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CASE REPORT

Laparoscopic long myotomy and Dor fundoplication guided by perioperative endoscopic ultrasound

Daisuke Ueno[1] · Hideo Matsumoto[1] · Noriaki Manabe[2] · Takaaki Ensako[1] · Haruaki Murakami[1] · Masaharu Higashida[1] · Rui Nakato[3] · Akiko Shiotani[3] · Ken Haruma[2] · Toshihiro Hirai[1]

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Abstract An 80-year-old man with diffuse esophageal spasm underwent high-resolution manometry perioperatively and postoperatively. Integrated relaxation pressure was normal, and distal latency and peristaltic waves had disappeared. Endoscopic ultrasound (EUS) revealed esophageal muscle layer thickening to more than 1 cm in an area spanning the esophagogastric junction to the oral side. Laparoscopic long myotomy (LM) was performed followed by Dor fundoplication. The patient was discharged with a good postoperative course. Perioperative EUS-guided LM via the transhiatal approach was useful in this case.

Keywords Esophageal function disorder · Long myotomy · Endoscopic ultrasound · Dor fundoplication · Esophageal muscle hypertrophy

Introduction

Diffuse esophageal spasm (DES) and jackhammer esophagus are idiopathic motility disorders that cause uncontrolled contraction of the esophagus. In long myotomy (LM) for esophageal function disorders (EFDs) of the lower esophagus, the length of the incision from the esophagogastric junction (EG-J) to the oral site is controversial. A case of achalasia treated via endoscopic ultrasound (EUS)-guided LM was reported [1]. Conversely, no case of EUS-guided laparoscopic LM for EFD has been reported. In this study, we present a patient with EFD who was successfully treated using esophageal LM through the hiatus and Dor fundoplication (DF). The upper limit of the myotomy was confirmed by intraoperative EUS. We report the usefulness of intraoperative EUS for confirming esophageal muscular wall thickening.

High-resolution manometry (HRM) is an esophageal motility diagnostic system that measures intraluminal pressure activity in the esophagus using a series of 36 closely spaced pressure sensors. The sensors are distributed longitudinally and radially in the esophagus to permit simultaneous pressure readings in both sphincters and the interposed esophagus. An INSIGHT G3 HRiM catheter (Sandhill Scientific Inc., Highlands Ranch, CO, USA) was used to perform HRM, a GIS-H260 (Olympus, Tokyo, Japan) was used to perform gastrointestinal endoscopy (GIS), and a UM-3R 20 MHz (Olympus) was used to perform EUS.

Case report

An 80-year-old man with a multi-year history of dysphagia was referred to our hospital. He had no histories of any other conditions. Laboratory data revealed no obvious abnormalities. Contrast-enhanced computed tomography (CT) uncovered esophageal wall thickening to the level of the tracheal bifurcation, and fluoroscopic esophagography (FE) identified segmental contraction (Fig. 1a, b). GIS revealed a normal mucosal layer with mild corkscrew-like changes (Fig. 1c). EUS uncovered thickening of the middle–lower esophageal muscle layer (Fig. 1d). Esophageal

✉ Daisuke Ueno
daisuke0111@hotmail.co.jp

[1] Department of Digestive Surgery, Kawasaki Medical School, Matsushima, 577 Kurashiki, Okayama 701-0192, Japan

[2] Division of Endoscopy and Ultrasonography, Department of Clinical Pathology and Laboratory Medicine, Kawasaki Medical School, Kurashiki, Japan

