Minimally Invasive Repair of Pediatric Morgagni Hernias Using Transfascial Sutures with Extracorporeal Knot Tying

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ABSTRACT

Background: Morgagni hernias are rare, with a reported incidence of 2% to 5% of congenital diaphragmatic hernias.

Objectives: To review a laparoscopic technique to repair Morgagni hernias in pediatric patients.

Methods: Retrospective chart review of pediatric patients who underwent minimally invasive repair of a Morgagni hernia from November 2009 to September 2017 within a defined population.

Results: During an 8-year period, 15 patients with Morgagni hernias were identified. Four patients with Morgagni hernias were excluded because they had open repairs. Eleven Morgagni hernias were repaired through a completely minimally invasive approach. Three repairs were completed using a soft-tissue patch (Gore-Tex patch, W L Gore & Associates Inc, Flagstaff, AZ). All minimally invasive repairs were completed with transfascial sutures using an endoscopic suturing device (Endo Close, Covidien/Medtronic, Fridley, MN) and 2-0 nonabsorbable synthetic sutures with extracorporeal knot tying. Median follow-up was 40 months (range = 2.6 months to 7.3 years). No patients had postoperative pectus excavatum defects. There were no recurrences.

Conclusion: Morgagni hernias are amenable to minimally invasive repair with this simple technique. With large defects, synthetic patches should be used. Recurrences are rare, and morbidity is low.

INTRODUCTION

Congenital diaphragmatic hernias have an estimated incidence of 1 in 2000 to 1 in 5000 live births. Of these, Morgagni hernias are the most rare, with an incidence of 2% to 5% of all congenital diaphragmatic hernias.¹ Whereas Bochdalek hernias represent a posterolateral defect in the diaphragm, Morgagni hernias are anterior and more central in location.²

Figure 1. A. Port placement for repair of Morgagni hernia in pediatric patient. B. Tension is assessed by bringing the anterior rim of the diaphragm up to the abdominal wall and depressing the anterior aspect of the abdominal wall.

As noted, they are less common, tend to present later, and cause fewer respiratory symptoms than do Bochdalek hernias. Both the pediatric and adult literature have described various techniques for repairing Morgagni hernias including open repair,^{2,3} laparoscopic,⁴⁻¹² thoracoscopic,¹³ and robotic techniques^{14,15} as well as repairs completed with prosthetic patches.^{2,8,16,17} The purpose of this study is to review the minimally invasive techniques used to repair pediatric Morgagni hernias at our institution.

METHODS

Patients

A retrospective chart review was completed of pediatric patients who underwent repair of a diaphragmatic hernia from November 2009 to September 2017 at 4 Kaiser Permanente Southern California (KPSC) hospitals by 4 pediatric surgeons. Patients with Morgagni hernia who underwent an open repair were excluded from the study. All surgeries were completed by 1 or more of the attending surgeon authors. Data collected included basic patient demographics, symptoms, additional congenital anomalies, hernia sac contents, types of repairs, recurrence, and follow-up. Follow-up included physical assessment through a clinic visit or

radiographic follow-up with imaging such as a chest x-ray film, or both. This study was approved by the KPSC institutional review board (no. 10902).

Surgical Technique (Figure 1)

The 3-mm umbilical port was placed for the camera, followed by 2 upper-quadrant, working 3-mm ports (Figure 1A). Three 3-mm incisions were required for the instruments. Once the ports were placed, the defect was assessed with use of a 30° telescope. If the defect extended to both sides of the falciform ligament, the ligament was divided. The anterior rim of the diaphragm was then brought up to the abdominal wall, and the abdominal wall compressed to assess the amount of tension placed on the diaphragm (Figure 1B). If there was minimal tension, we proceeded with a primary repair; however, if there was increased tension, we proceeded with a patch repair. With either type of repair, the

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edge of the hernia sac was detached from the edge of the muscle. This prevented the mesothelial lining from interfering with the healing of the fascial edges. In most cases the cephalad portion of the hernia sac was left in the chest.

