



# Robotic Morgagni hernia repair: an emerging approach to a congenital defect

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## Abstract

Morgagni hernia (MH) is a rare, congenital diaphragmatic hernia (CDH). The use of robotic surgery to repair MH in adults has recently been described in the literature, but only on two previous occasions. The objective of this report is to describe four cases of robotic repair of MH in adults performed by a single surgeon to better delineate an emerging approach to this rare condition. A retrospective review of patients who underwent robotic repair of MH by a single surgeon was performed. Four consecutive patients were identified and included. The median age of patients was 43 (range: 23–70). All patients had symptoms prior to diagnosis, including substernal chest pain ( $n=3$ ), dyspnea ( $n=4$ ), dysphagia ( $n=1$ ), and regurgitation ( $n=1$ ). All patients underwent hernia reduction, primary tissue repair, and mesh implant with minimal average estimated blood loss. All hernias were right sided, and the average length of surgery was 129.8 min. The average length of stay was 2 days. No intraoperative complications or 30-day postoperative complications were reported. Symptoms, including chest pain and dyspnea, resolved postoperatively for each patient. With this technique, robotic Morgagni hernia repair can be done with short operative time, few complications, and favorable length of stay. This operation takes advantage of the dexterity and wristed nature of the instruments; suturing of the diaphragmatic defect and mesh (performed on the “ceiling” of field) and incorporating pledgets into these sutures become straightforward endeavors when performed robotically. We have found the robotic platform useful for a transabdominal approach to Morgagni hernia repair.

**Keywords** Hernia · Robotic · Morgagni · Congenital

## Introduction

Morgagni hernia (MH) in adults is a very rare, congenital diaphragmatic hernia (CDH). Though once thought to be largely asymptomatic and discovered incidentally on chest radiograph, recent studies found 72% of patients presented with MH-related symptoms [1, 2]. When discovered, surgical intervention is warranted due to the increased risk of visceral strangulation and other complications [1]. Though thoracotomy is still the most common approach, the use

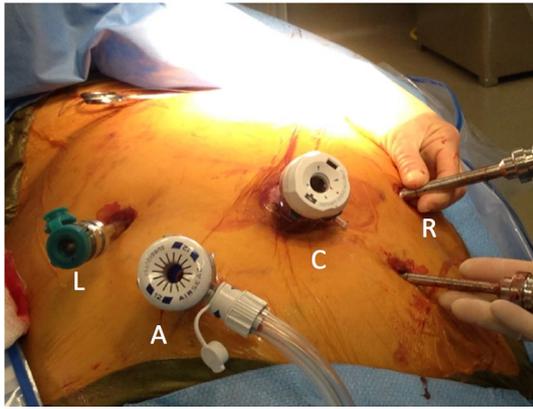
of minimally invasive techniques, including laparoscopy, thoracoscopy, and video-assisted thoracic surgery (VATS), has increased over the past 25 years [2–5]. Laparoscopy, in particular, has gained wide-spread popularity, having been found to be equally effective as thoracotomy with no additional risk, decreased morbidity, and shorter length of stay [2].

The use of robotic surgery to repair Morgagni hernias in adults has recently been described in the literature, but only on two previous occasions. The objective of this report is to describe four cases of robotic repair of Morgagni hernia in adults performed by a single surgeon to better delineate an emerging approach to this rare condition.

**Electronic supplementary material** The online version of this article (<https://doi.org/10.1007/s11701-018-0892-4>) contains supplementary material, which is available to authorized users.

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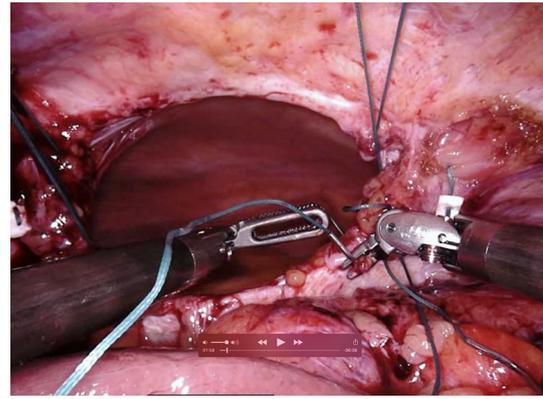
**Fig. 1** Port positioning for robotic Morgagni hernia repair. C camera port, L left robotic arm port, R right robotic arm port, A assistant port

