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Central Pancreatectomy for a Pediatric Grade 4 Pancreatic Transection

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Background	Due to decreased abdominal wall musculature, pediatric patients are more predisposed to visceral injury from blunt abdominal trauma. If the pancreas is damaged, the grade of the injury determines the most appropriate management method. While grade 4 pancreatic transections are treated with distal pancreatectomy and optional splenectomy, a central pancreatectomy with Roux-en-Y pancreatojejunostomy may be done instead to prevent type I diabetes mellitus (T1DM) and would be beneficial to a pediatric patient with this injury.
Summary	We describe a nine-year-old male patient who presented to our institution with injury from blunt abdominal trauma. After being diagnosed first by computed tomography (CT) and then determining duct involvement through endoscopic retrograde cholangiopancreatography (ERCP), he then underwent central pancreatectomy with Roux-en-Y pancreatojejunostomy. He recovered well and was discharged home. A literature review of this technique demonstrates the main complication of pancreatic fistula formation. Additionally, as autologous islet cell transplantation does not entirely prevent the onset of T1DM, the parenchymal-sparing central pancreatectomy serves as the best option in a pediatric patient for preserving endocrine function.
Conclusion	Central pancreatectomy with Roux-en-Y pancreatojejunostomy for a grade 4 pancreatic transection is beneficial to the distal pancreatectomy and splenectomy. We advocate that this intervention be considered over the distal pancreatectomy in pediatric patients for whom the risk of endocrine dysfunction would be undesirable or prohibitive.
Key Words	pancreatectomy; pancreas; laceration; trauma; pediatrics

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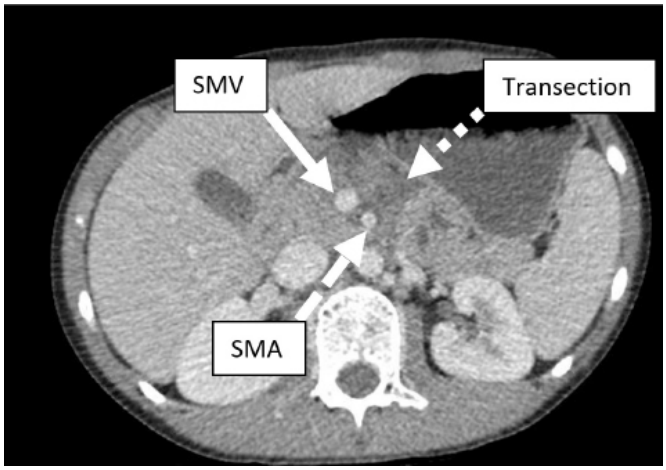
Case Description

Pediatric patients are more predisposed to visceral injury from blunt abdominal trauma due to their underdeveloped abdominal wall musculature. The most commonly injured organs are the liver and spleen, while the kidney and pancreas are often spared.[1] However, even if the pancreas is damaged, the grade of the injury determines the most appropriate management method.[2] Grade 1 and 2 injuries can be treated nonoperatively as neither involves the main pancreatic duct, and such conservative management is often favored in younger children.[1] However, grade 3-5 injuries are best managed operatively to decrease the rate of pseudocyst formation and the need for repeat interventions.[3] Grade 3 injuries are often treated with spleen-preserving distal pancreatectomy to decrease the post-infectious and thromboembolic risks associated with splenectomy, whereas grade 5 injuries may be treated with a pancreatoduodenectomy.[4]

The management of grade 4 injuries is controversial. The gold standard is to perform a distal pancreatectomy with splenectomy for patient hemodynamic instability, but recent literature favors parenchymal-sparing procedures.[3,5] Such interventions leave the body and tail of the pancreas in situ through a central pancreatectomy with Roux-en-Y pancreatojejunostomy. They have come into favor as they preserve a significant amount of islet-producing cells, decreasing the risk of developing type I diabetes mellitus (T1DM). Therefore, a pediatric patient with a grade 4 transection could benefit from this procedure. We present a case at our institution where such consideration was taken.

