Laparoscopic Surgical Intervention for Pediatric Paraduodenal Hernia: Overview and Literature Review of a Rare Cause of Abdominal Pain and Obstruction

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Paraduodenal Hernia (PDH) is an extremely rare cause of bowel obstruction. The true incidence of pediatric PDH is unknown since there are very few published cases of this phenomenon. PDH carries a high morbidity and mortality rate if unidentified. Proper diagnosis and prompt surgical intervention are extremely important. Our case is of a healthy 3-year-old male who presented with six days of generalized abdominal pain associated with constipation, anorexia, insomnia, and non-bloody, non-bilious emesis. Abdominal ultrasound (US) was negative for intussusception and failed to visualize the appendix. Abdominal x-ray (AXR) showed nonspecific distention of several loops of bowel with air-fluid levels. Computerized tomography (CT) scan was concerning for an internal hernia versus possible transverse colonic volvulus. The patient's abdominal pain and distension worsened after nasogastric (NG) tube placement. With the combination of physical and imaging findings, the patient underwent diagnostic laparoscopy. Intraoperatively, severely dilated bowel was encountered, which was decompressed via the appendix. After which, we discovered a PDH on the left side of the ligament of Treitz which was successfully reduced. The patient had no complications and continues tolerating a regular diet with return of normal bowel function. Our case describes successful laparoscopic surgical reduction of a pediatric left paraduodenal hernia.

Keywords: paraduodenal hernia; laparoscopic surgery; pediatric surgery

Introduction

Internal herniation refers to protrusion of internal organs through a defect in the peritoneum or mesentery [1]. Internal hernias account for less than 1% of all abdominal hernias. Paraduodenal Hernia (PDH) account for about half of internal hernias and are divided into three types based on location [2]. PDH is most common in the fourth to sixth decades of life. The overall incidence of pediatric PDH is unknown as there are few published cases [2].

PDH typically presents with abdominal pain, nausea, vomiting, partial bowel obstruction, complete bowel obstruction, or mesenteric vascular compromise [2, 3]. Computerized tomography (CT) scan is considered the gold standard imaging modality [2, 4]. Other imaging modalities used include abdominal radiography, ultrasonography, and small bowel follow-through radiography [5]. Though PDH can be seen with imaging, only 10%–15% are discovered preoperatively [1].

Overall, PDH accounts for less than 1% of all bowel obstructions [4]. PDH presenting with obstruction or strangulation has a high associated morbidity and mortality rate thus proper diagnosis and prompt treatment is of the utmost importance. The treatment of choice for PDH is surgical intervention [2, 6]. Here we present successful laparoscopic surgical intervention for a pediatric left paraduodenal hernia.

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Case

Our patient was a healthy 3-year-old male who presented with six days of ongoing, generalized abdominal pain associated with constipation, anorexia, insomnia, and non-bloody, non-bilious emesis with the last reported bowel movement on the day of presentation.

On our initial evaluation, the patient was afebrile and hemodynamically stable. Lab work was significant for an elevated C-reactive protein (CRP) of 32.2 mg/L, a white blood count (WBC) of $16 \times 10^3/\mu L$, and a respiratory panel positive for adenovirus. Prior outside institution abdominal ultrasound (US) imaging of the appendix failed to visualize the appendix. A further abdominal US was obtained, which was negative for intussusception. An abdominal x-ray (AXR) showed nonspecific distention of several loops of bowel with air-fluid levels (Fig. 1). On physical exam, he had mild distension and diffuse tenderness without peritoneal signs and was subsequently admitted to the hospital. The patient's abdominal distention worsened prompting nasogastric (NG) tube placement. A computerized tomography (CT) scan of the abdomen/pelvis was obtained. On imaging, the cecum was more superiorly located than nor-

