Endoscopic Retrograde Cholangiopancreatography

Pancreatic Endoscopy

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KEYWORDS

• Chronic pancreatitis • Pancreatoscopy • Pancreatic duct stone
• Pancreatic duct stricture • Pancreas divisum • Acute recurrent pancreatitis
• Pancreatic duct leak • Intraductal papillary mucinous neoplasm

KEY POINTS

- Therapeutic endoscopic retrograde cholangiopancreatography (ERCP) offers a potential treatment option for pancreatic duct leaks and disruptions as either primary therapy or as an adjunctive modality.
- Pancreatic duct (PD) stent placement has been shown to reduce the risk of post-ERCP pancreatitis.
- ERCP with PD stent placement offers an effective and durable treatment for chronic pancreatitis-associated PD strictures.
- The development of pancreatoscopy-guided lithotripsy offers a safe and effective treatment option for PD stones in patients with chronic pancreatitis.
- Pancreatoscopy facilitates diagnosis of main-duct intraductal papillary mucinous neoplasms (MD-IPMNs) and can be used intraoperatively to guide resection margins.

INTRODUCTION

Endoscopic retrograde cholangiopancreatography (ERCP) has evolved from largely a diagnostic tool to a primarily therapeutic procedure with nearly 180,000 ERCPs performed a year in the United States alone.[1] Most commonly performed for biliary indications, the role of ERCP for pancreatic indications has greatly expanded over the past several decades with interventions including pancreatic sphincterotomy, pancreatic duct (PD) stent placement, and PD stone lithotripsy. The introduction and refinement of single-operator pancreatoscopy via ERCP has in particular advanced the field of pancreatic endoscopy, enabling direct visualization of the PD and thereby enhancing

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therapies for PD strictures and stones while aiding the diagnosis of neoplasia such as intraductal papillary mucinous neoplasms (IPMNs).

Guidelines from the United States and Europe advocate for pancreatic ERCP as a primary treatment option for structural complications of pancreatitis involving the main PD.[2,3] As such, the majority of this article will cover utilization of pancreatic ERCP for indications within the spectrum of pancreatitis—from acute pancreatitis (AP) to recurrent acute pancreatitis (RAP) to chronic pancreatitis (CP).

For the purposes of this article, the authors will focus on ERCP involving the main PD, endoscopic retrograde pancreatography (ERP), and will not cover ERCP involving biliary indications. Additionally, while acknowledging that therapeutic endoscopic ultrasound has transformed the management of pancreatic diseases such as pancreatic pseudocysts and walled-off pancreatic necrosis and can often be performed in conjunction with pancreatic ERCP, as therapeutic EUS has been extensively detailed previously, this article will largely exclude EUS from discussion.[4]

ENDOSCOPIC RETROGRADE CHOLANGIOPANCREATOGRAPHY FOR ACUTE PANCREATITIS AND RECURRENT ACUTE PANCREATITIS

Pancreatic Duct Leaks, Disconnected Pancreatic Duct Syndrome, and Pancreatic Fluid Collections

PD leaks most commonly occur after an episode of AP, abdominal trauma, or post-pancreatic surgery. While many PD leaks will resolve spontaneously, persistent leaks can manifest via formation of pancreatic fistulae, pancreatic ascites, pleural effusion, and/or pancreatic fluid collections (PFCs). PFCs are categorized into 4 types: (1) acute peripancreatic fluid collection, (2) pancreatic pseudocyst, (3) acute necrotic collection, and (4) walled-off necrosis.[5] It remains important to distinguish between PD leaks and disconnected pancreatic duct syndrome (DPDS). DPDS typically occurs within the setting of acute necrotizing pancreatitis (ANP), occurring in up to half of patients with ANP.[6] DPDS refers to complete disruption of the PD leading to potential isolation of the section of the pancreas upstream of the disruption from the duodenum.[7]

ERP allows for accurate identification and characterization of a PD leak through visualization of any contrast extravasation on pancreatogram.[8] In complete disruption of the PD (**Fig. 1**), no contrast will reach the PD upstream of the leak, while in a partial

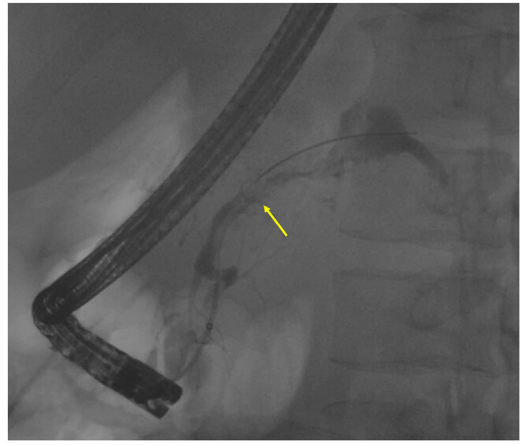

Fig. 1. Complete disruption (*arrow*) of the pancreatic duct with no contrast reaching the upstream pancreatic duct.

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disruption (Fig. 2), contrast will fill into the proximal duct. Although helpful in diagnosing a PD leak, the primary role of ERCP in the management of these complications is placement of a transpapillary PD stent. In cases of PD leaks, PD stent placement attempts to divert flow of pancreatic fluid into the duodenum with ideally the stent bridging the site of the leak. In a 2-center retrospective study of 107 patients with a PD leak, 103 (96.3%) had successful PD stent placement with bridging of the leak achieved in 44% of the cases.[9] This led to successful resolution of symptoms in 80 patients (75%) with recurrence seen in 8 (10%) patients, the majority of whom received successful repeat pancreatic endotherapy. In an older single-center prospective study including 26 patients with a PD leak, PD stent placement was successful in resolving the leak in 76.9% of the patients, with the majority of treatment failures occurring in individuals with DPDS.[10] A single-center retrospective study of 97 patients found a 36% failure rate with PD stenting in resolving PD leaks with failure to bridge the leak being significantly associated with clinical failure (OR: 0.08, 95% CI: 0.023–0.34). Similarly, smaller retrospective case series have found that successful bridging of the PD with a transpapillary stent is associated with successful resolution of a leak.[8,11,12]

