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CASE REPORT

Robotic duodeno-duodenostomy creation in a pediatric patient with idiopathic duodenal stricture

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Abstract
Duodenal stenosis is one of the leading causes of duodenal obstruction in the pediatric population, usually diagnosed in newborns and in Down syndrome patients. It has historically been treated with duodeno-duodenostomy, an operation that is now commonly performed laparoscopically. We present a case of a 10-year-old child with a rare chromosomal abnormality who was diagnosed with a duodenal stricture after presenting with failure to thrive and inability to tolerate tube feeds. Duodeno-duodenostomy was performed using the da Vinci® robot, allowing for improved intra-operative range of motion and control during anastomosis creation, with the same cosmetic benefits of laparoscopic surgery, and subsequent improvement in symptoms postoperatively. This case highlights the utility of robotic surgery in complex operations in the pediatric population.

Keywords Duodenal stricture · Robotic surgery · Pediatric surgery · Duodeno-duodenostomy

Introduction

In the pediatric population, anatomic abnormalities of the proximal and mid duodenum including duodenal stenosis, duodenal atresia, and annular pancreas are common causes of failure to thrive. These abnormalities are usually diagnosed in the first few months of life. Patients with rare genetic disorders, however, often have new and different presentations. Therefore, pediatricians and pediatric surgeons must keep an open mind and look for innovative strategies in the diagnosis and treatment of these patients.

Case report

Here, we present a 10-year-old boy who was admitted to the hospital for gastric distention and inability to tolerate tube feeds. He notably has a history of a chromosomal abnormality (Xp 11.4 and Xp 11.3 deletion), cerebral palsy intellectual deficiency, global developmental delay, eosinophilic esophagitis, and is g-tube dependent with a surgical history of Nissen fundoplication and hiatal hernia repair. He underwent upper endoscopy that showed dilation of the duodenal bulb, with biopsies that showed mild gastritis and intestinal mucosa with lymphoid hyperplasia and mild eosinophilia. A subsequent upper GI contrast study showed a short stricture at the junction of the second and third portions of the duodenum (Fig. 1). The diagnosis of annular pancreas was considered given an elevated amylase and lipase (177 and 587, respectively); however, pancreatic ultrasound showed normal pancreatic anatomy with no ductal dilation or peripancreatic fluid.

The pediatric surgery service was consulted for management of the duodenal stricture. Because of the patient's complex medical history and anatomy, as well as his developmental delay, it was decided that he would be a good candidate for a robotic-assisted duodeno-duodenostomy, as it would allow him the best chance to get back to baseline quickly postoperatively. In the operating room, a 12-mm da Vinci® camera was placed in the umbilicus, one da Vinci® robotic 8-mm port was placed infra-umbilically and two robotic 8-mm ports were placed in the left upper and right upper quadrants. A laparoscopic assistant port was placed lateral to the left upper quadrant port. The patient was placed in reverse Trendelenburg position, and after the robot was docked, a stitch was placed through the falciform ligament to retract the liver out of the operative field. The duodenum was

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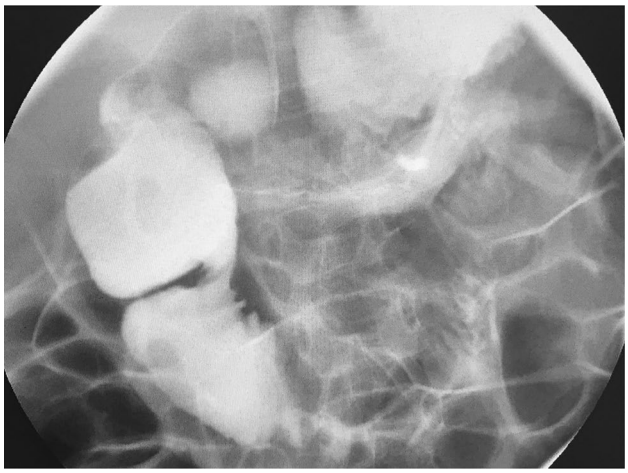

Fig. 1 Upper GI contrast study revealing duodenal narrowing

kocherized and once it was free from its lateral attachments, it was clear that the proximal portion of the duodenum was dilated and there was a short stricture between the second and third portions of the duodenum, consistent with the upper GI series findings. It was decided to leave the stricture in place, bypassing it with a duodeno-duodenostomy. The duodeno-duodenal anastomosis was created using the diamond technique, with a transverse enterotomy created on the proximal duodenum, and a longitudinal enterotomy made in the duodenum distal to the stricture. 2-0 barbed suture was used in a running fashion, first forming the back wall and then the front wall of the anastomosis (Fig. 2). After irrigating and inspecting the operative field, the trocars were removed, port sites closed, and the patient was extubated and transported to the recovery room in stable condition.

