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CASE REPORT

Transabdominal robotic repair of a congenital right diaphragmatic hernia containing an intrathoracic kidney: a case report

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Abstract Bochdalek diaphragmatic hernia is a rare condition and is typically diagnosed prior to adulthood. Furthermore, right-sided defects are also uncommon due to the location of the liver, but can contain colon, omentum, small bowel, or rarely the kidney. Minimally invasive laparoscopic and thoracoscopic diaphragmatic hernia repairs are associated with improved outcomes when compared to open approaches—recently, robotic-assisted repairs have been performed in children with no morbidity and minimal complications. We report a case of an 80-year-old female who presented with an enlarging right-sided Bochdalek hernia containing an acquired intrathoracic kidney that was repaired using a robotic-assisted laparoscopic transabdominal approach with mesh placement. In this case, the robotic platform's advantages included excellent visualization of the posterolateral defect and efficient suturing during mesh placement. This approach is a viable option for skilled minimally invasive surgeons; however, further studies are warranted to investigate its utility in the management of diaphragmatic hernia repair.

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Introduction

Bochdalek diaphragmatic hernia is a rare condition with an incidence of 0.08–0.45 per 1000 births [1]. It rarely progresses to adulthood because most hernias present as neonatal respiratory distress or gastrointestinal obstruction and are immediately repaired, which has a morbidity rate up to 50 % [2, 3]. Nevertheless, in adults, asymptomatic patients typically are female with right-sided defects, whereas symptomatic patients tend to have left-sided defects [4]. Due to the liver's location and early embryonic fusion of right-sided pleuroperitoneal folds, up to 90 % of Bochdalek herniations occur on the left, usually containing colon, stomach, omentum, or small bowel [4–6]. In <1 % of cases, kidney herniation can occur either from direct migration of the kidney through the defect during a patient's lifetime (acquired), or less often during embryogenesis (intrathoracic renal ectopia) [7, 8].

Diaphragmatic hernias are preferably repaired using a minimally invasive laparoscopic or thoracoscopic approach, as morbidity and complication rates (0 and 5 %, respectively) are lower compared to those of open repairs (3 and 17 %, respectively) [4]. To date, however, robotic-assisted repairs have only been reported in children, with minimal morbidity and complications [9]. Herein, we report a rare case of an 80-year-old female who presented with an enlarging right-sided Bochdalek hernia associated with an acquired intrathoracic kidney that was repaired using a robotic-assisted laparoscopic transabdominal approach with mesh placement.

Case description

Case presentation

An 80-year-old woman with a history of hypertension, ischemic heart disease, and peptic ulcer disease (PUD) was referred by her gastroenterologist for surgical evaluation of a right diaphragmatic hernia. The patient originally presented with a 2-year history of severe nausea, decreased appetite, epigastric pain improved with pantoprazole, and occasional shortness of breath. She denied any prior thoracic or abdominal trauma. Her surgical history included an open right inguinal hernia repair. Physical examination at initial presentation was unremarkable. Her vital signs were within normal limits. Respiratory examination demonstrated clear breath sounds bilaterally and unlabored respiratory effort. Abdominal examination showed a soft, nontender, non-distended, scarless abdomen with normoactive bowel sounds.

The patient's workup included an upper endoscopy, which showed erythematous gastritis consistent with her history of PUD, but no ulcers or structural abnormalities. A gastric emptying study demonstrated normal motility, and an abdominal ultrasound revealed an incidental mild right hydronephrosis. A subsequent computed tomography (CT) angiography scan was obtained to rule out mesenteric ischemia, but instead showed an enlarging right posterolateral diaphragmatic hernia measuring 3.6 cm (anteroposterior) containing the right kidney, perinephric fat and renal hilum (Fig. 1). In fact, the hernia was originally identified on a chest CT scan obtained 4 years prior to evaluate a benign pulmonary nodule; however, at that time, the hernia contained only omentum in the thoracic cavity and the patient was asymptomatic. Laboratory values were within normal limits, including serum creatinine and urine electrolytes. Given the findings of an enlarging hernia now containing the right kidney with associated hydronephrosis, surgical repair was recommended.

