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Endovascular intervention for management of pancreatitis-related bleeding: a retrospective analysis of thirty-seven patients at a single institution

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PURPOSE
The aim of this study was to assess the outcome of endovascular intervention for pancreatitis-related hemorrhage at a single institution.

METHODS
From January 2000 to October 2012, thirty-seven patients underwent endovascular intervention for the management of pancreatitis-related hemorrhage. The underlying etiology of the disease, clinical symptoms and laboratory findings, abnormalities seen on computed tomography, and details regarding the endovascular procedures were assessed, as were the outcome of each procedure and procedure-related complications.

RESULTS
A total of 41 endovascular procedures were performed in 37 patients. The splenic artery (34.8%) was the most commonly treated artery, and pseudoaneurysm was the most commonly detected abnormality on digital subtraction angiography (78.3%). Transcatheter embolization was performed in the majority of patients (95.1%), while two patients were treated with stent-grafts. Successful hemostasis without rebleeding was achieved in 34 patients (91.9%). Two cases of rebleeding were successfully treated by reintervention. Focal splenic infarction, which developed in eight patients, was either asymptomatic or accompanied by mild, transient fever. Splenic abscess was the only major complication occurring in three patients. Two of these patients died from resulting sepsis, while the third recovered after antibiotic treatment.

CONCLUSION
Endovascular management is effective for achieving hemostasis in patients with pancreatitis-related bleeding and demonstrates low recurrence and mortality rates.

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Serious bleeding complications have been reported to occur in up to 14.5% of patients with acute and exacerbated chronic pancreatitis and are potentially fatal when left untreated (1). Computed tomography (CT) serves an important role in the diagnosis of pancreatitis-related hemorrhage, demonstrating radiologic features such as the presence of hematomas, hemorrhagic pseudocysts, extravasation of contrast media or the formation of arterial pseudoaneurysms. Timely intervention, either surgical or endovascular, is essential in this clinical setting, especially for active bleeding or pseudoaneurysm formation. Even though the latter may sometimes be clinically silent, arterial pseudoaneurysms are widely considered to be life-threatening "time-bombs" due to their risk of rupture (2–4). The mortality rate of bleeding pseudoaneurysms has been reported to reach as high as 40% when managed conservatively (5).

Endovascular treatment has advantages over surgery for managing complications related to pancreatitis. It is less invasive and can be performed in patients with comorbidities who are contraindicated for surgery. Even for those without surgical contraindications, surgery is often difficult owing to severe inflammatory change around the pancreas. Traditionally, the mainstay of endovascular treatment has been transcatheter embolization. More recently, stent-graft placement for exclusion of arterial rupture and pseudoaneurysms has gained popularity. Current literature suggests that such endovascular techniques are effective in achieving hemostasis in patients, and the outcomes are comparable or superior to those of surgery (2, 6, 7). However, despite the widespread popularity of endovascular treatment, the literature is mostly limited to case reports and small case series. We have performed a web-based search of the literature and have found a surprisingly limited number of publications comprising more than a handful of patients in a single study. By performing this retrospective, single-center study, we aim to provide firmer evidence in support of endovascular intervention as the first-line treatment for the management of pancreatitis-related hemorrhage.

Methods

Patients

A retrospective review was performed for all patients who underwent endovascular treatment for vascular complications of pancreatitis from January 2000 to October 2012. Approval was given by our local ethics committee, and the requirement for informed consent was waived. We identified a total of 37 patients. In line with the trend at the authors' institution, all patients but one underwent primary angiographic eval-

uation and endovascular intervention before receiving any kind of surgery to manage the vascular complications. The only patient who received prior surgery underwent exploratory laparoscopy at another institution, which failed to identify the bleeding focus. Our study included two female patients and 35 male patients. The mean patient age was 52.0 years (age range, 19–85 years).

