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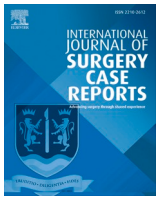

Case report

Robotic repair of a giant Larrey-type congenital left-sided diaphragmatic hernia in a young woman. A case report and literature review

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ABSTRACT

Congenital diaphragmatic hernia is a rare condition caused by a malformation in the diaphragm that is usually diagnosed in newborns, infants and children. Sometimes it can be incidentally identified in adults. Once the diagnosis is made, surgery is indicated to avoid the risk of life-threatening complications of herniated viscera. Traditional approaches include laparotomy or thoracotomy or both; in the last decades minimally invasive techniques have proved to be a safe alternative to the open approach but only few cases of robotic hernia repair have been described so far, the most with a combined thoracic-abdomen approach. We report a case of an 18-year-old female presenting with abdominal pain due to a giant left-sided anterior diaphragmatic hernia (Larrey-type) that was repaired using a robotic-assisted laparoscopic approach with mesh placement. The hernia contents included gastric body and fundus, duodenum, jejunum, ileus, cecum, right colon and mesentery; spleen and pancreas were rotated and dislocated anteriorly. The outcome was unremarkable, with no major post-operative complications and no signs of long-term recurrence. The robotic approach seems to be a valid option for the treatment of diaphragmatic hernias, improving post-operative outcome and providing surgeon better visualization, greater precision and enhanced dexterity in a confined space.

1. Introduction

Congenital diaphragmatic hernia is a rare congenital malformation of the diaphragm, with an incidence of 0.08-0.45 per 1000 births [1]. The spectrum of this malformation includes Bochdalek hernia (the most common type – 95 % of all diaphragmatic hernias), Morgagni-Larrey hernia (also known as retrosternal or parasternal – only 2 %), diaphragm eventration and central tendon defects [2]. Bochdalek hernia is a posterolateral diaphragmatic defect, usually located in the left side of the diaphragm because of the presence of the liver that protects the right side. Morgagni-Larrey hernia is an anterior defect that consists on the migration of abdominal viscera usually on the right side through the foramina of Morgagni (Morgagni hernia, 70–90 %) and less frequently in the left side through the Larrey's space (Larrey hernia, 10–30 %). These congenital diaphragmatic malformations are usually diagnosed before birth or in newborns and an immediate surgical repair is mandatory [3].

Occasionally these hernias remain asymptomatic and undiagnosed. In adults diagnosis is incidental and can occur after an acute event such as pain due to complications of herniated viscera (i.e., incarceration, strangulation or ischemia). Surgery is considered to be necessary once the diagnosis is suspected, to avoid complications and to avoid unnecessary cardiopulmonary burden through compressing phenomena [4,5]. Traditional approaches are thoracotomy and laparotomy but, in the last decades, the use of minimally invasive techniques, including laparoscopy and video-assisted thoracic surgery (VATS), improved dramatically [2]. Kuster et al. carried out the first laparoscopic repair of a Morgagni hernia in 1992 [6] and the first reported laparoscopic repair of a Bochdalek hernia in adults was performed by Al-Emadi in 1998 [4]. Anterolateral defects are usually simpler to repair than posterolateral defects and can be easily managed with a minimally invasive approach [7]. For giant congenital diaphragmatic hernia, usually a combined thoracic and abdominal approach is needed to overcome the limitations due to inadequate space leading to difficult visualization and mobilization of the herniated viscera [8]. Nowadays, robotic has developed and been applied for these hernia repairs [9] but only few cases of diaphragmatic hernia repair using an only-abdominal approach with robot-assisted technique have been reported, with minimal morbidity and complication.

