# Superselective Embolization for the Management of Postpancreatectomy Hemorrhage: A Single-Center Experience in 25 Patients

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## ABSTRACT

**Purpose:** To evaluate the efficacy of superselective embolization in patients with late postpancreatectomy hemorrhage (PPH).

**Materials and Methods:** Between January 2002 and July 2010, 25 patients (19 men) with suspected late PPH (> 24 hours after the operation) were evaluated. The primary study endpoint was technical success, defined as complete angiographic occlusion of the site of hemorrhage. Secondary study endpoints were multidetector computed tomography (CT) and angiographic findings regarding accurate detection of the site of hemorrhage, persistence of hemorrhage, or occurrence of rebleeding during clinical follow-up.

**Results:** Multidetector CT was performed before the intervention in 17 (68%) patients with detection of hemorrhage in 15 (88%) patients. The site of hemorrhage was detected in 23 (92%) of 25 patients by angiography. Four (17%) patients required a superselective catheter position. Embolization was attempted in all 23 patients with angiographically visible hemorrhage. In three (13%) patients, embolization could not be performed because a superselective catheter position was not achievable. Technical success was 83% (19 patients). In one patient, hemostasis was not achieved by embolization. Minor complications occurred in three (13%) patients. No major complications occurred. Three patients with technically successful embolization (16%) had a second episode of bleeding during follow-up and required repeat embolization 5–23 days after the procedure. The 30-day mortality rate was 20%.

**Conclusions:** Superselective embolization is a technically and clinically effective procedure in patients with late PPH. Diagnostic angiography should be performed with a superselective microcatheter position to detect the bleeding site effectively.

## ABBREVIATION

PPH = postpancreatectomy hemorrhage

Although perioperative mortality in patients undergoing pancreatic surgery has declined to < 5% (1), morbidity remains 30%–40%. The main causes of morbidity are delayed gastric emptying, anastomotic leakage or fistula, and intraabdominal abscess formation (2,3). Postpancreatectomy hemorrhage (PPH) is less common (1%–8%) (4–6) but represents a potentially life-threatening clinical condition with mortality rates up to 50% (7). Hemorrhage can occur in the early and late postoperative phase (8,9). In the early phase after surgery, hemorrhage is usually caused by technical failure or coagulopathy and requires repeat laparotomy and surgical hemostasis. Late hemorrhage can result from vessel erosion in the case of pancreatic leakage (10), intraabdominal infection with vessel involvement, or vascular injury during resection and pseudoaneurysm formation in the postoperative interval (9). After pancreaticoduodenectomy, the gastroduodenal artery stump is the most common source of bleeding in patients (11). Sentinel bleeding often occurs before the onset of late hemorrhage (4,12–14).

Contrast-enhanced computed tomography (CT) has generally proven helpful for detection of bleeding sites and procedure

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None of the authors have identified a conflict of interest.



*J Vasc Interv Radiol 2012; 23:504–510*

DOI: 10.1016/j.jvir.2011.12.013

planning in patients with suspected hemorrhage (15,16). In patients with sentinel bleeding after pancreatic surgery, pseudoaneurysms can be detected by contrast-enhanced CT (15). The purpose of this study was to evaluate the technical success of superselective embolization in patients with PPH, defined as angiographically complete closure of the site of hemorrhage. Secondary study goals were to compare the findings of multidetector CT with angiography regarding the accurate detection of the site of hemorrhage, ongoing hemorrhage after the procedure, or rebleeding during follow-up.

## MATERIALS AND METHODS

### Patients

Data were obtained from a prospective clinical database and reviewed for patients undergoing angiography for suspected late PPH between January 2002 and July 2010. Institutional review board approval was obtained for this retrospective study. Hemorrhage was suspected when one or more of the following signs were observed: fresh blood loss through abdominal drains or nasogastric tubes, hematemesis or melena, unexplained hypotension or tachycardia, or decrease in hemoglobin (9).

