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Robot-assisted Repair of a Left-Sided Diaphragmatic Eventration with Concomitant Diaphragmatic Hernia

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1. Abstract

1.1. Introduction

Diaphragmatic eventration (DE) and diaphragmatic herniation (DH) rarely occur concomitant. Herein, we report a case of simultaneous presentation of these pathologies with a focus on preoperative identification and the technique for minimally-invasive repair.

1.2. Case Description

A 53-year-old male with no significant medical history presented with epigastric pain. He was found to have a large left sided diaphragmatic eventration on CT scan. He was taken for elective repair and identified to have a diaphragmatic eventration with concurrent apical diaphragmatic hernia. He underwent a successful combined robot-assisted abdominal hernia reduction and thoracic diaphragmatic resection and plication.

1.3. Discussion

This represents the first report of concurrent left sided diaphragmatic eventration and herniation repaired through a combined robotic assisted abdominal and thoracic approach.

2. Introduction

Estimated to occur in <0.05% of the population, diaphragmatic eventration (DE) is an abnormally high position of the diaphragm,[1] more often occurring on the left side [2]. Eventrations are most often congenital in nature and are thought to be secondary to abnormal migration of myoblasts to the septum transversum and pleuroperitoneal membrane. This results in a characteristically thin, membranous and atrophic affected portion of the diaphragm [3]. In contrast to the less common DE, which exhibits complete diaphragmatic continuity [4], diaphragmatic hernias (DHs) are far more prevalent and occur through a diaphragmatic defect [4]. Although often asymptomatic, presentation of symptomatic DE can differ widely, ranging from acute respiratory distress in infants [5], with congenital DE to respiratory or gastrointestinal complaints in adults with acquired DE [6]. Here we present the case of a 53-year-old male with a large DE with concomitant DH treated with robot-assisted hernia reduction, diaphragm resection and plication.

3. Case Presentation

A 53-year-old male with no significant past medical history presented to the ED for epigastric pain. He noted similar pain prior that resolved with dietary modifications and bowel movements. Computed tomography (CT) scan revealed a large left-sided eventration containing small bowel, colon, spleen, distal pancreas, and duodenum. There was also a diaphragmatic hernia present. This was most evident on coronal and sagittal reconstructions (Figure 1 A and B). The patient was not obstructed and pain resolved with a bowel movement. He was discharged with plans for elective repair.

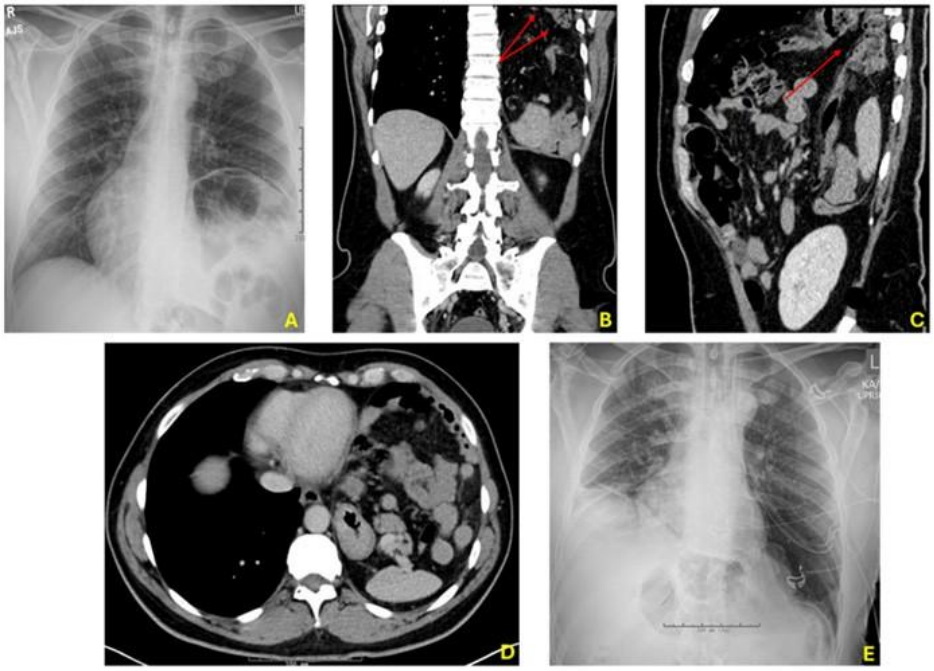

Figure 1: (A): PA Chest X Ray on ED presentation demonstrating marked elevation of left hemidiaphragm. (B): CT AP coronal view with combined eventration and large diaphragmatic hernia. (C): CT AP Sagittal view axial view depicting hernia defect (D): CT AP axial view with herniation of stomach, spleen, and bowel. (E): Post operative day 0 chest X ray.

