Laparoscopic repair of Morgagni hernia in children: Tips and tricks learned in 20 years' experience at a tertiary pediatric center

R.J. Ortiz, J. Ruiz, M. Andrade Manso, A. Reusmann, M.M. Boglione , C. Giuseppucci, C.M. Pérez Espinosa, S. Canestrari, M. Capparelli, L. Korman, E.J. Redondo, V. Giubergia, V.H. Ayarzabal, M.E. Barrenechea

Pediatric Surgery Department. Hospital de Pediatría Prof. Dr. Juan P. Garrahan. Buenos Aires (Argentina).

ABSTRACT

Objective. Morgagni hernia (MH) is a congenital diaphragmatic defect located in the retrosternal region. This study aims to report and analyze 20 years of experience in the diagnosis and management of MH at a tertiary pediatric center.

Material and methods. We conducted a retrospective review of patients who underwent laparoscopic MH repair between 2002 and 2022. Data on symptoms, defect location, surgical techniques, complications, and recurrences were analyzed.

Results. Fifty-five children were included in the study. Thirty-two (58%) were male. Mean age at surgery was 36 months (3 days-11 years). Mean follow-up was 45.16 months (8-110 months). Most hernias were discovered incidentally (61.8%). Nineteen patients (34.6%) had upper respiratory tract symptoms and a history of recurrent lung infection. Two patients (3.6%) presented with intestinal occlusion. Fifteen patients (27.2%) had Down syndrome, and seven (12.7%) had cardiac defects. The repair technique involved transabdominal laparoscopic-assisted repair with percutaneous sutures and extracorporeal knotting. Reoperation due to recurrence was necessary in two patients (3.6%), one of whom needed two redo procedures.

Conclusions. The transabdominal laparoscopic-assisted technique with percutaneous sutures and extracorporeal knotting is effective for MH repair, offering a low recurrence rate and minimal complications. Emphasizing the technical aspects, including tips and tricks, may further benefit the readership.

KEY WORDS: Hernias, diaphragmatic, congenital; Morgagni hernia; Minimally invasive surgical procedures.

CORRECCIÓN LAPAROSCÓPICA DE LA HERNIA DE MORGAGNI EN NIÑOS: CONSEJOS Y TRUCOS APRENDIDOS A LO LARGO DE 20 AÑOS EN UN CENTRO PEDIÁTRICO DE TERCER NIVEL

RESUMEN

Objetivo. La hernia de Morgagni (HM) es un defecto diafragmático congénito localizado en la región retroesternal. El presente estudio tiene por objeto describir y analizar 20 años de experiencia en el diagnóstico y manejo de la HM en un centro pediátrico de tercer nivel.

Material y método. Estudio retrospectivo de pacientes sometidos a corrección laparoscópica de HM entre 2002 y 2022, analizando los síntomas, la ubicación del defecto, las técnicas quirúrgicas, las complicaciones y las recidivas.

Resultados. En el estudio participaron un total de 55 niños, 32 (58%) de los cuales varones. La edad media en el momento de la cirugía fue de 36 meses (3 días-11 años). El seguimiento medio fue de 45,16 meses (8-110 meses). La mayoría (61,8%) de las hernias se descubrieron de forma accidental. 19 pacientes (34,6%) presentaban síntomas del tracto respiratorio superior y antecedentes de infección pulmonar recurrente. 2 pacientes (3,6%) sufrían obstrucción intestinal. 15 pacientes (27,2%) tenían síndrome de Down, y 7 (12,7%), anomalías cardíacas. La técnica de corrección consistió en una laparoscopia transabdominal con suturas percutáneas y nudos extracorpóreos. Fue necesaria reintervención por recidiva en 2 pacientes (3,6%), uno de los cuales precisó de dos procedimientos.

Conclusiones. La técnica laparoscópica transabdominal con suturas percutáneas y nudos extracorpóreos es eficaz a la hora de corregir la HM, con un bajo índice de recidiva y mínimas complicaciones. Si se ponen de relieve los aspectos técnicos y estos se acompañan de consejos y trucos, el beneficio para la comunidad será aún mayor.

PALABRAS CLAVE: Hernia diafragmática congénita; Hernia de Morgagni; Cirugía mínimamente invasiva.