Acknowledging that EUS-guided transmural drainage has become the treatment of choice for symptomatic and/or infected PFCs, smaller collections less than 5 to 6 cm in size may represent ideal candidates for transpapillary PD stenting, given the technical challenge of performing transmural drainage in smaller collections.[13] The efficacy of transpapillary PD stenting appears to vary based on the type of PFC. In a single-center retrospective study of 116 subjects with primarily pseudocysts (n = 94), both transpapillary PD stenting and the combination of transpapillary PD stenting with transmural drainage carried high technical (>90%) and clinical success rates (83%–93%).[14] Recurrence, however, occurred in over 20% of the patients. In contrast, in a large retrospective multicenter study with 375 patients (174 with pseudocysts, 46.4%) with PFCs, combined transpapillary PD stenting and transmural drainage was performed in 79 (45%) patients, compared to transmural drainage alone in 95 (55%) patients.[15] Technical success of performing combination therapy was significantly lower than transmural drainage along (44% vs 97%), but there was no difference between the 2 treatment approaches in terms of symptomatic or radiologic

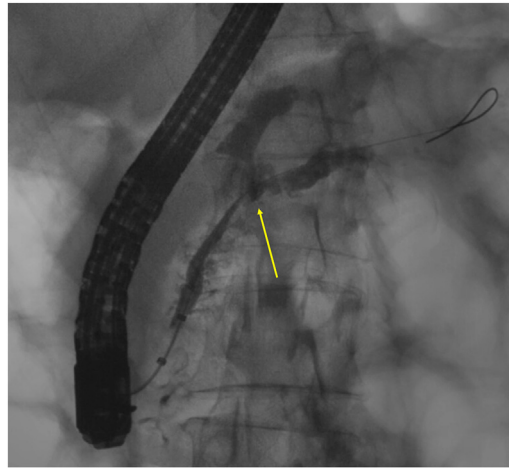

Fig. 2. Partial disruption (*arrow*) of the pancreatic duct with associated stricture with contrast reaching the upstream (dilated) pancreatic duct.

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resolution of the pseudocyst. Conversely, in a single-center retrospective study examining 110 patients with PFCs (62% pseudocysts), 36% of the patients underwent transpapillary PD stenting in combination with transmural drainage.[16] In this study, concomitant PD stenting was independently associated with treatment success (aRR: 1.14, 95% CI: 1.01–1.29).

In patients with walled-off pancreatic necrosis (WOPN), the benefit of transpapillary PD stenting as adjunctive therapy with transmural drainage (**Figs. 3** and **4**) remains unclear. In the context of DPDS where there is a complete disruption of the PD, endoscopic transluminal drainage is preferred as it not only drains the PFC, but also creates an alternative route of drainage for the isolated, but viable, section of the pancreas. In a retrospective multicenter study including 291 patients with PFCs, 167 (46.3%) of which had DPDS, only 83 (23%) patients successfully received bridging PD stents in addition to transmural drainage.[17] A single-center retrospective study involving 31 cases of DPDS similarly found that only 9.6% (n = 3) of the patients had successful bridging of the PD via stent placement (with successful resolution of symptoms in all 3 cases).[18] In a large single-center retrospective study of 226 patients with WOPN, however, ERP was successfully performed in 204 (90.3%) patients.[19] Partial PD disruption was found in 103 (50.5%) patients and complete disruption found in

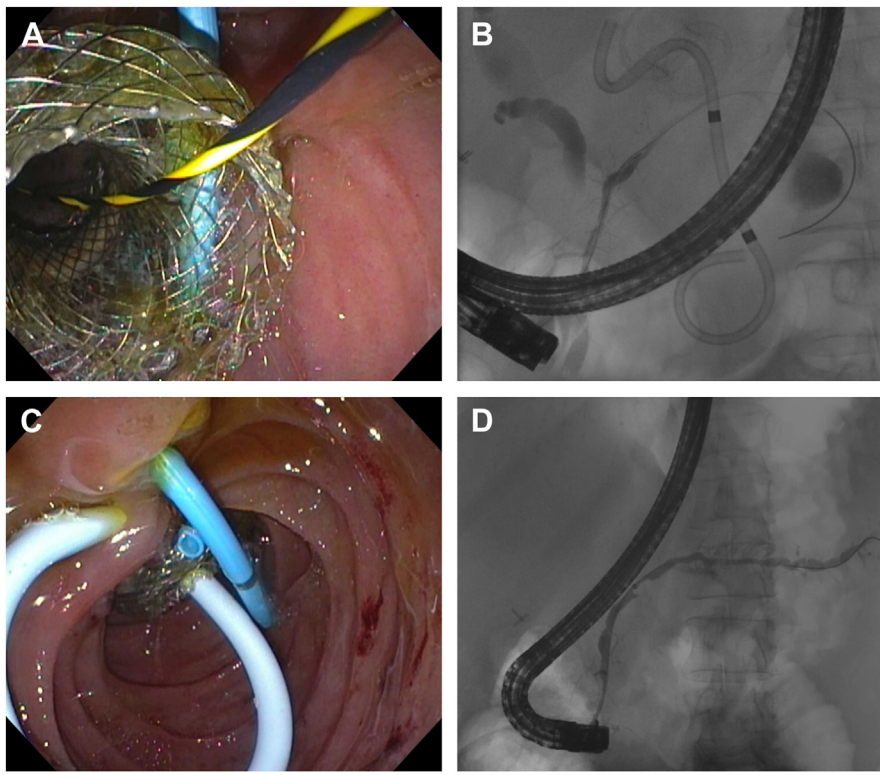

Fig. 3. Disconnected pancreatic duct syndrome treated by concomitant (*A*) transmural drainage of associated walled-off pancreatic necrosis using a lumen-apposing metal stent, (*B*) guidewire advancement during endoscopic retrograde cholangiopancreatography (ERCP) into the collection, followed by (*C*) transpapillary pancreatic duct stent placement with resolution of the disruption (*D*) after 3 months of pancreatic duct stenting.

