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Original Article

Can Empirical Segmental Angioembolization of Splenic Artery Salvage Pancreatic Intraluminal Bleed?

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Abstract

Background Postpancreatectomy hemorrhage (PPH) and Hemosuccus Pancreaticus (HP) may present with slow but significant intraluminal bleed which may not be evident on imaging. We evaluated the efficacy of empirical segmental-angioembolization of splenic artery in intraluminal PPH and HP.

Result This is a cross-sectional study done by analyzing all consecutive patients with PPH and HP who underwent empirical coil embolization of splenic artery. There were total of 137 pancreaticoduodenectomies (PD), 68 distal pancreatectomies (DP), 11 patients with median pancreatectomies (MP) and 134 admissions for acute pancreatitis and exacerbation of chronic pancreatitis during the study period. Eleven (5.1%) patients had PPH, of which two were managed surgically. Among nine patients, 4/9 (44.4%) with pseudoaneurysm on computed tomography angiography (CTA) were excluded. Among pancreatitis, 7 (5.2%) had HP, and 5/7 (71.4%) patients with pseudoaneurysm on CTA were excluded. Hence, seven patients, PPH—5 and HP—2, were included. Both HP patients were managed successfully with empirical segmental coil embolization of splenic artery. Among PPH, one patient required laparotomy for failed embolization. Overall, 6/7 (85.7%) had successful coil embolization. No reintervention, continued bleed, or blood transfusions were required postprocedure, and no splenic infarct or abscess was seen in any of the seven patients postembolization. The 72-hour rebleed rate was 1/7 (14.3%), which was managed surgically.

Conclusion Empirical segmental coil embolization of splenic artery in intraluminal pancreatic bleed holds promise as a salvage life-saving procedure even when no blush or pseudoaneurysm is evident.

Keywords
- Empirical Coil Embolization
- Pancreatectomy
- Post Pancreatectomy Hemorrhage
- Splenic Artery Pseudoaneurysm

Introduction

Postpancreatectomy hemorrhage (PPH) and Hemosuccus Pancreaticus (HP) are potentially serious situations which can end up in mortality if not dealt with appropriately. Hemorrhage of pancreatic origin is an extremely tricky situation because of heterogeneous presentation. PPH may occur at several potential sites with variable severity and time of onset. The occurrence of PPH is often associated with postoperative pancreatic fistula (POPF), and the incidence of PPH in this setting varies between 6% to 10% in different

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series. The presentation ranges from subtle signs of herald or sentinel bleed to massive hemorrhage. The mortality associated with PPH ranges from 30 to 50% and hence a swift and appropriate intervention is the key for optimal recovery.[1–5] Computed tomography angiogram (CTA) is the preferred primary diagnostic modality, which most often detects the source of bleed, thereby directing the surgeon to intervene appropriately. However, the offending aneurysm or the source of bleed is occasionally not seen either on CTA or at digital subtraction angiography (DSA), thus complicating the scenario.[6–9] Hemorrhage in this setting is usually intraluminal and may be from small pseudoaneurysms or from the cut end of the pancreas in the territory of splenic artery which are difficult to pick up by imaging. These bleeds are often subtle to begin with but have the propensity to bleed profusely, resulting in hemodynamic instability and mortality. Hence, we evaluated the efficacy of empirical segmental angioembolization of splenic artery in the setting of intraluminal PPH and HP following pancreatitis.

Materials and Methods

This is a cross-sectional study done by analyzing the prospectively held pancreatic database in the department from January 2009 to December 2018. All consecutive patients with PPH following pancreaticoduodenectomy, median pancreatectomy or distal pancreatectomy and hemorrhage following pancreatitis (acute and chronic) who underwent empirical coil embolization of splenic artery were included for the study. Those patients who showed blush on CTA or DSA and those who were managed primarily with surgery were excluded. We collected data on patients' demographics, clinical presentation and the time of bleed, data on CTA and angiographic findings with subsequent therapy for bleeding including endovascular or surgical procedure.

Definition of Empirical Segmental Angioembolization

Embolization of midsegment of splenic artery short of the splenic hilum immediately after the first episode of herald bleed, so that most of the pancreatic branches are blocked except the terminal most ones arising near the splenic hilum. The hypothesis is that when there is intraluminal bleed, and no obvious source of bleed can be identified on CTA or DSA, the source is most likely the splenic artery bed, and blocking the segment of splenic artery will reduce the perfusion pressure inside them, thereby resulting in thrombosis of the bleeding vessel.