We report a case of an 18-year-old female with an enlarging left-sided diaphragmatic hernia that was repaired using a robotic-assisted

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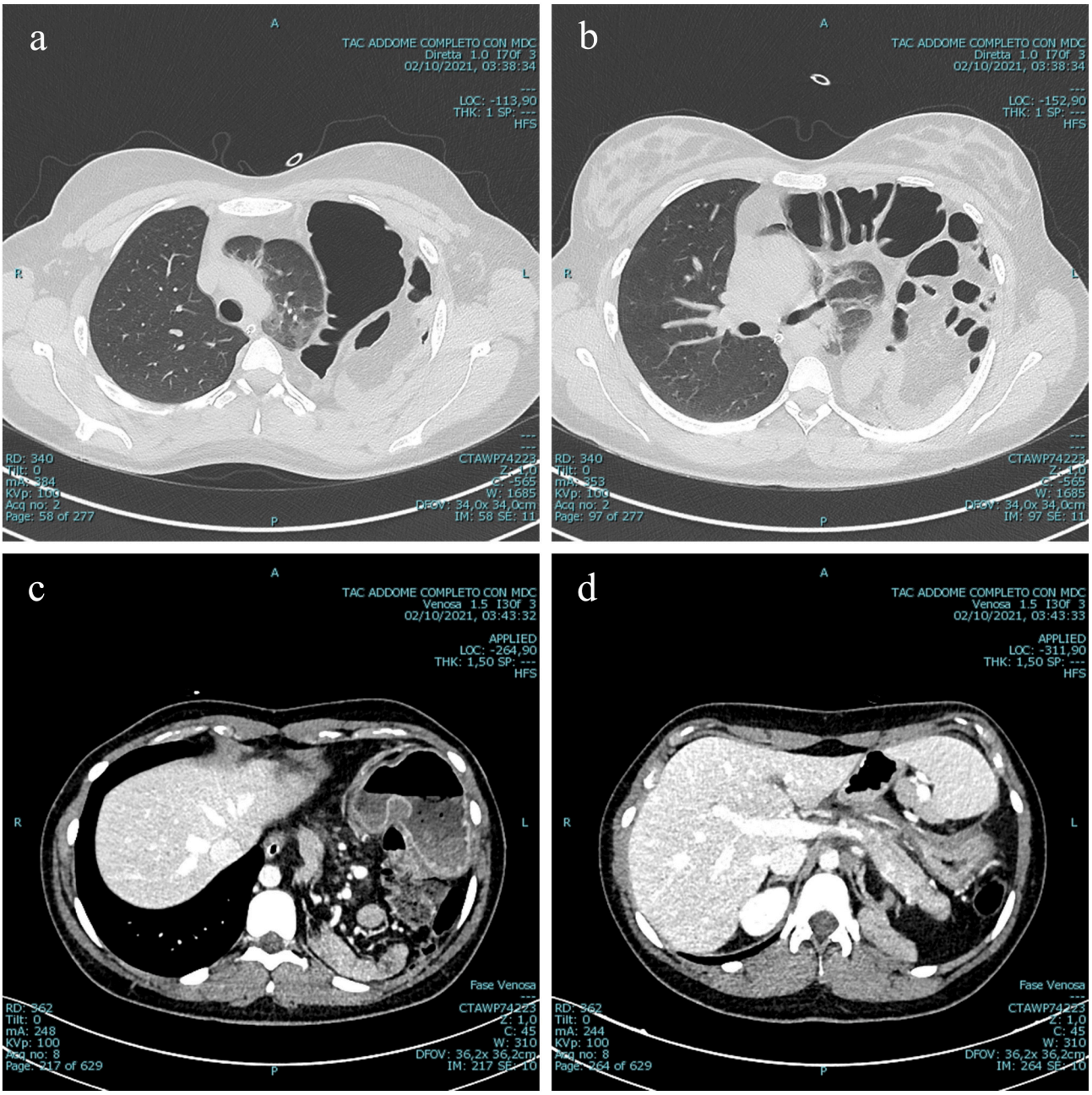

Fig. 1. Axial images of Chest and Abdomen CT-scan showing the severe left lung hypoplasia (a), the size of the left diaphragmatic Larrey-type hernia (b-c) and the dislocation of the spleen (d).

transabdominal approach with mesh placement.

The work has been reported in line with the SCARE criteria [10] and with the PROCESS criteria [11].