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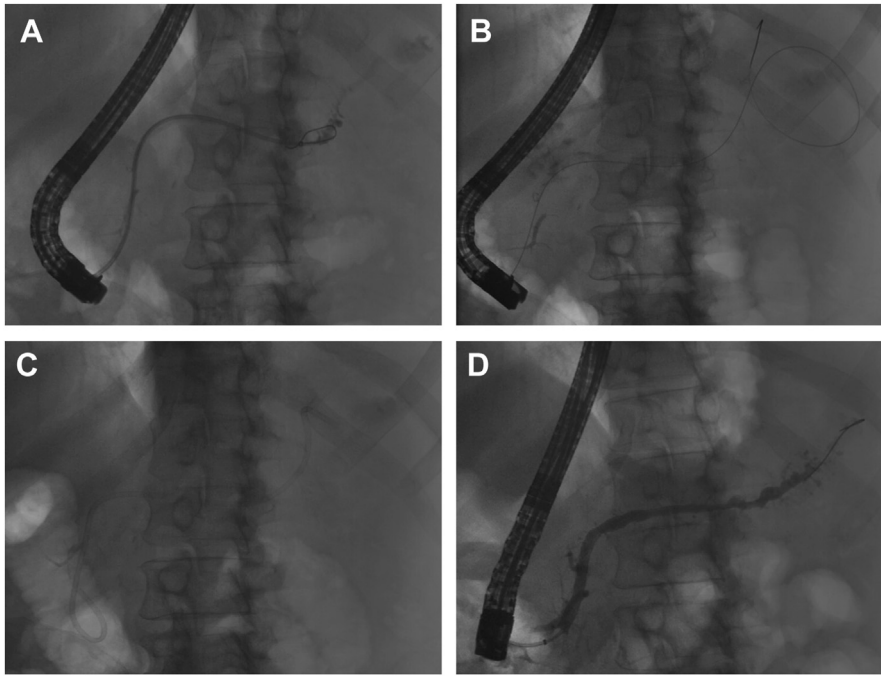

Fig. 4. Pancreatic duct leak resulting in pancreatic fluid collection not amenable to transmural drainage with (*A*) contrast leaking from the tail of the pancreas, (*B*) guidewire advancement into the fluid collection, (*C*) transpapillary pancreatic duct stent placement into the collection, and (*D*) resolution of leak/fluid collection 2 months after stent placement.

63 (30.9%) patients with successful PD stenting performed in 154 (92.8%) of these patients with PD disruption. Successful ERP was associated with a higher rate of clinical success (95.1% vs 81.8%) and a lower rate of recurrence (9.3% vs 50%). Given the limited and conflicting data, several questions remain as to when transpapillary PD stenting should be attempted, how long PD stents should be left in place, and where PD stents should be placed if unable to bridge a leak (eg, into the collection, downstream of the leak). Additionally, while transpapillary PD stent placement carries a lower risk of perforation and bleeding compared to transmural drainage, secondary infection may occur with this technique when contrast enters the collection.

Pancreas Divisum and Recurrent Acute Pancreatitis

Minor papilla sphincterotomy (papillotomy) with or without PD stent placement (**Fig. 5**) for the treatment of RAP in patients with pancreas divisum represents an area of significant controversy. A single-center pilot randomized trial of 19 individuals compared PD stent placement via the minor papilla (serial exchanges every 4 months for 1 year) with pancreatogram alone (no stent placement).[20] In the control group, 6 patients developed pancreatitis (7 total episodes) while only 1 patient in the stenting group developed an episode of pancreatitis during the follow-up period. A significantly higher proportion of patients (90% vs 11.1%) in the stenting group also reported a $\geq$50% improvement in pain. A meta-analysis including 23 studies (all case series of suboptimal quality) with 874 patients estimated endoscopic efficacy at 67.5% (95% CI: 0.61–0.73) with a pooled rate of post-ERCP pancreatitis at 10.1% (95% CI: 0.08–0.12).[21] Given the

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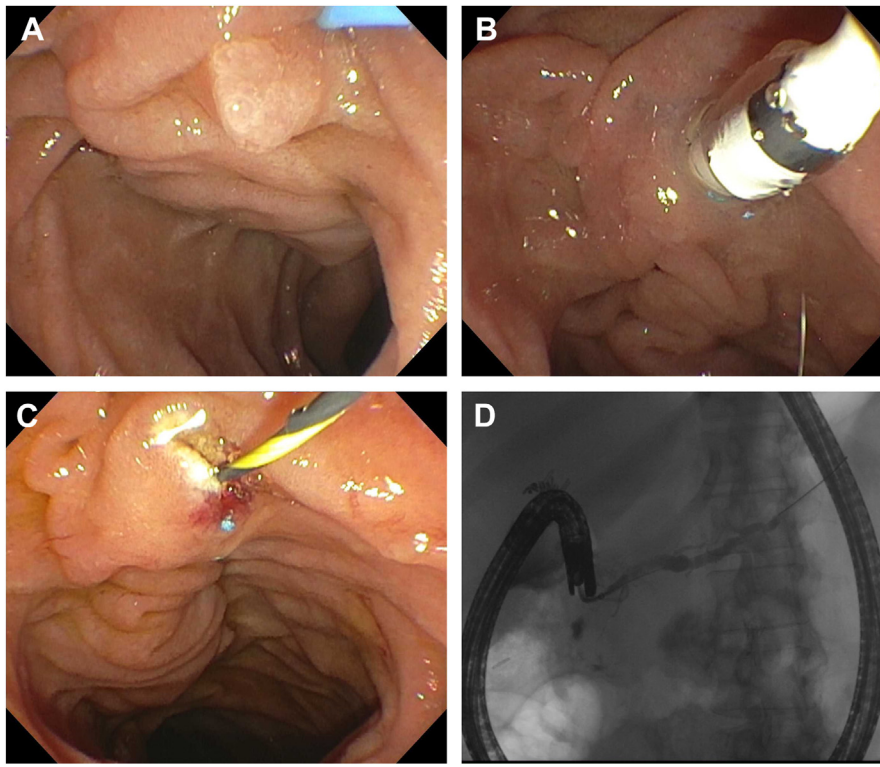

Fig. 5. Visualization of a minor papilla (*A*) in a patient with pancreas divisum and recurrent acute pancreatitis treated via balloon dilatation (*B*) of the minor papilla followed by sphincterotomy (*C*) with pancreatogram (*D*) performed with the duodenoscope in the long position.

significant heterogeneity of these studies, an ongoing multicenter randomized sham-controlled trial (SHARP) comparing EUS alone (sham) to the combination of EUS with ERCP aims to determine whether minor papilla sphincterotomy benefits patients with pancreas divisum and RAP (ClinicalTrials.gov NCT03609944).[22]

Post-Endoscopic Retrograde Cholangiopancreatography Pancreatitis Prophylaxis

As the prevention and management of post-ERCP pancreatitis (PEP), the most common adverse event (AE) of ERCP, is largely outside of the scope of this article, this review will focus primarily on the role of PD stent placement as prophylaxis for PEP (**Fig. 6**). Recent guidelines from the American Society for Gastrointestinal Endoscopy recommend rectal non-steroid anti-inflammatory drugs for both low-risk and high-risk patients while also recommending PD stenting in high-risk cases as long as PD access is easily achieved.[23] The recent landmark stent vs. indomethacin (SVI) study, a multicenter randomized controlled trial, compared indomethacin alone with the combination of indomethacin with PD stenting in high-risk patients (n = 1950), finding that indomethacin alone was inferior to combination prophylaxis with PD stent placement (14.9% vs 11.3%).[24] Of note, the reduced risk of PEP was seen despite a 20% failure rate of PD stent placement, suggesting that in high-risk patients, PD stent placement should be attempted even when accounting for the possibility of unsuccessful stent placement.