We reviewed each patient's medical documents in order to identify the underlying disease etiology, indications for treatment including clinical symptoms and laboratory findings, and documented any changes in the clinical course following embolization including procedure-related complications. Contrast-enhanced multiphase CT scans, obtained using a four-channel multidetector CT scanner (LightSpeed QX/I or LightSpeed Plus, GE Medical Systems) or a 16-channel multidetector CT scanner (Somatom Sensation 16, Siemens Healthcare), were available for all patients included in this study with the exception of a few patients who had undergone CT at outside institutions. The scan protocol was diverse due to the following reasons: first, while some patients underwent routine scans (usually including portal venous and delay phase scans) to find out the cause of nonspecified acute abdomen, others underwent CT to evaluate the site of bleeding, in which case, early arterial phase was included. Second, some of the patients had CT scans that were brought by the patients themselves from other hospitals. Third, the retrospective data was collected over a period of 10 years, during which the protocol has been adjusted several times. The images were reviewed on a picture archiving and communication system. The CT severity index was also assessed.

Angiography and endovascular technique

Digital subtraction angiography (DSA) and endovascular procedures were performed by seven board-certified radiologists with one to 26 years of clinical experience in endovascular therapy. Using the standard technique to access the right common femoral artery, a 5 F RH angiography catheter (Cook Medical) and a 0.035-inch hydrophilic guidewire (Radifocus, Terumo) were used to catheterize the celiac or superior mesenteric artery and to perform DSA. Selective angiography was additionally performed with the use of a 2.0–2.8 microcatheter (Progreat, Terumo). DSA images were obtained in order to assess the presence of extravasation of contrast medium, pseudoaneurysm formation, and other vascular abnormalities. The suspected abnormalities seen on DSA were matched with those initially detected on CT in order to establish their validity.

The vascular abnormalities were either treated by transluminal embolization or by stent-graft placement. Regarding transcatheter embolization, the choice of embolic material was operator-dependent and included platinum coils (Tornado or Nester, Cook Medical), N-butyl cyanoacrylate (NBCA, Histoacryl, B. Braun Melsungen AG), and gelatin sponge particles. In order to prevent back-bleeding, the standard technique was to embolize the bleeding artery both proximal and distal to the vascular lesion using coils and/or NBCA. In cases where the distal segment could not be reached, NBCA, which could be propagated distal to the site of vascular abnormality, was chosen. The microcatheter was flushed with 5% dextrose in water in order to prevent premature polymerization of NBCA, after which NBCA mixed with iodized oil (Lipiodol, Andre Guerbet) at ratios ranging from 1:1 to 1:4 was injected through the microcatheter. When bleeding was found to occur from one or more small, distal branches, either NBCA or gelatin sponge particles were delivered through a microcatheter after superselective catheterization of these branches. Due to reimbursement issues, as well as its limited availability in our country at the time, the stent-graft came into use in the latter years of the study period. At our institution, its use was further limited to occasions where the artery was easily accessible to the stent-graft delivery system, for example, arteries with relatively larger lumina, such as those in proximity to their orifice in the aorta (e.g., proximal celiac, common hepatic, and splenic arteries) and arteries that were not too tortuous. For stent-graft placement, a guiding sheath (Cook Medical or Arrow International) was first positioned at the entrance of the problematic vessel, through which the balloon-mounted stent-graft (Jo-Graft, Abott) or self-expanding polytetrafluoroethylene-covered stent (VIABAHN, W. L. Gore and Associates) was then delivered over the wire, taking care to completely cover the arterial defect or pseudoaneurysm. After embolization or stent-graft placement, DSA was repeated to verify that the vascular abnormality had been completely excluded from the parent artery.

Outcome and follow-up

Successful hemostasis was determined based on the following findings: 1) extravasation of contrast media or pseudoaneurysm that was no longer visible on the final angiogram; 2) follow-up of the clinical features demonstrating symptomatic resolution, stabilization of laboratory findings and vital signs, and the absence of recurrence and procedure-related complications; 3) follow-up CT images demonstrating resolved hemorrhage or pseudoaneurysm. Complications related to the procedure were classified as major and minor according to the Society of Interventional Radiology Clinical Practice Guidelines (8). At follow-up, the clinical signs and symptoms as well as CT images of each patient were assessed by reviewing the electronic medical charts.