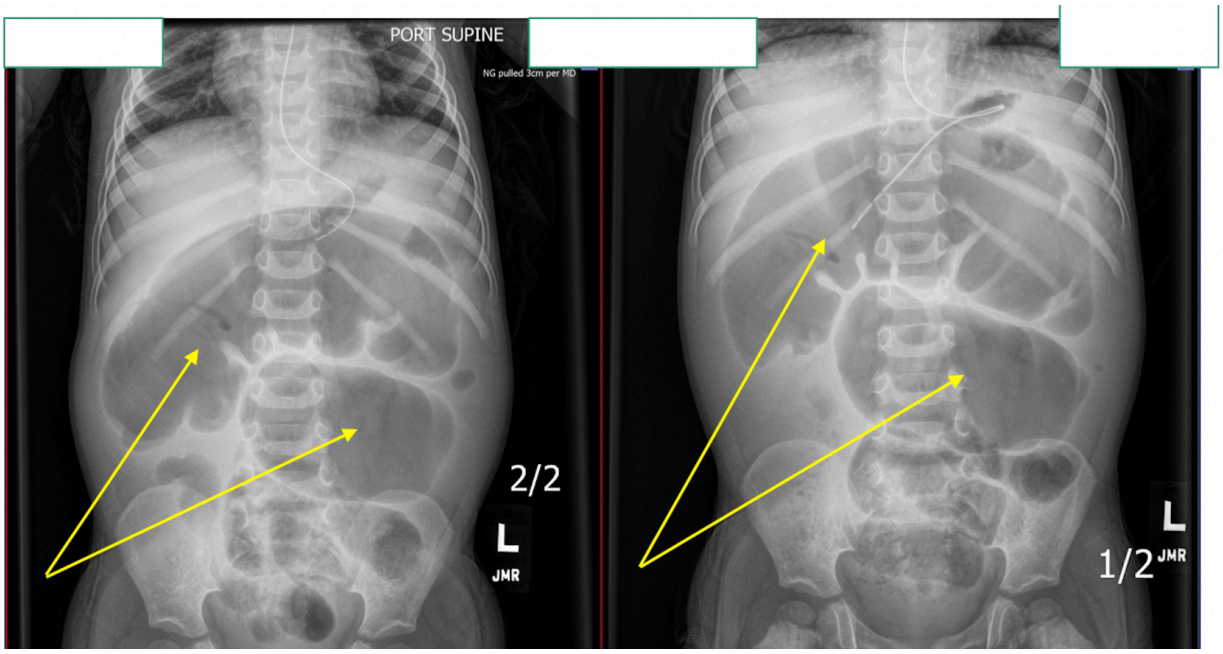

Fig. 1. Abdominal X-ray showing gaseous distension of loops of bowel raising concern for obstructive process with arrows pointing to distended loops of bowel.