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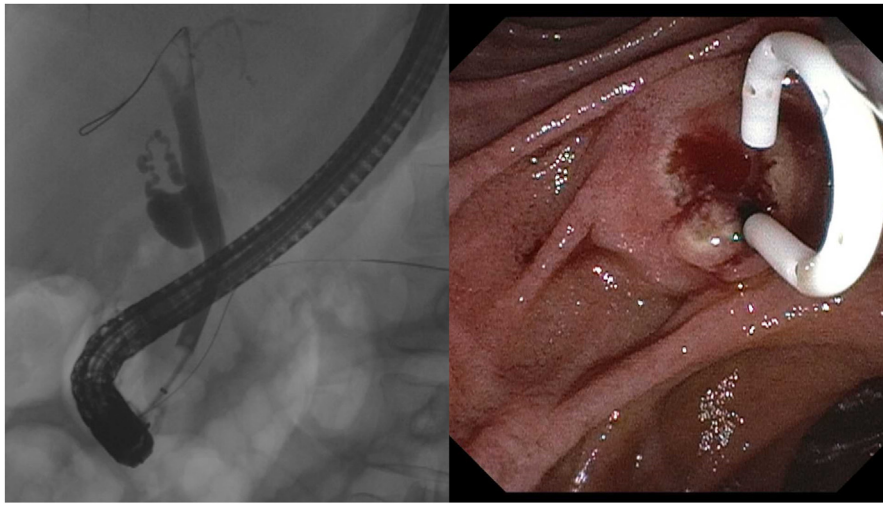

Fig. 6. Double-guidewire technique used for biliary cannulation with pancreatic duct wire (left panel) used for placement of a pancreatic duct stent (right panel) for prophylaxis against post-ERCP pancreatitis.

ENDOSCOPIC RETROGRADE CHOLANGIOPANCREATOGRAPHY FOR CHRONIC PANCREATITIS

Endoscopic Retrograde Cholangiopancreatography for Pancreatic Duct Strictures

PD strictures present as a fibrosis-related complication that occurs in up to half of patients with CP.[25] The treatment of PD strictures largely consists of dilation of the stricture in conjunction with PD stent placement (**Fig. 7**). European guidelines recommend the placement of a single 10-Fr stent for up to a year with exchanges performed at least every 6 months, although PD stents have been found to occlude within 3 months.[3,26] In cases of refractory strictures (stricture persisting > 1 year despite 10 Fr stenting), multiple stents can be placed, providing a greater total outer diameter of stents.[3]

Several long-term studies have evaluated the efficacy and durability of PD stenting for CP-related PD strictures. A single-center prospective study treated 19 patients with refractory strictures with multiple side-by-side PD stents (median of 3 stents) for a median of 7 months, finding a stricture resolution rate of 95%.[27] During a mean follow-up of over 3 years, 84% of the patients remained asymptomatic while stricture recurrence occurred in 2 patients (10.5%). A follow-up study by the same group involving 48 patients found that at a mean follow-up duration of 9.5 years, 74.4% remained asymptomatic while 7% developed stricture recurrence.[28] Another single-center prospective study examined the efficacy of placement of a single PD stent in 19 patients with PD strictures located predominantly in the head (84.2%).[29] Stent therapy (mean stenting duration of 5.6 months) was successful in stricture resolution in 17 patients (89.5%) and during 2 years of follow-up, 5 patients (26.3%) developed stricture recurrence with associated symptoms.

A limited number of studies have described the use of fully covered metal stents for PD strictures, particularly as salvage treatment for refractory strictures. An international multicenter prospective study examined the use of a 4-mm or 6-mm diameter metal stent in 67 patients with dominant PD strictures.[30] Stents were left in place for 6 months and only 46 (68.7%) completed the study. A minority (26.1%) of patients

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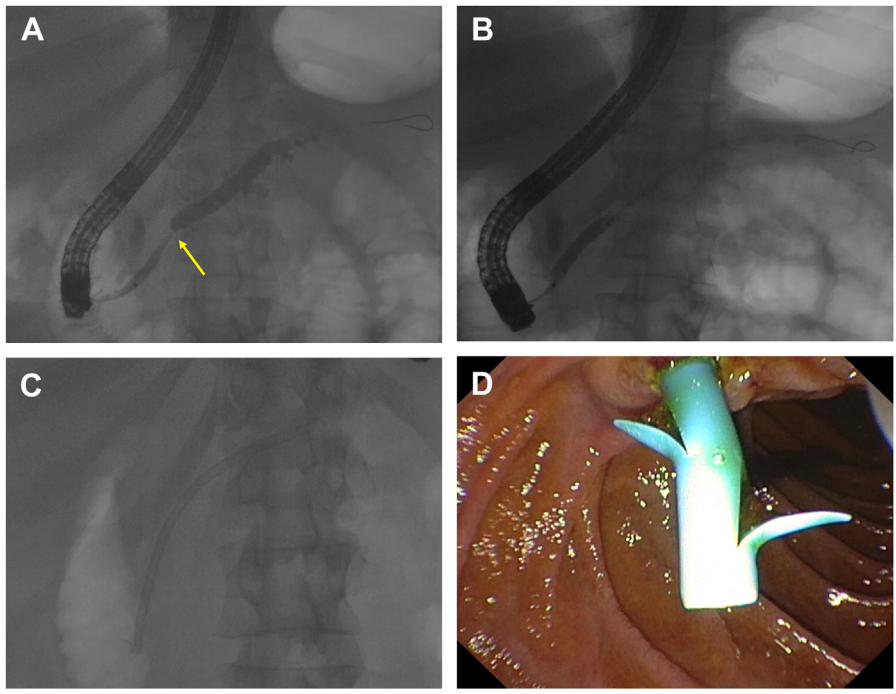

Fig. 7. Pancreatogram (*A*) demonstrating a pancreatic duct stricture (*arrow*) in the head of the pancreas treated via balloon dilation (*B*) and pancreatic duct stent placement (*C, D*).