[3] Department of Gastroenterology, Kawasaki Medical School, Kurashiki, Japan

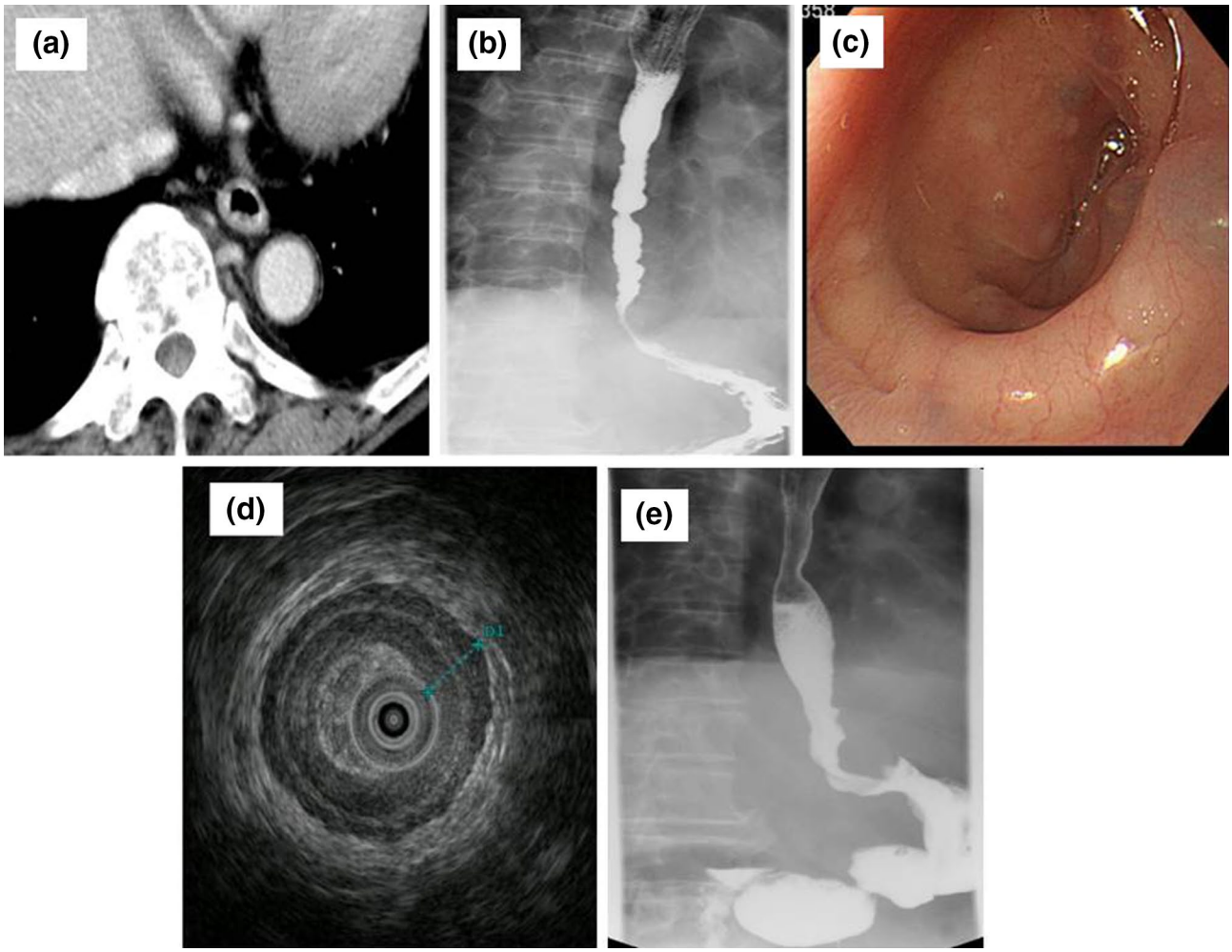

Fig. 1 Findings on preoperative examination. **a** Computed tomography revealed mild thickening of the esophageal wall to the height of the tracheal bifurcation. **b** Preoperative fluoroscopic esophagography revealed segmental contraction of the middle and lower esophagus. **c** Gastrointestinal endoscopy revealed normal mucosal findings, and synchronous contraction was found approximately 30 cm from the incisor line. Some contraction was spiral. **d** Endoscopic ultrasound revealed mild thickening of the middle–lower esophageal muscle layer. **e** Postoperative fluoroscopic esophagography revealed a delay of contrast medium movement under the carina, but there was no delay to the stomach

HRM disclosed no peristalsis in the esophageal body and fully synchronized waves of contraction with a marked increase in esophageal body pressure to 30 mmHg. The integrated relaxation pressure (IRP) and distal contractile integral (DCI) were 16.8 mmHg and 365 mmHg s cm, respectively. The lower esophageal sphincter (LES) pressure was normal at 30.3 mmHg (Fig. 2a). He was diagnosed with DES, and we planned to perform laparoscopic esophageal LM and DF.