After crashing his bike and the handlebars striking his upper abdomen, a nine-year-old male patient presented with a pancreatic neck transection to our emergency department. He was hemodynamically stable with a normal exam aside from a circular bruise over the epigastrium with tenderness to palpation but no distension. A computed tomography (CT) abdomen and pelvis was obtained and showed a pancreatic laceration measuring 1.1 cm immediately anterior to the superior mesenteric vein (SMV) (Figure 1).

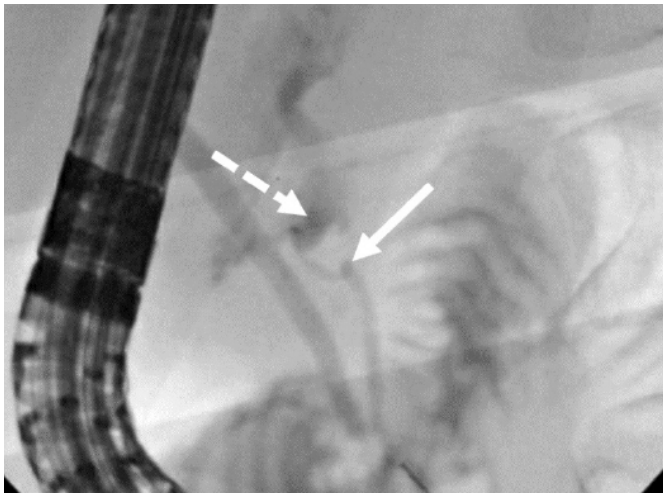
Figure 1. Axial Computed Tomography Scan of Abdomen. Published with Permission



Transection (dotted arrow) can be viewed close to portal vein (solid arrow) and superior mesenteric artery (dashed arrow).

A magnetic resonance cholangiopancreatography (MRCP) suggested a pancreatic duct transection but was ultimately inconclusive due to image artifact. After being admitted to the trauma surgery service, an endoscopic retrograde cholangiopancreatography (ERCP) was done, confirming the transection and demonstrating extravasation of contrast (Figure 2).

Figure 2. Axial Computed Tomography Scan of Abdomen. Published with Permission



Endoscopic retrograde cholangiopancreatography of patient's pancreatic transection (solid arrow). Active extravasation can be seen coming from proximal duct extending into abdominal space around pancreas (dashed arrow).

During the ERCP, stenting of the pancreatic duct was attempted but could not be accomplished. Therefore, he was taken to the operating room on hospital day two for a central pancreatectomy with Roux-en-Y pancreatojejunostomy by the hepatopancreatobiliary surgeon.

During the procedure, the proximal end of the pancreas was stapled, and the proximal duct was oversewn with a separate Prolene suture. The distal end of the pancreas was anastomosed to a jejunal Roux limb in an end-to-side (pancreas to jejunum) fashion. In small ducts with normal pancreas tissue, we utilize an externalized pancreatic stenting technique, which we have used for over 20 years without any identified leaks. We usually utilize a 5-French feeding tube as our stent, but due to the small size of the duct, it could only accept a 3-French catheter. The only 3-French catheter available was a urinary stent. This 3-French urinary stent was placed into the abdomen through a separate stab incision. The stent was then placed in the distal-most, stapled end of the Roux-en-Y limb with a 3-0 Vicryl purse string securing it in place. The stent was then brought out approximately 8 cm proximal through a tiny hole in the Roux-en-Y limb's antimesenteric border, just large enough to accept the 3-French catheter. This makes the entrance site of the stent upstream (in an antiperistaltic position) from the exit site 8 cm proximal. A two-layer anastomosis to the pancreas is then made with approximately eight 3-0 Vicryl sutures for a posterior pancreatic tissue layer followed by five posterior 6-0 PDS sutures in a duct to mucosa anastomosis at the hole in the antimesenteric border of the Roux-en-Y limb. After completing the posterior row of sutures, the stent is placed into the duct going out to the body and tail of the pancreas, and the anterior duct to mucosa anastomosis is completed, with three additional 6-0 PDS sutures. The final anterior layer of pancreatic tissue sutures is placed, utilizing eight to ten 3-0 Vicryl sutures. The stent is then secured at the skin level with a nylon suture and is left open to drain into a small drainage bag. Anterior and posterior drains were then placed utilizing ten flat Jackson-Pratt drains.