Results

Demographics and medical history of study patients are summarized in Table 1. Vascular complications were attributed to acute pancreatitis in six patients and to acute exacerbation of chronic pancreatitis in 31 patients. The causes of pancreatitis were alcohol abuse in 31 patients, procedure-related in two patients (endoscopic retrograde cholangiopancreatography in one patient and fine-needle aspiration biopsy in the other), biliary stones in two patients, secondary pancreatitis associated with pancreatic malignancy in one patient, and postsurgical in one patient who underwent total gastrectomy for early gastric cancer. The CT severity index in patients with acute inflammato-

Table 1. Demographics and medical history of 37 patients who underwent endovascular intervention for management of pancreatitis-related bleeding

Number of patients, n	37
Age (years), mean (range)	52 (19–85)
Male:female ratio	35:2
Underlying disease	
Acute pancreatitis	6 (16.7%)
Chronic pancreatitis	31 (83.8%)
Causes of pancreatitis	
Alcohol abuse	31 (83.8%)
Procedure-related (ERCP, FNAB)	2 (5.4%)
Gallstone	2 (5.4%)
Secondary pancreatitis in pancreatic malignancy	1 (2.7%)
Postsurgical (total gastrectomy)	1 (2.7%)
Clinical presentations	
Acute abdominal pain	15 (40.6%)
Gastrointestinal bleeding	9 (24.3%)
Bleeding from drains	3 (8.1%)
Asymptomatic	10 (27.0%)
Vital signs and laboratory abnormalities	
Hemodynamic instability	7 (18.9%)
Decreased hemoglobin and hematocrit levels	13 (35.1%)
Clinically stable	17 (46.0%)
Abnormal coagulation	
Platelet and INR within normal range	29 (78.4%)
Altered platelet count and/or INR	8 (21.6%)

Unless otherwise noted, data are presented as n (%).
ERCP, endoscopic retrograde cholangiopancreatography; FNAB, fine-needle aspiration biopsy; INR, international normalized ratio.

ry process in the pancreas ranged 4–10 (average, 7.2). Clinical presentations included acute abdominal pain in 15 patients, gastrointestinal bleeding in nine patients, bleeding from drains placed in pseudocysts in three patients, and clinically silent arterial lesions or hemorrhagic pseudocysts incidentally detected on CT in 10 patients (four of these patients presented with increase in size of previously diagnosed pseudoaneurysms at follow-up). Two patients with clinically silent pseudoaneurysms had been referred from other institutions after unrewarding exploratory surgery or diagnostic angiography. Hemodynamic instability (such as systemic hypotension, abnormal heart rate, and decreased urine outflow) was observed in seven patients, while progressively decreasing hemoglobin and hematocrit levels were observed in thirteen. The remaining patients had stable vital signs and no laboratory abnormalities were associated with their vascular lesions.

A total of 41 procedures were performed, including repeated procedures performed in three patients. Two of these patients underwent two procedures due to recurrent bleeding in the same location, while the third underwent three procedures for pseudoaneurysms arising in three different anatomical locations on each occasion. Anatomical locations and DSA presentations are summarized in Table 2. Forty-six visceral arteries were treated at nine different arterial locations, among which the splenic artery (n=16, 34.8%) was the most commonly treated (Fig. 1). For those in whom the pseudoaneurysm or extravasation of contrast media was clearly localized on CT, the focus was well-correlated in all but one patient. In this patient, a pseudoaneurysm was demonstrated on CT but not seen on DSA. Therefore, embolization of the gastroduodenal and pancreaticoduodenal arteries was carried out based on the CT findings. For other patients in whom the CT showed indirect signs of bleeding, such as hematoma or hemorrhagic pseudocyst, DSA was the first modality to reveal the bleeding focus. Except for the aforementioned angiographically negative case, DSA revealed a total of 45 vascular abnormalities, with pseudoaneurysm formation being the most common (n=36, 78.3%), followed by extravasation of contrast media (n=7, 15.2%). Among patients with DSA abnormalities, more than two lesions were found in three patients (8.3%). The maximum number of abnormalities discovered in a single patient was four pseudoaneurysms. In contrast to the relatively pronounced findings of pseudoaneurysm or extravasation, DSA disclosed subtle luminal irregularity (Fig. 1) at the suspected site of hemorrhage in two patients (4.3%). Transcatheter embolization was the most frequently performed procedure, accounting for the majority of the procedures (n=31, 93.9%). The remaining two procedures (6.1%) involved placement of stent-grafts to exclude pseudoaneurysms arising from the splenic artery or superior mesenteric artery (Fig. 2). Regarding transcatheter embolization, the choice of embolic material was made according to the operator's preference after considering various factors such as the location of the vascular lesion as well as the anatomy of the patient's visceral vasculature (Table 3). In terms of embolic material, coils were used in 22 patients (mean, 4.9 coils per patient), NBCA in 20 patients (mean, 0.8 mL per patient and 1:2.7 dilution with Lipiodol), and gelatin sponge particles in six patients. In eight patients, two different embolic materials were used in a single procedure. No misplaced coils were seen in nontarget arteries on the final angiograms. There were no cases hav-