2. Case presentation

An 18-year-old female referred to the local Emergency Department for acute onset of epigastric pain irradiated to the left side of the abdomen and associated to nausea and vomiting. There was no fever or diarrhea. Past medical history was unremarkable, with no prior thoracic or abdominal trauma and no systematic use of medication. She never complained dyspnea and she only suffered from several episodes of recurrent abdominal pain in childhood, always investigated with abdominal X-ray. Her vital signs were within normal limits and blood analysis showed mild leukocytosis (WBC 11.34 × 10^3/mcL) and a slight elevation of ALT (134 U/l) and lipase (147 U/l). Abdominal examination showed a soft, non-distended, scarless abdomen. Pain was evocated by deep palpation in epigastrium and left upper abdominal quadrant. Respiratory examination revealed reduced vesicular breath sounds on the left. Chest and abdominal X-rays revealed that the left hemithorax was almost completely occupied by the colon and the mediastinum was shifted to the right. A contrast-enhanced computed tomography (CT) scan demonstrated a Larrey-type interruption of the left anterior side of the diaphragm (6.6 cm wide) with the herniation of gastric body and fundus, duodenum, jejunum, ileum, cecum, right colon and mesentery. The herniated viscera appeared sub stenotic but with no acute vascular distress and the left lung looked hypo expanded and with homolateral atelectasis. Spleen and pancreas were rotated and dislocated anteriorly (Figs. 1 e 2).

The patient was then admitted to the department of General and

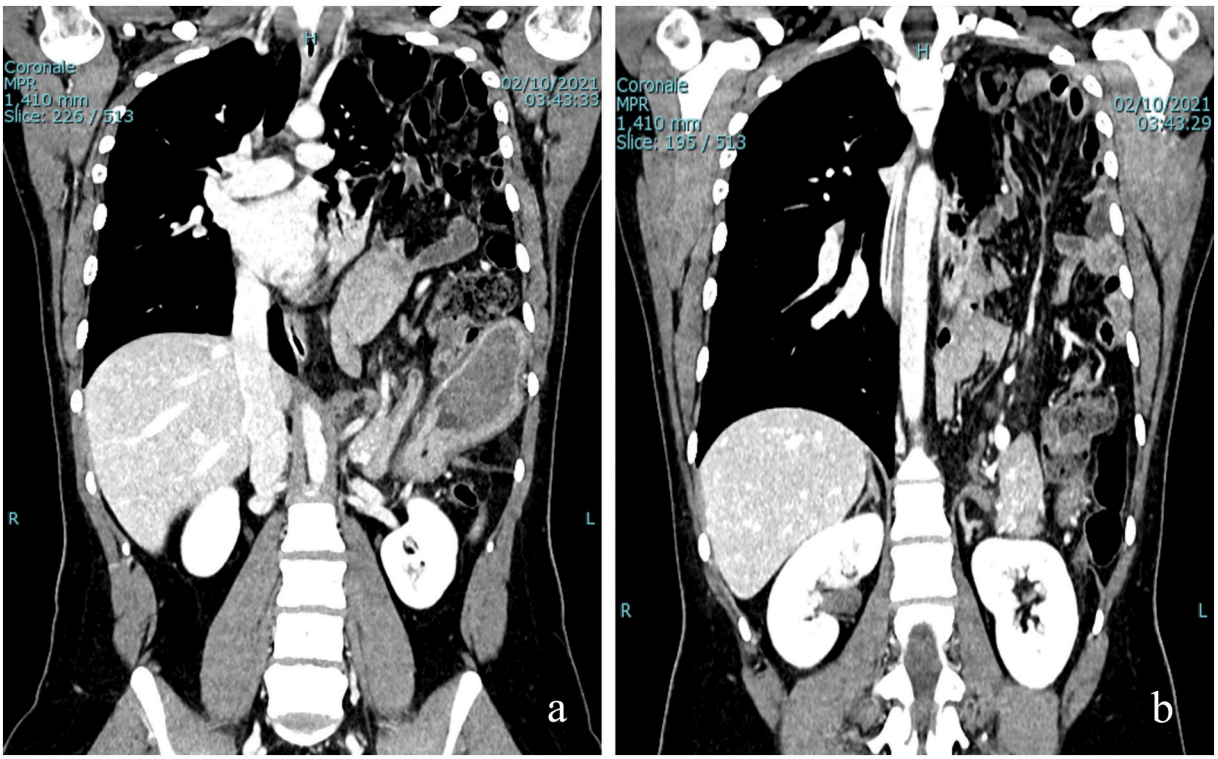

Fig. 2. Coronal CT-scan images demonstrating the giant left-sided hernia defect.

