Post-Pancreaticoduodenectomy Hemorrhage of Unusual Origin: Treatment with Endovascular Embolization and the value of preoperative CT Angiography

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ABSTRACT

Post-pancreaticoduodenectomy hemorrhage is a life threatening complication reported to occur in 2-7% of patients. Historically, treatment required an exploratory laparotomy. Introduction of endovascular embolization has broadened the available treatment options. The most common location for a post-pancreaticoduodenectomy hemorrhage is the gastroduodenal artery stump. Nonetheless, unusual sources of hemorrhage exist and are hard to localize, thus they are often treated with open surgery. Here we report two cases of CTA proven hemorrhage from the dorsal pancreatic arcade and transverse pancreatic artery, which were successfully located with conventional angiography and treated with endovascular arterial coil embolization. Both patients were status post-pancreaticoduodenectomy (Whipple procedure) and presented with a sentinel bleed and a drop in hematocrit levels.

CASE REPORT

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Case 1:

The patient is a 73-year-old male status post pancreaticoduodenectomy and cholecystectomy for periampullary mucinous neoplasm. On postoperative day 17, the patient had a sentinel bleed seen in his Jackson-Pratt (JP) drain. The patient also had a 4.5 % and 1.4 g/dl drop in hematocrit and hemoglobin levels respectively.

A computed tomography angiography (CTA) was ordered that demonstrated an18x9x8 mm pseudoaneurysm with possible contrast extravasation in the pancreatic bed adjacent to the celiac axis (figure 1). He was referred to interventional radiology for definitive therapy.

Access was obtained via the right common femoral artery using a micropuncture needle and a 0.018" wire was advanced. The needle was exchanged for a 5 Fr transitional catheter. The inner dilator and the wire were removed and a 0.035" Bentson wire (Cook Medical Inc., Bloomington, IN) was advanced into the artery. The transitional catheter was exchanged for a 5 Fr vascular sheath. A 5 Fr Cobra II catheter (Angiodynamics Inc., Latham, NY) was used to select the celiac trunk and an arteriogram was performed that demonstrated a ligated gastroduodenal artery (GDA) stump but otherwise conventional anatomy with no active extravasation or pseudoaneurysm formation (figure 2). The superior mesenteric artery (SMA) was then selected and an arteriogram was performed which also demonstrated conventional anatomy (figure 3). Given the CTA findings and despite negative nonsubselective angiograms, a Progreat microcatheter (Terumo Medical Corporation, Somerset, NJ) was coaxially loaded through the Cobra II catheter seated in the origin of the celiac axis, and using a GT wire (Terumo Medical Corporation, Somerset, NJ), the dorsal pancreatic artery was sub-selected and a subsequent arteriogram was performed. This demonstrated the pseudoaneurysm of the inferior pancreatic arcade corresponding to the finding on CTA. Hilal

microcoils (Cook Medical Inc., Bloomington, IN) were deployed distal and proximal to the pseudoaneurysm. A post-embolization angiogram was performed that demonstrated successful hemostasis with exclusion of the pseudoaneurysm (figure 4). In the 2.5 months following this procedure, the patient had no further clinically evident bleeding.

Case 2:

The patient is a 77-year-old male status post pancreaticoduodenectomy and a right hemicolectomy for pancreatic adenocarcinoma with duodenal and transverse colon involvement. On post operative day five, he had bloody output from his nasogastric tube, hemodynamic deterioration and decreased urine output as well as a drop in hematocrit and hemoglobin levels from 27.3% /8.7g/dl to 19.0% /6.1g/dl respectively (normal ranges 41-53% and 13-17 g/dl).

A CTA of the abdomen and pelvis was ordered that demonstrated a 7x6x8 mm pseudoaneurysm posterior to the pancreatic bed (figure 5). He was referred to interventional radiology for definitive therapy.