INTRODUCTION

Morgagni hernia (MH) is a congenital diaphragmatic defect located in the retrosternal region. Two muscle bundles from the tendon of the diaphragm are attached to the anterior xiphoid. Lateral to these bundles, there is a gap

DOI: 10.54847/cp.2025.02.11
Corresponding author: Dr. Ramiro Jorge Ortiz. Hospital de Pediatría Prof. Dr. Juan P. Garrahan. Pichincha 1890. C1245 CABA, Buenos Aires, Argentina.
E-mail address: ortizramiroj@gmail.com

Date of submission: January 2025 *Date of acceptance:* February 2025

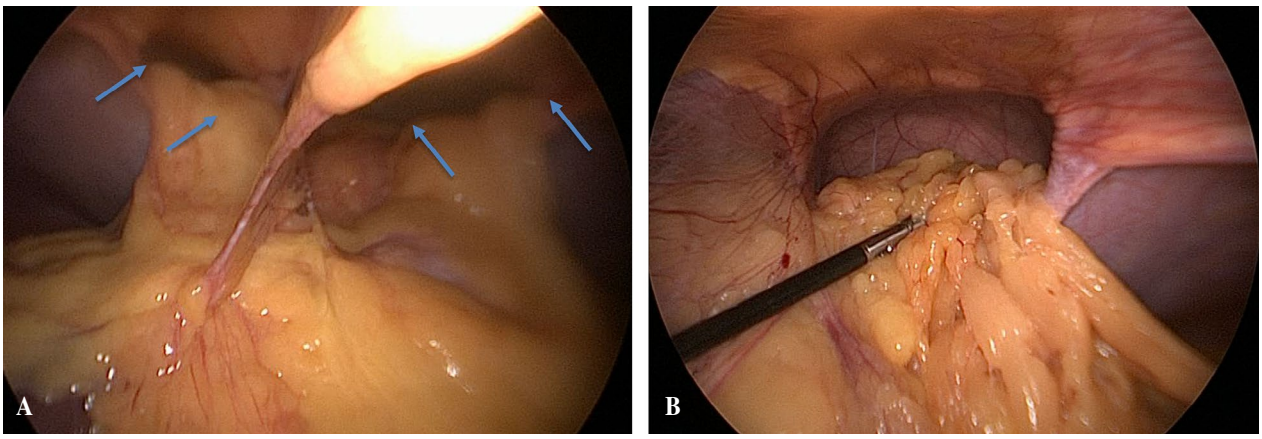

Figure 1. Identification and reduction of hernia content. A) Laparoscopic view showing the bilateral defect in the diaphragm, with the hernia sac visible on both sides. The arrows indicate the margins of the defect. B) Reduction of hernia content into the abdominal cavity. The laparoscopic instrument is shown grasping the omentum.

between the sternal and costal fibers of the diaphragm (Larrey region). Herniation of intra-abdominal organs through this space is referred to as a parasternal hernia or MH[1,2]. It was first described by Giovani Morgagni in 1769 and has unique features in terms of clinical presentation and associated anomalies[3,4].

Morgagni hernia is a rare condition, accounting for less than 6% of all surgically treated diaphragmatic hernias in the pediatric population[5,6]. It is often asymptomatic and discovered incidentally[6,7]. Since the advent of minimally invasive surgery, various laparoscopic techniques for MH repair have been described. Lima et al.[8] recommended primary closure with a continuous suture, while Fernandez et al.[9] advocated for interrupted sutures with intracorporeal knot tying. In addition, Ramachandran et al.[10] suggested using mesh reinforcement. In 2006, Patkowski et al. introduced the transabdominal extracorporeal wall closure technique[11], and Karadag et al. reported one of the largest published series of 22 patients undergoing MH repair[2].

This study aims to report on 20 years of experience with laparoscopic MH repair, focusing on technical aspects, complications, and patient outcomes. The laparoscopic approach, particularly through extracorporeal knotting and percutaneous sutures, has shown promise but warrants a detailed discussion of its technical nuances.

MATERIALS AND METHODS

We conducted a retrospective review of medical records for all patients with MH who underwent laparoscopic surgery at our institution between 2002 and 2022, there were no exclusion criteria. The variables analyzed included demographic data, presenting symptoms, defect location, surgical technique, postoperative complications, and recurrence rates. Preoperative assessments consisted of anterior-posterior and lateral chest X-rays for all patients, with additional CT scans and contrast studies performed in selected cases.

Laparoscopy was the initial approach in all cases. For minimally invasive surgery, the patient was positioned in reverse Trendelenburg position, with the surgeon at the foot of the table and the assistant on the right.