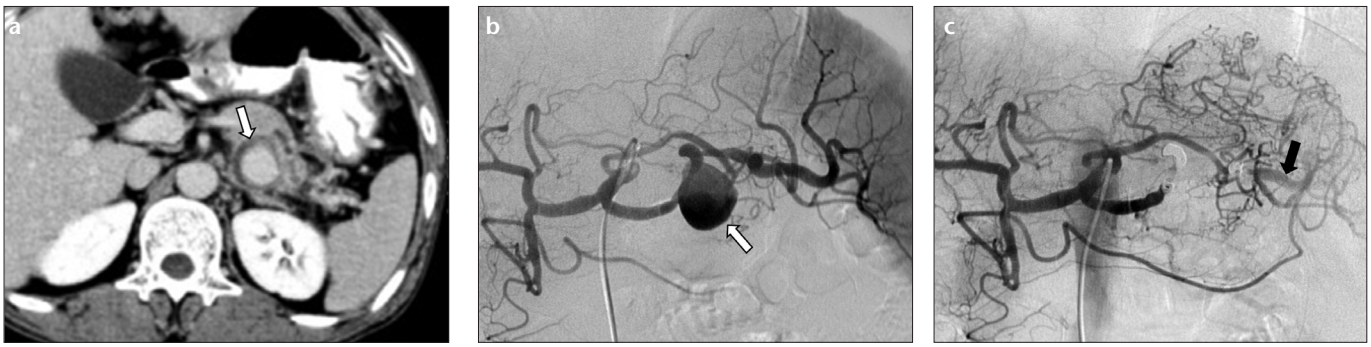

Figure 1. a–c. A 41-year-old male with chronic alcoholic pancreatitis was evaluated for left flank pain. Axial contrast-enhanced CT image **(a)** reveals a very large pseudoaneurysm *(arrow)* posterior to the body of the pancreas. Splenic arteriogram **(b)** demonstrates the pseudoaneurysm *(arrow)* arising from the middle segment of the splenic artery. The proximal and distal segments of the splenic artery were embolized using coils in order to exclude the pseudoaneurysm. Completion splenic arteriogram **(c)** confirms complete exclusion of the pseudoanerysm sac. Meanwhile, the distal segment of the splenic artery *(black arrow)* is opacified via collaterals in the stomach and pancreas. The patient was discharged four days later, after an uneventful recovery period.

Table 2. Angiographic findings

	n (%)
Anatomical location	
Splenic artery	16 (34.8%)
Pancreaticoduodenal artery	8 (17.3%)
Gastroduodenal artery	7 (15.2%)
Short gastric artery	4 (8.7%)
Left gastric artery	4 (8.7%)
Middle colic artery	2 (4.3%)
Left inferior phrenic artery	1 (2.2%)
Right gastroepiploic artery	1 (2.2%)
Superior mesenteric artery	1 (2.2%)
Jejunal branch (arising from the SMA)	1 (2.2%)
Replaced right hepatic artery (on SMA)	1 (2.2%)
DSA presentation	
Pseudoaneurysm	29 (78.4%)
Extravasation of contrast media	5 (13.5%)
Luminal irregularity	2 (5.4%)
No detectable lesion	1 (2.7%)
Total number of treated arteries	46 (100%)

SMA, superior mesenteric artery; DSA, digital subtraction angiography.

ing unintentional migration of NBCA into any of the terminal end-organs. The remaining two procedures (6.1%) involved placement of stent-grafts to exclude pseudoaneurysms arising from the splenic artery or superior mesenteric artery (Fig. 3). A stent-graft measuring 7 mm in diameter was placed in the splenic artery of one patient, while another measuring 8 mm in diameter was placed in the superior mesenteric artery of the second patient.