Emergency Surgery. During the hospital staying, the patient underwent a Magnetic Resonance Imaging (MRI) of chest and abdomen that confirmed the herniation of multiple abdominal viscera to the left thorax through a 6.7 × 7.1 cm defect in the middle third of the anterior left diaphragm, with regular insertion of the pillars of the diaphragm. A single contrast upper gastrointestinal study with water-soluble contrast showed a normal esophageal motility and the pulmonary functions tests demonstrated a mild obstructive deficit and a light reduction of Diffusing Lung of Carbon Monoxide (DLCO).

Given the findings of a giant hernia containing multiple abdominal viscera, after a proper diagnostic work-up, a robotic-assisted mesh surgical repair of the diaphragmatic defect was planned.

The procedure was performed by a well-trained surgeon via an anterior trans-abdominal robotic-assisted laparoscopic approach using the Da Vinci Xi Robotic Platform® (Intuitive Surgical; Sunnyvale, CA), under general anesthesia. The patient was positioned in supine position with open arms and legs and in reverse Trendelenburg (30°). The robot was docked at the head of the patient. The pneumoperitoneum was induced with Veress needle in the Palmer's point. Four-trocar setup was used: one 12-mm trocar peri-umbilical (optic camera), two 12-mm working ports in the right and left mid-clavicular line respectively, one 12-mm working port in the right anterior axillary line; the 12-mm AIRSEAL® for the first-assistant was placed at the left anterior axillary line (Fig. 3). The robotic instruments used were Da Vinci Permanent Cautery Hook®, Tip-Up Fenestrated Grasper®, Fenestrated Bipolar Forceps®, Maryland Bipolar Forceps®, Large Needle Driver® and 30° Endoscope with Camera®.

The preliminary exploration confirmed the presence of a wide left anterior diaphragm defect with massive herniation of gastric body and fundus, colon and small bowel. After a careful lysis of intrasaccular adhesions, the abdominal viscera were cautiously relocated in the abdomen and the homolateral collapsed lung rapidly re-expanded. The hernia sac was then carefully dissected with a combination of blunt dissection, energy device and bipolar cautery. The preparation of the margins of the defect was challenging due to the inadequate space left after the reduction of the hernia content in the abdomen, but the greater range of motion assured by the robotic instruments helped us to achieve the result. Primary closure of the diaphragmatic defect was performed with a 0 nonabsorbable suture: interrupted suture with intracorporeal knot-tying technique was chosen to provide additional security against recurrence due to suture failure; during the suture an aspirator was used to eliminate all the CO_2 from the thorax. Taking into account the wide diaphragmatic defect, the long-time and giant herniation of the viscera we decided to reinforce the closure with mesh placement: a 15 × 10 cm GORE-TEX® Soft Tissue Patch (W.L. Gore & associates INC; Newark, DE) was modeled on the diaphragmatic defect, placed and fixed with an interrupted nonabsorbable monofilament suture to the muscular layer to allow a tension-free mesh fixation (Fig. 4). At the end of the operation a left chest-tube and a left abdominal drain were placed. The operative time was 195 min. No intraoperative complications occurred, estimated blood loss was minimal and neither blood transfusions or Intensive Care Unit support were needed. The post-operative course was uneventful, the patient started oral feeding on post-operative day 4 and was discharged on post-operative day 8. The chest X-ray performed 1-month after surgery showed no signs of recurrences (Fig. 5). At 6-month follow up clinic visit, there were no complications and all the pre-operative symptoms had resolved.

3. Discussion

Congenital diaphragmatic hernia is a rare condition in adults and diagnosis can be incidental or done after the onset of acute symptoms. In our case, the most prominent presenting symptoms were acute onset of epigastric pain irradiated to the left side of the abdomen, associated to nausea and vomiting but surprisingly without dyspnea. Regardless of the symptomatology, surgical treatment is suggested in order to avoid common life-threating complications of herniated viscera [4,5]. Traditional open approaches included laparotomy and thoracotomy.

Fig. 3. Four-trocar setup plus AIRSEAL during trans-abdominal robotic-assisted laparoscopic approach for hernia repair.