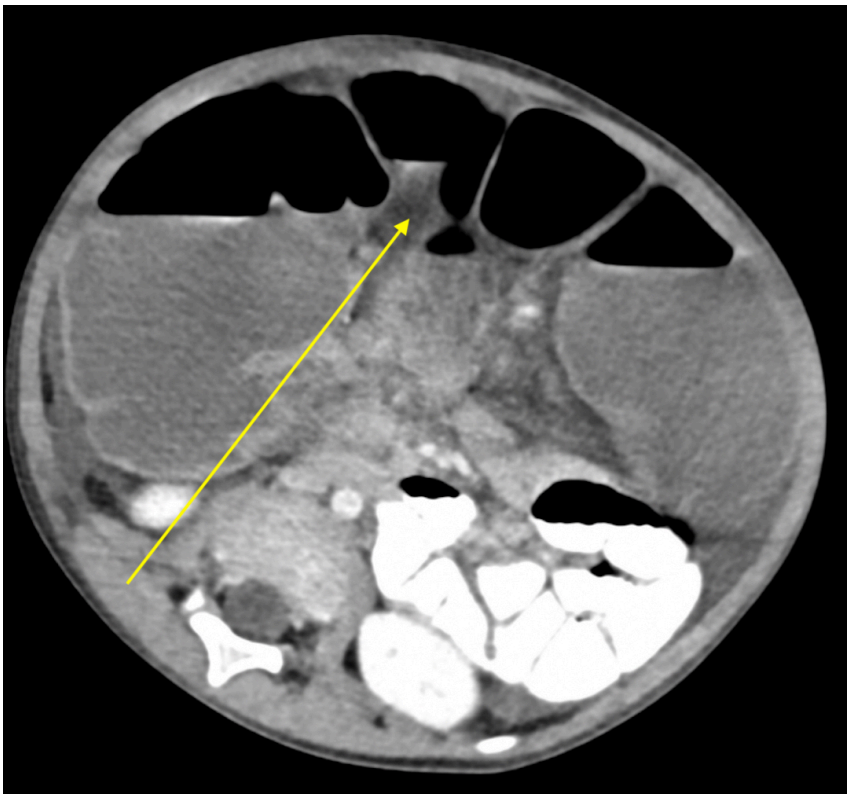

Fig. 2. Axial computerized tomography (CT) scan showing significant transverse colon distension with abrupt narrowing of mid transverse colon with the arrow pointing to the narrowing.

mal, but still within the right abdomen with normal configuration. The cecum was markedly distended. The transverse colon also appeared significantly distended and redundant (Fig. 2). There was an abrupt narrowing at the mid transverse colon near the central mesenteric root where there was tethering of many loops of bowel. The distal transverse colon and remaining bowel were decompressed. The distal and terminal ileum were also dilated. Malrotation was ruled

out as the duodenum appeared to cross the midline. Additionally, the superior mesenteric vein and superior mesenteric artery were in a normal relationship. These findings were concerning for an internal hernia versus possible transverse colonic volvulus. Due to these findings, we excluded concern for an infectious enteritis etiology.

Due to clinical worsening and CT imaging concerning for possible internal hernia versus transverse colonic volvulus, the patient was booked for a diagnostic laparoscopy. On entry to the abdomen, the bowel was severely dilated limiting our view. We decompressed the colon by enterotomy of the appendix for better visualization of the abdomen. We identified what appeared to be a congenital adhesion, forming a band crossing over the terminal ileum and the transverse colon, effectively creating a closed loop obstruction. The adhesion was lysed freeing this obstruction. We ran the small bowel and followed the adhesion proximally. What we thought was a congenital band was an extension of a paraduodenal hernia sac that was to the left of the ligament of Treitz. We then cut the hernia sac to the right of the inferior mesenteric vein and reduced the hernia by opening the sac to the peritoneum. Seeing no further sign of obstruction, we completed an appendectomy and concluded the procedure.

The patient's post-operative course was uneventful, and the patient was discharged by post-operative day two. Immediately post-operative the patient was started on a clear liquid diet and advanced to a regular diet as tolerated. The patient returned to normal activity level prior to discharge. Two weeks after surgery, the patient was seen in clinic and continued to recover appropriately as he was tolerating a regular diet and having normal bowel function.

Methods

A literature search was performed in PubMed, Ovid, Clinical Key, Cochrane Library, Web of Science, UpToDate, and Google Scholar. The search utilized the following terms and keywords: (Paraduodenal hernia AND pediatr*, paramesocolic hernia AND pediatr*, mesocolic hernia AND pediatr*, mesocolic hernia AND child*, paramesocolic hernia AND child*, paraduodenal hernia AND child*, and all of the previous keywords with the addition of "internal hernia"). We reviewed the resulting literature to determine the incidence of pediatric paraduodenal hernia as well as pathology, etiology, findings, and management to previous literature and well as published cases of paraduodenal hernia.