Percutaneous access was obtained via the right common femoral artery using a micropuncture needle, and a 0.018" wire was advanced. The needle was exchanged for a 5 Fr transitional catheter. The inner dilator and wire were removed and a 0.035" Bentson wire (Cook Medical Inc., Bloomington, IN) was advanced. The transitional catheter was exchanged for a 5 Fr vascular sheath. A SOS II catheter (Angiodynamics Inc., Latham, NY) was used to select the celiac axis and an arteriogram was performed. This demonstrated an absent right hepatic artery and a surgically ligated GDA stump, with no evidence of extravasation or pseudoaneurysm formation (figure 6). A 5 Fr Cobra II catheter (Angiodynamics Inc., Latham, NY) was used to select the SMA and an arteriogram was performed. This demonstrated a replaced right hepatic artery with no evidence of extravasation or pseudoaneurysm formation (figure 7). A J shaped Excelsior microcatheter (Boston Scientific, Natick, MA) was coaxially loaded through the Cobra II catheter and used to select the replaced right hepatic artery and an arteriogram was performed. A 0.014" Synchro wire (Boston Scientific, Natick, MA) and combination microcatheter were used to subselect the inferior pancreaticoduodenal artery and an arteriogram was preformed. A pseudoaneurysm in the pancreatic bed arising from the transverse pancreatic artery was identified. There was associated active extravasation of contrast from the aneurysm. The pseudoaneurysm was successfully embolized proximally and distally using four 1cm Hilal straight microcoils and three 1cm x 3mm microcoils. Post embolization arteriograms through the inferior pancreaticoduodenal artery and SMA demonstrated no filling of the pseudoaneurysm. There was residual contrast staining in the pancreatic bed for the continued extravasation while coiling (figure 8).

DISCUSSION

The incidence of perioperative mortality from pancreatic surgery has decreased significantly and is now less than 5%. Nonetheless, morbidity from pancreaticoduodenectomy remains substantially elevated at 30-50% [1]. Common complications of the pancreaticoduodenectomy include: delayed gastric emptying, anastomotic leakage, pancreatic fistulas, intra-abdominal abscess and gastrointestinal or intra-abdominal hemorrhage [2,3].

A serious complication of pancreaticoduodenectomy is hemorrhage, which is reported to occur in 2-8% of patients [4]. While uncommon, hemorrhage is life threatening, with a reported mortality rate of 18-47% [4]. Post-pancreaticoduodenectomy hemorrhage can be classified as either early or late [1]. Early hemorrhage begins less than 24 hours after the end of the operation and late hemorrhage corresponds to bleeding that begins beyond the 24-hour period [1]. Early hemorrhage is most often a result of technical failure or underlying coagulopathy, while late hemorrhage is usually secondary to complications such as abscess formation, erosions of vessels, pancreatic fistulas, ulcerations at anastomosis sites, and the development of pseudoaneurysms. Peri-pancreatic hemorrhage may become evident when blood is observed via hematemesis, melena, nasogastric drainage, or abdominal drains in a relatively stable patient. Conversely hemorrhage may present as hemodynamic decompensation with tachycardia and hypotension. Furthermore, an unexplained drop in hemoglobin and hematocrit levels may be evident. A "sentinel bleed," which is a small amount of blood present in a surgical drain or enteric tube prior to a hemorrhage is an important indicator of impending massive hemorrhage. Sentinel bleeds may be present in 30 to 100% of patients prior to hemorrhage [1]. Depending on the clinical stability of the patient, post- pancreaticoduodenectomy hemorrhage may be confirmed upon reoperation, upper gastrointestinal endoscopy, angiography, or contrast enhanced cross sectional imaging.

Hur et al. [5] used CTA as the initial diagnostic modality for detection of GDA pseudoaneurysms. In their series, CTA correctly identified 14 /14 GDA pseudoaneurysms. The usefulness of CTA in patients with unusual sites of bleeding has not been studied, however CTA in our first case was useful as conventional angiograms of the celiac trunk and SMA were negative, failing to demonstrate any area of extravasation or pseudoaneurysm formation. The superb accuracy of CTA may help the interventional radiologist in planning for the procedure and is thus likely to decrease the number of angiograms required to localize the bleed and in turn the contrast load and radiation dose given to the patient. Although large cohorts are required for further establishment of the role of CTA in patients with an unusual origin of bleeding, it is suggested that in patients with post Whipple bleeding, if the patient is deemed stable to undergo CTA, it should be used as the first diagnostic modality. CTA can allow for early detection of pseudoaneurysms and can help with approximate localization of the bleeding site with regards to the adjacent major vessels [2,3]. Despite this, CTA is not helpful in

identifying the underlying cause of hemorrhage or predicting the success rate of endovascular coil embolization.