Outcome

After ensuring the technical success of transcatheter embolization, the clinical success of embolization was defined as cessation of bleeding with no further hemodynamic instability, hemoglobin drop, requirement of transfusion, need for reembolization, and need for surgery. The rebleeding and mortality rates were assessed at 72 hours and 30 days respectively.

Results

There were total of 137 pancreaticoduodenectomies (PD), 68 distal pancreatectomies (DP), 11 patients with median pancreatectomies (MP) and 134 admissions for acute pancreatitis and exacerbation of chronic pancreatitis during the study period. We did not have any case of PPH following distal pancreatectomy. Among all the pancreatectomies, 11 (5.1%) patients had PPH, and two patients were managed primarily with surgery and hence excluded (►**Table 1**). Among the nine patients, 4 had positive findings on CTA and were excluded. Among the patients with pancreatitis, 7 (5.2%) had HP, of which 5 patients had positive finding on CTA, and they proceeded with angioembolization and were excluded from study (►**Figs. 1** and **2**). Hence, 7 patients (PD—5 and pancreatitis—2) who underwent empirical angioembolization were included for analysis (►**Table 2**).

Among the 216 pancreatectomies, 11 patients had PPH (5.1%). Two patients had to be taken for emergency reexploration without imaging due to hemodynamic instability. The remaining 9 patients underwent CTA, of which 4 patients had positive findings on CTA (presence of pseudoaneurysm or contrast extravasation). One patient was taken for primary surgery due to hemodynamic instability, and the other three patients underwent coil embolization (of which one patient failed and had to be reexplored). Five patients did not show any positive findings on CTA or DSA. However, they had slow luminal bleed (evidenced by hemoglobin drop, blood in Ryle's tube and melena) associated with tachycardia. These patients were taken up for empirical segmental-embolization of splenic artery. Among the PPH, all the patients had POPF and severe PPH. The overall mortality in PPH was 3/11. Two patients (one each with acute and chronic pancreatitis) who had HP and did not show any positive findings in CTA but had symptomatic intraluminal bleed were taken up for empirical embolization of splenic artery.

Among the 7 patients, 5 patients (71.4%) had PPH (male: female = 4:1), and 2 (28.6%) had HP (male = 2). Among the pancreatitis, one was ethanolic acute pancreatitis and other chronic calcific pancreatitis (ethanolic). Both patients were managed successfully with segmental coil embolization of splenic artery. Among the PPH, one patient required laparotomy for failed embolization. Overall, 6/7 had successful coil embolization (►**Fig. 3**). No reintervention or surgery, continued bleed, hemoglobin drop, and requirement of transfusion were seen in any of the six patients. There was no evidence of splenic infarct or abscess (the anticipated

Table 1 Incidence of PPH in pancreatectomy

Surgery	Total	PPH
PD	137	9 (6.5%)
DP	68	0
MP	11	2 (18.2%)

Abbreviations: DP, distal pancreatectomy; MP, median pancreatectomy; PD, pancreaticoduodenectomy; PPH, postpancreatectomy hemorrhage.