A 5- or 10-mm trocar was placed infraumbilically using Hasson's technique, and pneumoperitoneum was established at 8 to 12 mm Hg with a flow rate of 4 to 8 L/min. A 30° 5- or 10-mm telescope was inserted through the umbilical port. Two 3- or 5-mm working ports were placed in both flanks.

The hernia sac was identified, and hernia contents were reduced (Fig. 1). To improve exposure of the defect, the falciform ligament was resected , and the edges of the defect were scored with electrocautery (Fig. 2). In all cases, an attempt was made to excise the sac, and the defect edges were also scored using electrocautery (Fig. 3).

A stab incision is made in the skin where the stitch will be placed. A small subcutaneous pocket is created directly over the portion of the defect to be corrected. The defect is repaired with 2-0 Ethibond sutures (Ethicon, Johnson & Johnson, USA), which are passed percutaneously through the full thickness of the anterior abdominal wall into the abdominal cavity, grasped with a laparoscopic needle holder, and then passed through the posterior edge of the defect as a U suture before being withdrawn through the anterior abdominal wall and exiting subcutaneously a few millimeters lateral to the entry point (Fig. 4). After applying all the required sutures, complete closure of the defect is tested under laparoscopic visualization without pneumoperitoneum (Fig. 5). Sutures are then tied within the subcutaneous plane. Finally, a reinforcing continuous suture is performed with Ethibond 3-0 (Ethicon, Johnson

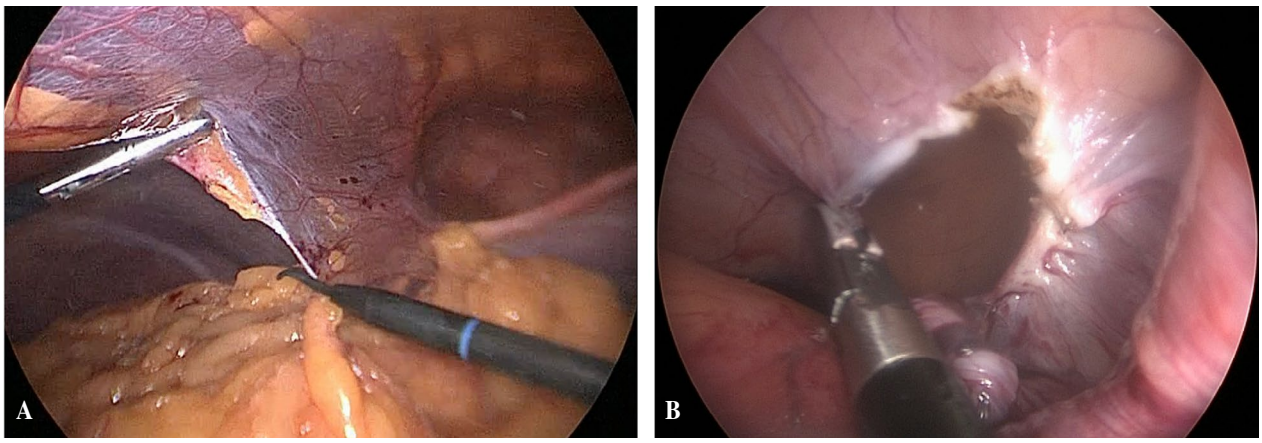

Figure 2. Resection procedures. A) Removal of the falciform ligament, with the laparoscopic instrument shown grasping and cutting the ligament. This step is crucial to gain access to the hernia sac and defect area. B) Resection of the hernia sac, showing the sac is dissected and excised from the defect site. The image highlights the detachment and preparation of the hernia sac for removal.