experienced complete or partial (≥50%) pain relief and stent migration (predominantly complete migration out of the PD) occurred in 47.7% of the patients. Notably, serious AEs occurred in 21 patients (31.3%) with abdominal pain and PEP accounting for the majority (26.8%) of these and 5 patients (7.5%) developed a stent-associated stricture. In comparison, a single-center prospective study examining the use of a metal stent (6–10 mm diameter) with antimigration features in 32 patients found that after 3 months of in-dwell time, all patients achieved pain relief with no instances of stent migration.[31] There were 3 cases (9.4%) of PEP and 5 patients (15.6%) developed de novo stent-associated strictures at the proximal end. Another single-center prospective study involving 25 patients utilized short (3- and 5-cm length), non-flared metal stents with a central saddle (1 cm length) intended to directly overlie the stricture and a distal lasso that can be used to retrieve the stent if left intraductally (**Fig. 8**).[32] After 3 months of stenting, stricture resolution was seen in all patients with associated pain relief. During a median follow-up period of 34 months, stricture recurrence occurred in 2 patients (8%) who were successfully treated via repeat stenting. Of note, no prospective studies have directly compared metal stents with plastic stents for PD strictures and no metal stents are currently approved by the US Food and Drug Administration for use in the PD. Lastly, a single-center pilot study utilizing pancreatoscopy-guided laser dissection (**Fig. 9**) found high success rates (88.2%) in the treatment of refractory PD strictures with no recurrences seen at 1 year follow-up.[33]

Endoscopic Retrograde Cholangiopancreatography for Pancreatic Duct Stones

ERCP allows for lithotripsy of PD stones with standard techniques including balloon sweeping and basket extraction, often in conjunction with stricture dilation, given

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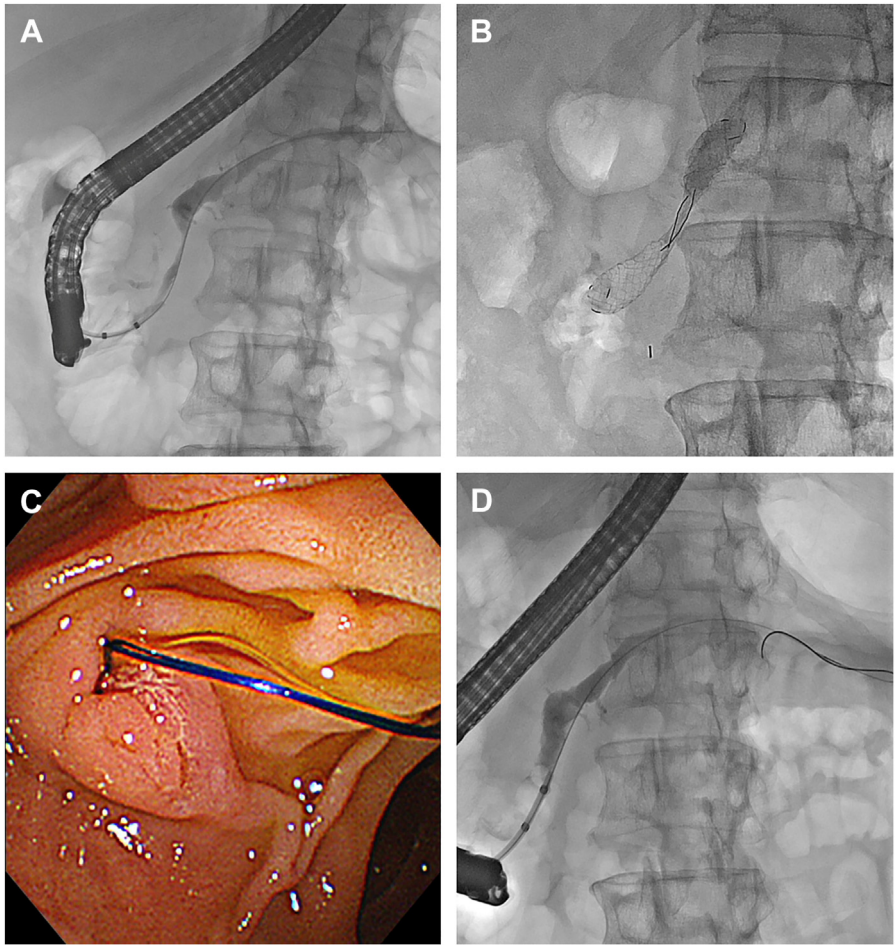

Fig. 8. Pancreatogram revealing a dominant stricture in the head of the pancreas (*A*) treated with placement of a non-flared fully covered metal stent with a central saddle (*B*) and a distal lasso (*C*) for retrieval that led to resolution of the stricture (*D*) on follow-up ERCP. (Images provided courtesy of Dr. Jong Ho Moon and Dr. Il Sang Shin).

the frequent finding of concomitant PD strictures and stones.[2,3] In addition to ERCP, extracorporeal shock-wave lithotripsy (ESWL, **Fig. 10**) has been used as an adjunctive therapy to fragment larger stones to facilitate endoscopic removal.[3] A 2-center randomized trial compared ESWL alone to the combination of ESWL and ERCP using standard maneuvers (without pancreatoscopy) in 55 patients with CP.[34] Successful PD stone clearance was achieved in all patients with a significant decrease in the number of pain episodes in both arms during the 2 years of follow-up. Pain relapse, however, occurred in 45% of the patients treated with both ERCP and ESWL and in 38% of the patients treated with ESWL alone ($P = .76$).

Pancreatoscopy, particularly with refinement of the single-operator system, facilitates intraductal lithotripsy by providing direct visualization of PD stones while also enabling use of a lithotripsy probe via the working channel (**Fig. 11**). Electrohydraulic lithotripsy (EHL), primarily due to its widespread availability, is most commonly utilized

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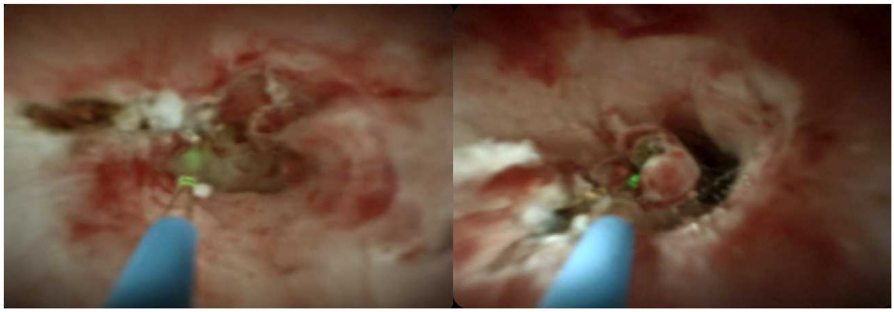