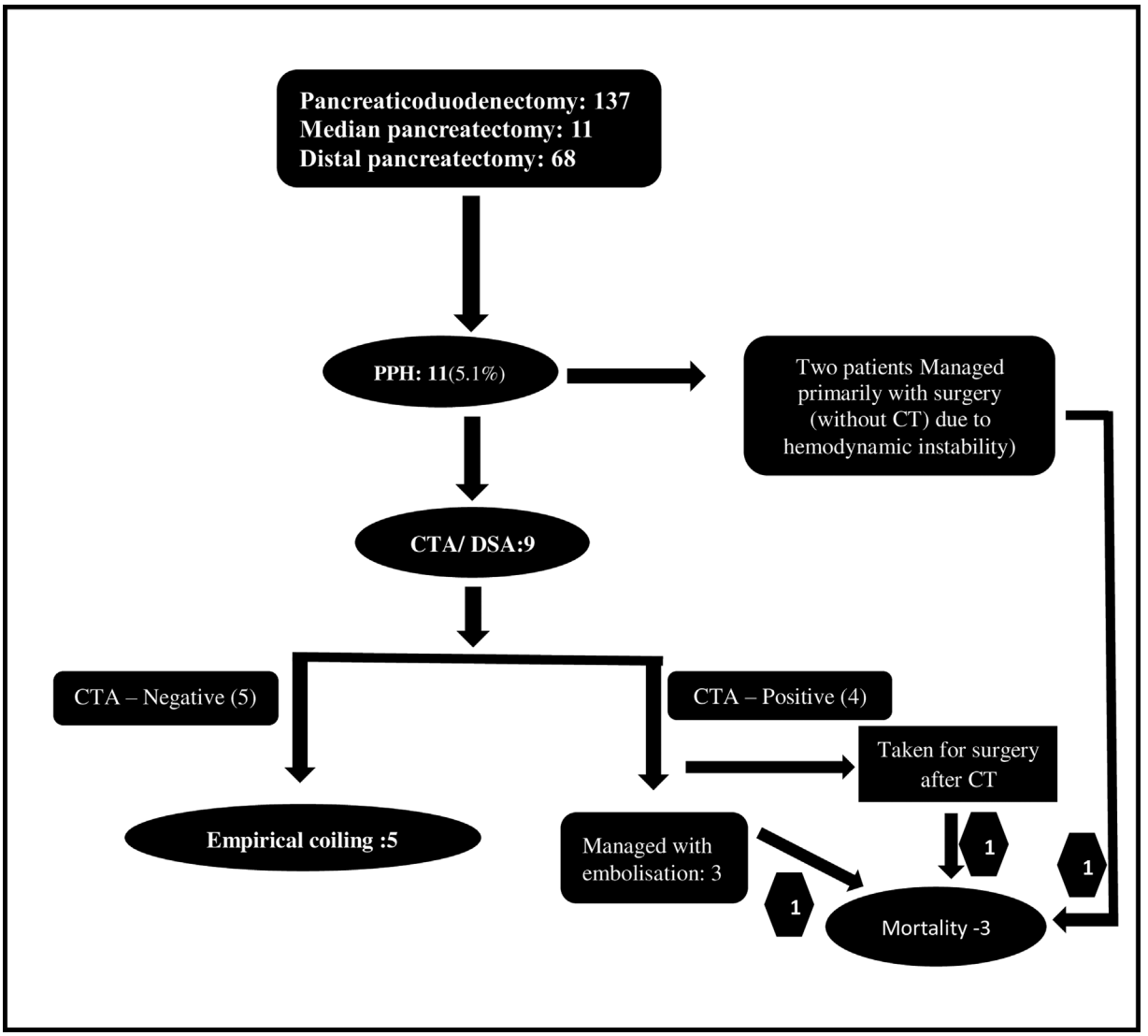

Fig. 1 Inclusion flowchart.

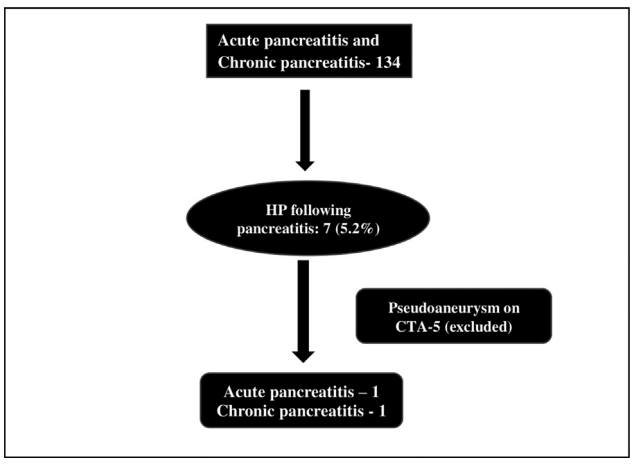

Fig. 2 Inclusion flowchart.

complication postsplenic artery embolization) in any of the seven patients who underwent empirical embolization. The 72-hour rebleed rate was 1/7, and emergency reexploration was undertaken for control. There was no 30-day mortality in any of these seven patients. The yield of CTA to identify the offending artery in PPH and HP were 4/9 (44%) and 5/7 (71.4%), respectively (►**Table 3**).

