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## Thoracoscopic plication for idiopathic eventration of the bilateral diaphragm: Report of a case



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### ABSTRACT

**INTRODUCTION:** Diaphragmatic eventration, defined as permanent elevation of the diaphragm without defects, is a rare anomaly in adults. Trauma, neoplasms, infection, and degenerative disease are the most common causes of this condition, whereas idiopathic eventration of the diaphragm is relatively infrequent.

**PRESENTATION OF CASE:** We herein present the rare case of an 85-year-old female with idiopathic eventration of the bilateral diaphragm. The patient demonstrated a rapidly progressive course with dyspnea; therefore, thoracoscopic surgery of the unilateral diaphragm was performed. She subsequently withdrew from home oxygen therapy, which had introduced preoperatively, and exhibited a significant improvement in her pulmonary function for one year after the operation.

**DISCUSSION:** Various approaches for diaphragmatic plication have been reported, including open (transthoracic or transabdominal) and minimally invasive methods, such as thoracoscopic or laparoscopic plication. We consider thoracoscopic plication to be an effective minimally invasive method, although single-lung ventilation is required.

**CONCLUSION:** We experienced a case in which thoracoscopic plication of the unilateral diaphragm resulted in adequate objective improvements in the pulmonary function in a patient with idiopathic eventration of the bilateral diaphragm.

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## 1. Introduction

Diaphragmatic eventration, which is more common in males, is a rare anomaly defined by permanent elevation of the diaphragm without defects, representing atrophy and progressive distension of the diaphragmatic muscles. The presence of diaphragmatic eventration in adults indicates different possible etiologies, including trauma, neoplasms, infection, degenerative disease and idiopathy. Congenital eventration is rarely recognized in adulthood alone [1].

Surgical treatment is indicated only in the presence of symptoms [2]. The established surgical therapy is diaphragmatic plication, which can be achieved with various techniques and approaches, such as transthoracic or transabdominal, open or closed and/or minimally invasive methods [2]. We herein, describe

the use of video-assisted thoracoscopic plication of the right hemidiaphragm in a patient with idiopathic eventration of the bilateral diaphragm.

## 2. Case report

An 85-year-old female with right diaphragmatic eventration newly detected on a chest roentgenogram (Fig. 1A) visited our hospital. She had no symptoms, and was therefore, followed closely without treatment. Two months later, she presented with dyspnea, and bilateral diaphragmatic eventration was detected on chest X-rays (Fig. 1B), without any underlying causes, such as neoplasms, trauma, infection or neuromuscular disorders. Computed tomography scans showed neither intrathoracic tumors nor a subphrenic process causing the diaphragmatic eventration. An arterial blood gas analysis performed under room air revealed the following data: pH 7.389; carbon dioxide tension 47.2 mm Hg; oxygen tension 62.3 mm Hg; base excess 2.3. Spirometry showed a forced volume capacity (FVC) of 800 ml (40.6% of predicted) and forced expiratory

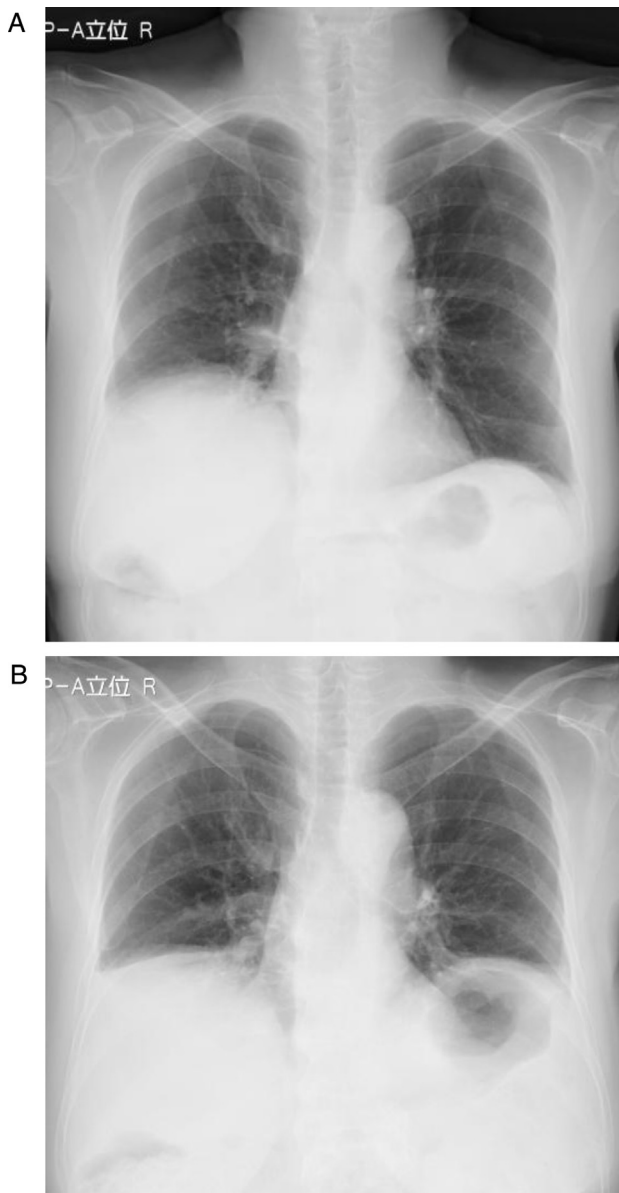
*Abbreviations:* FVC, forced volume capacity; FEV<sub>1.0</sub>, forced expiratory volume at 1 second; HOT, home oxygen therapy; VATS, video-assisted thoracoscopic surgery.