The patient was admitted to the pediatric intensive care unit in stable condition. On postoperative day (POD) 3, the patient was started on clear liquids, and this was slowly advanced as tolerated until he was tolerating a regular diet. Once the patient began tolerating a normal diet, and the Jackson-Pratt drains output and amylase levels had fallen, suggesting no ongoing pancreatic leak, the pancreatic stent was capped. Twenty-four hours later, there was only 3 mL in the posterior Jackson-Pratt drain and only 10 mL in the anterior drain with minimal amylase elevations, so these were removed. Twenty-four hours after the Jackson-Pratt drains had been removed, the patient was clinically doing well with no evidence of a pancreatic leak, and so the pancreatic stent was removed. These externalized pancreatic stents and Jackson-Pratt drains can be left for weeks if needed to control a pancreatic leak. Drain amylase levels on POD 2 were 1286 U/L for the posterior drain and 615 U/L for the anterior drain. Serum lipase was 857 U/L on POD 1 and 275 U/L on POD 2. The output for the posterior drain was <25cc/day postoperatively, with only 3cc in 24 hours on the day of removal. The anterior drain had 277cc out on POD 2 but decreased to 105cc the next day, then <25cc/day with 10cc out on the day of removal. At no point in his recovery were somatostatin analogs used. The patient was discharged on POD 9 (hospital day 10). At the two-week outpatient follow-up, the patient reported some transient diarrhea that was self-limited and had otherwise normal bowel function. He experienced no short-term complications, and a chart review indicates that he was still doing well and enjoying a normal diet six months later.

Discussion

Many studies have assessed the glycemic merits of performing a central versus distal pancreatectomy with conflicting results on complication rates. For instance, while central pancreatectomy has lower rates of T1DM, it results in two potential locations for postoperative pancreatic fistula formation, the pancreatic head and the distal pancreas. Dragomir et al. performed a meta-analysis of 21 studies that addressed the issue and found that while central pancreatectomies were associated with higher fistula rates at 38.7%, as compared to the 24.6% seen with distal pancreatectomy, they also had an overall decreased onset of T1DM at 6.7% versus 22.3%.[6] Similar findings were found in the meta-analysis done by Iacono et al., which found that although central pancreatectomy is associated with increased risk of fistula formation (RR = 1.63, 95% CI 1.28 to 2.08) and overall complications (47.1% versus 29.4%), it is a generally safe procedure with good long-term endocrine functional reserve, with only 5.5% of patients developing T1DM as compared to 23.6% seen with distal pancreatectomy.[7] This echoed the decreased insulin requirements following central pancreatectomy found by DiNorcia et al. (14% versus 28%), but this study found no significant difference in fistula rates (24% versus 20%).[8] Therefore, while patients do better postoperatively concerning their pancreatic endocrine function, the risk of fistula formation is still present with this intervention. We

have not had any pancreatic fistulas or completion pancreatectomies in over 400 pancreatic anastomoses at our institution (primarily Whipple procedures) utilizing this externalized pancreatic stenting for all difficult pancreatic anastomosis and salvage any patient with a postoperative pancreatic leak. The risk of fistula formation utilizing this technique is much lower than the reported rates above. Given that long-term diabetes-related to distal pancreatectomy is dramatically improved, this appears to be the best option for pancreatic preservation with minimal, to no risk, of pancreatic fistula formation.