Discussion

Internal hernias are classified into different categories based on location. The common types are paraduodenal, pericecal, foramen of winslow, and transmesenteric or transmesocolic, which account for 53%, 13%, 8%, and 8%, respectively. Additional categories of internal hernia are intersigmoid and retroanastomotic [3]. PDH was first described in 1857 and then classified in 1889 by Jonnesco [1, 2]. PDH is divided into three types; left PDH (75%), right PDH (25%), and transverse PDH, which is extremely rare [2]. Left PDH is located in Landzert's fossa which is lateral to the fourth part of the duodenum and bordered anteromedially by the inferior mesenteric vein (IMV) and the ascending branch of the left colic artery [3]. Right PDH is located in Waldeyer's fossa and results from an incomplete counterclockwise rotation trapping the small bowel in a hernia sac formed by the peritoneum behind the colonic mesentery [5]. Transverse PDH occurs when the small bowel herniates through the transverse mesocolon [2].

PDH is the most frequent overall etiology of internal hernia, accounting for up to 53% of cases [4]. Although accounting for a high percentage of internal hernia, PDH is only responsible for 0.2–0.9% of all bowel obstructions [4]. Internal hernia is three times more common in males than in females and typically presents between the fourth and sixth decades of life [2]. Overall, there are not many published cases of pediatric PDH [2]. Shadhu *et al*. [7], reported that there were only 28 case reports published between 1998 and 2015. Nam *et al*. [6] reported that until 2012 only 21 cases of laparoscopic repair of paraduodenal hernia were described. Our review of literature has found 43 published cases for PDH, with our current case being the 44th (Table 1, Ref. [1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33]). Of these cases, 25% are in the pediatric population.

Roughly half of patients with a PDH present with significant abdominal discomfort ranging from constant vague abdominal pain to intermittent colicky abdominal pain, nausea, vomiting, symptoms of partial bowel obstruction, symptoms of complete bowel obstruction, recurrent bowel obstruction, or mesenteric vascular compromise [2, 3]. Abukhalaf *et al*. [2] report that 69% of cases present with chronic symptoms including dyspepsia, intermittent colicky abdominal pain, or vomiting preceding an obstruction or strangulation episode. Severity of symptoms relates to the duration of the hernia and the presence or absence of incarceration and strangulation. Symptoms may be altered, reduced, or relieved by changes in patient positioning [3]. Physical exam findings may include a benign abdominal exam or nonspecific findings such as abdominal distension and tenderness. Left PDH can rarely present as a palpable left upper quadrant abdominal mass [2, 34].

Obstruction or strangulation of PDH is associated with high morbidity and mortality rate, rendering prompt management important [2]. Abdominal CT is the most common modality for definitively diagnosing PDH and is considered the gold standard imaging modality [2, 4]. CT scan findings can reveal dilated small bowel around the duodenum or jejunum with associated engorgement of mesenteric vessels, herniated bowel posterior to the IMV in left PDH, or herniated bowel posterior to the SMV in right PDH [5]. Other diagnostic imaging modalities considered are

Table 1. Reported cases of paraduodenal hernia repairs.

YEAR	PUBLICATION	GENDER	AGE	CASE	Reference
1998	Uematsu *et al*.	M	44	1	[8]
2000	Finck *et al*.			1	[10]
2004	Fukunaga *et al*.	M	51	1	[11]
2004	Rollins *et al*.	M	21	1	[12]
2004	Antedomenico *et al*.	F	24	1	[13]
2006	Moon *et al*.	M	18	1	[14]
2007	Dassinger and Eubanks	M	13	1	[15]
2007	Shoji *et al*.	M	60	1	[16]
2008	Jeong *et al*.	M, F	52, 58	2	[17]
2008	Palanivelu *et al*.	3M, F		4	[18]
2009	Uchiyama *et al*.	F	80	1	[19]
2009	Bittner *et al*.	F	26	1	[20]
2009	Poultsides *et al*.	F	67	1	[21]
2010	Parmar and Parmar	M	38	1	[22]
2010	Falk *et al*.	F	76	1	[23]
2010	Khalaileh *et al*.	F	53	1	[24]
2011	Al-Mufarrej *et al*.	M	42	1	[25]
2011	Tang *et al*.	F, F	8, 8	2	[26]
2012	Hussein *et al*.	M	59	1	[27]
2012	Coakley *et al*.	M	25	1	[28]
2012	Nam *et al*.	M, F	3 mon, 12	2	[6]
2013	Siddika *et al*.	M	35	1	[29]
2014	Lee and Choi	F	74	1	[30]
2014	Cundy *et al*.	M	55	1	[31]
2016	Kulkarni *et al*.	M, M	36, 42	2	[32]
2019	Lopez *et al*.	M	16	1	[9]
2018	Shadhu *et al*.	5M	68, 34, 68, 75, 40	5	[7]
2019	Abukhalaf *et al*.	M	1	1	[2]
2020	Kadhem *et al*.	M	26	1	[33]
2022	Wang *et al*.	M	8	1	[1]
2022	Gabra and Ageel	F	7	1	[5]
2022	Ikoma *et al*.	M	9	1	[4]
2023	current case	M	3	1	