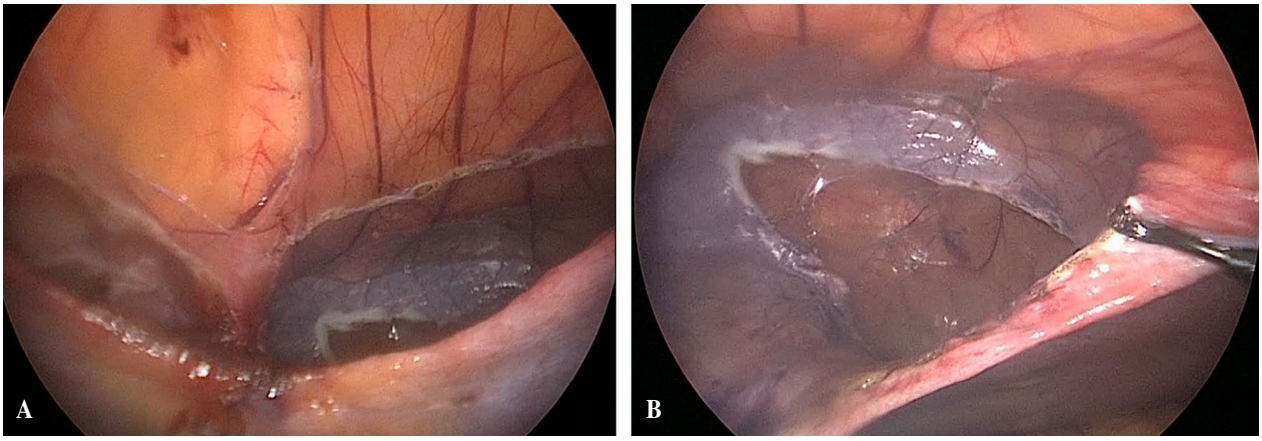

Figure 3. Defect visualization and preparation. A) Complete visualization of the defect site after the resection of the falciform ligament and hernia sac. The image shows a clear view of the defect's edges, which are now fully exposed. B) Defect edges scored with electrocautery, showing the process of cauterizing the edges to promote adhesion and reduce recurrence. The scoring marks are visible along the defect margins.

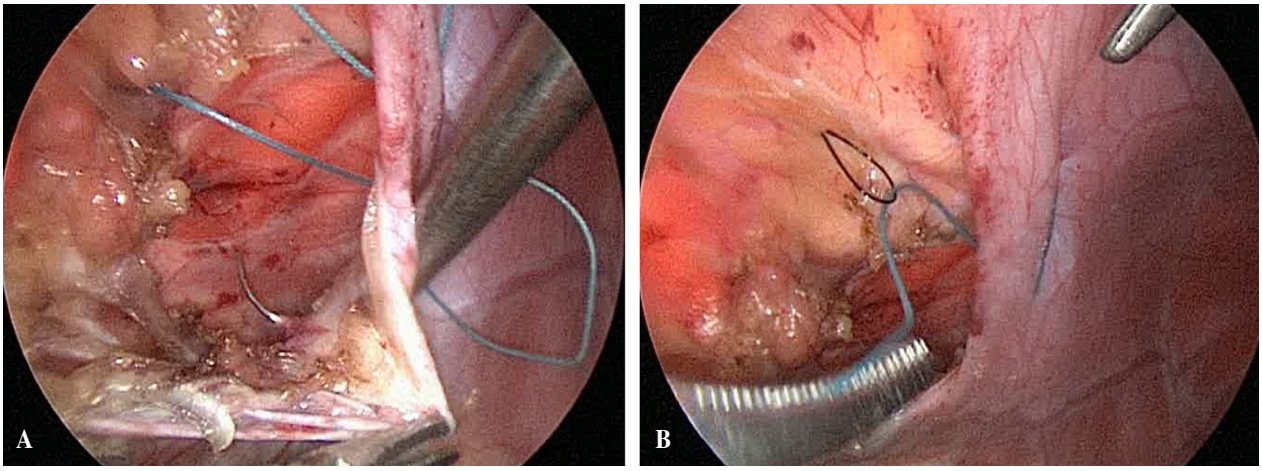

Figure 4. Suture techniques. A) Sutures being passed through the posterior edge of the defect in a U-suture. The image shows the suturing process with the needle and suture material inserted from the posterior aspect. B) The suture being drawn through the anterior abdominal wall using a loop. This image demonstrates the technique of securing the suture and pulling it through the defect for effective closure.

