Covered Stents and Coil Embolization for Treatment of Postpancreatectomy Arterial Hemorrhage

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ABSTRACT

Purpose: To evaluate the efficacy and clinical outcomes associated with stent-graft placement and coil embolization for postpancreatectomy arterial hemorrhage (PPAH).

Materials and Methods: Retrospective review of 38 stent-graft and/or embolization procedures in 28 patients (23 men; mean age, 65.1 y) for PPAH between 2007 and 2014 was performed. Time of bleeding, source of hemorrhage, intervention and devices used, repeat intervention rate, time to recurrent bleeding, complications, and 30-day mortality were assessed. Independent risk factors for recurrent bleeding and 30-day mortality were identified.

Results: Median onset of hemorrhage was at 39 days (mean, 27.9 d; range, 5–182 d). Covered stents were used in 65.7% of interventions, coil embolization in 23.6%, stent-assisted embolization in 5.2%, and stent-graft angioplasty in 2.6%. A total of 28 stent-grafts were placed, of which 19 were self-expandable and nine were balloon-mounted. Mean stent-graft diameter was 6.6 mm (range, 5–10 mm). Recurrent bleeding occurred following 26.3% of interventions in seven patients at a mean interval of 22 days. The site of recurrent bleeding was new in 80% of cases. There was no significant difference in recurrent bleeding rate in early-onset (< 30 d; $n = 22$) versus late-onset PPAH (> 30 d; $n = 6$; $P > .05$). No ischemic hepatic or bowel complications were identified. The 30-day mortality rate was 7.1% ($n = 2$) and was significantly higher in patients with initial PPAH at ≥ 39 days ($n = 5$; $P = .007$).

Conclusions: Covered stents and coil embolization are effective for managing PPAH and maintaining distal organ perfusion to minimize morbidity and mortality. Recurrent bleeding is common and most often occurs from new sites of vascular injury rather than previously treated ones.

ABBREVIATIONS

GDA = gastroduodenal artery, PPAH = postpancreatectomy arterial hemorrhage, SMA = superior mesenteric artery

Postpancreatectomy arterial hemorrhage (PPAH) continues to be a troublesome postoperative complication, accounting for 11%–38% of perioperative mortalities (1,2). Operative management of late-onset hemorrhage (> 24 h) is difficult and carries high morbidity and mortality rates, as ligation of the affected vessel or vascular reconstruction is often required (1). To reduce perioperative mortality, there has been a shift toward nonoperative treatment, first described with the use of superselective coil embolization and more recently described with placement of covered stents to exclude the site of vascular injury (3,4). Superselective transcatheter embolization for late-onset PPAH has technical success rates as high as 83%, but rates of hepatic ischemia and hepatic failure are high, resulting in mortality rates as high as 46% (5–8). Placement of covered stents has been described to have better results in a few case reports and small case series (5,9–14). Minimally invasive endovascular therapies are beneficial for PPAH, but it is unclear which technique(s) may be superior. Studies in the literature report that mortality and morbidity following endovascular therapy for PPAH often results from distal organ ischemia and organ failure (8). These results

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suggest that maintaining distal organ perfusion is as critical to survival as obtaining control of the acute hemorrhage.

The objective of the present study was to evaluate the efficacy and clinical outcomes of covered stent placement and coil embolization for the management of late-onset PPAH while maintaining distal organ perfusion. Data were also analyzed to identify risk factors associated with recurrent bleeding and 30-day mortality.

MATERIALS AND METHODS

Patients

The present study was approved by the institutional review board, and requirement for informed consent was waived. A single-center retrospective review was performed of all patients who underwent endovascular intervention for PPAH between May 2007 and December 2014. A total of 28 patients (23 male, five female) underwent attempted covered stent placement and/or coil embolization for PPAH. The mean age of patients was 65.1 years (range, 40–86 y). Underlying pancreatic pathologic condition and type of pancreatic resection are listed in Table 1. Postoperative pancreatic leaks/fistulae were present in 23 of 28 patients (82.1%). Average clinical follow-up was 21.6 months (median, 18 mo; range, 1 d to 66 mo) after intervention.

