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Laparoscopic-assisted repair of Morgagni hernia in children

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Abstract

Background: Morgagni hernia (MH) is a rare diaphragmatic hernia with nonspecific symptoms and variable presentation. MH is managed surgically via laparotomy or a thoracotomy. Recently, laparoscopy was described for the repair of MH. The objective of this study is to report our institutional experience in laparoscopic repair of MH in infants and children.

Results: Twenty-five patients with MH were included; 17 of them were males (68%). Their median age at the time of diagnosis was 18 months. Sixteen patients (64%) presented with a recurrent chest infection. MH was on the right side in 8 patients, left side in 2, and central in 12, and 3 patients had bilateral hernias. Eleven patients (44%) had congenital heart disease, 10 (40%) had Down's syndrome, and 2 (4%) had malrotation of the bowel. The median size of the hernia defect was $3 \times 3.5\ cm^2$, and the most common content was the colon ($n = 19$). One patient with Down's syndrome developed recurrence and underwent open repair. The median operative time was 95 min. The postoperative recovery was uneventful, and the average postoperative stay was 3 days. The median follow-up was 4.5 years, and there was no reported mortality.

Conclusions: Morgagni hernia is commonly associated with other congenital anomalies. Laparoscopic repair of Morgagni hernia in children is feasible with excellent postoperative outcomes.

Keywords: Morgagni hernia, Laparoscopy, Post-sternotomy hernia

Background

Morgagni's hernia (MH) is a retrosternal herniation of the abdominal contents through a diaphragmatic defect, and it presents 3–5% of all diaphragmatic hernias [1]. In most cases, the diaphragmatic defect is congenital in origin; however, it could be acquired as an incisional hernia after median sternotomy. Abdominal contents usually herniate on the right side in 90% of the patients [2], and the omentum is the most commonly reported herniated structure (60%) [3].

In the pediatric age group, the presentation of congenital Morgagni's hernia is variable. The hernia can be discovered incidentally, or it can present with nonspecific gastrointestinal or respiratory symptoms and, in severe cases, with respiratory distress requiring support [4, 5]. Because of the rarity of the condition, as well as the nonspecific presentation, the diagnosis is usually delayed. Patients typically have a chest X-ray as the initial diagnostic tool, and if the diagnosis of MH is suspected, further investigation with a barium study, computed tomography (CT) scan, or magnetic resonance imaging (MRI) is warranted, which additionally aid in defining the size and the content of the hernia sac [6].

The standard treatment of MH is surgical closure of the defect via laparotomy or thoracotomy. Currently, various laparoscopic techniques for the repair, including a primary closure of the defect with intracorporeal sutures, stapler, or a mesh, have been proposed [3]. Minimal invasive repair of MH has achieved satisfactory results with less trauma and earlier return to physical activity; however, the rate of complications is still high [2,

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7]. The objective of this study was to report the results of laparoscopic-assisted repair of Morgagni's hernia in infants and children in our institution.

Methods

Data sources and study design

This is a retrospective cohort study that included infants and children admitted to our hospital with the diagnosis of Morgagni's hernia from January 2005 to December 2019. A total of 25 infants with MH were presented to our center. Patients' data, including the age at presentation, sex, the presenting symptoms, radiological investigations, management, conversion to open surgery, and outcome of surgery, were retrieved from the medical charts. All patients had a laparoscopic-assisted repair of the MH.

The study was approved by the Hospital Institutional Review Board (REF: SURG-J/520/40). Written informed consent was taken for the procedure, and verbal approval from the parents of enrolled children was taken during the procedure consent to use the data in research.

Laparoscopic repair of Morgagni's hernia

The repair of the MH was carried out under general anesthesia with endotracheal intubation. We positioned the patient in the supine position, and the legs were padded and protected. A folded towel was kept under the thighs to slightly flex the hip joint and prevent excessive stretching of the femoral nerve. The monitor was placed at the head end of the table towards the left side. The operating surgeon stood at the foot end, cameraman to the right, and nurse to the left. A nasogastric tube was inserted to decompress the stomach. Three ports were inserted; the first port was 5 mm and was inserted at the umbilicus using an open technique. A 30° telescope was used in all cases. Carboperitoneum was maintained at 8 mmHg, and the flow was set at 2 L/min. The patient was given an anti-Trendelenburg position to allow the bowel to move down towards the pelvis. A preliminary assessment was carried out to delineate the site and size of the defect and its contents. Two additional 3–5 mm ports were inserted on the left and right of the midline in the midclavicular line depending on the patient's size and instrument availability.