Management and outcome

The hernia repair was performed via an anterior transabdominal robotic-assisted laparoscopic approach, using the da Vinci® Si robotic platform (Intuitive Surgical Inc., Sunnyvale, CA, USA). The patient was placed in the left lateral decubitus position on a broken bed with the robot docked over the right shoulder. The port placement and instrument assignments were as follows: the camera was inserted through a right mid-clavicular port at the level of the umbilicus, a double fenestrated grasper and suction device were alternated through a right anterior axillary port below the costal margin, a vessel sealer was operated

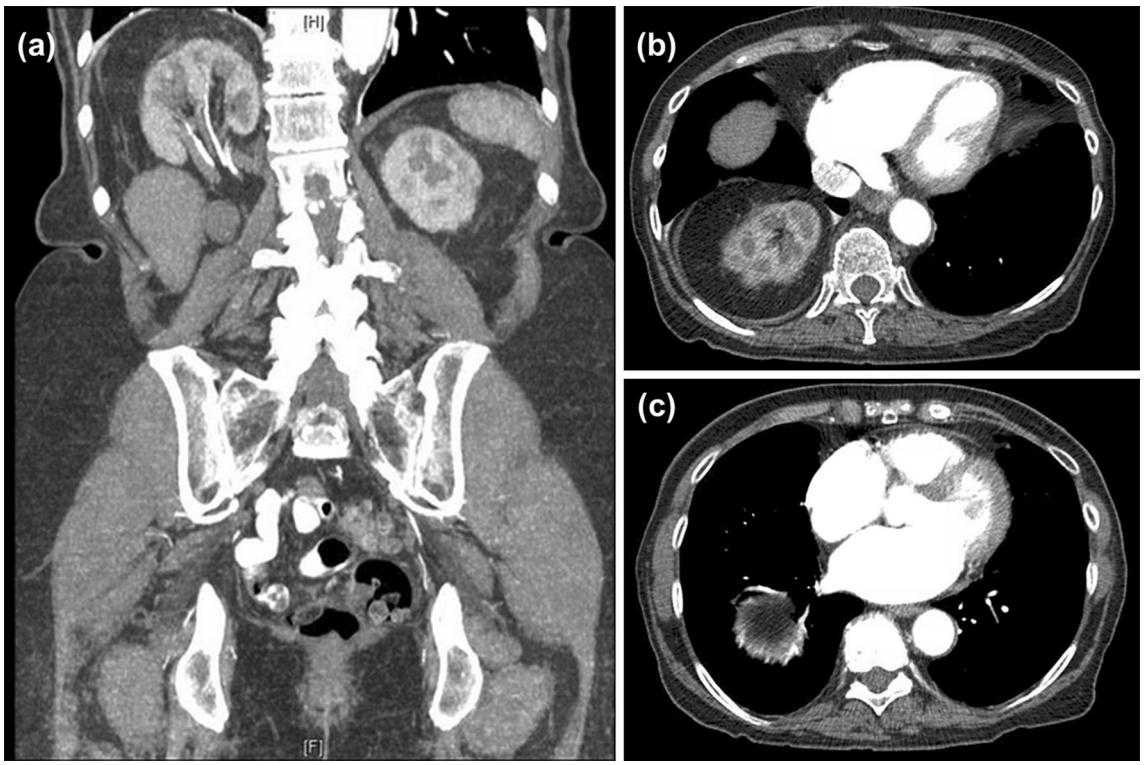

Fig. 1 **a** Coronal image of computed tomographic scan showing kidney herniation through the right diaphragm. **b**, **c** Axial images demonstrating kidney herniation into the thorax