In patients with early hemorrhage due to technical failure, early surgical exploration is the treatment of choice [1,6], however, with delayed post- pancreaticoduodenectomy hemorrhage, exploratory laparotomy and endovascular embolization have both been used to successfully achieve hemostasis. Limongelli et al. in a meta-analysis found that overall mortality and morbidity also favored endovascular embolization in comparison to laparotomy, however neither result was statistically significant [6]. Nonetheless, endovascular treatment is a feasible option in the management of post- pancreaticoduodenectomy hemorrhage.

Arterial embolization has been shown to be an effective first line treatment for treating delayed post-pancreaticoduodenectomy hemorrhage in multiple studies [2,3,4,5,6]. The gastroduodenal artery (GDA) is believed to be the most common site of delayed massive hemorrhage after pancreaticoduodenectomy [5]. Endovascular management of delayed post- pancreaticoduodenectomy hemorrhage is well documented to treat pseudoaneurysms of the GDA stump usually with coil embolization. Less commonly, life-threatening hemorrhage may also result from injury to other arteries, which can be managed with minimally invasive transcatheter arterial embolization as well. When compared to laparotomy, embolization is much less invasive and not surprisingly is associated with less morbidity and mortality [6]. Re-operation may become complicated due to post-surgical inflammation and limited access to the bleeding vessels [2].

The most common complications for transcatheter arterial embolization include re-bleeding and post embolization ischemia. If hemostasis is not adequately achieved by interventional embolization, then a laparotomy can be performed. Likewise in hemodynamically unstable patients, emergent laparotomy becomes the treatment of choice. Nonetheless, in the majority of patients with delayed post Whipple hemorrhage, transcatheter embolization does achieve hemostasis, and the patient is spared from a second laparotomy [6]. The incidence of hepatic infarct after common hepatic artery embolization was 7.6% in a study by Hur et al. They related their low incidence of hepatic infarct post common hepatic artery embolization to the existence of collateral arterial flow, which was evident on post embolization arteriogram [5]. Prior to embolization of the common hepatic artery, one could use arteriograms to identify collateral flow and therefore avoid the potential complication. Furthermore, covered stents may also be used to maintain hepatic arterial patency while achieving hemostasis.

TEACHING POINT

Transcatheter arterial coil embolization can be the first line treatment for controlling the delayed postoperative hemorrhage after pancreaticoduodenectomy. CTA is an effective diagnostic tool, which is useful in preprocedural planning for detection of unusual bleeding vessels.