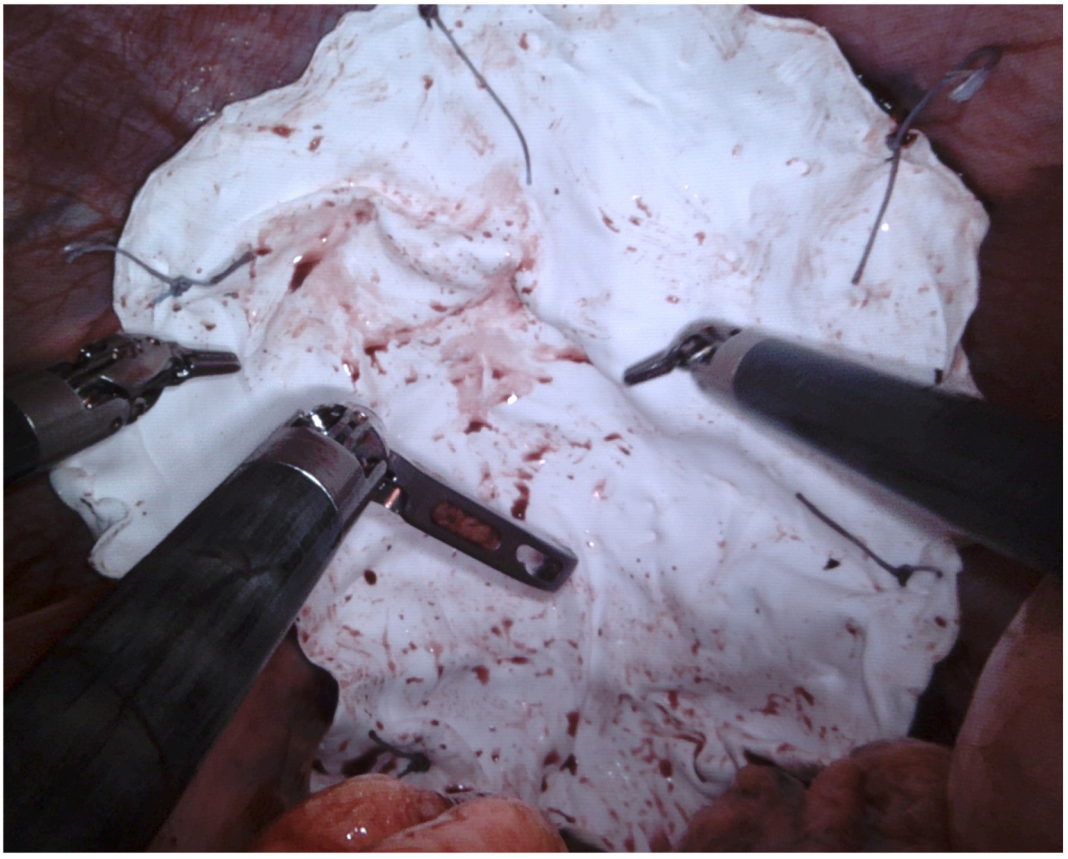

Fig. 4. Intraoperative photo of mesh placement over the diaphragmatic defect.