In most patients, the post-cardiac hernia was the most frequent type, and an anterior defect in the diaphragm spanning on both sides of the midline was visualized. The large bowel herniating through the defect could be easily reduced by using tension-free repair. The hernial sac was dissected free from the pericardium and pleura using gentle blunt dissection and excised, and usually, it was challenging to do so and one patient had the sac adherent to the pericardium. It is advised not to remove the sac because this can cause more damage to the pleura or the pericardium; therefore, if the sac was not removed, the edge of the defect was cauterized using a diathermy hook. The falciform ligament was passing either from the right side or posterior to the defect. The falciform ligament was divided in two patients (8%) for better exposure of the defect. The falciform ligament was not cut routinely, only when interfering with the repair, particularly in bilateral MH. When the content of the sac was liver, dissection was done using ligasure.

The edge of the diaphragm was sutured to the abdominal muscles with one of three methods: trans-fascial sutures with the knots residing in the subcutaneous plane, endo-fascial closer, or with a modified regular needle and passing it through the abdominal wall. A stab incision was made just below the sternum at the site of the diaphragmatic defect in the epigastric region. The type of sutures often used was Ethibond 2-0 suture material (Ethicon Inc. Cornelia, GA, USA), and Prolene was used in three patients (12%) (Ethicon Inc. Cornelia, GA, USA). A horizontal mattress suture was taken, ensuring an adequate bite of the edge of the diaphragm at the site of the defect. This suture was then retrieved through the same incision. Four to five such sutures were inserted and held with hemostats. After placing all sutures, the carboperitoneum was reduced to 4 mmHg; the sutures were pulled upwards to even out the tension, and each one was tied. The knots of the tied sutures lay in the subcutaneous tissue. Gore-Tex mesh (W. L. Gore & Associates, Inc. Flagstaff, AZ, USA) was required in four patients (16%) using the same approach because of a large defect that could not be closed without tension (n = 3) and for a recurrent case (n = 1).

Statistical analysis

Continuous variables were presented as median and 25th and 75th percentile or range when appropriate and categorical variables as number and its percentage. Mann-Whitney test was used to test the significant difference in continuous outcomes. All analyses were performed using Stata 14.2 (StataCorp, College Town, TX, USA)

Results

Twenty-five patients with Morgagni hernia were presented to our hospital during the study period. Their demographics and preoperative data are summarized in Table 1. Their age at the time of diagnosis ranged from 28 days to 9 years (median, 18 months).

Recurrent chest infection was the most common presenting symptom (n = 16; 64%). One patient presented at the age of 18 months with poor feeding, vomiting, and tachycardia, the chest X-ray was highly suggestive of

Table 1 Preoperative patients' characteristics

Variable	(*n*=25)
Age (months)	18 (15-24)
Male n (%)	17 (68%)
Site of the hernia	
Bilateral	3 (12%)
Central	13 (52%)
Right	2 (8%)
Left	7 (28%)
Content of the hernial sac	
Colon	19 (76%)
liver	3 (12%)
Omentum	3 (12%)
Major associated lesions	
Congenital heart disease	11 (44%)
Down Syndrome	10 (40%)
Bowel Malrotation	2 (4%)

MH, and the diagnosis was confirmed with a computed tomographic (CT) scan.

Three patients had bilateral Morgagni hernia on the CT scan of the chest, and this was confirmed during the surgery (Table 1). In all patients with Morgagni hernia, the diagnosis was suspected on chest X-ray, especially on a lateral view, then confirmed by CT scan (Figs. 1 and 2).

Associated anomalies were seen in 23 (92%) patients (Table 1). The median size of the hernial defect was 3 × 3.5 cm^2. All patients had a laparoscopic-assisted repair of the hernia (Fig. 3). The median operative time was 95 min (25th and 75th percentile, 89 and 117 min), and operative time did not differ significantly in patients who had prior cardiac surgery (p = 0.38) or those with Down's syndrome (p = 0.65). Gore-Tex mesh was used in 4 patients (16%); none of them had a recurrence; however, one had postoperative pericardial effusion, which resolved spontaneously after 3 days. The postoperative chest X-rays were normal, and feeding was started after 6 h in all patients. The postoperative

