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Endovascular Management of Pseudoaneurysms and Aneurysms Following Gastrointestinal Surgery

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1. Abstract

1.1. Purpose: This study aimed to evaluate the characteristics of pseudoaneurysms and aneurysms following gastrointestinal surgery treated with endovascular management (i.e., transcatheter arterial embolization or stent-graft placement).

1.2. Methods: This retrospective study included 17 patients with pseudoaneurysms and 1 patient with an aneurysm following gastrointestinal surgery in a tertiary care hospital between 2011 and 2021. There were 15 men and 3 women aged 37–85 years, with an average age of 67 years. All patients underwent endovascular management. We retrospectively analyzed their angiographic features and clinical outcomes.

1.3. Results: Arterial embolization was performed in 11 patients, and stent-graft placement was performed in 7 patients. Additional arterial embolization was necessary for another bleeding lesion in 2 patients, while 1 patient died of multiple organ failure. Stent-graft occlusion occurred after a few days in 3 out of 7 patients without any antithrombotic drugs. Extravascular migration of the occluded stent-grafts was observed in 3 out of 7 patients, wherein these stent-grafts migrated to the intestine and eventually disappeared in 2 patients. There were no clinical symptoms related to the occlusion or migration of the stent-grafts.

1.4. Conclusion: Both arterial embolization and stent-graft placement are effective in the management of postoperative pseudoaneurysms and aneurysms. Stent-graft placement is suitable for cases with poor collateral flow because it preserves arterial patency. The use of antithrombotic treatment and the risk of stent-grafts migration should be taken into consideration.

2. Introduction

Traditionally, surgical treatment is considered the first-line approach for pseudoaneurysms and aneurysms. Recently, less invasive techniques have been developed, such as Transcatheter Arterial Embolization (TAE) and stent-graft placement. This study aimed to review our experience on the treatment of pseudoaneurysms and an aneurysm following gastrointestinal surgery and to evaluate the effectiveness of endovascular management.

3. Materials and Methods

3.1. Study Design and Patients

We retrospectively reviewed 17 patients with pseudoaneurysms and 1 patient with aneurysm following gastrointestinal surgery between January 2011 and May 2021 at our hospital. There were 15 men and 3 women with an average age of 67 years (range 37–85 years).

The following clinical information were also analyzed: primary disease, surgical procedure, postoperative complications and bacterial culture results prior to bleeding, interval from operation to bleeding, symptoms, interval from detection of bleeding via computed tomog-

raphy (CT) to angiography, bleeding site, size of pseudoaneurysm or aneurysm, endovascular management, re-bleeding, and prognosis and findings after stent-graft placement.

3.2. Diagnosis and Treatment of Pseudoaneurysm

Pre-interventional CT scans were acquired for 17 patients before the first angiography. CT scans were not acquired for patient #18, who directly underwent angiography.

Celiac and superior mesenteric angiography were performed through the transfemoral or brachial approach. Once the pseudoaneurysm was identified, TAE with microcoils or stent-graft placement (polytetrafluoroethylene-covered stent; 5–7 mm in diameter, 50 mm in length) was performed, depending on the vascular lesion site.

3.3. Follow-up

During hospitalization and even after discharge, CT scan is usually performed on follow-up for the evaluation of hemostasis, end organ perfusion, and stent patency. Furthermore, liver color doppler ultrasound is performed to detect the hepatic perfusion and the blood flow at the stent implantation site.

4. Results

4.1. Patients

The clinical features of the 18 patients are presented in (Table 1). An analysis of the clinical features of 17 pseudoaneurysm cases is discussed below. Regarding medical history, 12 of 17 patients had undergone pancreatic surgery (71%), 3 had undergone gastrectomy (18%), and others had undergone proctectomy, hepatectomy, and laparoscopic cholecystectomy. Regarding postoperative complications prior to bleeding, 11 patients (65%) had pancreatic fistula, 3 (18%) had gastrointestinal leak, and 2 (12%) had bile leak. Bacterial culture results were positive in 13 patients (76%). The median interval from initial surgery to hemorrhage was 16 days (range: 2–57 days). In summary, 12 patients presented with bleeding from drains (71%), 5 with either or both hematemesis and melena (29%), and 2 with abdominal pain (12%). Hypovolemic shock was observed in 10 patients (59%). Arterial bleeding was detected by CT in all patients, except for patient #2. The median interval from detection of bleeding via CT to angiography was 1.5 h (range: 0.27–12 h). In patient #2 and #18, the intervals measured were from the occurrence of hematemesis or bleeding from drains to angiography.

Table 1: Clinical features of patients with pseudoaneurysm or aneurysm

No.	Age Sex	Diseases	Surgical procedure	Postoperative complication	Bacterial culture results prior to bleeding	Postoperative period	Symptoms	Interval from bleeding to angiography
1	72 M	Bile duct caner	PD	None	-	31 days	Hematemesis, melena	1 hour
2	69 M	Bile duct caner	PD	Chylorrhea, bile leak	-	26 days	Hematemesis, melena	1 hour
3	37 M	Pancreatitis	Drainage	Enteritis, Gastroduodenocolic fistula	+	57 days	Hematemesis, melena, bleeding from drain	4.5 hours
4	78 M	Pancreatic cancer	DP-CAR, PG	Anastomotic leak	+	24 days	Hematemesis, bleeding from drain	1 hour
5	67 M	Pancreatic cancer	PD	None	-	5 days	Bleeding from feeding tube insertion site	3.5 hours
6	74 M	Pancreatic tumor	PD	None	+	8 days	Abdominal pain, bleeding from drain	1.5 hours
7	85 F	Gastric cancer	TG	Duodenal stump leak	+	10 days	Bleeding from drain	40 minutes
8	66 M	Gastric perforation	DG	Panperitonitis	+	10 days	Wound bleeding, lightheadedness	2.2 hours
9	74 M	Rectal cancer	Proctectomy	Abscess	+	14 days	Bleeding from drain	6 hours
10	79 F	Bile duct cancer	PD	None	+	15 days	Bleeding from drain	3 hours