3.1. Operative Technique

The patient was placed in the supine position, the abdomen was insufflated, and four 8 mm robotic trocars were placed in a line across mid abdomen. A large left eventration of the hemidiaphragm was identified along with an 8 cm incarcerated hernia at the apex of the eventration. Due to significant incarceration and adhesions, the hernia defect was extended, lysis of adhesions was performed, and all of the hernia contents including the omentum and colon were gently reduced into the abdomen.

The patient was repositioned in the left lateral decubitus position and a bronchial blocker was placed in the left mainstem bronchus. A subscapular port was placed and the chest was insufflated. Two additional robotic and an AirSeal port were placed. The redundant diaphragm was elevated away from the abdominal contents and a large portion of the thin central tendon was excised with multiple robotic Endo-GIA blue staple fires. The diaphragm was then plicated using felt pledgets on each side of the plication in a U-stitch fashion, reinforcing the staple line. The lung was re-expanded over a 24 Fr chest tube, robot was undocked, and the patient closed. He progressed appropriately and was discharged uneventfully. At last follow up, there was no evidence of recurrence of the eventration or hernia and he reported resolved epigastric discomfort.

4. Discussion

Here we present the case of an adult diagnosed with a left sided diaphragmatic eventration with diaphragmatic hernia treated successfully with robotic abdominal hernia reduction and thoracic diaphragm plication. As far as we know, this is the first concurrent DH and DE to be treated robotically.

DHs can present as severe congenital malformations [7], or secondary to trauma, iatrogenic injury, or spontaneous occurring lesions [8]. While DH is a true defect of the diaphragm, DEs occur as a diaphragmatic malformation with disruption of muscle development and replacement of fibroelastic tissue [3]. CDEs differ from acquired cases which include paresis from phrenic nerve injury, trauma, or secondary to thoracic surgeries [9]. While distinct in etiology and morphology, both DH or EHs can be discovered incidentally or can present with chest pain, dyspnea, abdominal pain, post-prandial fullness, nausea, and emesis [10]. Although the presence of concomitant DE and DH has not previously been reported, acute DE rupture is an uncommon but reported clinical sequelae of the presence of eventration. Rupture of a diaphragmatic eventration has been reported in five adult patients [11], in each of these cases, symptoms were acute, severe, and or associated with obstruction. Acute rupture seems unlikely in our patient given the more subacute nature of his symptoms, however a remote rupture of the DE creating a DH should be considered as a possible explanation for this patient's findings.

Our patient presented us with a combination of eventration and hernia. While typically cross-sectional imaging can be used to attempt to differentiate DE and DH, imaging findings can vary making it challenging [12]. MRI or CT imaging are used to differentiate the DHs and EHs but are not perfect modalities [12]. However, patient's preoperative CT scan depicted an eventration and hernia (Figure 1, Supplemental video 1), allowing the surgical team to make preoperative assessment to perform the operation robotically.

As with many thoracic and abdominal pathologic conditions, eventration has historically been approached using open techniques; but modern management is more commonly through a minimally invasive approach. Whether to approach eventration through the chest or the abdomen is a matter of ongoing discussion [11]. Some argue that abdominal approaches allow evaluation of both diaphragms and exploration for abdominal complaints.[11] Other methods such as open transabdominal, thoracoscopic [13], and laparoscopic abdominal [12] plication have also been performed for DE [4]. We chose to start robotically with an abdominal approach. This allowed safe reduction of the hernia while having good visualization of all critical abdominal structures. We then moved to the chest where the thinned-out portion of the diaphragm was resected to ensure good visualization of its lateral muscular component of the diaphragm. This ensured that we placed our plication stitches in strong tissue. Furthermore, by stapling and removal of the eventration tissue, we prevent potential bleeding from the phrenic vessels, while avoiding injury to the abdominal contents. Further, we fortified our staple line with a pledgeted plication over the staple line using a non-absorbable suture. We feel that a thoracic approach provides the best view for unilateral diaphragmatic plication.

In some cases, adult diaphragmatic hernias are repaired with mesh reinforcement [14], [15] In the literature, primary repair has been described up to 5 cm2 for closure, but success up to 10 cm2 has been reported. Deciding between prosthetic mesh, muscle flap, or primary suture closure depends on the quality of the tissue and size of the defect. Mesh repairs need to balance a tension free repair with the risk of infection. We were able to repair the current patient's defect and plicate the tissue in a tension free repair.

5. Conclusion

Diaphragmatic hernias are most commonly discovered in infancy and may present with substantial mortality and morbidity. In rare cases, CDHs may be diagnosed in symptomatic or asymptomatic adults. CDEs present radiographically similar to CDHs but have an intact de-muscularized diaphragm. To our knowledge this is the first combined abdominal hernia reduction and thoracic diaphragm plication to be performed using a minimally invasive robotic technique.

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