Discussion

Bleeding of pancreatic origin (postpancreatic resection or pancreatitis) is multifactorial, involving arteries, veins and capillaries. Because of the pulsatility of arteries, they are prone to pseudoaneurysm formation or direct arterial erosion due to enzymes. There occurs degradation of the arterial wall by either pancreatic enzymes or sepsis, direct erosion by a pseudocyst, or traumatic injury to small arteries during surgery or percutaneous interventions. The factors that influence the incidence of hemorrhagic complications include the presence of pancreatic fistula, type of surgery, presence of pancreatic necrosis, aggressive debridement in patients with necrotizing pancreatitis, sepsis, and the presence and size of the pseudocyst.[6,8,10]

Local inflammation and enzymatic damage to peripancreatic vessels, infection, and regional necrosis may lead to

Table 2 Demographics of patients with PPH with negative CTA/DSA

Number of patients	5
Median age, y	54
Gender (M:F)	4:1
POPF	
Grade A	2
Grade B	1
Grade C	2
Surgery	
PPPD	3
Whipple resection	1
MP	1
Anastomosis	
Dunking PJ	4
Duct to mucosa	1
Median bleed postoperative day (range)	8 (6–15)

Abbreviations: CTA, computed tomography angiography; DSA, digital subtraction angiography; MP, median pancreatectomy; PJ, pancreaticojejunostomy; POPF, postoperative pancreatic fistula; PPH, postpancreatectomy hemorrhage; PPPD, pylorus preserving pancreatoduodenectomy; y, years.

direct vessel rupture or pseudoaneurysm formation from which bleeding can occur. This is either into the gastrointestinal tract, retroperitoneum, or peritoneal cavity.[6,11–13]

The low incidence and very nature of severe hemorrhage preclude the suitability of randomized trials to evaluate the efficacy of embolization. It is likely, therefore, that opinions on the optimal management of hemorrhage will continue to be formed from the experiences of individual institutions based on retrospective analysis of data.

Following a pancreatic resection with the presence of POPF, inflammation and friability of tissues, it is always desirable to consider nonoperative ways to combat PPH than reexploration. Interventional radiology (IR) has become an important tool over the years with improvement in techniques and improved success rates, with the benefit of being performed under sedation, thereby avoiding the potential insult of general anesthesia and resurgery in a compromised patient and also eliminating the complications associated with reoperating a surgical field with dense adhesions in the presence of POPF and a potentially challenging task of identifying a bleeding pseudoaneurysm.[1,6,9,14,15]

In the study by Kalva et al,[8] 28/51 (54.9%) of PPH patients did not show positive findings on CTA. The 30-day rebleed and 30-day mortality was 11/28 (39.3%) and 21/28 (75%), respectively. The study analyzed outcome of preemptive embolization of doubtful vessels on angiogram in two patients. This study shows a significantly high proportion of negative findings on CTA following PPH.

In a study by Yekebas et al, the overall prevalence of sentinel bleed in PPH was 33% and relaparotomy rate associated with sentinel bleed was 83%.[14] In yet another study, Song et al showed delayed massive bleed of 42.8% when no prophylactic embolization was done for sentinel bleed.[9] Hence, the significance and justification of preemptive or empirical embolization of the offending vessel cannot be overemphasized.

In another study by Wolk et al,[2] the most common causes of hemorrhage during the entire study period were pancreatic anastomosis (31.1%), splanchnic arteries (23.5%), gastric ulcers (16.8%), organ lesions (10.1%), nonsurgical (8.4%) and

Table 3 The yield of imaging in identifying the offending bleeder

Yield of CTA in PPH for source detection	4/9 (44.4%)
Yield of CTA in pancreatitis for source detection	5/7 (71.4%)
Yield of DSA in PPH for source detection (CTA-neg)	1/5 (20%)

Abbreviations: CTA, computed tomography angiography; DSA, digital subtraction angiography; PPH, postpancreatectomy hemorrhage.