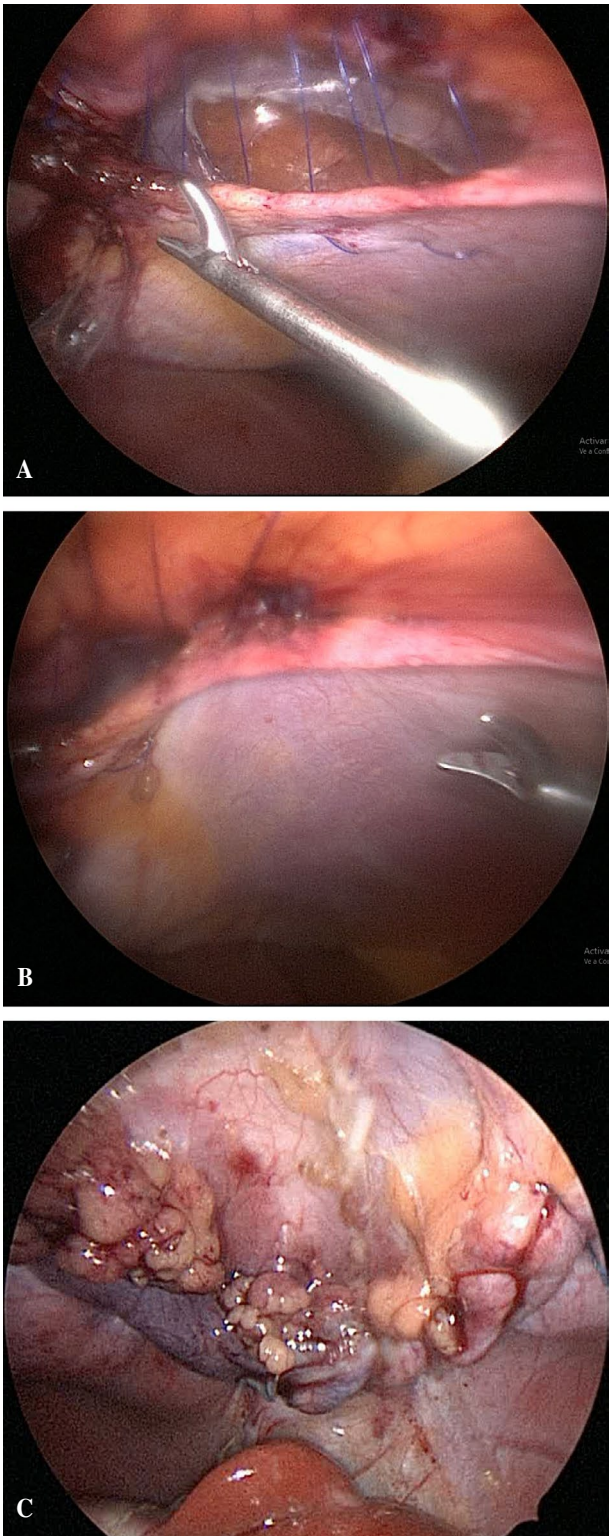

Figure 5. Completion of the repair. A) All sutures applied, showing the defect with sutures in place. The image provides a detailed view of the completed suture pattern before final closure. B) Testing of complete closure of the defect under laparoscopic visualization to ensure that all sutures are properly placed and the defect is adequately closed. C) Final image of the repaired defect, demonstrating complete and secure closure after all sutures have been applied and tested.

Table 1. Demographics and clinical presentation.

Demographic	
Male	32 (58%)
Female	23 (42%)
Mean age	36 mths (r: 3 days-124 mths)
Side	
Bilateral	34 (61.8%)
Right	9 (16.4%)
Left	12 (21.8%)
Diagnosis	
Incidental diagnosis	34 (61.8%)
Symptomatic	21 (38.2%)
Associated anormality	
Down syndrome	15 (27.2%)
Cardiac defect	7 (12.7%)
Genetic disorder	3 (5.4%)
Duodenal atresia	2 (3.6%)
Malrotation	2 (3.6%)

& Johnson, USA) or a barbed suture (V-Loc, Covidien) along the entire length of the defect. The residual pneumoperitoneum is evacuated and the skin incisions are closed.

The surgery was performed by the chief resident or a senior resident in all cases and supervised by the same staff surgeon in almost all cases.

Patients were followed-up with regular appointments and chest X-rays at 1, 3, 6, and 12 months postoperatively, and annually thereafter. Continuous variables are presented as the median (range), and categorical variables as absolute values and corresponding percentages.

RESULTS

Between 2002 and 2022, 55 patients with MH underwent surgery at our institution, of whom 32 were male (58%). The mean age at surgery was 36 months (range, 3 days to 11 years). The mean follow-up duration was 45.16 months (range, 8 to 110 months) (Table 1).

In 34 patients (61.8%), the hernia was incidentally detected through imaging studies. Nineteen patients (34.6%) had upper respiratory tract symptoms and a history of recurrent lung infection, while two patients (3.6%) presented with signs of intestinal obstruction. The mean age at symptom onset was 22.3 months (range, 1 month to 9 years). The diagnosis was made using X-rays in 38 patients (69.1%), esophagogastroduodenal contrast studies

in eight (14.5%), colon contrast studies in five (9.1%), and CT scan in four (7.3%).