Procedure outcome is presented in Table 3. Successful hemostasis without rebleeding was achieved in 34 patients (91.9%). The remaining three patients underwent repeated interventions recurrent bleeding. The cause of rebleeding was recanalization of the embolized artery occurring one day after the embolization in one patient, development of new bleeding sites occurring two weeks after embolization in the second patient, and persistent retrograde filling of the pseudoaneurysm in the third patient in whom only the proximal feeding artery could be embolized owing to technical difficulties that were encountered during catheterization. While the first two patients were successfully managed by subsequent reintervention, the third patient underwent a total of three procedures which were all unsuccessful. Meanwhile, two patients who underwent stent-graft placement were successfully treated without complications. Only one patient had a failed embolization procedure, among eight patients who demonstrated disturbances in coagulation, i.e., prolonged international normalized ratio (INR) and/or decreased platelet count.

Complications were only observed among patients who underwent embolization of the splenic artery. Among sixteen patients who underwent embolization of the splenic artery, eight patients demonstrated radiologic features of focal splenic infarction on CT at follow-up. These eight cases of focal splenic infarction were classified as minor complications (19.5%), since five patients were asymptomatic and three were managed conservatively for mild, transient fever. Meanwhile, three patients developed splenic abscess which was categorized as a major complication (8.1%). One of these patients recovered after antibiotic treatment while the other two expired from resulting sepsis despite percutaneous abscess drainage and aggressive antibiotic therapy, yielding a mortality rate of 4.9%. Complications in the spleen developed only in cases where