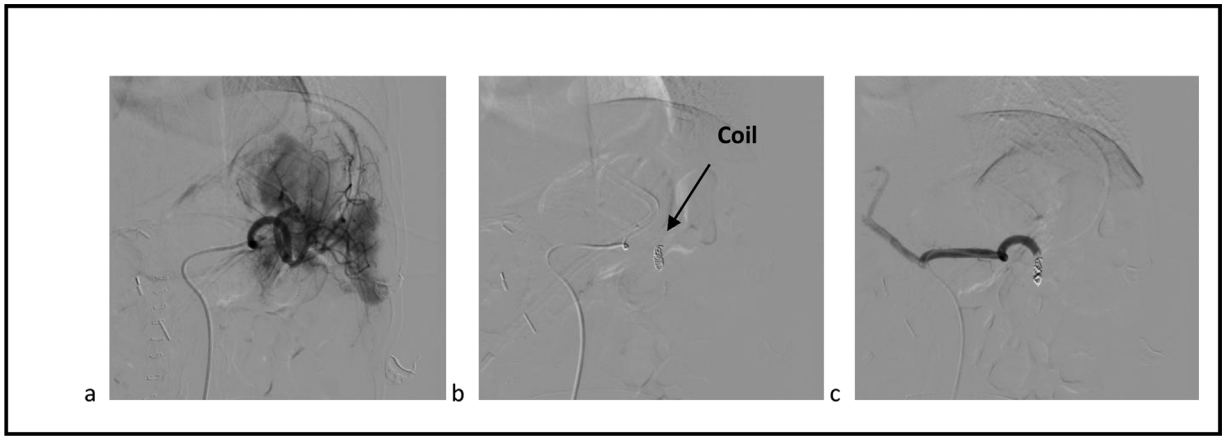

Fig. 3 (**a**) Flush angiogram showing no obvious source of bleed in a case of postpancreatectomy hemorrhage (PPH), (**b**) empirical segmental coil embolization of splenic artery, and (**c**) check angiogram postembolization showing segmental block of the splenic artery.