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FIGURES

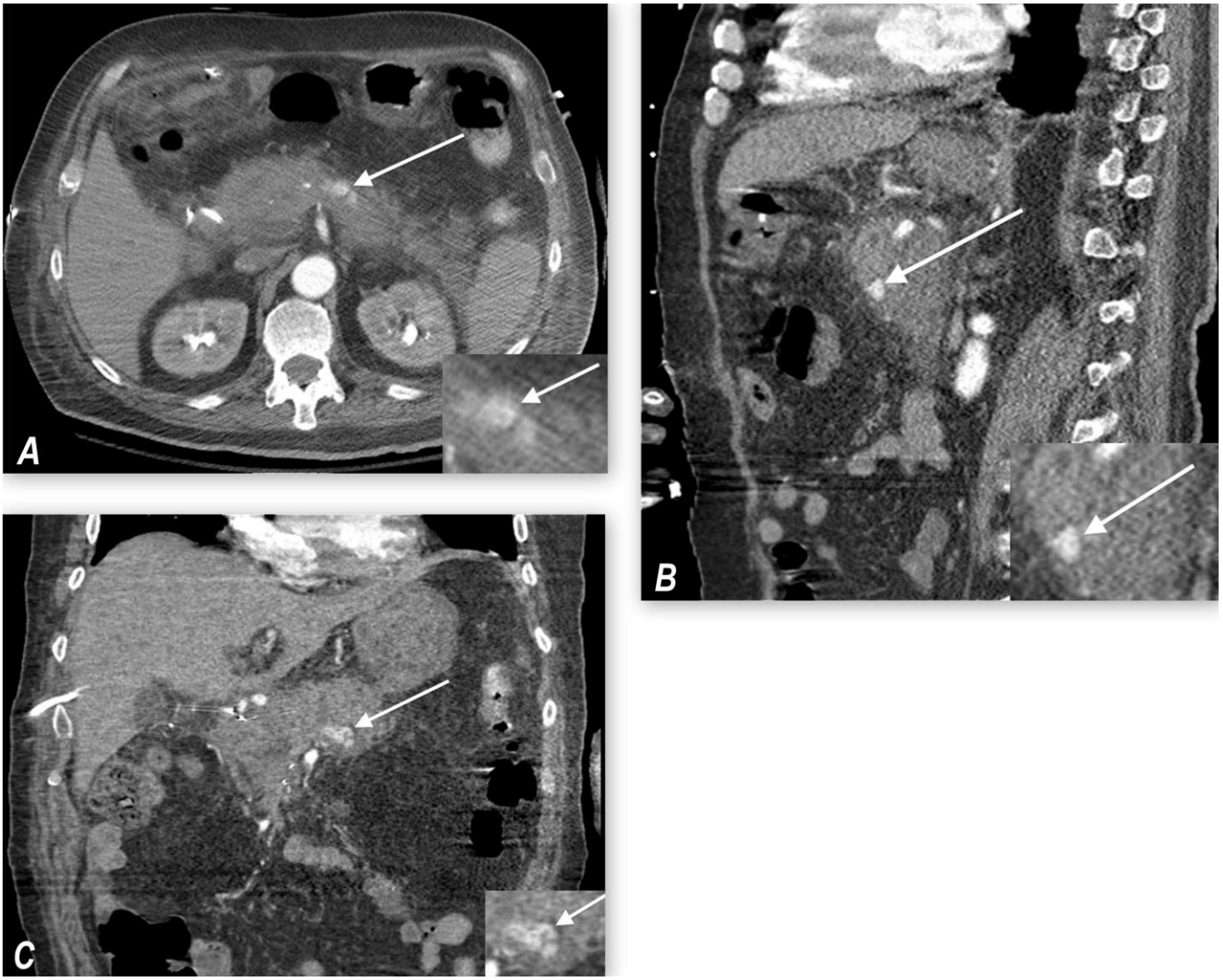

Figure 1: 73-year-old male with post-pancreaticoduodenectomy hemorrhage. (a) axial, (b) sagittal and (c) coronal CTA images of the abdomen with magnified coned-down views in the right lower corner show the18x9x8 mm pseudoaneurysm (arrow) with possible contrast extravasation in the pancreatic bed. [Protocol: 374 mA, 140 KV, 5 mm slice thickness, 100 cc Omnipaque (Iohexol) 350, GE Healthcare, Waukesha, WI]

Figure 2 (left): 73-year-old male with post-pancreaticoduodenectomy hemorrhage. Selective digital subtraction angiographic image of the celiac trunk with magnified coned-down view in the right lower corner shows no evidence of active extravasation. The GDA stump (arrow) is unremarkable. [Protocol: Injection of 25 ml contrast media at a flow of 5 ml/sec, Visipaque (Iodixanol) 320, GE Healthcare, Waukesha, WI]

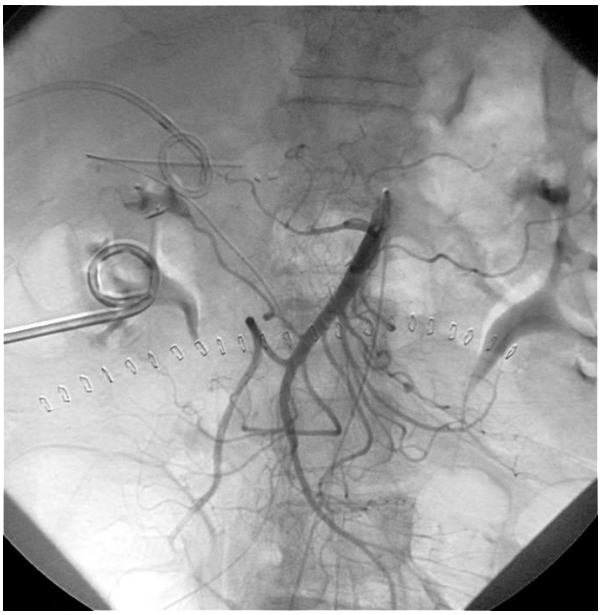

Figure 3 (left): 73-year-old male with post-pancreaticoduodenectomy hemorrhage. Selective angiographic image of the SMA shows no evidence of active extravasation. [Protocol: Injection of 20 ml contrast media at a flow of 4 ml/sec, Visipaque (Iodixanol) 320, GE Healthcare, Waukesha, WI]