## Materials and methods

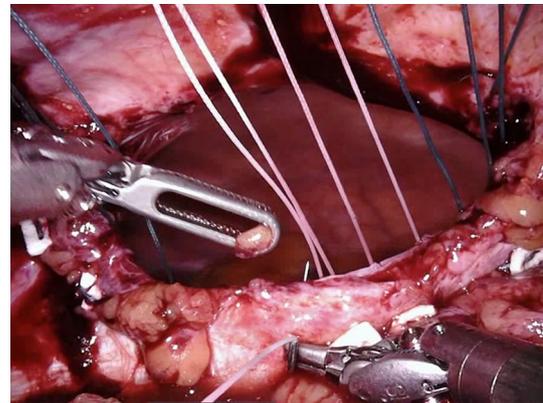
A retrospective review of patients who underwent robotic repair of MH by a single surgeon was performed. Four consecutive patients were identified and included. Informed consent for each procedure was obtained. Consent for participation in the study was waived due to the retrospective nature of the study.

## Technique

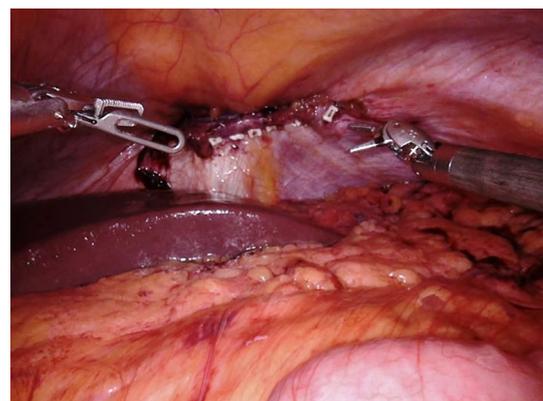
The patient was placed in the supine position. Abdominal insufflation was achieved via a Veress needle introduced in the supraumbilical region. Port position for the operation done with the da Vinci Si System (Intuitive Surgical; Sunnyvale, CA) is shown in Fig. 1. We used the Si system for the first two cases, and the Xi system for the last two cases. The 12-mm disposable camera port in the Si system is replaced with an 8-mm reusable metal robotic port when using the Xi system. For the last two cases, we found that using an additional 4th robotic port (unlabeled port in Fig. 1) was not necessary. After placing the patient in reverse Trendelenburg position, the herniated contents were reduced from the chest with laparoscopic instruments via a combination of blunt and sharp dissection as appropriate. We judged that reducing the hernia contents laparoscopically was safer, as it would be easier to detect resistance to reduction and avoid potential injury to the viscera given the absence of haptic feedback on the robotic system. The hernia sac was not dissected or resected during the operation, as we found that the hernia sac was so insubstantial as to make this step impractical. Once the hernia was reduced, the bed was turned 90° from the anesthesia cart and the robot was docked to the patient coming from over the patient's head when using. Turning



**Fig. 2** Teflon-pledgeted horizontal mattress 0 non-absorbable braided suture placed in the diaphragm

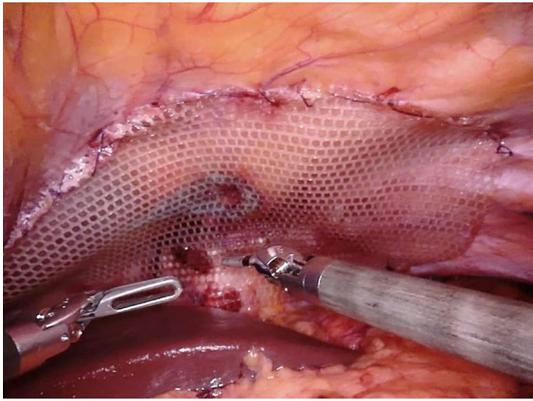


**Fig. 3** Teflon-pledgeted horizontal mattress 0 non-absorbable braided sutures placed in the diaphragm

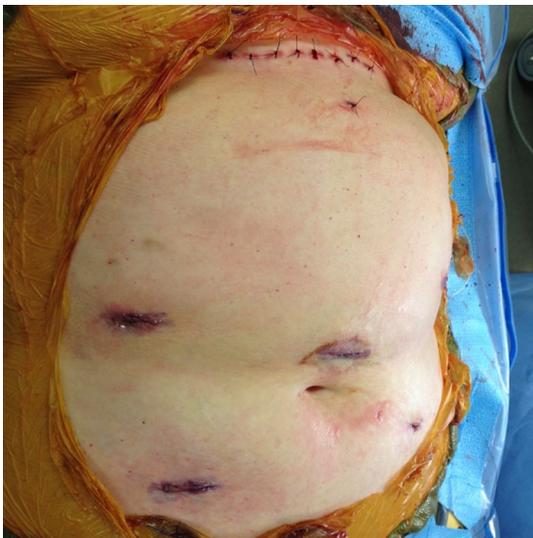


**Fig. 4** Primary repair of diaphragm

the bed is not required when using the Xi robot. Teflon-pledgeted horizontal mattress 0 non-absorbable braided sutures were placed in the diaphragm and exteriorized with