Primary Repair (Figure 2 A-E)

In addition to the 3-mm port incisions noted previously, a few small (2-mm) skin incisions were made, through which the repair sutures (2-0 braided synthetic non-absorbable sutures) were passed into the abdomen. An endoscopic suturing device (Endo Close, Covidien/Medtronic, Fridley, MN) was used to pass these sutures into the abdomen. Each suture was placed laparoscopically through the anterior rim of the diaphragm. Once the suture was placed, the needle end was retrieved with the Endo Close through the same 2-mm skin incision but 1-cm cephalad to the previous fascial opening, thus allowing the suture to be tied securely around a bundle of fascia. Once all the sutures were placed, they were tied extracorporeally, with the knot easily buried underneath the subcutaneous fat.

Patch Repair (Figure 3)

If increased tension was felt during the initial assessment, a patch was used to complete the repair. A soft-tissue patch (Gore-Tex patch, W L Gore & Associates Inc, Flagstaff, AZ) trimmed to the appropriate size was used. The patch was inserted into the abdomen through one of the port incisions after temporarily removing the port. The posterior edge of the patch was sutured to the anterior diaphragm rim using 2-0 braided synthetic nonabsorbable sutures. The anterior edge of the patch was then sutured to the anterior aspect of the abdominal wall using the same technique as for the primary repair using the Endo Close device for the extracorporeal knots.

After the repair was completed, the abdomen was desufflated and the ports were removed. The umbilical port was closed with absorbable sutures. The Endo Close incisions were closed with adhesive skin closure strips (Steri-Strips, 3M, Maplewood, MN).

RESULTS

Demographics and Presenting Symptoms

Between November 2009 and September 2017, a total of 15 pediatric patients

Figure 2. Primary repair. A. Endoscopic suturing device (Endo Close indicates Endo Close, Covidien/Medtronic, Fridley, MN) passes a braided synthetic nonabsorbable suture into the abdomen. B. Intracorporeal sutures are passed through the anterior rim of the diaphragm using laparoscopic needle drivers. C. Needle is retrieved with the Endo Close through the same skin incision but 1 cm cephalad to the previous fascial entry site, thus allowing the suture to be tied securely around an anterior rib or muscle bundle. D. All sutures are placed. E. Sutures are tied extracorporeally.

Figure 3. Patch repair. Intracorporeal knots secure the posterior part of the soft-tissue patch (Gore-Tex patch, W L Gore & Associates Inc, Flagstaff, AZ) to the anterior edge of the diaphragm with extracorporeal knots, using the technique described in Figure 2 to secure the anterior edge of the patch to the anterior aspect of the abdominal wall.

were identified with Morgagni hernias. Eleven of the 15 patients underwent a minimally invasive repair. Four of the 15 patients had open repairs and were excluded. The patients who underwent open repairs did so because of the large size of their defects, with greater than or equal to 50% of the diaphragm missing. None of

the laparoscopic cases were converted to open repair. Six patients were male, and 5 were female. The median age at the time of repair was 1.4 years (range = 8 days to 3.4 years).

At presentation, 8 patients had respiratory symptoms, including recurrent pulmonary infection, wheezing, or cough.

Three patients were asymptomatic, with their hernias found incidentally on imaging.

Additional Congenital Anomalies

Seven of the 11 patients had 1 or more additional congenital anomalies. Four patients had cardiac anomalies, including dextrocardia ($n = 1$), endocardial cushion defects ($n = 2$), and pulmonary valve stenosis ($n = 1$). Five patients had skeletal anomalies; 1 patient each had thumb hypoplasia, scoliosis, craniosynostosis, and pectus carinatum, and the fifth patient had lumbar spine anomalies, scoliosis, bilateral rib anomalies including an accessory right 13th rib, syringomyelia, tethered cord, and ear and foot anomalies. Three patients had chromosomal anomalies: 2 with trisomy 21 and 1 with deletion of chromosome 8p. One patient had gastroschisis and 1 had intestinal malrotation. One patient had a horseshoe kidney. One patient had macroglossia. One patient had bilateral conductive hearing loss.

Hernia Sac Contents

A representative chest x-ray film is shown with the colon entering the chest through an anterior diaphragmatic defect (Figure 4 A and B). In this series, 10 patients had either large bowel or small bowel in the hernia sac, 2 of whom additionally had liver in the sac and 1 of whom had stomach as well.