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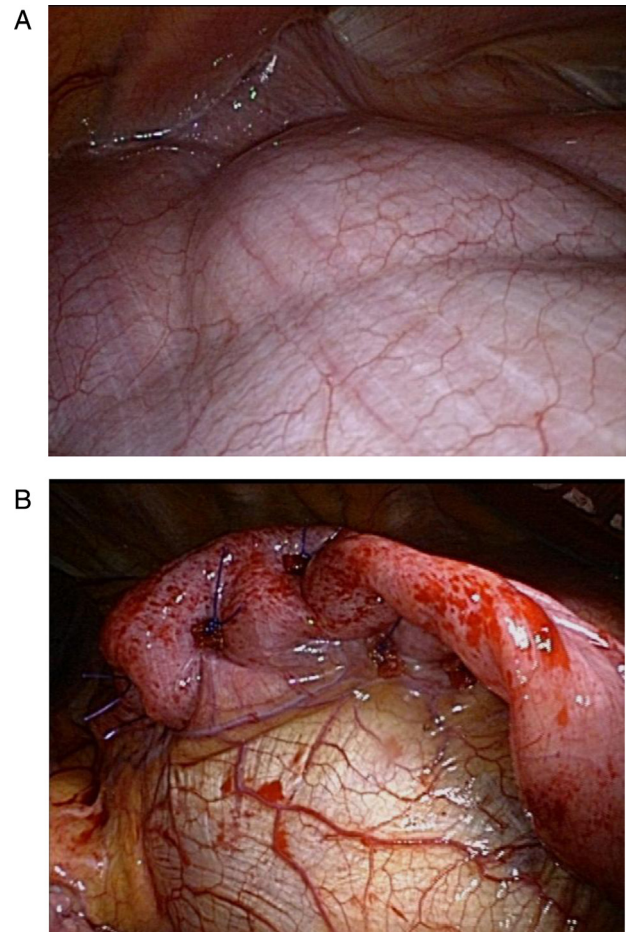
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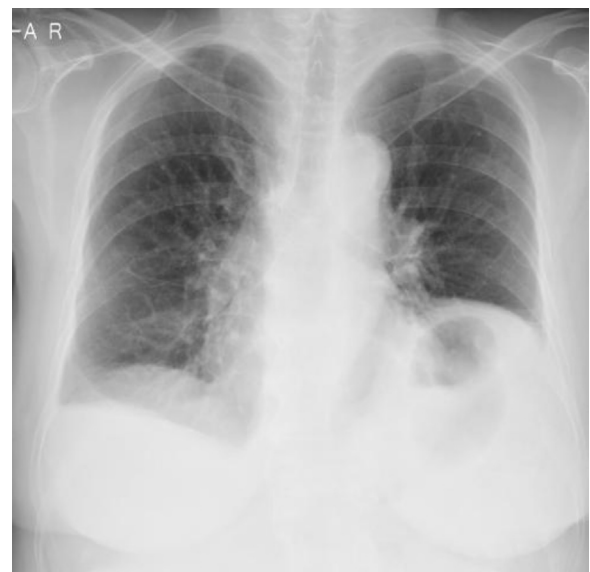


**Fig. 1.** (A) Chest X-rays show right diaphragmatic eventration. (B) Chest X-rays reveal eventration of the bilateral diaphragm.

volume in 1 s ( $FEV_{1.0}$ ) of 550 ml (38.1% of predicted). She required home oxygen therapy (HOT) and surgical treatment was considered to be essential due to her progressive dyspnea. Plication of the right diaphragm using video-assisted thoracoscopic surgery (VATS) was performed in order to avoid injury to the intestines. A 10-mm port was placed in the ninth intercostal space along the postaxillary line, followed by 4-cm mini thoracotomy in the eighth intercostal space in the left decubitus position. The lung was deflated to reveal the right diaphragm, and the operative findings showed the right diaphragm to be pushed up toward the thoracic cavity by the celiac organs (Fig. 2A). We subsequently performed plication using interrupted horizontal mattress sutures with polypropylene and absorbable pledgets to prevent the device cutting through the tissue (Fig. 2B). The patient's symptoms disappeared immediately after the procedure, and postoperative chest X-rays showed the right diaphragm to be fixed in the normal location (Fig. 3). The patient was then withdrawn from HOT, and thereafter, exhibited an uneventful postoperative course for one year after the operation.