Figure 4 (bottom): 73-year-old male with post-pancreaticoduodenectomy hemorrhage. Sub-selective angiographic image (a) and digital subtraction angiographic image (b) of the dorsal pancreatic artery with magnified coned-down views in the right lower corner show the 18x9x8 mm pseudoaneurysm (arrow) of the inferior pancreatic arcade. (c) Post-embolization angiographic image shows successful hemostasis with exclusion of the pseudoaneurysm. [Protocol: Hand injection of 5 ml Visipaque (Iodixanol) 320, GE Healthcare, Waukesha, WI]

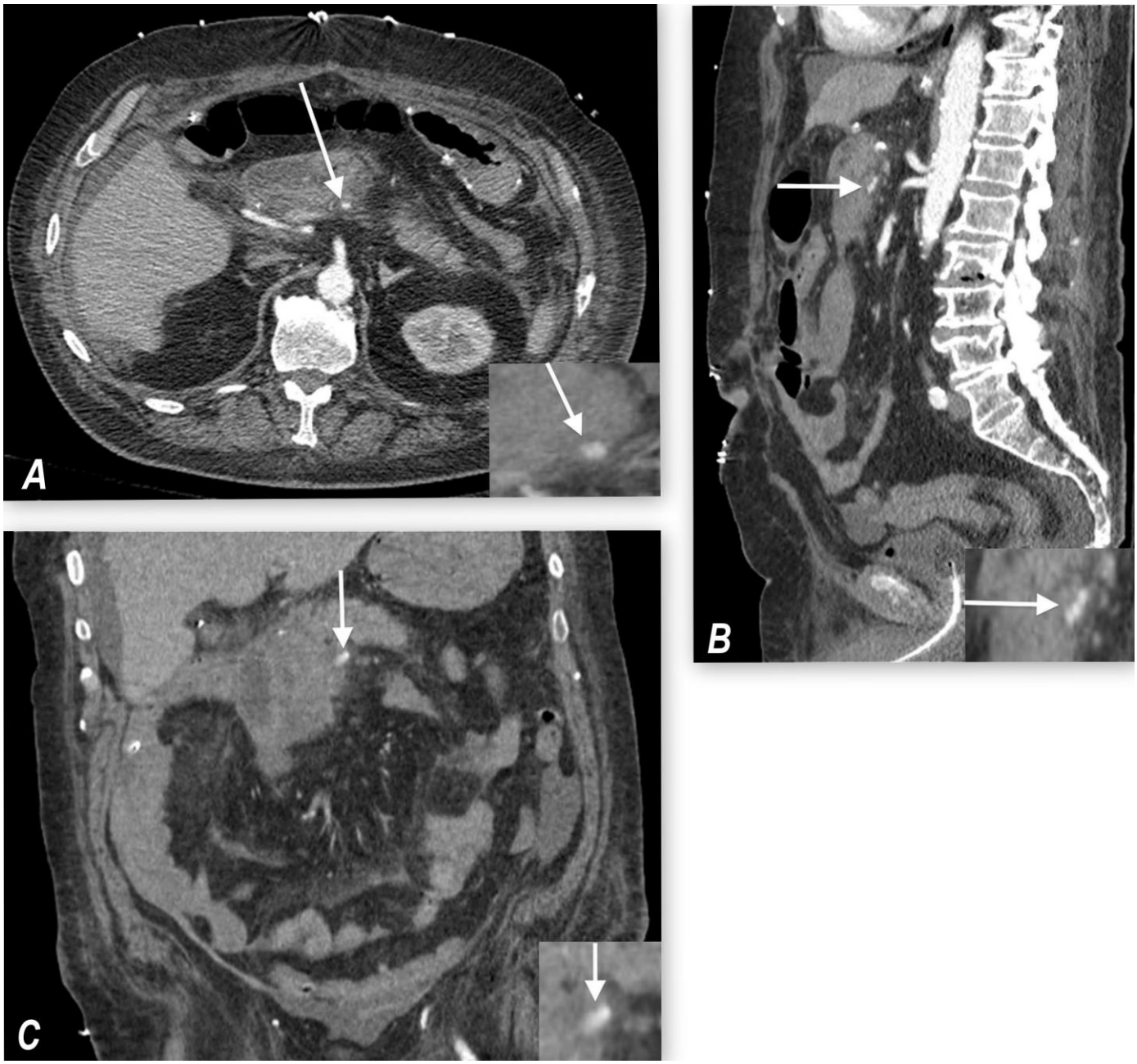

Figure 5: 77-year-old male with post-pancreaticoduodenectomy hemorrhage. (a) axial, (b) sagittal and (c) coronal CTA images of the abdomen with magnified coned-down views in the right lower corner show a 7x6x8 mm pseudoaneurysm (arrow) with possible contrast extravasation in the pancreatic bed. [Protocol: 440 mA, 120 KV, 1.25 mm slice thickness, 100 cc Omnipaque (Iohexol) 350, GE Healthcare, Waukesha, WI]