F, female; M, male; mon, months.

abdominal radiography, ultrasonography, and small bowel follow-through [5]. PDH can spontaneously reduce therefore imaging is best performed when patients are symptomatic for most accurate diagnosis [3]. PDH remains a diagnostic challenge as only 10%–15% of cases are discovered preoperatively [1]. Most PDH are diagnosed incidentally, intraoperatively, or at autopsy [1, 2]. In order to mitigate morbidity and mortality associated with PDH, clinicians should have a higher suspicion for this pathology in cases of worsening abdominal pain or obstruction in a pediatric patient without a surgical history.

Spontaneous reduction of PDH is highly uncommon and irreversible bowel ischemia and necrosis can develop, which accounts for the 20–50% mortality rate [2, 4]. The treatment of choice for PDH is surgical reduction of herniated bowel loops, restoration of normal anatomy, and closure of the hernia defect [6]. Open, laparoscopic, and single-incision laparoscopic surgery (SILS) techniques have been described for PDH [5]. Uematsu *et al*. [8], first reported laparoscopic intervention for PDH in 1998, which with the advancement of laparoscopic surgery, is now more commonly used to diagnose and repair PDH [8]. Shadhu *et al*. [7] report advantages of a laparoscopic approach to treatment which include reduced overall morbidity, decreased post-operative pain, earlier food consumption, and shorter hospital length of stay. These benefits occurred regardless of elective or emergency intervention. The use of mesh is reserved for large defects and recurrent hernias [9, 10].

Conclusions

Paraduodenal Hernia's are extremely rare and overall incidence in pediatrics is unknown since there are not many published cases of pediatric PDH. Complications from obstruction or strangulation can result in high morbidity and

mortality rates and as such, surgeons should have this diagnosis on their list of problems when dealing pediatric abdominal pain. Abdominal CT scan should be utilized if high concern for PDH. Open, laparoscopic, and single-incision laparoscopic surgery (SILS) techniques are used in the treatment of PDH. Minimally invasive surgical intervention has been shown to have decreased post-operative pain and shorter hospital length of stay [7]. Here, we describe a successful case of laparoscopic surgical intervention of a pediatric left paraduodenal hernia. Further research should go towards better awareness of this condition in pediatric surgery which subsequently can reduce morbidity and mortality associated with the condition. Larger scale analysis through meta-analysis or systematic review could show the benefits of minimally invasive surgery for PDH.

Availability of Data and Materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Author Contributions

WC, CS, and SH all made substantial contributions to conception and design of the project, were involved in drafting the manuscript, were involved in revising the manuscript. AB is the senior author and participated in the project idea and editing the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to all aspects of the work.

Ethics Approval and Consent to Participate

AdventHealth's Office of Sponsored Programs has given institutional acknowledgement and approval of this case. The AdventHealth IRBNET ID# is 2232537-1. The study was conducted with the informed consent of the patient. The study adheres to the Declaration of Helsinki.

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Conflict of Interest

The authors declare no conflict of interest.

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