Fig. 9. Pancreatoscopy-guided laser dissection performed of a refractory pancreatic duct stricture in a patient with chronic pancreatitis using a thulium laser.

during pancreatoscopy. A multicenter prospective study from Germany found that in 40 patients with PD stones $\geq$5 mm, pancreatoscopy-guided EHL led to complete stone clearance in 90% of the patients within a mean of 1.36 procedures.[35] At 6 months follow-up, complete or partial pain relief was seen in 82.4% of the patients. Adverse events included primarily pain (5%) and PEP (2.5%). A single-center study prospectively examined the success of pancreatoscopy-guided EHL in 34 patients with painful CP and PD stones >5 mm.[36] EHL was technically successful in 70.6% of the patients with cases of failure due to inability to deeply cannulate the PD (14.7%) and fragmentation of the stone after stent placement alone (11%) that eliminated the need for EHL. A median of 2 ERCPs (median of 1 session of EHL) was required to achieve complete stone clearance and at 6 months follow-up, clinical success (>50% reduction in pain or decreased opiate use) was seen in 72% of the patients. A single-center retrospective study with long-term follow-up comparing pancreatoscopy-guided EHL (n = 19) with ESWL followed by standard ERCP (n = 18) found that stone recurrence occurred in 37% of the patients (at a median of

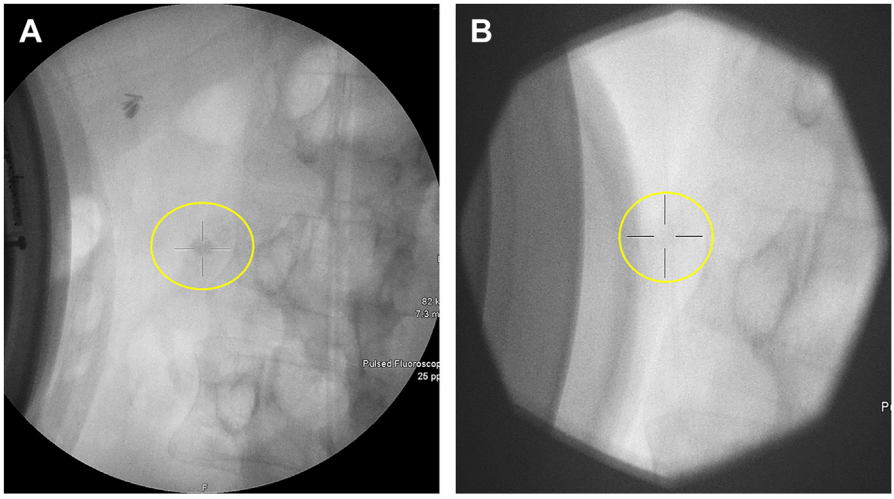

Fig. 10. Ten-mm pancreatic duct stone (*A*) treated with extracorporeal shock-wave lithotripsy with complete fragmentation of the stone (*B*).

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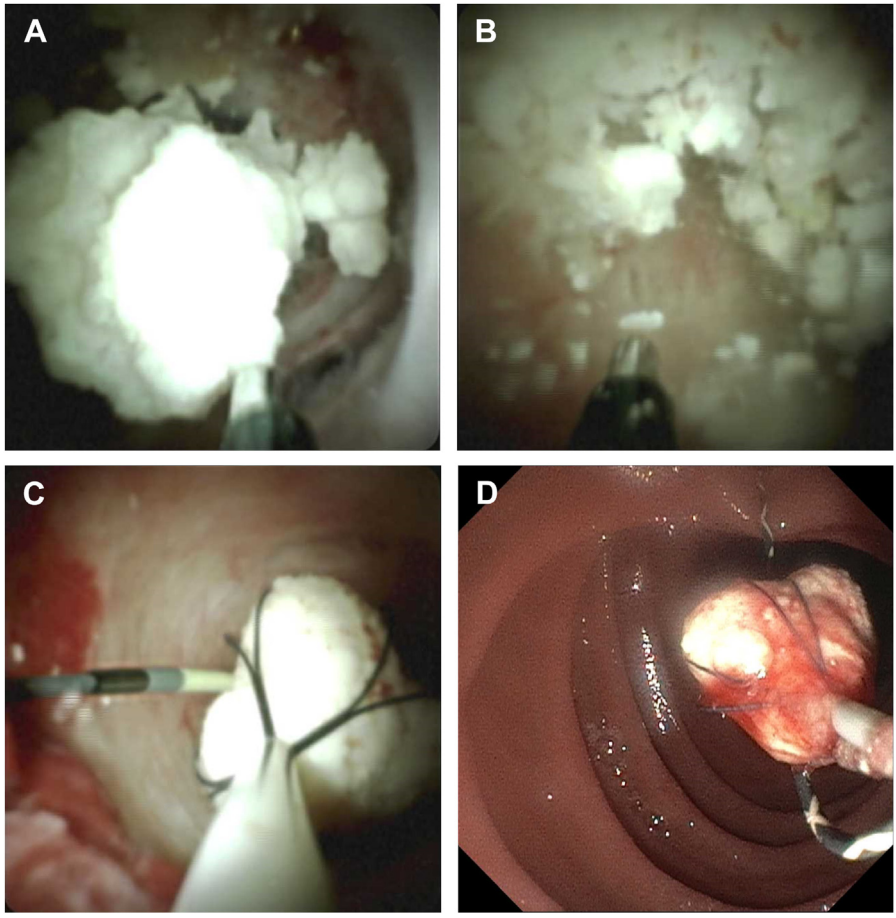

Fig. 11. Pancreatoscopy-guided electrohydraulic lithotripsy (*A*) performed with fragmentation (*B*) of pancreatic duct stone and pancreatoscopy-guided basket extraction (*C*) of large pancreatic duct stone (*D*).

12 months post-treatment) treated with EHL.[37] This was significantly lower than the 61% stone recurrence rate seen with ESWL. At a median follow-up period of 35 months in those treated with EHL, pain levels were found to be significantly improved compared to baseline.