Fifteen patients (27.2%) had Down syndrome, seven (12.7%) had cardiac defects (ventricular septal defect in four, tetralogy of Fallot in two, and atrial septal defect in one), and three patients (5.4%) had other genetic disorders. Two patients (3.6%) had duodenal atresia, and two (3.6%) had undergone a Ladd procedure for malrotation. One patient (1.8%) had previously undergone two Bochdalek hernia repairs at another institution.

All repairs were performed using the transabdominal laparoscopic-assisted technique. Conversion to laparotomy was necessary in only one patient (1.8%) due to a very large defect requiring a Gore-Tex mesh (W. L. Gore & Associates, Inc.) This patient also had a history of two previous Bochdalek hernia repairs at another institution. Nine patients (16.4%) had right-sided hernias, 12 (21.8%) left-sided, and 34 (61.8%) bilateral hernias. The falciform ligament was removed in all cases to improve defect visualization, and the defect edges were scored to facilitate healing. The hernia sac was removed in 54 patients (98.2%). The contents varied: colon alone in 19 patients (34.6%), omentum alone in 12 (21.8%), omentum and colon in eight (14.5%), small bowel in six (10.9%), liver in five (9.1%), and combinations of colon with small bowel or liver in five patients (9.1%).

Reoperation due to recurrence was necessary in two patients (3.6%), one of whom required two redo procedures. Although the same technique was used in all our patients, these two cases were managed by a surgical team that was not familiar with the procedure. The first patient experienced abdominal pain 50 months after the surgery, and diagnosis was confirmed through X-ray. A laparoscopic approach was used. The hernia contents included colon, small bowel, and omentum. The defect was repaired using a transabdominal Ethibond 2-0 suture and a Goretex patch (Dualmesh).

In the second patient, hernia recurrence was identified 3 months post-surgery using during a follow-up X-ray. The second recurrence occurred 17 months later, with symptoms of abdominal pain and vomiting, and a new x-ray was conducted for diagnosis. Both redos were performed laparoscopically. In the first redo, the hernia content was omentum, while in the second it involved small bowel. On both occasions, the defect was repaired with a transabdominal Ethibond 2-0 suture.

In this series, no intraoperative or postoperative complications were observed. The patients demonstrated favorable cosmetic outcomes of the wound in the long-term postoperative period.

DISCUSSION

Morgagni hernia is a rare congenital diaphragmatic defect, accounting for less than 6% of pediatric diaphragmatic hernias[5,6]. Our 20-year study evaluated 55 patients who underwent laparoscopic repair of MH. The majority of cases (62.5%) were discovered incidentally, often during imaging for unrelated reasons. The laparoscopic transabdominal repair technique used extracorporeal knotting and percutaneous sutures, resulting in a low recurrence rate (3.6%) and minimal complications, underscoring the effectiveness and safety of the technique.

Morgagni hernia operations can be performed through open, laparoscopic, or abdominal approaches. Although high success rates have been reported for all these methods, laparoscopic repair offers several advantages, including a short hospital stay, good cosmetic results, and early initiation of nutrition[11]. Our series of 55 patients, all underwent laparoscopic transabdominal repair. Lian et al. previously reported 15 cases repaired with extracorporeal knotting via the transabdominal approach[14], and Karadag et al. presented 22 patients who were treated laparoscopically[2]. Our study is among the largest series with an extended follow-up using this technique, with a case distribution similar those reported in the literature[2,15,16]. The mean age of our patients was 36 months (range, 3 days-11 years), in agreement with previously published data. Consistent with the literature[16], MH was more common in boys, with 24 girls (42.8%) and 32 boys (57.2%) in our series.

Patients are generally asymptomatic, and the hernia is often discovered incidentally during chest or abdominal X-rays undertaken for unrelated reasons. Morgagni Hernia can present with a wide range of clinical manifestations, including cough, upper respiratory tract symptoms (URTS), fever, vomiting, or even ileus[17]. In the literature, URTS is reported as one of the main symptoms of MH[2,4]. In our study, 19 cases presented with URTS. The most common presentation in our series, however, was an incidental finding, in contrast to Karadag et al.[2], who reported only four out of 22 patients as asymptomatic. Despite often being asymptomatic, patients with MH should undergo surgical repair to prevent potential complications, such as intestinal obstruction. In our series, two patients presented with intestinal obstruction, but neither required intestinal resection.