The Fistula Risk Score can be calculated to quantify better a patient's risk of developing a pancreatic fistula. This score considers gland texture (soft versus firm), duct diameter, gland pathology other than adenocarcinoma or pancreatitis, and estimated blood loss from the surgery and has been well-correlated in predicting the development of a clinically relevant postoperative pancreatic fistula (CR-POPF).[9] These fistulas can then be assigned a grade based on the extent of the leak, determined by the amylase content of the surgically placed drain; grade B and C fistulas are variants of CR-POPF.[10] While patient and injury-related factors influence the risk of fistula formation, several technical interventions can be performed to improve outcomes, such as intraductal stent placement, which has been found to decrease the incidence of both CR-POPF and grade A fistulas.[11] The choice of the instrument also carries influence, as Takahashi et al. found that traditional scalpel debridement had a lower grade B fistula formation rate than ultrasonically activated scalpel excision.[12] Furthermore, the type of anastomosis performed is important, where performing a pancreatojejunostomy over a pancreatogastrostomy has been shown to reduce POPF incidence.[13] Some patient factors have also been shown relevant, as visceral obesity was found to be correlated with the development of a grade B or C pancreatic fistula postoperatively in the study done by Uchida et al. The team also found that intraperitoneal administration of a lipase inhibitor prevented the deterioration of any postoperative biochemical leaks into higher grade fistulas.[14] Therefore, while analyses have found a higher rate of fistulas, this risk can be reduced in multiple ways, many of which were utilized for our high-risk patient with a score of 7 (soft gland with a duct <1mm, pathology other than adenocarcinoma or pancreatitis, and minimal blood loss).

An argument could be made for doing a distal pancreatectomy due to advances in autologous islet cell transplantation. This technique has improved postoperative outcomes in patients suffering from chronic pancreatitis. This technique is done by infusing the excised pancreas with collagenase to isolate the islet cells, implanting them into the liver by portal venotomy. It has been shown to yield improved glycemic control in patients undergoing pancreatic resection for trauma.[15,16] Though this technique does not prevent the onset of T1DM, the study done by Yoon et al. found using it to be far superior to oral antidiabetic drugs in patients undergoing distal pancreatectomy for chronic pancreatitis. However, both arms of this study saw an overall increase in hemoglobin A1C of about 5%.[17,18] Case reports detailing the use of islet cell transplantation with distal pancreatectomy describe adequate outcomes. Still, no direct study comparing central pancreatectomy with Roux-en-Y pancreatojejunostomy to this technique has been conducted.[19,20]

Aside from surgical interventions, a nonoperative alternative to be considered is intraductal stent placement by endoscopy or ERCP. This procedure is performed by traversing a well-approximated transected pancreatic duct with an endoscopic wire over which the stent can be placed. When successful, stenting can promote duct continuity and obviate the need for major surgery, especially in a younger patient.[21] However, Iqbal et al. found that outcomes in pediatric patients who underwent operative management for grade 2 and 3 injuries, in contrast to conservative measures, had a shorter time to goal oral feeds (8 days versus 15 days) and shorter hospital admission (13 days versus 18 days). Furthermore, it also had lower pseudocyst formation (0% versus 18%), where 26% of those that developed in the nonoperative arm required further intervention for drainage.[22] Furthermore, the review conducted by Lin et al. found that endoscopic stenting is better suited for partial transections, whereas complete transections necessitated surgery.[23] In this case, where complete duct transection was seen, stenting was not feasible, and surgery was required.

Conclusion

In this case report, we present an instance where a central pancreatectomy with Roux-en-Y pancreatojejunostomy was used for a grade 4 transection and discuss some potential advantages of this procedure over distal pancreatectomy. While the current literature comparing the two techniques describes the former having higher fistula formation, we advocate that this intervention be considered over distal pancreatectomy in patients for whom the risk of endocrine dysfunction would be undesirable or prohibitive.

Lessons Learned

While the management of grade 1 and 2 pancreatic injuries is nonoperative, grade 3 injuries are often treated with distal pancreatectomy, whereas grade 5 injuries may require pancreatoduodenectomy. Performing a central pancreatectomy with Roux-en-Y pancreatojejunostomy for a grade 4 injury prevents the development of T1DM as compared to distal pancreatectomy. Although the risk of fistula formation is elevated, the risk can be decreased with meticulous operative technique, making it an optimal procedure for preserving endocrine function.

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