Repairs

Eleven minimally invasive repairs were completed, and 3 cases used a Gore-Tex patch. Minimally invasive repairs had a median length of 98 minutes (range = 48–245 minutes). The patient whose repair took 245 minutes had a large, 9 cm $\times$ 6 cm defect and underwent a combined umbilical hernia repair. The length of stay was a median of 1 day (range = 1–21 days) for minimally invasive repairs. Almost all patients remained in the hospital for 1 to 2 days; however, 1 patient with a large ventricular septal defect with left to right shunting remained hospitalized for an extended period because of his cardiac anomaly. In 4 (80%) of the 5 patients presenting with respiratory distress, their respiratory symptoms resolved on completion of the hernia repair.

Figure 4. Chest x-ray films demonstrate a Morgagni hernia with a herniated colon. A. Anteroposterior view and B. lateral view with arrows pointing toward the herniated colon. L = left.

All 11 patients were able to be extubated at the end of the case except 1 patient who remained intubated postoperatively because of oxygen desaturations during the repair. This complication was thought likely to be secondary to his severe congenital ventricular septal defect.

Follow-up

The patients had a median follow-up with physical assessment through a clinic visit of 40 months (range = 2.6 months to 7.3 years). Median follow-up with a chest x-ray film was 1 year (range = 9 days to 1.6 years). Presenting symptoms for all patients had resolved. None of these minimally invasively repaired hernias have recurred. No patients had postoperative pectus excavatum defects.

DISCUSSION

Earlier techniques of open repair of Morgagni hernia with upper midline or upper transverse incisions were previously recommended²; however, advances in laparoscopy since Georgacopulo et al⁴ first described a laparoscopic Morgagni hernia repair in a child suggest that a minimally invasive approach is preferred. Laituri et al⁸ recommend laparoscopy because an anterior defect is easily seen with a laparoscopic view. This study, as well as multiple others^{5–7,9,10,12} advocate the laparoscopic approach, and some investigators use extracorporeal knot tying as well.^{6,10} Even with patch repair, laparoscopy is feasible,^{8,17,18} especially if it will reduce the tension placed on the diaphragm and chest wall.¹⁶ This technique provides a

simple and easy way to incorporate the use of a patch into a laparoscopic repair, with good-quality repair and excellent cosmetic results.

There also has been much debate regarding excision of the hernia sac, with advocates for^{6,12} and against^{19,20} sac excision. In this study the sac was detached from the peritoneum at the edge of the defect with the hook cautery, but the actual sac is left in situ with no recurrences thus far. Although there have been previous reviews with large numbers of patients with Morgagni hernia,^{6,8,11,13,19} to our knowledge, this study has one of the largest cohorts of Morgagni hernia repairs performed completely and solely using the laparoscopic technique.

The principal reason for reporting this study is to illustrate a simple technique for closing the defect in patients with an anterior diaphragmatic defect. Sutures are passed into the abdomen through small 2-mm skin incisions in the anterior aspect of the abdominal wall, passed through the edge of the diaphragm, and then retrieved back out through the same small skin opening. All sutures are placed first, then tied outside the body. This makes the technique quick, simple, and secure. If there is a larger distance between the anterior diaphragm edge and the anterior aspect of the abdominal wall, an appropriate-sized piece of Gore-Tex patch can be sutured to the anterior edge of the diaphragm with standard intracorporeal knots then secured to the anterior aspect of the abdominal wall as noted in Figures 2 A–E and 3. The main criticism for this technique is

cosmetic because of the small skin incisions; however, they heal well as very small scars on the anterior part of the abdomen.

The alternative to this type of laparoscopic repair is to pass an internal needle through the anterior diaphragm edge and to take a bite of the posterior aspect of the abdominal wall. That suture then has to be tied internally, which is difficult because of its anterior position. Also, it is challenging to place all the sutures and tie them at the end with this purely internal technique. Surgeons who have tried both techniques will recognize how simple it is to use the presented extracorporeal knot-tying technique.

CONCLUSION

A minimally invasive laparoscopic approach using the technique described here with extracorporeal knot tying using a suture passer device is recommended for Morgagni hernia repairs. The technical tip recommended is to place all sutures first and tie them at the end. This technique allows for a good repair with a low recurrence rate (none in our cohort) and resolution of patients' symptoms. It also has excellent cosmetic results. Laparoscopic repairs with patches are easy to complete with this technique. However, larger defects may require an open approach for repair. Morbidity and mortality are low for Morgagni hernia repairs with this technique. ♦

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

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