**Fig. 5** Symbotex Composite Mesh (Medtronic; Minneapolis, MN) reinforcement sutured in place



**Fig. 6** Closed port sites including fascial sutures arrayed beneath the xiphoid process

a Carter-Thomason Suture Passer (Cooper Surgical; Trumbull, CT) via very small counter incisions arrayed horizontally just below the subxiphoid process (Fig. 2). After an appropriate number of sutures were placed, the defect was closed primarily by tying down the sutures (Figs. 3, 4; see video). The reason for exteriorizing the suture ends and tying the knots via small counter incisions was to ensure transfascial pexy of the diaphragm; intracorporeal suturing of the diaphragm to the abdominal wall was initially attempted and found to be unreliable in terms of getting the suture securely and definitely through the fascia, as opposed to peritoneum. A 10 × 15-cm rectangular piece of Symbotex Composite Mesh (Medtronic; Minneapolis, MN) underlay was used to further reinforce the repair.

The mesh was secured to the abdominal wall just below the hernia repair with a 0 Ethibond suture that was tied to the center of the mesh. Taking care to avoid injuring the heart, the superior corners of the mesh were secured to the pericardium with multiple 3-0 polypropylene sutures. A continuous V-Loc 3-0 PDS suture (Medtronic; Minneapolis, MN) was sewn along the inferior edge of the mesh to prevent herniation from below (Fig. 5). The closed port incisions are shown in Fig. 6.

Following discharge, patients were seen at a routine 1-month clinic visit with a chest radiograph.

## Results

### Case #1

A 60-year-old female with medical history of well-controlled OSA and GERD presented with 2–3 episodes of progressive, substernal chest pain over the past month. She described dyspnea, dysphagia, and periodic regurgitation of solids and liquids. CT scan showed a Morgagni-type anteromedial hernia with the right hemithorax containing fat and a large portion of the proximal transverse colon. Defect measured 8 cm in length. Other potential causes for chest pain were ruled out. It was felt that the patient's diaphragmatic hernia was responsible for her symptoms; thus robotic diaphragmatic hernia repair was recommended. The patient agreed to the plan and wished to proceed.

No intraoperative complications occurred. Estimated blood loss was minimal. Length of surgery was 156 min. The patient was discharged home on the second postoperative day.

At 1-month follow-up, all preoperative symptoms had resolved and the patient was instructed to return to clinic on an as-needed basis.

### Case #2

A 26-year-old male with no pertinent medical history presented with dyspnea, cough, and hemoptysis. Workup diagnosed pneumonia and incidentally revealed defect consistent with diaphragmatic hernia. CT showed Morgagni hernia on right containing large amounts of adipose tissue and vasculature from the upper abdomen. It was unclear to what extent the defect versus the pneumonia was responsible for the patient's symptoms. Following treatment for his pneumonia, the patient elected to proceed with surgical repair of his MH defect due to risk of intestinal strangulation.

No intraoperative complications occurred with minimal estimated blood loss. Length of surgery was 121 min. The patient was discharged home on the second postoperative

day. At 1-month follow-up clinic visit, there were no complications and his symptoms had resolved.

### Case #3

A 23-year-old female 1-month status post-gastric sleeve for chronic morbid obesity presented for surgical evaluation of congenital diaphragmatic hernia. Patient described recently worsening dyspnea and right-sided substernal chest pain with past medical history significant for GERD. CT showed a Morgagni-type anteromedial hernia with the right hemithorax containing fluid and fat. Defect measured 6 cm in length. Robotic diaphragmatic hernia repair was recommended. The patient agreed to the plan and wished to proceed.

No intraoperative complications occurred with minimal estimated blood loss. Length of surgery was 132 min. The patient was discharged home on the second postoperative day.

At 1-month follow-up, the patient was doing very well, reporting improved dyspnea and chest pain. Chest radiograph showed what was likely fluid in the residual space where the hernia was. This did not appear to represent early recurrence. CT scan performed at a clinic visit 15 months after the operation showed resolution of the seroma. She denied any dyspnea at the time.

### Case #4

A 70-year-old male with past medical history of prostate cancer and GERD presented with Morgagni hernia found incidentally upon workup for prostate cancer. Patient described dyspnea on exertion and occasional left-sided chest pain. CT scan showed a Morgagni-type anteromedial hernia on the right with omental fat herniating into the pericardium causing substantial mass effect on the heart. The defect measured 8 cm in length. Surgical repair was recommended to prevent potential incarceration of the bowel and possibly improve symptoms. The patient agreed to the plan and wished to proceed.