Chromosomal and cardiac defects are common in MH. Fifteen of our cases had Down syndrome, and seven had a cardiac anomaly. These additional anomalies did not impact the selected surgical technique.

Although in the literature 90% of MH cases are reported to be right-sided, only 16% of our cases were right-sided defects. In our series, the defect was predominantly bilateral. We believe that removing the falciform ligament allows for proper assessment of the defect.

Our study confirms the efficacy of laparoscopic transabdominal repair for MH, particularly with the use of extracorporeal knotting. This technique offers the advantages of the laparoscopic approach, with suturing performed outside the body, which has been shown to enhance repair strength

by engaging the full thickness of the abdominal wall[2,14]. This approach also simplifies the procedure compared to intracorporeal knotting, as it avoids complex in-cavity maneuvers. In contrast to intracorporeal knotting, extracorporeal knotting is more intuitive and less prone to error[11]. Intracorporeal techniques often require advanced skill and experience due to the limited working space within the abdominal cavity. Our findings align with those of Lian et al.[14] and Karadag et al.[2], who reported successful outcomes using similar techniques.

The removal of the hernia sac during surgery is a debated topic. Ergun et al.[18] advocate for sac removal, suggesting it reduces recurrence rates, while other studies[19] have found no significant impact of sac removal on recurrence. However, Karadag et al.[2] reported a large series in which the hernia sac was not removed, and no recurrences were observed. In our cohort, we removed the sac in 54 out of 55 patients. Notably, the one patient without sac removal experienced recurrence 3 months after the initial surgery, supporting the concept that sac removal may be helpful to prevent recurrence. This finding is consistent with the viewpoint that sac removal can contribute to a more durable repair[18].

Our study's conversion rate to laparotomy was 1.8%, which is lower than the 9% reported by Karadag et al.[2]. This suggests that our approach effectively manages most cases laparoscopically. Additionally, the use of Gore-Tex mesh was required in only one patient with an exceptionally large defect and two previous repairs for a Bochdalek hernia, indicating that mesh reinforcement may be reserved for select cases rather than used routinely.

Our results are generally consistent with the existing literature on laparoscopic MH repair. Hernia recurrence is a recognized complication[20-22]. The recurrence rate in our study (3.6%) is comparable to that reported by Bawazir et al.[20] but is lower than the 42% recurrence rate observed by Garriboli et al.[22]. The absence of recurrences in the studies by Karadag et al. and Anadolulu et al.[2,4] may reflect differences in surgical experience, as our two recurrence cases were managed by a less experienced surgical team. This suggests that surgical proficiency may influence recurrence outcomes.

The findings of our study underscore the efficacy of laparoscopic repair using extracorporeal knotting for MH. This technique has demonstrated significant benefits in terms of reduced recurrence rates, shorter operation times, and lower complication rates[11]. The percutaneous internal ring suturing technique described by Patkowski et al.[11] is particularly relevant, as it highlights the simplicity and effectiveness of using external knot-tying methods in minimally invasive surgeries. Incorporating these techniques into routine practice can enhance surgical outcomes and optimize patient recovery.

The retrospective design of the study and the involvement of multiple surgeons, despite adherence to a standardized protocol, may have introduced variability in outcomes. Additionally, the rarity of MH limits the generalizability of our findings, highlighting the need for larger studies to confirm our results.

Prospective, multicenter studies are essential to validate our findings and further refine surgical techniques. Future research should focus on comparing different repair methods, evaluating long-term outcomes, and assessing the impact of sac management strategies on recurrence rates.

In conclusion, laparoscopic transabdominal repair of MH using extracorporeal knotting and percutaneous sutures has proven to be effective, with low complication and recurrence rates. This approach simplifies the surgical technique and enhances repair strength by engaging the full thickness of the abdominal wall. Given these benefits, laparoscopic repair should be considered as a feasible technique for managing MH.