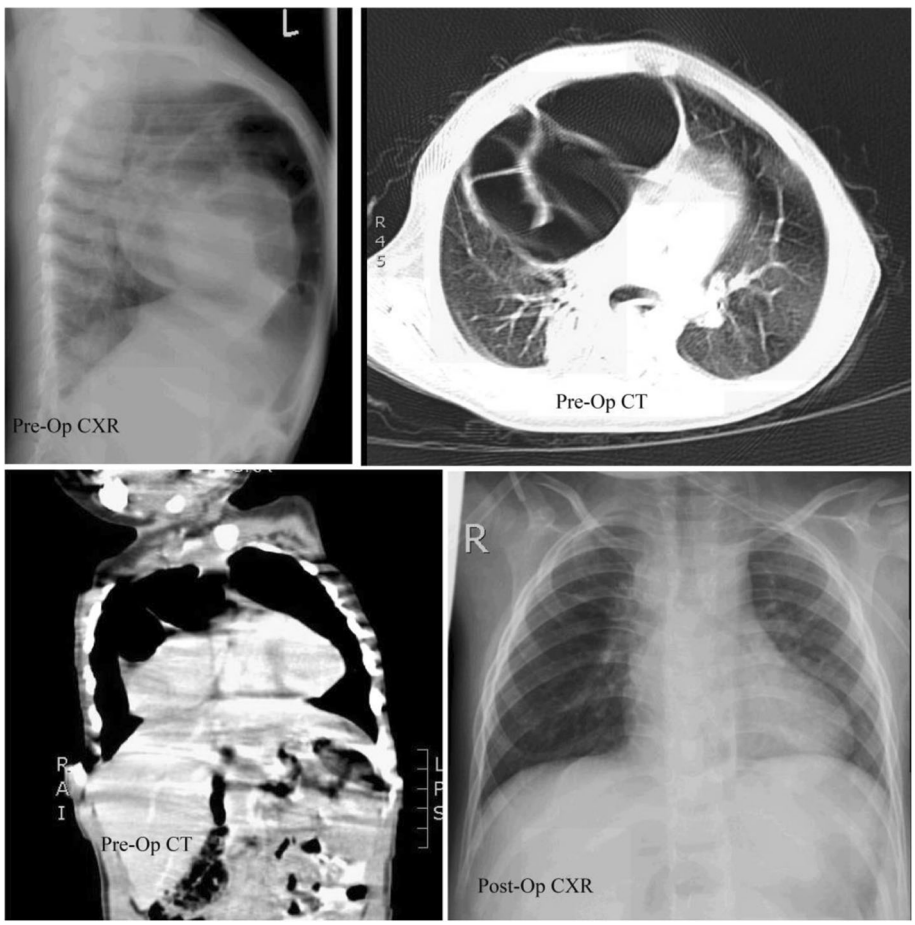

Fig. 1 **a**) Lateral chest x-ray of a case of Morgagni hernia. **b** and **c**) CT chest showing herniation of the colon on the right side. **d**) Postoperative chest x-ray with the hernia reduced