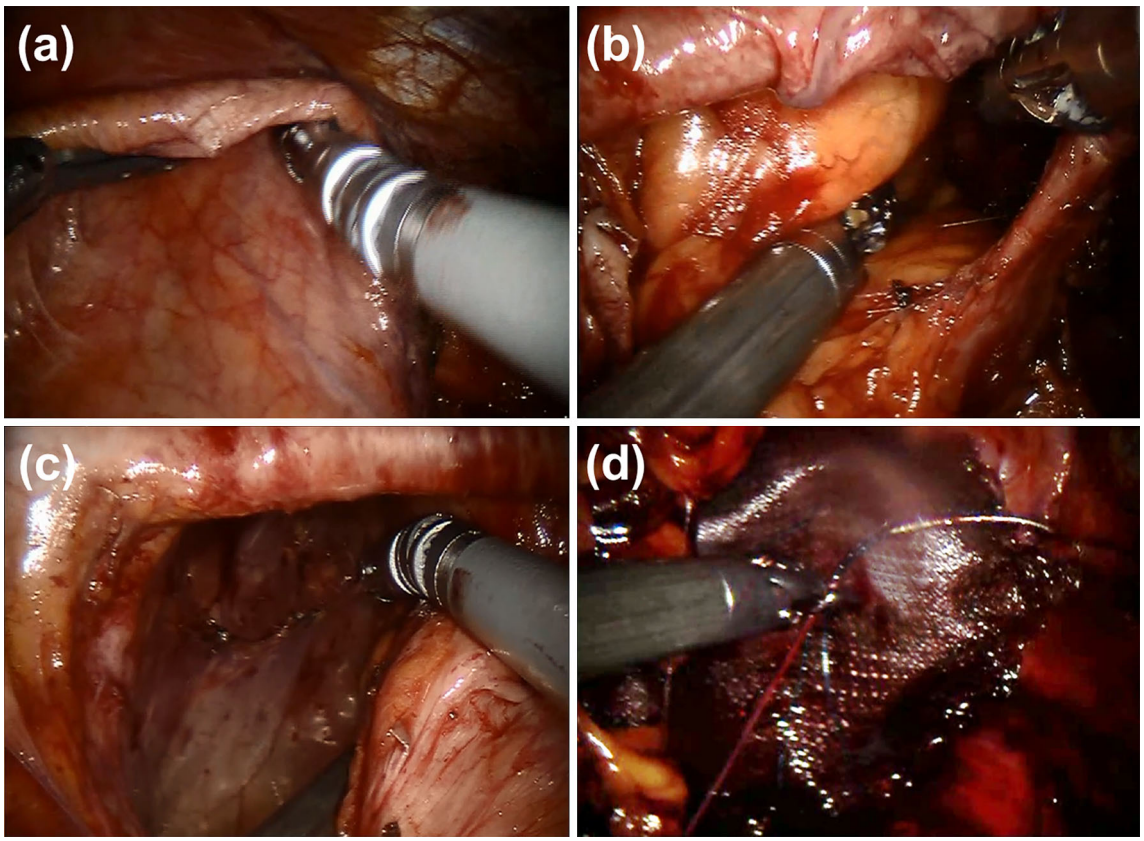

Fig. 2 Intraoperative photos of the, **a** identification and **b** dissection of diaphragmatic hernia, followed by **c** reduction of the kidney and **d** mesh placement over the defect

through an infra-umbilical port, and a double fenestrated grasper retracted the liver through a left mid-clavicular port below the costal margin.

The triangular ligament was divided and the right hepatic lobe was retracted medially to reveal the right hepatic vein and the displaced right renal vein and artery. The right hepatic vein was followed to expose both the inferior vena cava and medial edge of the posterolateral hernia defect (Fig. 2a). The hernia sac was dissected circumferentially (Fig. 2b), after which the kidney was reduced back into the abdominal cavity (Fig. 2c). The hernia defect was measured and closed with a Parietex^{TM} Optimized Composite two-sided mesh (Covidien, New Haven, CT, USA) (Fig. 2d), which was used as the site of nephropexy attachment.