Prospective studies examining the use of laser lithotripsy (LL) are currently lacking, but retrospective studies have demonstrated high success rates with LL for treating PD stones. In a multicenter retrospective study with 28 patients treated with prior ERCP and ESWL, pancreatoscopy-guided LL resulted in complete stone clearance in 79% and partial stone clearance in 11% of the patients.[38] Clinical success (>50% improvement in pain levels or > 50% reduction in pain medication use) was found in 89% of the patients after a median follow-up period of 13 months. Another multicenter retrospective study (n = 109) examined both EHL (n = 59) and LL (n = 50) in the treatment of refractory PD stones, finding a complete stone clearance rate of 89.8%.[39] LL had a 100% complete stone clearance rate, of which 70% of the cases required only 1 treatment session. Stone recurrence was found in 6.5% of the patients

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treated with LL at a median of 1.23 years. An ongoing multicenter randomized trial is comparing pancreatoscopy-guided EHL and LL with ESWL for the treatment of large PD stones to determine the ideal treatment algorithm for these stones (ClinialTrials.gov NCT04115826).[40]

Several randomized trials have compared pancreatic endotherapy with surgical drainage in patients with PD strictures and/or stones.[41,42] In a landmark randomized trial involving 39 patients with painful CP (79% with both strictures and stones), 19 patients underwent endotherapy (median of 5 procedures) and 20 patients receive a surgical pancreaticojejunostomy.[41] Technical success for the endotherapy group was only 53% and complete or partial pain relief was achieved in only 32% of the patients in the endotherapy group, compared to 75% in the surgery group. The follow-up report to this trial (mean follow-up period of 79 months) reported a recurrence rate of 47% of the patients who initially received endotherapy.[43] There was no longer a significant difference in terms of patients' pain scores and there was no difference in quality of life between the 2 treatment groups. More recently, the Dutch Pancreatitis Study Group conducted a multicenter randomized trial in 88 patients with CP and a dilated PD, comparing early surgery to endotherapy.[42] Patients who received endotherapy had a median of 3 procedures with a technical success rate or 62%. While the surgery group had a lower area under the curve for the Izbicki pain level than the endotherapy group, there was no difference in complete or partial pain relief (58% surgery vs 39% endotherapy) or quality of life between the 2 groups.

Notably, while randomized trials have compared endoscopy with surgery, placebo-controlled trials have been lacking in endotherapy-related trials in CP. This is important within the context of a recent multicenter randomized placebo-controlled trial examining an oral serine protease inhibitor (camostat) in CP which found a nearly 50% placebo response rate.[44] A single-center randomized trial comparing early endotherapy with medical management alone was prematurely closed due to insufficient patient enrollment, highlighting the particular challenge of placebo-controlled trials when using endotherapy as the intervention.[45] An ongoing multicenter randomized trial is attempting to compare the combination of ESWL and ERCP with a sham control in patients with painful CP (ClinicalTrials.gov NCT03966781).[46] Lastly, the durability of endotherapy warrants further investigation as a large multicenter US cohort demonstrated that nearly half of patients with CP who undergo pancreatic ERCP receive repeat treatment within 2 to 3 years.[47]

ENDOSCOPIC RETROGRADE CHOLANGIOPANCREATOGRAPHY FOR PANCREATIC NEOPLASMS

Endoscopic Retrograde Cholangiopancreatography for Main Duct Intraductal Papillary Mucinous Neoplasms

Main duct intraductal papillary mucinous neoplasms (MD-IPMNs) carry a high rate of malignant transformation and can typically be diagnosed via cross-sectional imaging.[48] ERCP, and specifically pancreatoscopy, can aid in both confirming the diagnosis of an MD-IPMN and characterizing the extent of involvement of the PD.

In making the diagnosis of an MD-IPMN, visual inspection of the PD via pancreatoscopy can reveal fronds/papillary projections, mass lesions, "fish-egg" structures, and abnormal lining of the PD (**Fig. 12**).[49] Furthermore, pancreatoscopy allows for targeted biopsies that can be particularly helpful in providing the level of dysplasia. A multicenter retrospective study from the United States including 31 patients with MD-IPMN found that in 42% of the cases, pancreatoscopy identified findings (eg, nodules,

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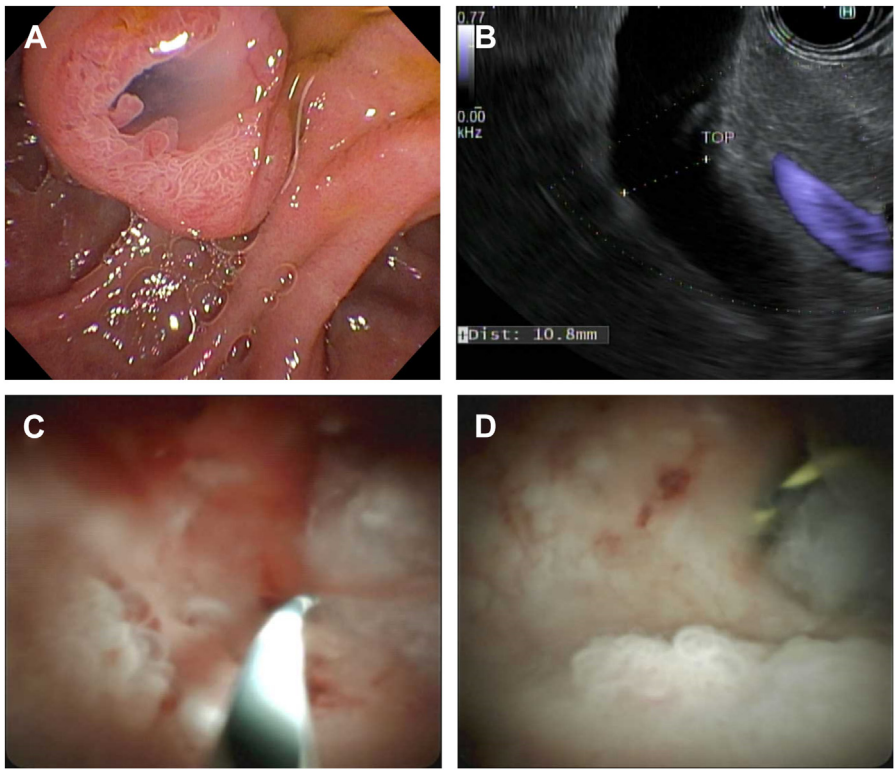

Fig. 12. Patulous "fish mouth" major papilla (*A*) with a diffusely dilated pancreatic duct seen on endoscopic ultrasound (*B*) with pancreatoscopy demonstrating "fish-egg" structures (*C*, *D*) in a patient with a main-duct intraductal papillary mucinous neoplasm.

masses) that were not visible on imaging or EUS.[49] Similarly, another multicenter retrospective study from Europe (n = 84) evaluated the role of pancreatoscopy in MD-IPMN evaluation, finding that in 85% of the cases, pancreatoscopy provided new information that directly affected patient care.[50]

Pancreatoscopy can also be utilized pre-operatively or intra-operatively to determine resection strategies for MD-IPMNs. In a single-center retrospective study, intraoperative pancreatoscopy was performed in 46 patients with an MD-IPMN.[51] Nearly two-third of the patients (65.2%) had surgical plans altered with extended resections performed in 43.4% of the patients (found to have skip lesions) and smaller resections performed in 21.7% of the patients (only segmental resection needed). Similarly, a systematic review detailing 10 studies involving 147 patients found that pancreatoscopy identified a total of 46 skip lesions (31.3%).[52] Surgical plans were directly altered from pancreatoscopy results in 37.4% of the patients, predominantly in the form of extended resections.