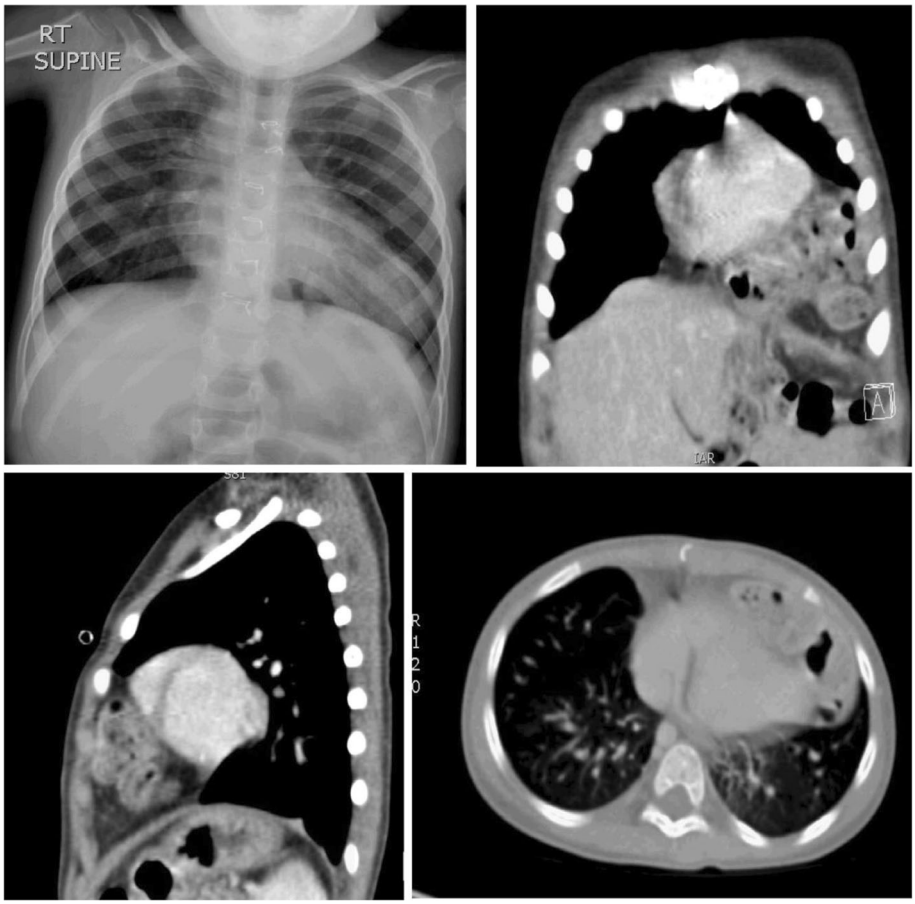

Fig. 2 a) Posteroanterior chest x-ray with left side Morgagni hernia. **b, c**, and **d**) CT chest showing left-side Morgagni hernia with colonic herniation

recovery was uneventful without any incidence of atelectasis or other postoperative complications. Mild pericardial effusion was reported in one patient (4%). The average postoperative stay was 3 days. The median follow-up was 4.5 years (25th and 75th percentile, 3 and 6.5 years). One patient with post-cardiac surgery hernia sized 4 × 4 cm and Down's syndrome developed recurrence and underwent repair using the open approach. There was no operative or long-term mortality.

Discussion

Morgagni hernia is a rare type of the diaphragmatic hernias in which the hernia defect is formed because of the failure of the fusion of sternal and costal parts of the diaphragm [8]. In our series, 10 (40%) of the patients had Down's syndrome, and 11 (44%) had congenital heart disease and presented after surgical correction via median sternotomy. The high number of patients presented after cardiac surgery could be related to the nature of our hospital as a tertiary care center. Moreover, chest drains inserted in the substernal area post-cardiac surgery may lead to poor tissue healing in this area and contribute to the increased incidence of Morgagni hernia after cardiac surgery. Additionally, tissue healing is further impaired in Down's syndrome due to altered cellular immunity [9], and the association between MH and Down's syndrome has previously described [7, 10, 11] Six of our patients have Down's syndrome and MH without previous sternotomy.

Morgagni hernias are mostly small and asymptomatic, and they are diagnosed incidentally on chest radiographs [12, 13]. MH may present with nonspecific gastrointestinal or respiratory symptoms and rarely with severe respiratory distress, cardiac tamponade, bowel strangulation or perforation, and gastric volvulus. Chest radiography is usually the first diagnostic tool, and in suspected cases, the diagnosis is confirmed with other modalities. A CT scan is the most common diagnostic tool utilized in our series, and it has the advantages of imaging the defect and evaluating the extent of the sac and its content.

Surgical treatment is the preferred modality to avoid MH complications such as strangulation, despite its rarity. The standard surgical procedure can be performed