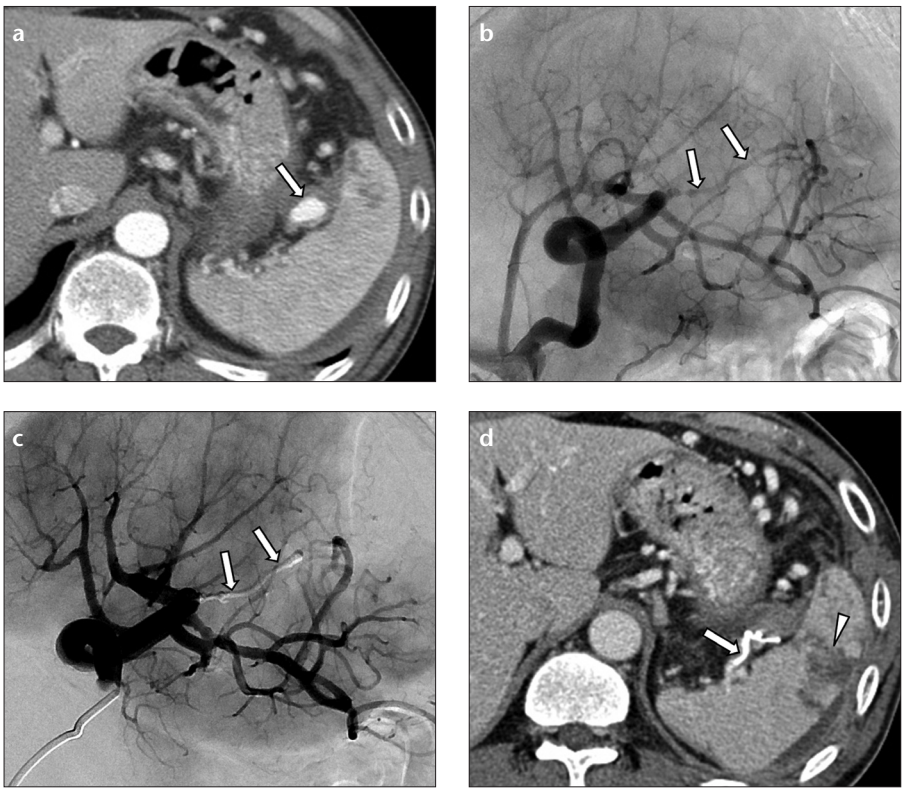

Figure 2. a–d. A 50-year-old male with chronic alcoholic pancreatitis was evaluated for exacerbated abdominal pain. Axial contrast-enhanced CT image **(a)** shows a pseudoaneurysm *(arrow)* situated near the splenic hilum. Splenic arteriogram **(b)** failed to demonstrate the pseudoaneurysm sac; however, luminal irregularity *(arrows)* is noted in one of the branches of the splenic artery. Completion splenic arteriogram **(c)** shows embolization of the irregular branch artery using N-butyl cyanoacrylate *(arrows)*. Follow-up axial contrast-enhanced CT image **(d)** shows thrombosis of the pseudoaneurysm sac. Although localized splenic infarction *(arrowhead)* was seen on CT, the patient was asymptomatic. Note the hyperattenuating embolic material *(arrow)* within the splenic artery near the splenic hilum.

Table 3. Details of endovascular intervention and outcomes

Procedure	n=41
Transcatheter embolization	39 (95.1%)
Coil	22
N-butyl cyanoacrylate	20
Gelatin sponge particles	6
Stent-graft placement	2 (4.9%)
Outcome	**n=37**
Successful hemostasis without re-bleeding	34 (91.9%)
Minor complications	
Focal splenic infarction (asymptomatic or mild fever)	8 (19.5%)
Major complications	
Splenic abscess	3 (8.1%)
Procedure-related mortality	2 (4.9%)

Data are presented as n or n (%).

the splenic artery had been embolized in the distal segment adjacent to or at the splenic hilum. No complications were observed following embolization of other arterial locations or after stent-graft placement. Excluding the aforementioned patient in whom embolization was unsuccessful and the two patients who died from sepsis, none of the patients developed recurrent bleeding during a mean follow-up duration of 38.5 weeks after their latest embolization procedure.

Discussion

The DSA findings in our study could be categorized into three types of abnormalities: contrast extravasation due to arterial rupture, pseudoaneurysm formation, and luminal irregularity. Arterial pseudoaneurysm was the most frequently detected type of abnormality, accounting for nearly 80% of all angiographically detected lesions. Arterial pseudoaneurysms are basically pulsatile, blood-filled extraluminal sacs that communicate with the arterial lumen, and approximately 10% are thought to be related to pancreatitis (9–12). The most widely-accepted mechanism for pseudoaneurysm formation is elastolytic erosion of the vessel wall resulting from the necrotizing inflammatory process around the pancreas, extravasated proteolytic and lipolytic enzymes, secondary abscesses, and long-standing pseudocysts (1). The result is progressive weakening of the vessel wall leading to rupture or the formation of pseudoaneurysms. Not surprisingly, the most commonly affected arteries in the setting of pancreatitis have been described to be those in proximity to the pancreas, such as the splenic artery, gastroduodenal artery and its branches, and the superior mesenteric artery (13–15). The most frequently affected vessel seen in our study was the splenic artery, a finding which agrees with the results of previous reports. Pseudoaneurysms require special attention for they are potentially fatal if they rupture into the peritoneal space, retroperitoneum, gastrointestinal tract, or pancreatic duct (2–4, 16). Despite their wide recognition, questions remain regarding the natural history of pseudoaneurysms. Consequently, there is controversy regarding the ideal timing for aggressive management of these lesions, especially for those that are clinically silent (10, 17). Even with evidence in the literature that some visceral pseudoaneurysms