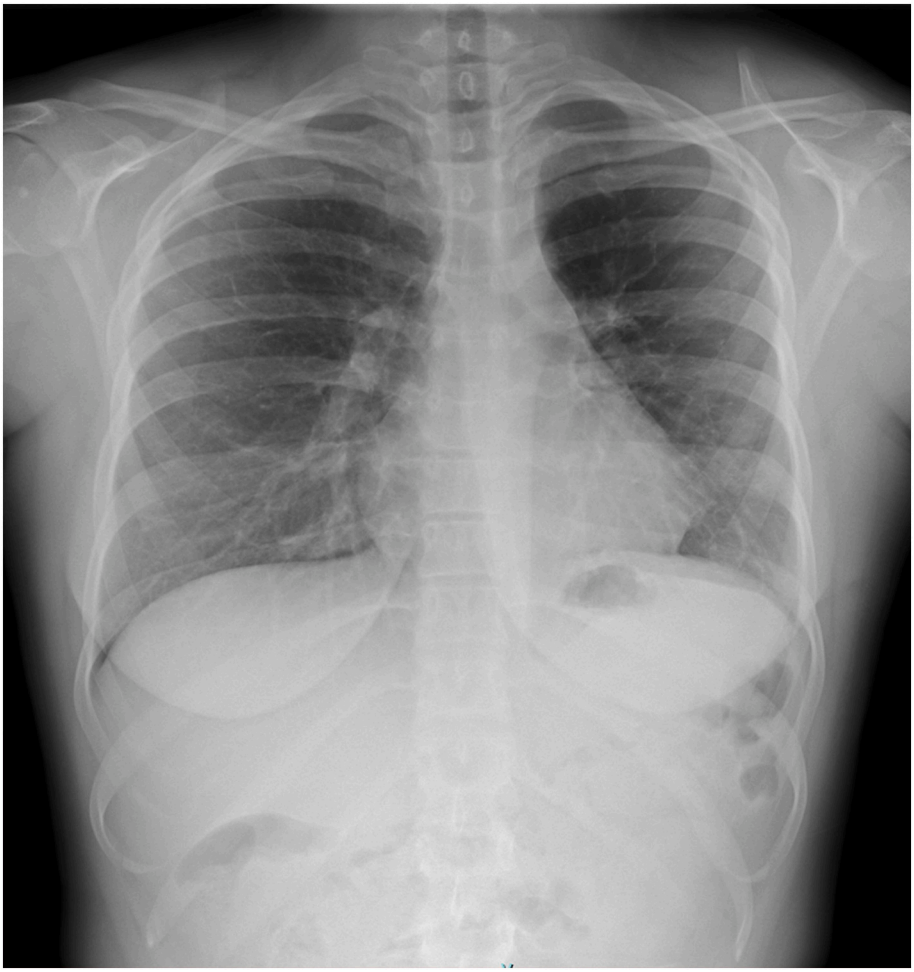

Fig. 5. Chest X-ray performed 1-month after surgery, showing no signs of recurrences.

However, new minimally invasive approaches have proved to be viable options [7]. Laparoscopy and VATS appear to be safe and associated with improved post-operative outcome, shorter hospital staying and recovery, reduced complication rates, reduced post-operative pain and better cosmetic results [12].

Robotic surgery developed in the last decades and it has been successful applied to repairs of these type of hernias. Our review of literature showed that only 11 cases of trans-abdominal robotic repairs of congenital Morgagni-Larrey diaphragmatic hernias in adults have been described [5,12–20,22]. None of these cases required conversion to open surgery and post-operative course was free of major complications; robotic repair, even in comparison with laparoscopic techniques, appears to be associated with a shorter length of stay [7,13].

Both the mesh and the mesh-less techniques have advantages and disadvantages. We used mesh placement because of the large deficit. Moreover, the use of mesh appears to have excellent results in terms of avoiding recurrences [18]. Mesh fixation can be performed with glue, suture or surgical tacks[21]. We used suture because of the size of the diaphragmatic defect and the proximity to the heart: glue seemed to be too weak and we didn't have the possibility to make appropriate counter pressure to apply surgical tacks.

Concerning the robotics platform, it allows better flexibility and visualization [14], greater precision and enhanced dexterity to tackle complex hernia repairs and to perform intracorporeal closure of hernia defects and mesh placement, facilitating the surgical approach in a confined space which is technically challenging to approach with laparoscopic instruments [5,13–17].

4. Conclusion

If available, robotic approach for diaphragmatic hernias repair can be considered a first-line option in selected patients and in the hands of well-trained surgeons. The minimally invasive approach is becoming a standard approach to repair diaphragmatic hernias. Robotics carries further advantages such as the possibility to repair large hernias as presented in this case. Standardization and development of experience with robotic technique must go on.

Provenance and peer review

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Ethical approval

Case Report. Exempt from ethical approval.

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.

Author contribution

Cristina Nistri: Writing - Original Draft, Writing - Review & Editing, Visualization, Conceptualization, Investigation

Laura Marinelli: Writing - Original Draft

Adriana Di Giacomo: Investigation

Luca Bonariol: Investigation

Marco Massani: Supervision, Project administration, Conceptualization, Investigation

Registration of research studies

Nothing to declare.

Guarantor

Cristina Nistri, Marco Massani.

Declaration of competing interest

Nothing to declare.

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