The patient's postoperative course was uncomplicated. He was kept on parenteral nutrition, NPO, with an NG tube to low continuous suction for 5 days to allow anastomotic healing. Thereafter, he was started on tube feeds which he tolerated well, and his bowel function returned to normal.

Discussion

Duodenal stenosis, along with duodenal atresia, is most commonly seen in newborns, with a prevalence of 1 in 5000 to 1 in 10,000 live births. These anomalies are more frequent in patients with chromosomal abnormalities, most commonly associated with Down syndrome [1]. In this patient, the cause of the duodenal stricture remains unclear, and is likely part of his underlying genetic syndrome. Interestingly, this stricture did not present in the first few months of life but presented later, at 10 years of age.

Until the 1970s, the standard procedure for duodenal atresia or duodenal stricture was classical duodeno-duodenostomy or duodeno-jejunostomy with a parallel anastomosis [2]. In the late 1970s, the diamond-shaped anastomosis, a variant of the classical duodeno-duodenostomy, was introduced, allowing for a wider anastomosis and potentially easier passage of duodenal contents [3]. This anastomosis has since been commonly and successfully implemented using a laparoscopic approach [4, 5]. This case represents the first robotic anastomosis of this type reported in the pediatric literature.

There are relatively few reports in the literature on robotic pediatric foregut surgery. The first comprehensive study of pediatric robotic surgery was from 2008, and reported on 100 consecutive non-cardiac, non-urologic pediatric robotic cases at a single institution [6]. The majority of cases (89%) were intra-abdominal, of which the most common was fundoplication (34%) followed by cholecystectomy (17%). There were only two small bowel resections and one duodenal atresia repair, which were performed without complications, and one pancreas tumor resection that was converted to open due to anatomical difficulties. Another single institution performed a prospective study of their pediatric robotic surgery cases from 2013 to 2015 [7]. Of their abdominal cases, there were ten cholecystectomies, one interval appendectomy, and one distal pancreatectomy, all of which were completed robotically without major complications. Another institution wrote on their robotic duodenal atresia repair in a 1-day-old term neonate [8]. They credited the robotic platform for the successful completion of the complex procedure, specifically citing the robot's articulating instruments allowing for more precise suture placement in duodenal atresia where the distal intestinal segment is very small.

There are special techniques and/or instruments that can assist with complex pediatric robotic cases. For small children and babies, some recommend recessing the trocars out slightly toward the skin to give another few centimeters of intra-abdominal instrument length [8]. Additionally, da Vinci® makes 5-mm instruments for use in pediatrics, as opposed to the standard 8-mm adult instruments. There is also a 5-mm camera, however it only produces 2D images, as opposed to the 3D capabilities of the 12-mm camera [9]. For the case of the 10-year-old boy with duodenal stenosis presented here, the standard 8-mm instruments and 12-mm camera worked well; however, for neonates with duodenal atresia, the smaller instruments may be beneficial.

Compared to the laparoscopic approach, the robotic approach offers the benefits of wrist-like articulation, tremor filtration, 3D view, and motion scaling, which translates large motions of the surgeon into small movements of the instrument [10, 11]. Especially in complex cases, these benefits can allow for easier intracorporal knot tying compared to the laparoscopic platform. Despite this particular benefit, we chose to use knotless barbed suture for our duodeno-duodenal anastomosis. Barbed sutures have been shown to