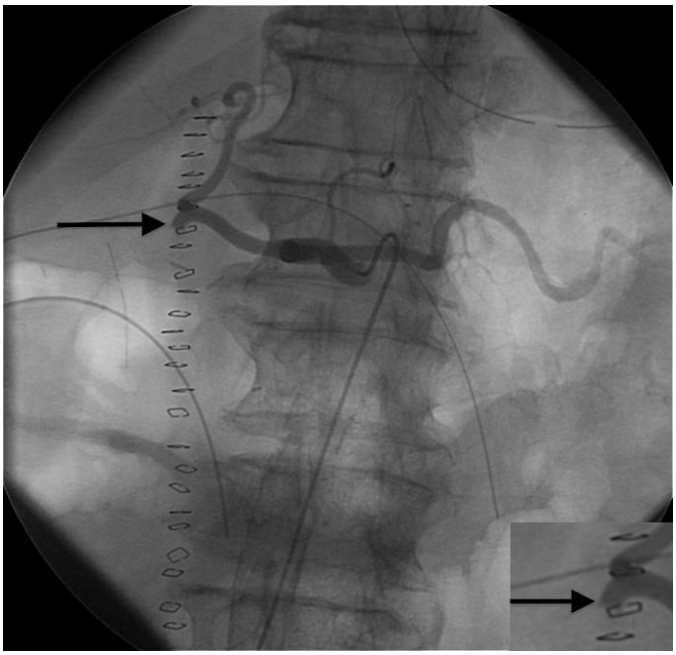

Figure 6: 77-year-old male with post-pancreaticoduodenectomy hemorrhage. Selective angiographic image of the celiac trunk with magnified coned-down view in the right lower corner shows no evidence of active extravasation. The GDA stump (arrow) is unremarkable. [Protocol: Injection of 25 ml contrast media at a flow of 5 ml/sec, Visipaque (Iodixanol) 320, GE Healthcare, Waukesha, WI]

Figure 7: 77-year-old male with post-pancreaticoduodenectomy hemorrhage. Selective digital subtraction angiographic image of the SMA shows no evidence of active extravasation. A replaced right hepatic artery (arrow) is noted. [Protocol: Injection of 20 ml contrast media at a flow of 4 ml/sec, Visipaque (Iodixanol) 320, GE Healthcare, Waukesha, WI]