REFERENCES

1. Li S, Liu X, Shen Y, Wang H, Feng M, Tan L. Laparoscopic repair of Morgagni hernia by artificial pericardium patch in an adult obese patient. J Thorac Dis. 2015; 7(4): 754-7.
2. Karadag CA, Erginel B, Yildiz A, Kaba M, Demir M, Sever N. Laparoscopic repair of Morgagni hernia in children. J Pediatr Surg. 2023; 58(9): 1670-3.
3. Morgagni G. Seats and causes of diseases. Vol. 3. In: Millar A, Cardell T, editors. London: Millar and Cardell; 1769. p. 205-7.
4. Anadolulu AI, Gerçel G, Kocaman OH. Laparoscopic repair of Morgagni hernia in children. Ann Med Surg (Lond). 2022; 30: 56-7.
5. Contini S, Dalla Valle R, Bonati L, Zinicola R. Laparoscopic repair of Morgagni repair: Report of the case and review of the literature. J Laparoendosc Adv Surg Tech. 1999; 9(1): 93-9.
6. Mallick MS, Alqahtani A. Laparoscopic-assisted repair of Morgagni hernia in children. J Pediatr Surg. 2009; 44(8): 1621-4.
7. Vogelaere K, Backer A, Delvaux G. Laparoscopic repair of diaphragmatic Morgagni hernia. J Laparoendosc Adv Surg Tech. 2002; 12: 457-60.
8. Lima M, Dòmini M, Libri M, Morabito A, Tani G, Dòmini R. Laparoscopic repair of Morgagni-Larrey hernia in a child. J Pediatr Surg. 2000; 35(8): 1266-8.
9. Fernandez-Cebrian JM, De Oteyza JP. Laparoscopic repair of hernia of foramen of Morgagni: a new case report. J Laparoendosc Surg. 1996; 6(1): 61-4.
10. Ramachandran CS, Arora V. Laparoscopic transabdominal repair of hernia of Morgagni-Larrey. Surg Laparosc Endosc Percut Tech. 1999; 9: 358-61.
11. Patkowski D, Czernik J, Chrzan R, Jaworski W, Apoznański W. Percutaneous internal ring suturing: a simple minimally invasive technique for inguinal hernia repair in children. J Laparoendosc Adv Surg Tech A. 2006; 16(5): 513-7.
12. Al-Salem AH, Zamakhshary M, Al Mohaidly M, Al-Qahtani A, Abdulla MR, Naga MI. Congenital Morgagni's hernia: a national multicenter study. J Pediatr Surg. 2014; 49(4): 503-7.

13. Pokorny WJ, McGill CW, Harberg FJ. Morgagni hernias during infancy: presentation and associated anomalies. J Pediatr Surg. 1984; 19(4): 394-7.
14. Lim L, Gilyard SM, Sydorak RM, Lau ST, Yoo EY, Shaul DB. Minimally invasive repair of pediatric Morgagni hernias using transfascial sutures with extracorporeal knot tying. Perm J. 2019; 23: 18.208.
15. Escarcega P, Riquelme MA, Lopez S, González AD, Leon VY, Garcia LR, et al. Multi-institution case series of pediatric patients with laparoscopic repair of Morgagni hernia. J Laparoendosc Adv Surg Tech A. 2018; 28(8): 1019-22.
16. Lauriti G, Zani-Ruttenstock E, Catania VD, Antounians L, Lelli Chiesa P, Pierro A, et al. Open versus laparoscopic approach for Morgagni's hernia in infants and children: a systematic review and meta-analysis. J Laparoendosc Adv Surg Tech A. 2018; 28(7): 888-93.
17. Parlak A, Gurpinar AN. Laparoscopic repair of Morgagni hernia in children. J Laparoendosc Adv Surg Tech A. 2022; 32(7): 811-6.
18. Ergun E, Gollu G, Ates U, Sozduyar S, Jafarov A, Bahadir K, et al. Laparoscopic assisted anterior transabdominal wall closure using loop suture removing technique in Morgagni hernia: safe and easy method. Pediatr Surg Int. 2020; 36(6): 679-85.
19. Alqahtani A, Al-Salem AH. Laparoscopic-assisted versus open repair of Morgagni hernia in infants and children. Surg Laparosc Endosc Percutan Tech. 2011; 21(1): 46-9.
20. Bawazir OA, Mahomed A, Fayyad A, Bagaryn E, Bawazir A, Mandora R. Laparoscopic-assisted repair of Morgagni hernia in children. Ann Pediatr Surg. 2020; 16: 1-7.
21. Altinkaya N, Parlakgümüş A, Koc Z, Ulusan S. Morgagni hernia: diagnosis with multidetector computed tomography and treatment. Hernia. 2010; 14(3): 277-81.
22. Garriboli M, Bishay M, Kiely EM, Drake DP, Curry JI, Cross KM, et al. Recurrence rate of Morgagni diaphragmatic hernia following laparoscopic repair. Pediatr Surg Int. 2013; 29(2): 185-9.