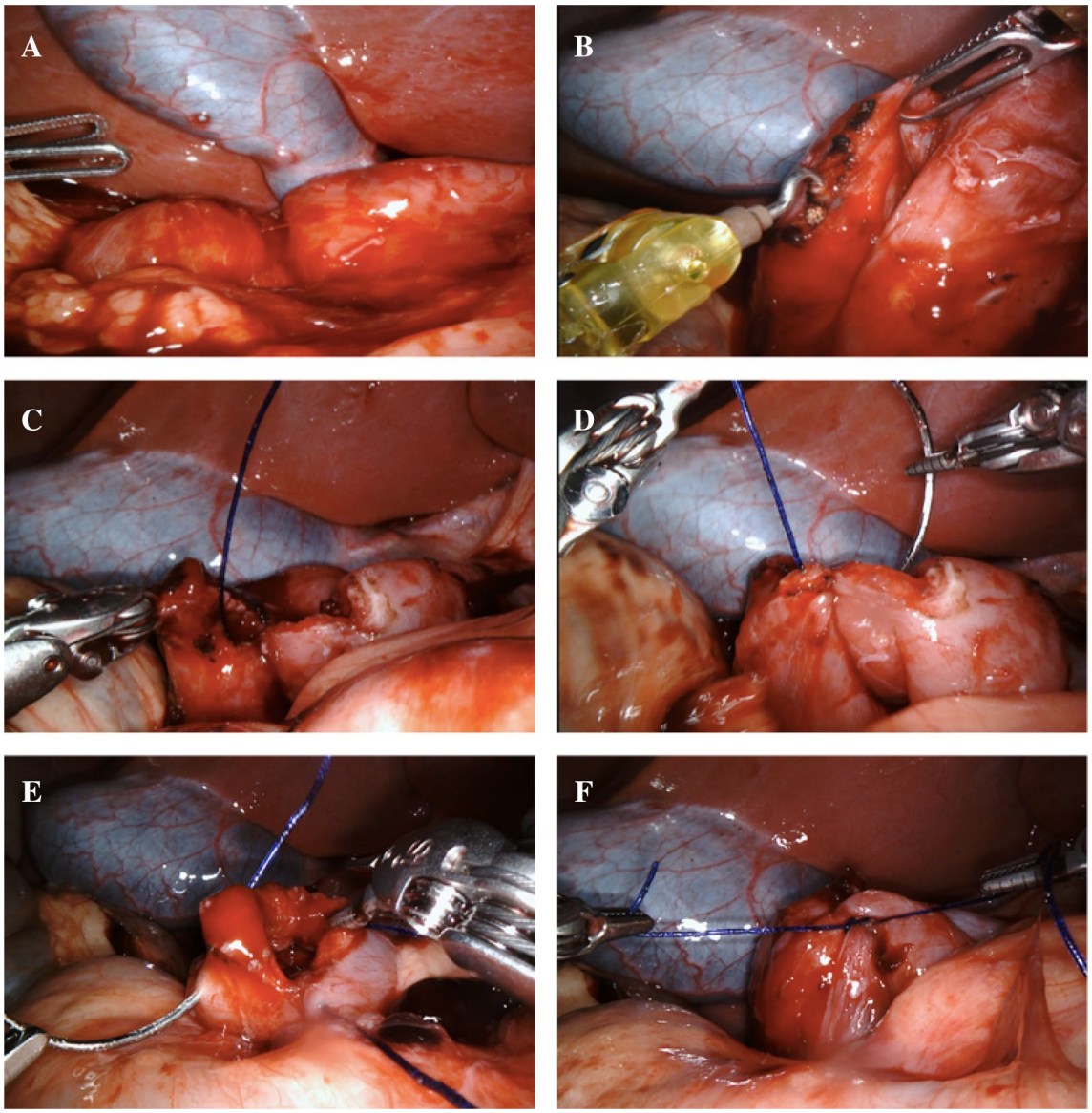

Fig. 2 Formation of diamond anastomosis. **a** Intra-operative view of duodenal stricture, **b** creation of enterotomy, **c, d** posterior anastomosis, **e** anterior anastomosis, **f** finished anastomosis

be helpful in creating a water-tight anastomosis by allowing the surgeon to efficiently use both hands and focus on each subsequent stich placement, without the need to maintain tension on preceding throws to prevent slippage [12]. This is particularly helpful in tight spaces or difficult-to-access areas such as the duodenum.

While there are many benefits to the robotic platform, there are some limitations. One of the most commonly cited limitations of robotic surgery is the learning curve, not only for the surgeon but also for the entire operative team, as it takes practice to learn to correctly position the patient and the robotic machinery, and to efficiently dock the robotic arms and change instruments intraoperatively. One group suggests that when initiating a robotic surgery program, it is best to start with routine cases such as cholecystectomies, before moving on to more complex work such as the case presented here [6]. We agree with this rationale, as our experience with performing robotic cholecystectomies routinely [11] has allowed our team to become familiar with the intricacies of the robotic platform, making the transition to more complex cases very smooth.

Another limitation is the cost of acquiring a da Vinci® robot, which is prohibitive for many pediatric surgery centers. Many believe that this is why robotic surgery has not gained momentum as quickly in the pediatric community as it has in adults [7]. If technically feasible, cost sharing

with adult colleagues can help. However, even in standalone pediatric hospitals, the increased cost of purchasing a robot can be mitigated if cases that are normally difficult to perform laparoscopically can now be performed in a minimally invasive manner, with all of its known benefits such as smaller incisions, decreased postoperative pain, and quicker recovery.

Conclusion

In the case presented, the da Vinci® robot was safely and effectively used to perform a complex operation in a child with a rare diagnosis. While currently more commonly utilized in the adult population, robotic surgery is being used with increasing frequency in pediatric patients. The 3D view as well as the benefits of tremor filtration and wrist-like articulation are of major benefit to the pediatric surgeon working in small spaces, especially in patients with complex or abnormal anatomy.

Compliance with ethical standards

Conflict of interest Andrea R. Marcadis MD, Carmelle V. Romain MD, and Fuad Alkhoury MD declare that they have no conflict of interest.

Informed consent Written informed consent was obtained from the patient's parent/legal guardian 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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