Relatedly, ERCP and pancreatoscopy can also help distinguish MD-IPMNs from CP. The identification of a PD stricture, for example, in patients with a dilated PD can aid in making the diagnosis of CP.[51] In a small subset of patients, the presence of PD stones, which are typically pathognomonic for CP, can lead to inadvertent diagnosis of CP in cases of MD-IPMNs.[53] A 2-center pilot study found that in 13 patients with presumed CP complicated by PD stones, pancreatoscopy led to the diagnosis of MD-IPMN

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(Fig. 13), which speaks to another potential benefit of performing pancreatoscopy-guided lithotripsy.[54]

Endoscopic Retrograde Cholangiopancreatography in Pancreatic Ductal Adenocarcinoma

The role of endoscopy in pancreatic ductal adenocarcinoma (PDAC) has traditionally focused on tissue sampling and biliary stenting. On the basis of relieving malignant PD obstruction, several studies have examined the utility of PD stenting to ameliorate "obstructive" type pain, which has typically been characterized as pain associated with eating. An early single-center study including 20 patients with PDAC in the head of the pancreas found that PD stent placement (7 Fr or 10 Fr stent) was technically successful in 95% of the patients.[55] PD stent placement was associated with significant reduction in pain and opiate dosing in addition to improvement in short-term quality of life. Similarly, a meta-analysis including 12 studies with 192 total patients reported a pain response rate of 93% with a mean pain improvement duration of 94 days.[56] Most recently, a single-center pilot randomized trial compared biliary stenting alone to the combination of biliary and PD stenting in 13 patients with unresectable PDAC presenting with jaundice.[57] Utilizing the ^{13}C-mixed triglyceride breath test before and 2 weeks after ERCP to measure pancreatic exocrine function, patients who received a PD stent were found to have a significant improvement in pancreatic function. There was no significant improvement seen in abdominal pain, however, 2 weeks after ERCP.

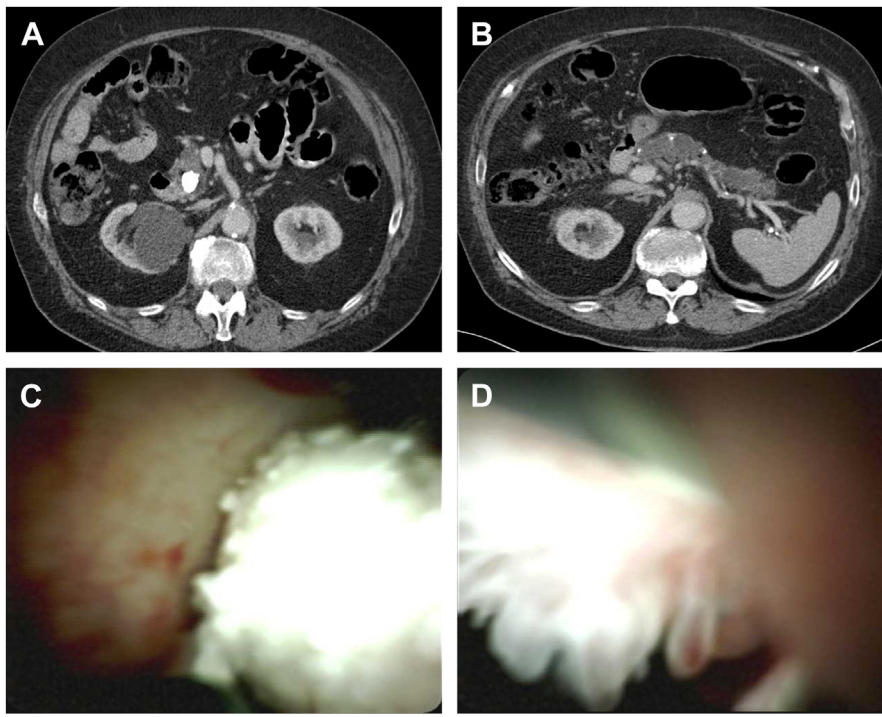

Fig. 13. Computed tomography images demonstrating large pancreatic duct stone (*A*) with upstream pancreatic duct dilation (*B*) and pancreatoscopy revealing a large pancreatic duct stone (*C*) and papillary projections (*D*) consistent with a main-duct intraductal papillary mucinous neoplasm on biopsy.

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SUMMARY

Pancreatic ERCP provides a therapeutic tool for the treatment of structural complications of pancreatic diseases, including PD leaks, strictures, and stones. The mainstay of pancreatic ERCP includes PD stent placement and PD stone lithotripsy with pancreatoscopy greatly facilitating the latter. Ongoing randomized studies will help further delineate the benefit of pancreatic ERCP, but further work is needed in determining its durability and its effect on patient-centered outcomes, and improving training of this challenging procedure.[58]

CLINICS CARE POINTS

- ERCP with PD stenting can help treat PD leaks and disruptions particularly in conjunction with EUS-guided transmural drainage for walled-off pancreatic necrosis and disconnected pancreatic duct syndrome.
- Prophylactic PD stent placement can help reduce the risk of post-ERCP pancreatitis, particularly in high-risk cases.
- Minor papillotomy for the treatment of recurrent acute pancreatitis in patients with pancreas divisum remains controversial and is the focus on an ongoing international multicenter randomized sham-controlled trial.
- PD stenting represents first-line therapy for the treatment of CP-related PD strictures, ideally with a minimum target diameter of a 10 Fr stent.
- Pancreatoscopy-guided lithotripsy is effective for the treatment of large, refractory PD stones in patients with CP.
- Pancreatoscopy can help diagnose MD-IPMNs while allowing for accurate delineation of the extent of PD involvement, which can facilitate precise surgical resection.

DISCLOSURE

Author S. Han is a Consultant for Boston Scientific. Author V. Chandrasekhara is a Consultant for Boston Scientific, a shareholder for Nevakar Corp, and receives research support from Micro-tech Endoscopy and STARmed.

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