Under the five ports, the left lobe of the liver was freed by cutting the triangular ligament, and the vagus nerve and abdominal esophagus were taped. We performed the peeling between the esophagus and hiatal crus. Without dissecting the hiatal crus, we lifted using a long hook on the ventral side of hiatal crus. In this manner, observation up to the height of the tracheal bifurcation was possible. When the laparoscopic light was deactivated, the light of the endoscope, which indicated the end of thickness of the muscle layer, could be confirmed. Then, we proceeded with esophageal myotomy from the EG-J to the end of thickening. In this manner, laparoscopic esophageal LM was performed. Thickening of the muscle was observed mainly in the inner muscle layer from the EG-J to the level of the left inferior pulmonary vein, followed by a 2-cm gastric myotomy for the distal side. The myotomy was performed using ultrasonic incisors (Harmonic Ace®, Ethicon Endo-Surgery Inc., Cincinnati, OH, USA).

Esophageal HRM revealed waves of contraction 1 month after surgery (Fig. 2b). IRP had increased to 17.8 mmHg, and LES pressure had decreased to 11.6 mmHg. On FE,

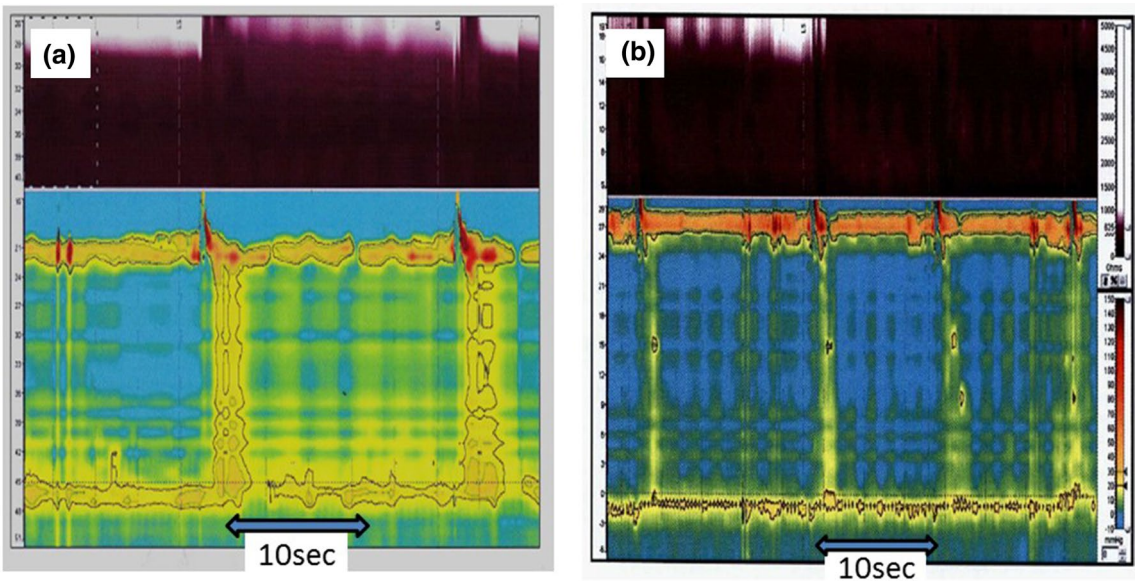

Fig. 2 Esophageal high-resolution manometry. **a** Preoperative: esophageal high-resolution manometry revealed no peristaltic waves in the esophageal body. **b** Postoperative: esophageal high-resolution manometry uncovered no peristaltic waves in the esophageal body similarly as the preoperative analysis

Table 1 The three cases of diffuse esophageal spasm which being performed laparoscopic long myotomy and Dor fundoplication

	Sex	age	IRP (mmHg)	IRP* (mmHg)	DCI (mmHg s cm)	DCI* (mmHg s cm)	LESP (mmHg)	LESP* (mmHg)	Residual LESP (mmHg)	Residual LESP* (mmHg)
Case 1	80	Male	16.8	17.8	365	3	30.3	11.6	−0.5	5.5
Case 2	52	Male	28.3	11.9	5962	667	31.3	10.6	6.9	3.1
Case 3	62	Male	20	−1	2608	324	27.7	3.0	1.4	1.1

IRP integrated relaxation pressure, *DCI* distal contractile integral, *LESP* lower esophageal sphincter pressure

* Postoperative

segmental contraction had disappeared, and the flow of barium to the stomach was not delayed (Fig. 1e). The patient's symptoms had improved.