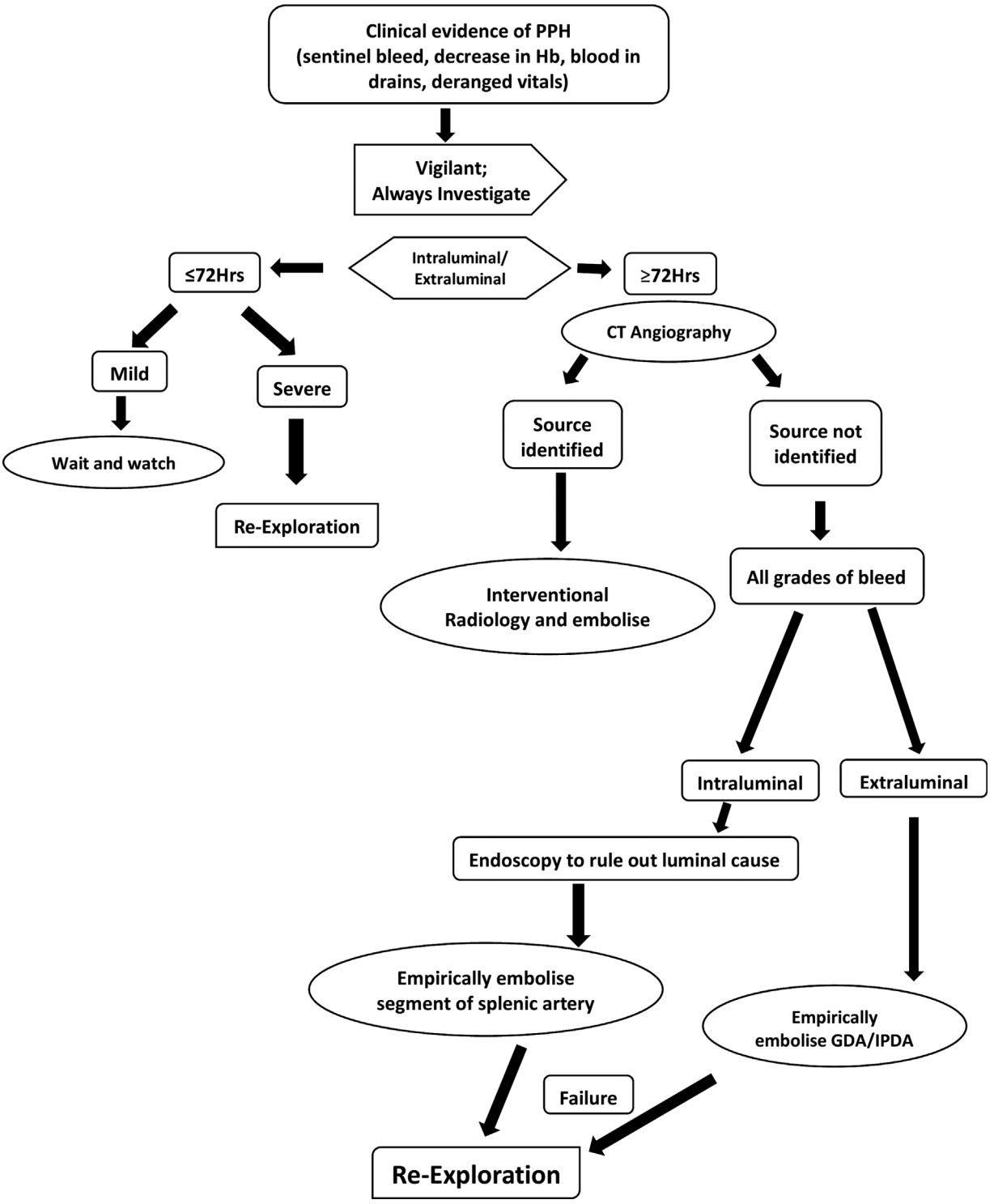

Fig. 4 Our institutional protocol.

portal vein (4.2%). This study shows the importance of bleeding at the anastomotic site.

In our study, four patients of PPH were following PD, and in all of them, the empirical segmental coil embolization of splenic artery was successful. The patient with MP had a failed embolization for which emergency reexploration was done, and the bleed was found to be from the splenic artery which required suturing; however, the patient developed rebleed and had a second reexploration wherein salvage completion distal pancreatectomy was done, following which he recovered.

In the setting of acute and chronic pancreatitis, pseudoaneurysms can be potentially devastating with high mortality. CTA is the crucial diagnostic modality with 57% accuracy, the most common site being splenic artery followed by pancreaticoduodenal artery.[16,17] DSA has 90 to 100% efficacy in identifying the pseudoaneurysms[17] and has a success rate

of 79 to 100% in achieving control of bleed in most cases of pseudoaneurysms associated with pancreatitis.[2,16–18]

Another important aspect in splenic artery embolization is possibility of splenic infarcts or formation of splenic abscess. Embolization of the midsegment of splenic artery ensures adequate blood supply to the spleen from the short gastric collaterals, also taking care of the offending pancreatic parenchymal vessels that cause bleeding. Our study did not show splenic infarcts or abscess postembolization, which was also elucidated in study by Song et al.[9]

There is very minimal literature on empirical embolization of splenic artery in PPH, one such study is from Song et al.[9] Empirical embolization is also reported in bleed from advanced malignancy.[19] In PPH, the limitation of CTA in detecting the source of bleed universally has been proven in various studies.[8] DSA has also limitations in identifying the source of pancreatic bleed, the sensitivity in a study by Yekebas et al being 79%.[14,15] Hence, when the culprit vessel is seen in angiography, the proposed mode of intervention will be to go ahead with IR techniques to embolize the vessel. However, when the source of bleed is not seen and the bleed is significant, it is advised to preemptively block the most likely source of bleed. When the bleeding is predominantly extraluminal and significant, the most likely at-risk vessel is gastroduodenal artery, which needs to be embolized empirically. However, when the bleed is intraluminal, slow and clinically significant after a PD/MP, the pancreatic stump as a source of bleeding has to be of prime consideration, and we propose to empirically embolize a segment of splenic artery to block small culprit vessels, which are missed in angiography, and also reduce pressure in these small vessels, which may thrombose eventually. In our study, we have obtained clinically significant results in PPH and also in HP.

Our institutional protocol in the management of PPH has been outlined in the algorithm below (►**Fig. 4**).

Conclusion

Empirical coil embolization of segment of splenic artery in pancreatic bleed holds promise as a salvage life-saving procedure in clinically significant intraluminal slow bleeds, even when no blush or pseudoaneurysm is seen on CTA or DSA. With significant improvement in IR techniques and considering a high mortality (20–50%) of PPH and HP, small but significant splenic arterial bleeds may be dealt empirically as the complications following the same are minimal.

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This project did not receive any grants and financial support.

Author Contributions
R.R. outlined concept and gave guidance for study. Data analysis and interpretation were done by B.N. and R.S.S. V. J. and E.R.J. did IR procedure and interpretation of data. S.S. acquired data and drafted manuscript. Critical editing was done by R.R.

Conflict of Interest
None declared.

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