Postoperative late hemorrhage after pancreatic surgery was evaluated according to the following International Study Group of Pancreatic Surgery guidelines (9):

1. Time of onset: Late hemorrhage defined as hemorrhage > 24 hours after the operation
2. Location: Intraluminal (intraenteric) vs extraluminal (extraenteric, bleeding into the abdominal cavity)
3. Severity of hemorrhage:
   a. Mild (grade B hemorrhage): Small or medium volume blood loss (decrease in hemoglobin level < 3 g/dL), mild clinical impairment, transfusion of 1–3 units of packed cells
   b. Severe (grade C hemorrhage): Large volume blood loss (decrease in hemoglobin level ≥ 3 g/dL), clinically significant impairment

Sentinel bleeding was defined as appearance or increase of blood from the abdominal drains or the gastrointestinal tract and classified as grade B.

### Preinterventional Multidetector CT

Image acquisition was performed with either a 4-detector row multidetector CT scanner (Volume-Zoom; Siemens, Erlangen, Germany) or a 64-detector row multidetector CT scanner (Definition DS; Siemens). Nonenhanced, arterial, venous, and delayed phase images were acquired. After the nonenhanced phase, 130 mL of iomeprol iodinated contrast material (Imeron 350; Bracco, Milan, Italy) was injected with an automated injector at 5 mL/s. The arterial phase was performed with automated bolus tracking. The venous phase was started with a delay of 60 seconds. The delayed phase was performed 120 seconds after the venous phase. The entire abdomen was scanned, and axial and coronal reformations with 3-mm slice thickness and 2-mm overlap were reconstructed and analyzed.

Multidetector CT imaging was reviewed by two experienced radiologists (U.S., B.R.), and the diagnosis was made as a consensus decision. Arterial hemorrhage was defined as contrast agent extravasation or detection of a pseudoaneurysm (**Figure, a**). Presence, morphology (contrast agent extravasation or pseudoaneurysm), and source of hemorrhage were evaluated and compared with the angiographic findings.

### Diagnostic Angiography

Angiography was performed with Polystar (Siemens) or Integris system (Philips Medical Systems, Andover, Massachusetts). For vascular access, a 4-F sheath was introduced in the right femoral artery. For reduction of bowel movement, 20–40 mg of butylscopolamine (Buscopan; Boehringer Ingelheim, Ingelheim, Germany) was administered. In every patient, selective and superselective angiograms were obtained including the late (portal venous) phase. Selective angiography was performed with a 4-F reverse curve catheter positioned in the celiac trunk and in the superior mesenteric artery with automated injection of 35 mL of iodinated contrast material at a rate of 5–6 mL/s. Superselective angiography was performed with manual injection of 2.5 mL of iodinated contrast material via a 2.7-F microcatheter system (Progreat; Terumo, Tokyo, Japan). Definition and evaluation of arterial hemorrhage on angiography was identical to multidetector CT and separately analyzed on selective and superselective angiography. Similar to multidetector CT imaging, angiography was reviewed by two experienced radiologists (U.S., B.R.), and decision making by consensus was employed.

### Embolization

Embolization was indicated in all patients with angiographically proven arterial hemorrhage. Embolization was performed with a superselective catheter position by coil embolization (fibered platinum coils and Interlocking Detachable Coils; Boston Scientific, Cork, Ireland) (**Figure, b–d**), by liquid embolization with glue (Histoacryl; Braun, Melsungen, Germany) mixed with ethiodized oil (Lipiodol; Guerbet, Sulzach, Germany) or zein ethiodized oil emulsion (Ethibloc; Ethicon, Norderstedt, Germany), or by a combination of coil and liquid embolizations. In patients undergoing liquid embolization, a sandwich technique was used with injection of 40% glucose before and after the injection of the embolic agent. The embolic agent and quantity were noted. Technical success was defined as complete occlusion of the bleeding site or pseudoaneurysm with absence of contrast material extravasation shown by selective and superselective control angiography 15 minutes after embolization. Procedure-related minor and major complications according to the Society of Interventional Radiology (SIR) classification were analyzed (17).