No intraoperative complications occurred with minimal estimated blood loss. Length of surgery was 110 min. The patient was ready for discharge on first postoperative day; however, his stay was extended by 1 day due to an allergic reaction to an ACE inhibitor.

At 1-month follow-up, no complications were observed and all preoperative symptoms had resolved. The patient was instructed to return to clinic on an as-needed basis.

## Discussion

Morgagni hernias are rare congenital malformations on the anteromedial aspect of the diaphragm, typically on the right. They are most often found in childhood or adolescence, but occasionally go undiagnosed into adulthood. Once discovered, surgery is almost always recommended to prevent stricture, strangulation, or other complication.

Over the last 25 years, minimally invasive techniques have been increasingly used to correct these malformations. In 2008, Horton et al. reported a review of the literature from 1951 to 2006 finding 298 cases of MH management. Of these cases, 49% were performed via thoracotomy, 30% via laparotomy, 17% via laparoscopy, and 0.7% via thoracoscopy. The laparoscopic approach was found to have significantly shorter length of stay, averaging 3 days for 39 patients. This, when paired with the approach's lower morbidity, has made it a favorable alternative to open thoracotomy [2].

In the last 10 years, some surgeons have expanded the minimally invasive armamentarium for MH repair to include robot-assisted surgery; however, almost all cases found in the literature are described for the pediatric population. Only two sources mention using this modality for treatment in adults.

In 2014, Diez del Val et al. looked at a cohort of 130 robot-assisted gastroesophageal surgeries, of which 3 were MH repairs (median age 68; 60.5–73). They reported an average length of stay of 4 days (3.5–4) for the MH repairs and found that the main benefit of the robotic approach was facilitating the fixation of supporting mesh to the anterior part of the diaphragmatic defect [6].

In 2017, Arevalo et al. reported the first case series in the literature which described robotic MH repair ( $n = 3$ ; median age 23; range: 21–78) with an average length of stay of 1.7 days. For this population, all patients had pulmonary symptoms at the time of diagnosis. Each underwent sac excision, primary tissue repair, and mesh implant with minimal estimated blood loss. Average length of surgery was 149 min for right-sided MH ( $n = 2$ ) and 300 min for left-sided MH ( $n = 1$ ). No intraoperative or 30-day postoperative complications were reported. Respiratory symptoms improved in all patients [7].

For this study, the median age of the four patients was 43 (range: 23–70). All patients had symptoms prior to diagnosis, including substernal chest pain ( $n = 3$ ), dyspnea ( $n = 4$ ), dysphagia ( $n = 1$ ), and regurgitation ( $n = 1$ ). All patients underwent hernia reduction, primary tissue repair, and mesh implant with minimal average estimated blood loss. All hernias were right-sided, and average length of surgery was 129.8 min. Average length of stay was 2 days. No intraoperative complications or 30-day postoperative complications

were reported. Symptoms including chest pain and dyspnea resolved postoperatively for each patient.

Our approach differs from that described by Arevalo et al. in that no sac excision was performed. As described in the comprehensive literature review of MH case reports by Horton et al. [2], a wide variety of opinions exist amongst surgeons concerning sac excision. Only 31% of surgeons performing the repair laparoscopically elected to excise the sac, citing risk of pneumomediastinum and pneumothorax due to inability to observe the thoracic cavity [2].

In comparison with laparoscopic techniques, robotic repair appears to be associated with a shorter length of stay. Horton et al. found an average length of stay of 3 days ( $n=39$ ) from laparoscopic cases reported through November of 2006 [2]. Review of the literature from December of 2006 until August of 2017 found 20 additional case reports of laparoscopic repair of MH covering 42 patients. Of these, length of stay was included for 35 patients, averaging 2.9 days. This aligns very closely with that found by Horton, et al. In comparison, Arevalo et al. reported average length of stay of 1.7 days with robotic repair [7]. Our case series, which is the second published case series in the literature to describe MH repair via robotic surgery, found similar results with average length of stay of 2 days.

These case reports of robotic MH repair represent a small sample size and further evaluation in the literature is needed.

## Conclusion

With this technique, robotic Morgagni hernia repair can be done with short operative time, few complications, and favorable length of stay. This operation takes advantage of the dexterity and wristed nature of the instruments; suturing of the diaphragmatic defect and mesh (performed on the “ceiling” of field) and incorporating pledgets into these

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## Compliance with ethical standards

**Conflict of interest** Benjamin Wei and Bruce Pittman declare that they have no conflict of interest.

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