Definitions and Outcomes

PPAH was evaluated based on time of onset (early vs late), severity of hemorrhage (mild vs severe), and International Study Group of Pancreatic Surgery grade (A–C) (2). All episodes of PPAH were delayed hemorrhage (> 24 h following surgery) and included 19 cases of mild hemorrhage (hemoglobin decrease < 3 g/dL) and 19 cases of severe hemorrhage (hemoglobin decrease < 3 g/dL). Clinical success was the primary outcome evaluated in the study. This was defined as clinical improvement without the need for laparotomy, immediate cessation of hemorrhage following intervention, and return of hemodynamic stability. Technical success, rate and time to recurrent bleeding, rate of repeat intervention, 30-day mortality, and complications were studied as secondary outcomes. Complications and assessment of stent-graft patency were determined by review of available clinical notes, laboratory tests (aspartate and alanine aminotransferase levels), and computed tomography (CT) imaging. Complications were categorized as intraprocedural (arterial dissection and vessel thrombosis) and delayed (hepatic failure, hepatic abscess, hepatic infarction, bowel ischemia). Hepatic infarction was defined by a postintervention aspartate aminotransferase level > 700 IU/L or alanine aminotransferase level > 500 IU/L (6). Bowel resection or documented symptoms of mesenteric ischemia were interpreted as evidence of bowel ischemia.

Table 1. Disease and Pancreatic Resection Characteristics

Disease/Procedure	No.
Pancreatic adenocarcinoma	10
Intraductal papillary mucinous neoplasm	6
Ampullary carcinoma	4
Cholangiocarcinoma	3
Neuroendocrine tumor	3
Duodenal carcinoma	2
Pancreatic resection	
Classic pancreaticoduodenectomy	18
Pylorus-preserving pancreaticoduodenectomy	5
Distal pancreatectomy	4
Enucleation	1
Robot-assisted	13
Laparotomy	15

Techniques for Embolization and Stent-Graft Placement

Celiac and superior mesenteric arteriography was performed with a 5-F catheter and/or microcatheter. The decision to perform coil embolization versus covered stent placement was at the physician's discretion based on the size of the vessel to be treated, length of the abnormality, proximal (common/proper hepatic artery or superior mesenteric artery [SMA]) versus distal location (lobar hepatic artery or first-order branch of a visceral artery), potential for distal organ ischemia, and adjacent arterial anatomy/collateral supply. Each intervention was performed by one of 10 fellowship-trained interventional radiologists.

Embolization was performed by using a microcatheter and 0.018-inch fibered platinum microcoils (Tornado/MicroNester; Cook, Bloomington, Indiana). Techniques for coil embolization included distal and proximal embolization to exclude the abnormality, embolization of a vascular stump created during surgery, embolization of distal right or left hepatic arteries, or direct coil embolization of pseudoaneurysms if no other technique was suitable. Coils were placed until complete exclusion of the bleeding site was obtained, which was defined by absence of the vascular abnormality on repeat angiography. Embolization was most often performed for pseudoaneurysms of the pancreaticoduodenal arcade and in the lobar hepatic arteries for treatment of hemorrhage or for stent-graft–assisted embolization.

Covered stents were placed for vascular injuries of the common or proper hepatic artery, SMA, and splenic artery to maintain distal organ perfusion. A 45-cm, 6–9-F curved reinforced sheath (Flexor Ansel; Cook) was placed at the celiac or SMA origin for delivery of stent grafts. Self-expanding nitinol/expanded polytetrafluoroethylene (VIABAHN; W.L. Gore & Associates, Flagstaff, Arizona) or balloon-mounted stainless-steel/expanded polytetrafluoroethylene (iCast; Atrium Medical,

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