fistula (Fig.2 D-E).

3. Discussion

Esophageal diverticulum (ED) represents an uncommon condition characterized by the protrusion of either the esophageal mucosa or the complete parietal layer beyond the esophageal wall [22, 23]. The clinical consequences can vary significantly, depending on factors such as the size and location of the diverticulum, with those situated distally being the most likely to present symptoms[18]. Nonetheless, many EDs are either minimally symptomatic or completely asymptomatic and are sometimes identified during examinations of the upper gastrointestinal tract. A common clinical manifestation includes dysphagia, which may be accompanied by regurgitation, and as the diverticulum enlarges, it can lead to the secondary complications caused by the compression of nearby structures[24, 25].

Recently, a few case reports have described multiple giant esophageal diverticula[3, 26, 27]. Most lower-middle esophageal diverticula are associated with underlying esophageal dyskinesia, most commonly pancreatic achalasia[28]. The incidence of esophageal diverticula is estimated to be 1 case per 500,000 people per year, with a prevalence of 0.06%–4% based on radiological and endoscopic findings[29]. This patient was admitted with prominent symptoms of postprandial vomiting and acid reflux, and investigations revealed multiple large diverticula exceeding 4 cm. In cases of symptomatic giant diverticula, as reported in the literature, surgical excision is considered the optimal treatment[30]. While the size of the diverticulum alone is not an indication for surgery, spontaneous rupture has been observed in some patients with large diverticula[31]. Here, we performed diverticulotomy on this patient by artificially inducing a pneumothorax using CO_2 during the surgical procedure. This technique involves the continuous insufflation of CO_2 into the thoracic cavity through an artificial pneumoperitoneum machine, with carefully controlled flow rate and pressure. This ensures the establishment of stable, continuous positive pressure within the pleural cavity. As a result, the approach facilitates optimal surgical field exposure by inducing a controlled lung collapse and enhancing the visibility and accessibility of the operative area[32].

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