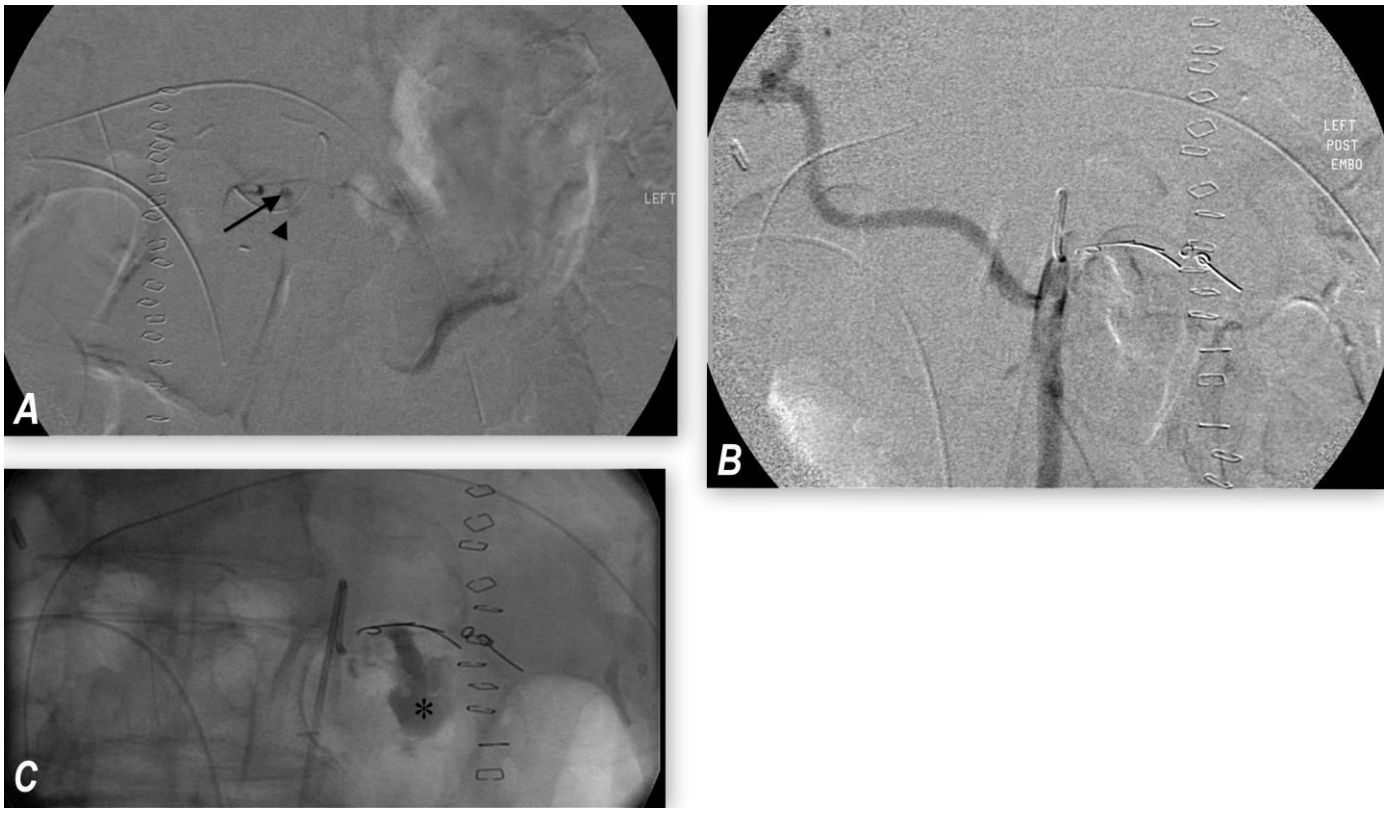

Figure 8: 77-year-old male with post-pancreaticoduodenectomy hemorrhage. (a) Sub-selective image of the dorsal pancreatic artery show a 7x6x8 mm pseudoaneurysm (arrow) with active extravasation of the contrast (arrowhead). (b) Post-embolization digital subtraction angiographic image shows successful hemostasis with exclusion of the pseudoaneurysm. (c) Post-embolization angiographic image shows retained contrast in the pancreatic bed (asterisk). [Protocol: Hand injection of 5 ml Visipaque (Iodixanol) 320, GE Healthcare, Waukesha, WI]

Etiology	Abscess formation, erosions of vessels, pancreatic fistulas, and ulcerations at anastomosis sites
Incidence	2-8%
Gender Ratio	Unknown
Age predilection	Unknown
Risk Factors	Infectious clinical signs and bile in the drainage fluid
Treatment	Laparotomy or endovascular coil embolization
Prognosis	Fair
Findings on Imaging	Active extravasation, pseudoaneurysm formation, abnormal fluid collections and acute hematomas

Table 1: Summary table for delayed post-pancreaticoduodenectomy hemorrhage

Diagnosis	Delayed Post-Pancreaticoduodenectomy Hemorrhage
X-Ray	None
US	None
CT	Active extravasation, pseudoaneurysm formation, abnormal fluid collections and acute hematomas
MRI	Unknown
Pattern of enhancement	Homogenous enhancement around the bleeding site in the case of active extravasation
Scintigraphy	Accumulation of Tc 99m labeled RBCs around the bleeding site in the case of active extravasation
PET	Unknown

Table 2: Imaging findings of delayed post-pancreaticoduodenectomy hemorrhage

ABBREVIATIONS

CTA= Computed Tomography Angiography
GDA= Gastroduodenal Artery
IR= Interventional Radiology
SMA= Superior Mesenteric Artery

KEYWORDS

Angiography; Computed Tomography; pseudoaneurysm; endovascular procedure; coil embolization

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