Discussion

DES was classified in 2015 under the Chicago classification [2]. The diagnostic criteria of DES are as follows: (1) normal median IRP, (2) ≥20 % premature contractions with DCI > 450 mmHg/s/cm, and (3) the presence of normal peristalsis to a certain extent. Although not established in medical therapy, acid secretion inhibitors, calcium antagonists, nitrites, and phosphodiesterase-5 inhibitors have been used previously. Also, surgery is indicated if pharmacological treatment, botulinum toxin injection, and pneumatic dilation are ineffective. Recently, per-oral endoscopic myotomy (POEM) was introduced to treat achalasia and DES. Successful treatment of jackhammer esophagus by extended POEM has been reported [3].

We also performed laparoscopic LM and DF for two other cases of DES (Table 1). The operative times for Cases 1, 2, and 3 were 122, 233, and 160 min, respectively. Slight blood loss was observed in Cases 1 and 3. However, blood loss in Case 2 equaled 540 ml, because adrenalectomy was performed simultaneously for suspected pheochromocytoma. We believe that LM and DF alone can be performed with minimal bleeding. All patients were discharged with good postoperative courses and symptom improvement.

LM for DES was first reported in Japan by Sato and colleagues [4]. Also, we performed muscle layer incisions for perioperative EUS-guided EFD, as reported previously [5]. If coordination dysfunction is observed despite normal LES pressure, a muscle layer incision including the EG-J is recommended [6]. The normal thickness of the muscle layer of the esophagus is 0.4 cm [7]. We defined muscle

layer thickening of the esophagus as a thickness exceeding 1.0 cm, and we attempted to perform a muscle layer incision at that level. It may be difficult to decide the oral side of myotomy for EFD. EUS-guided myotomy is possibly beneficial for clarifying the correct incision level.

Richards et al. [8] reported that 43 patients who underwent myotomy plus DF for achalasia had significantly fewer gastroesophageal reflux symptoms (9 vs. 48 %). On the contrary, in a study of 500 patients who underwent POEM for achalasia, Inoue et al. [9] reported GERD symptoms after POEM in 16.8–21.3 % of patients. Therefore, we selected LM and DF for EFD to reduce the risk of symptomatic gastroesophageal reflux. The muscle layer incision may be performed via thoracotomy relatively safe at the height of the tracheal bifurcation. However, in thoracotomy, it is difficult to perform DF. Moreover, the technique is highly invasive, and it is not desirable to perform both laparotomy and thoracotomy. Therefore, the strategy for treating EFD first proceeds with LM and DF by a laparoscopic approach via the transhiatus. When the patient displays postoperative dysphasia, the addition of POEM for the insufficient part of myotomy should be considered.

Dogan et al. [10] indicated that increased muscle thickness/muscle cross-sectional area is the result of EFD and a substantial proportion of other types of esophageal motor dysfunction, in addition to its presence in manometrically normal symptomatic patients. Also, they reported that nearly all patients with EFD had an increased muscle thickness or muscle cross-sectional area. Therefore, LM and DF may be useful against EFD in patients who do not respond to conservative medical treatment.

Because we encountered only three cases, a larger number of cases should be examined. We believe muscle layer incision guided by perioperative EUS is useful for treating EFD.

Conclusion

We experienced a case in which perioperative EUS-guided LM via the transhiatal approach was useful.

Ethical Statement All procedures followed were performed in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and the Helsinki Declaration of 1964 and later versions. Informed consent or a substitute was obtained from all patients for inclusion in the study.

Conflict of interest The authors have no conflicts of interest to declare.

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