The operating time was 5 h and intraoperative blood loss was 30 ml. Post-operatively, the patient was transferred to the surgical intensive care unit for ventilator weaning and extubation. She subsequently tolerated a diet without nausea or abdominal pain and was discharged to a physical therapy rehabilitation facility. Six months post-operatively, she is doing well and a CT scan revealed no evidence of recurrence as well as a normal-positioned right kidney.

Discussion and conclusions

Bochdalek hernia presenting during late adulthood with an associated right-sided intrathoracic hydronephrotic kidney is a rare entity. Most patients typically present during childhood with respiratory distress or gastrointestinal obstruction, and adults more commonly have left-sided defects containing colon, stomach, omentum, or small bowel [4, 5, 10, 11]. In contrast, our patient presented at 80 years of age with non-specific symptoms and a thorough workup revealed an enlarged right posterolateral diaphragmatic hernia measuring 3.6 cm (anteroposterior) containing a hydronephrotic right kidney.

Traditional open approaches have largely been replaced by laparoscopic or thoracoscopic repairs, as minimally invasive approaches have decreased average hospital length of stay (4 vs. 14 days), complication rates (5 vs. 17 %), and 30-day morbidity rates (0 vs. 3 %) compared to open repairs [4]. Left-sided and anterior defects are typically approached transabdominally, as the liver does not obstruct the operative field; however, the optimal surgical approach for right-sided defects is controversial. We describe a right-sided robotic-assisted repair, taking particular advantage of its improved visualization of the

posterolateral defect and wrist articulation for intracorporeal suturing during mesh placement.

In the largest series evaluating robotic repair of diaphragmatic hernias, Slater and Meehan reported eight pediatric Bochdalek hernia cases, consisting of six transthoracic and two transabdominal approaches [9]. The authors preferred the transthoracic approach, citing better visualization and ease of visceral reduction; however, two of these attempts were unsuccessful secondary to space constraints in the thoracic cavity. In contrast, we experienced ease of maneuverability without space restrictions or instrument collisions using a transabdominal approach. This approach may be better suited for the posterolateral Bochdalek defect because of better angulation of the robotic instruments and capitalization of the robotic wrist articulation, particularly after adequate liver mobilization. Slater and Meehan likewise had successful outcomes when they utilized a transabdominal approach in two (one Bochdalek and one Morgangi) of their eight repairs.

The Slater and Meehan study reported acceptable outcomes following robotic repair with only one of eight patients having a recurrence during an average follow-up of 18 months. In that case, the authors closed the defect primarily, but noted that mesh reinforcement could have potentially prevented a recurrence because the defect was large [9]. In our patient, we were unable to close the defect primarily due to its large loss of diaphragmatic domain and therefore employed mesh closure—6 months post-operatively, she does not have any evidence of recurrence on CT scan. Nevertheless, the expected recurrence rate of mesh repair for congenital diaphragmatic hernia ranges from 14 to 50 % [12], with one study reporting a significantly higher recurrence rate for mesh repair compared to primary closure (30 vs. 7 %) [13]. However, this is likely a result of the nature of the hernia and not the mesh repair itself: larger hernia defects have an inherently higher risk of recurrence, cannot be closed primarily, and thus require mesh placement [14]. Moreover, there are no large studies examining the outcome of mesh placement in adults with congenital diaphragmatic hernias, likely due to the rarity of these delayed-presentation cases.

In conclusion, a right-sided diaphragmatic hernia containing an intrathoracic kidney is a rare entity. Robotic-assisted transabdominal repair with mesh is a viable option for repair—its advantages include improved visualization and ease of intracorporeal suturing for mesh placement. Its use is limited by the experience of the surgeon, and large studies are warranted to further investigate its utility and outcomes in the management of diaphragmatic hernias.

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Compliance with ethical standards

Conflict of interest Brendan Chen BA, Brendan M Finnerty MD, Neal J Schamberg MD, Anthony C Watkins MD, Joseph DelPizzo MD, and Rasa Zarnegar MD: all authors declare that they have no conflict of interest.

Informed consent Written informed consent was obtained from the patient for publication of this case report/any accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal.

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