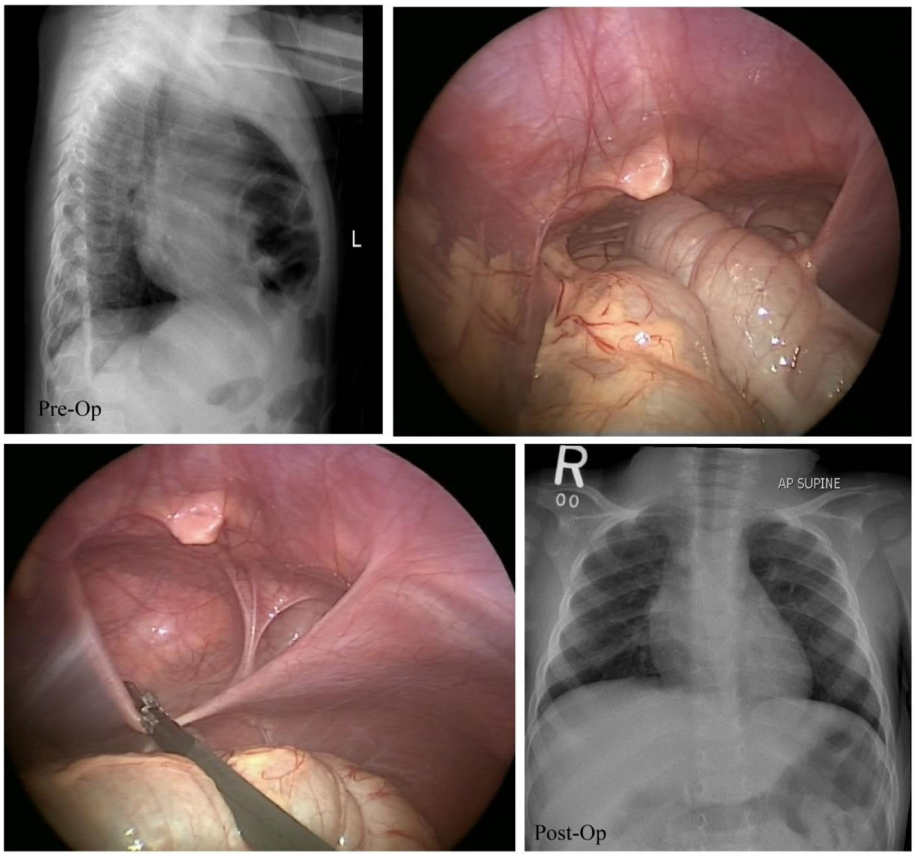

Fig. 3 a) Preoperative chest x-ay with Morgagni hernia **b**) laparoscopic view with colonic herniation. **c**) Laparoscopic view of the defect after cutting the adhesions. d) Postoperative chest x-ray

to close the defect with or without mesh, either transabdominal or trans-thoracic, and both approaches can be either open or endoscopic [14]. With the recent advances in minimally invasive surgery, laparoscopy became the preferred approach in children with MH [15]. Defects can be closed primarily, or in case of large defects, a mesh can be used [3]. The laparoscopic approach has several advantages in addition to the cosmetic results, including early feeding and ambulation, less pain, and shorter hospital stay [16]. There are several methods of laparoscopic repair, some investigators described total intracorporeal repair [17], while others recommended transabdominal sutures with extracorporeal knots with comparable results. Unfortunately, there are no randomized clinical trials to compare both approaches.

The use of synthetic patch during the primary repair was recommended by some authors to avoid tension [18, 19], and a high rate of recurrence after laparoscopic MH repair was reported if a patch was not used [20]. The use of synthetic patch becomes mandatory in case of large defects and when significant tension is expected after the primary repair. Four of our patients required Gore-Tex mesh to prevent tension after repairing large defects.

The excision of the hernia sac in MH remains controversial. Fernandez-Cebrian and De Oteyza [21] and Rau and their groups [22] recommended removal of the hernia sac, whereas others prefer to leave the hernia sac in situ [23, 24] This is a crucial step that needs to be done with the utmost care and gentleness to avoid pleural or pericardial injury. We routinely excise the hernia sac in MH because we believe this reduces the chances of recurrence. We try to remove the sac if it is technically feasible; however, if it is adherent or thick, it is better to leave it and cauterize the edges. We had experience in one case in which the sac was adherent to the pericardium and resulted in making a large pericardial window that required a Gore-Tex patch, and the patient had postoperative pericardial effusion which resolved spontaneously after 3 days.

Study limitations

The major limitation of the study is the retrospective nature with its inherited referral and selection biases, but

this study design is accepted when dealing with rare diseases. Another limitation is the single-center experience, and generalization of the results may be an issue. However, this study reports an extensive experience in the laparoscopic repair of MH over 15 years in the pediatric population.

Conclusion

Morgagni's hernia is a rare form of diaphragmatic hernias which could be congenital or acquired after cardiac surgery. MH is frequently associated with other anomalies such as congenital heart disease and Down's syndrome. Because of the nonspecific symptoms, the condition should be suspected in infants with a repeated chest infection. Laparoscopic repair is a relatively simple and effective technique of repair in children with decreased morbidity; an earlier return to physical activity and recurrence is uncommon.

Abbreviations

MH: Morgagni hernia; CT: Computed tomography scan; MRI: Magnetic resonance imaging

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Authors' contributions

OB and AM made the study design. AB and RM did the extensive literature review and analyzed and interpreted the patient data regarding Morgagni's hernia in children. AF and EB performed the data collection and was a major contributor in writing the manuscript. OB and AM supervised all other junior authors and did the final revision and correction of the manuscript.
All authors contributed to the conception or design of the work and/or the acquisition, analysis, and interpretation of data. Drafts were revised critically for important intellectual content, and the final version was approved by all. All agreed to be accountable for all aspects of the work and have read and approved the final manuscript.

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Availability of data and materials

The datasets generated and/or analyzed during the current study are not publicly available due [patient confidentiality policy in our institution] but are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Approval of research protocol IRB 2019-24: LAPAROSCOPIC MANAGEMENT MORGAGNI HERNIA IN CHILDREN SURG-J/520/40 was given by Institution Review Board (IRB)-Research center department at King Faisal Specialist Hospital and Research Centre (KFSH&RC) - Jeddah Branch. Verbal consent was obtained from the parents of all patients included in the study.

Consent for publication

Written informed consent for the publication of this data was given by the patients' parents or their legal guardians.

Competing interests

Author OB declares that he has no conflict of interest.

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