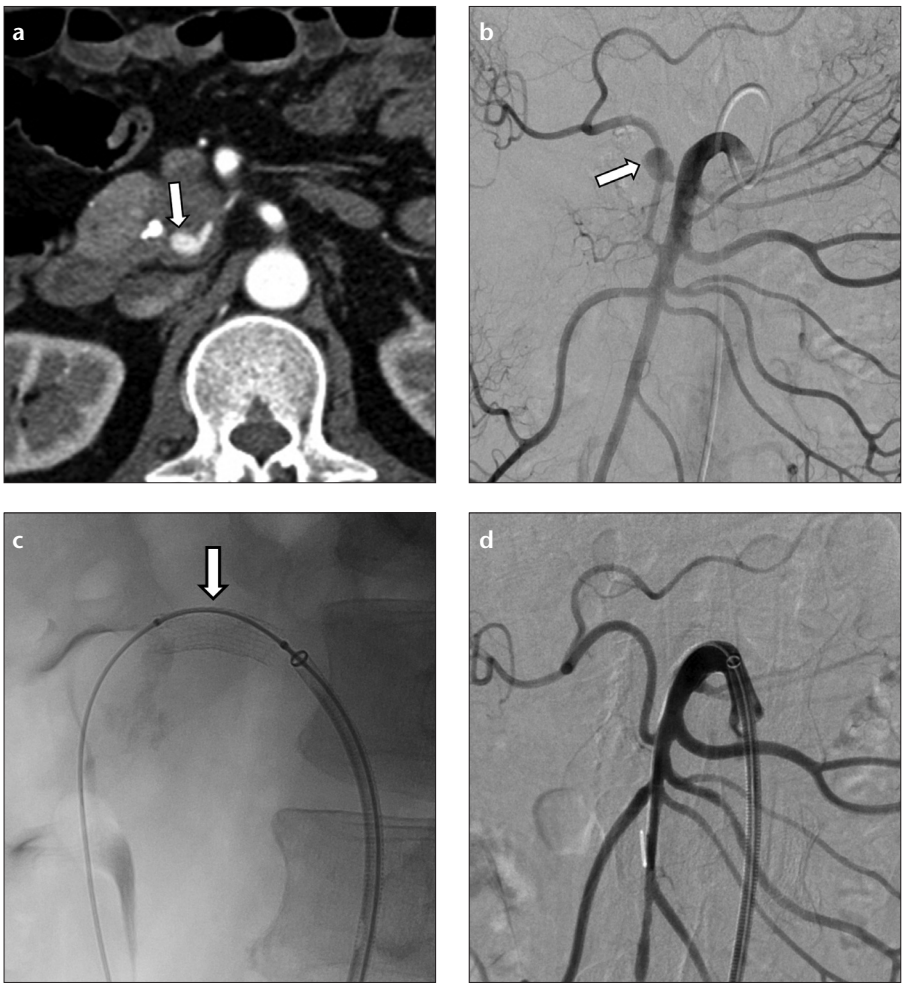

Figure 3. a–d. A 54-year-old male patient undergoing treatment for chronic alcoholic pancreatitis, underwent assessment after developing gastrointestinal bleeding. Axial contrast-enhanced CT image **(a)** shows a pseudoaneurysm *(arrow)* adjacent to a branch arising from the superior mesenteric artery. Superior mesenteric arteriogram **(b)** shows the well-demarcated pseudoaneurysm *(arrow)*. The native image **(c)** shows the stent-graft *(arrow)* placed over the pseudoaneurysm in the superior mesenteric artery. Completion superior mesenteric arteriogram **(d)** after stent-graft placement shows complete exclusion of the pseudoaneurysm. The patient's symptoms gradually subsided, and he was discharged four days later.

occasionally undergo spontaneous thrombosis, the largest drawback of the "wait-and-see" approach is that there is currently no means to predict the advent of pseudoaneurysm rupture (9, 17–20). For this reason, we support the premise that preventive measures such as endovascular intervention or surgery should be undertaken as soon as the pseudoaneurysm is discovered.

With respect to the treatment of acute bleeding or arterial pseudoaneurysms, surgery and endovascular techniques are the two primary options (21–23). The former is often challenging, especially when there is severe inflammation, and there is often the need to simultaneously perform necrosectomy and debridement along with pancreatectomy or splenectomy (1). Kriwanek et al. (24) have reported an interesting finding in their study in which bleeding complications were more frequently encountered in patients who underwent early surgical treatment than in those who underwent delayed interventions. They suggested that techniques such as gauze packing and drainage tube insertion performed during necrosectomy and debridement may cause iatrogenic injury to the fragile vessels, therefore increasing the risk of bleeding.