**Fig. 2.** (A) The operative findings show the right diaphragm to be pushed up toward the thoracic cavity by the celiac organs. (B) We performed plication using interrupted horizontal mattress sutures with polypropylene and absorbable pledgets to prevent the device cutting through the tissue.



**Fig. 3.** Chest X-rays after the operation show the right diaphragm to be fixed in the normal location.

**Table 1**  
FVC and FEV<sub>1.0</sub> preoperatively, 1 month and 12 months postoperatively.

	Preoperatively	1 month postoperatively	1 year post operatively
FVC	800 ml	1180 ml	1200 ml
FEV <sub>1.0</sub>	550 ml	810 ml	900 ml

FVC: forced vital capacity and FEV<sub>1.0</sub>: forced expiratory volume.

### 3. Comment

The incidence of diaphragmatic eventration is difficult to estimate. In one study, Christensen and associates identified 38 patients among 107,778 examined adults [3]. The disease can be unilateral or bilateral, although it usually involves the left hemidiaphragm. Furthermore, it can be partial, localized to a portion of the hemidiaphragm (anterior, posterolateral, medial) or complete, affecting the entire hemidiaphragm.

Most adult patients with diaphragmatic eventration remain asymptomatic, and the diagnosis is made incidentally on chest radiography. Among symptomatic patients, the most common symptom is dyspnea. Surgical treatment is indicated only in the presence of symptoms [2]. Trauma, neoplasms, infection, degenerative diseases and iatrogeny (surgery in the mediastinum/cardiac region) are the most common causes of diaphragmatic eventration. Less commonly, a cause cannot be identified (idiopathic eventration). The true incidence of this pathology is unknown, most likely attributed to under-recognition. In the current case, no particular etiology of the diaphragmatic eventration was confirmed; therefore, we diagnosed the patient to have idiopathic diaphragmatic eventration.

The first patients diagnosed with diaphragmatic eventration were reported by Petit in 1774, while Morrison published the first case of surgical repair in 1923 [4]. As a result of the initial description of repair, several articles subsequently focused on the indications for surgery in addition to operative techniques and results [5,6]. All surgical techniques aim to reduce the size of the abundant diaphragmatic surface and lower the diaphragmatic dome. Various approaches for diaphragmatic plication have been reported, including open (transthoracic or transabdominal) and minimally invasive methods, such as thoracoscopic or laparoscopic plication [2]. We consider thoracoscopic plication to be an effective minimally invasive method, although single-lung ventilation is required. Various suturing methods have also been applied, including the use of (buttressed or not) interrupted horizontal mattress sutures, multiple parallel U sutures, continuous running sutures and endo staplers. In addition, a variety of non-absorbable and absorbable sutures have been used. In the present case, we employed interrupted horizontal mattress sutures with polypropylene and absorbable pledgets to avoid cutting through the tissue for diaphragmatic plication. We believe that non-absorbable sutures are preferable in such cases, particularly when approximating non-muscular parts. The mini thoracotomy incision must be made near the sites of diaphragmatic insertion; otherwise, it can be difficult to begin suturing. The ninth and tenth inter-costal spaces have been reported to be the most suitable sites [7]. However, we obtained a comfortable view and working space using the eighth intercostal space in this case. Importantly, we thought that performing mini thoracotomy using the eighth intercostal space would particularly facilitate suturing at the mediastinal site.

The surgical treatment significantly improved the patient's respiratory condition. An arterial blood gas analysis performed under

room air revealed the following values: pH 7.420; carbon dioxide tension 45.3 mm Hg; oxygen tension 73.3 mm Hg; base excess 2.3, and spirometry showed an FVC of 1200 ml (66.2% of predicted) and FEV<sub>1.0</sub> of 900 ml (67.6% of predicted) one year after the operation (Table 1). We performed plication of the right diaphragm only in this patient with idiopathic eventration of the bilateral diaphragm in order to avoid injury to the intestines; however, she displayed a significant improvement in her pulmonary function for one year. Therefore, she was followed without treatment for the left diaphragmatic eventration.

In conclusion, we herein presented a case in which thoracoscopic plication of the unilateral diaphragm resulted in adequate objective improvements in the respiratory quality of life and pulmonary function in a patient with idiopathic eventration of the bilateral diaphragm. We believe that thoracoscopic plication of the diaphragm is therefore, a feasible and appropriate treatment for diaphragmatic eventration.

### Conflict of interest statement

None.

### Funding

None.

### Author contribution

Yoshinobu Ichiki: study design, data collections, data analysis, writing.

Shotaro Korehisa, Junji Kawasaki: data collections.

Takayuki Hamatsu: data collections.

Taketoshi Suehiro: data collections.

Makiko Koike: data collections.

Fumihiko Tanaka: study design, data collections, data analysis.

Keizo Sugimachi: data collections.

### Consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

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