Endovascular management is an alternative treatment option to surgery and provides safe and efficient hemostasis. Transcatheter embolization has traditionally been the mainstay of endovascular treatment for bleeding visceral arteries and has become widely accepted as the first-line modality of treatment in this area (4, 9, 14, 21, 22). Endovascular techniques can be applied to patients who cannot tolerate surgery and even those who have had an unrewarding surgery. One patient in our series was referred from the surgical department after surgical exploration failed to localize the bleeding focus; embolization was performed achieving successful hemostasis.

The details of the embolization procedure may differ slightly from institution to institution and according to technical variables such as patient anatomy (10, 25). While coils are the most widely used embolic material, there has recently been an increasing number of reports describing the use of NBCA (6, 7, 25, 26). In our series, NBCA was used in approximately half of our patients and was effective in achieving hemostasis in all patients but one. As demonstrated in our study, NBCA can be used individually or in combination with other embolic materials. The liquid nature of this embolic material allows it to conform according to the anatomy of the pathologic vessel, and it can be delivered distally into narrow or tortuous vessels that would otherwise be difficult, if not impossible, to reach with a microcatheter (27, 28).

The rebleeding rate after embolization varies in the literature. While the recurrence rate in the study by Boudghene et al. (29) was as high as 37%, in the study by Sethi et al. (30), there were no episodes of rebleeding and no in-hospital mortality. In our study, only three patients showed signs of rebleeding, two of whom were successfully treated by a second embolization procedure, leaving only one case of failed hemostasis. Among these three cases, the first patient did not have underlying coagulopathy and an immediate angiogram after embolization suggested a successful procedure with complete exclusion of the pseudoaneurysm. The second patient demonstrated bleeding from another site not related to the primary site of bleeding and embolization. Although the exact cause of rebleeding is unknown, both of these patients had extensive pancreatic necrosis and pseudocysts with CT

severity index of 8 and 10, respectively, suggesting the possibility of severe inflammation in the surrounding tissues contributing to the recurrence of bleeding. Meanwhile, the third patient had persistent pseudoaneurysm due to back-flow from the distal feeding artery since only the proximal artery could be embolized. Such an example stresses the importance of occluding both proximal and distal segments of the diseased artery to achieve complete hemostasis.

Complications were only found in those patients who underwent embolization of the splenic arteries. However, excluding the three patients who subsequently developed splenic abscesses, splenic infarction was either clinically silent or manifested as mild, transient fever that subsided after conservative management. Although two patients died after developing splenic abscesses following embolization, the mortality rate in our study is comparatively lower than the surgical mortality rate which, although varies from study to study has been reported to be as high as 23% (2, 22). One result to note in our study is that splenic infarction only occurred in cases where the splenic artery was embolized in its distal segment in proximity to or at the splenic hilum. In contrast, cases with more proximal embolization of the splenic artery were not associated with splenic infarction.

As an alternative endovascular procedure, stent-grafts may be placed in the bleeding vessel in order to exclude the site of bleeding or pseudoaneurysm sac, as demonstrated in two of our cases (31, 32). Considering that all complications in this study were associated with ischemic injury to the spleen after embolization of the splenic artery, the use of stent-grafts potentially decreases the likelihood of end-organ ischemia. However, compared with the more flexible, low-profile catheters used for selective embolization, stent-graft delivery systems are relatively rigid and have larger profiles, thus often necessitating the use of stiffer guidewire systems and guiding sheaths. Such factors may limit their use to large and easily accessible vessels only.

Although this study comprises the largest number of subjects from a single institution who underwent endovascular treatment for vascular complications of pancreatitis, there are nevertheless some limitations. First, this is a non-randomized, retrospective study where all data were collected through a review of each patient's medical documents and imaging studies. Second, also partly owing to the retrospective nature of this study, there was no common protocol with respect to the details of each procedure, including the techniques of endovascular treatment and the type of embolic material used. The number of operators who performed the procedures also adds to the variability that may potentially influence the results. Finally, the limited number of patients in this study may limit generalization of our findings.

In conclusion, endovascular management is effective for achieving hemostasis in patients with pancreatitis-related bleeding. The high success rate, low recurrence rate, and low mortality rate demonstrated in this study supports the wide use of endovascular techniques as the first-line therapeutic modality in this clinical setting.

Conflict of interest disclosure

The authors declared no conflicts of interest.

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