11	66 M	Pancreatic tumor	PD	None	+	38 days	Fever and chills	45 minutes
†12	73 M	Gastric cancer	TG, PS	None	-	4 years	None	38 days
13	56 M	Gallstone	LC	None	-	2 days	Abdominal pain	2 hours
14	80 M	Pancreatic tumor	PD	Heart failure, pneumonia, enteritis	+	13 days	Bleeding from drain	16 minutes
15	75 F	Bile duct cancer	PD	Pneumonia, lung embolism	+	16 days	Melena, bleeding from drain	2 hours
16	44 M	Pancreatic tumor	MP	None	+	16 days	Bleeding from drain	1.8 hours
17	56 M	Liver metastasis	Hepatectomy	Bile leak, abscess	+	52 days	Bleeding from drain	12 hours
18	52 M	Duodenal tumor	PD	None	+	20 days	Bleeding from drain	1.3 hours

DG: distal gastrectomy, DP-CAR: distal pancreatectomy with celiac axis resection, LC: laparoscopic cholecystectomy, MP: middle pancreatectomy, PD: pancreaticoduodenectomy, PG: proximal gastrectomy, PS: pancreatosplenectomy, TG: total gastrectomy

4.2. Angiographic Findings and Interventional Procedures

The results of angiography are presented in (Table 2). In patient #12, a saccular aneurysm 12 mm in diameter was found, and stent-graft placement was successfully performed. Below, 17 pseudoaneurysm cases are analyzed. Active arterial bleeding was detected in all cases. The maximum minor axis of the aneurysm was 12 mm, and that of pseudoaneurysms ranged from 3 to 22 mm. As a first treatment, TAE was performed in 11 cases, and stent-graft placement was performed in 6 cases. Re-bleeding was found in 2 cases either at a different vessel or proximal to the embolized vessel. They were successfully managed by repeat TAE. One patient died of sepsis and multiple organ failure. He had undergone intensive care after initial surgery because of cardiac insufficiency, pneumonia, and enteritis. Technical success was achieved in all 17 procedures (100%), while clinical success was achieved in 16 out of 17 patients (94%).

Table 2: Angiographic findings and clinical results of patients with pseudoaneurysm or aneurysm

No.	Lesion site	Size of aneurysm (mm)	Endovascular management	Re-bleeding site and management	Prognosis	Antithrombotic drugs after stent-graft placement	CT findings of stent-graft
1	Cystic artery	10	Coil	None	Alive		
2	SA	8	Coil	Proximal SA, Coil	Alive		
3	SA	3	Coil	None	Alive		
4	CHA	7	Coil	None	Alive		
5	RGA	13	Stent-graft	None	Alive	None	Occluded next day, migrated 3 months later, disappeared 5 months later
6	GDA	4	Coil	None	Alive		
7	SA	4.5	Coil	None	Alive		
8	SA	6	Coil	None	Alive		
9	Right inferior gluteal artery	8	Coil	None	Alive		
10	CHA	8	Stent-graft	None	Alive	Started aspirin next day	Patent 4 days later, migrated 6 months later
11	GDA	22	Stent-graft	None	Alive	None	Occluded 13 days later, migrated 4 months later, disappeared 15 months later

†12	Celiac artery	12	Stent-graft		Alive	Started apixaban next day	Patent 1 year later
13	Cystic artery	6	Coil	None	Alive		
114	GDA	5.5	Stent-graft	SA, Coil	Died next day of MOF	None	No CT follow-up
15	GDA, RGA	5	Stent-graft	None	Alive	None	Occluded 2 days later
16	SA	17	Coil	None	Alive		
17	Posterior hepatic artery	8	Coil	None	Alive		
18	GDA	11	Stent-graft	None	Alive	Started aspirin and heparin next day	Patent 5 months later

† A case of aneurysm.

CHA: common hepatic artery, GDA: gastroduodenal artery, PHA: posterior hepatic artery, RGA: right gastric artery, SA: splenic artery, MOF: multiple organ failure.

4.3. CT Findings in The Follow-Up Period

Partial splenic necrosis occurred as a postembolization complication in one patient who had undergone total gastrectomy, but this did not need any treatment.

In the 7 cases of stent-graft placement, stent patency was observed over a relatively long period in 3 cases who underwent either or both anticoagulant and antiplatelet therapies. On the other hand, stent occlusion occurred after a few days in 3 patients without such therapies. Occluded stent-grafts migrated intravascularly in 3 out of 6 patients, but these eventually disappeared in 2 (Figure 1, Figure 2). There were no clinical symptoms related to the occlusion or migration of the stent-grafts.

Figure 1(A): Contrast-enhanced computed tomography (CE-CT) scan showing an occluded stent-graft in the proper hepatic artery 1 day after stent-graft placement.

Figure 1 (B): After 3 months, CE-CT scan showed the extravascular migration of the stent-graft.

Figure 1 (C): Two months later, the stent-graft has disappeared.

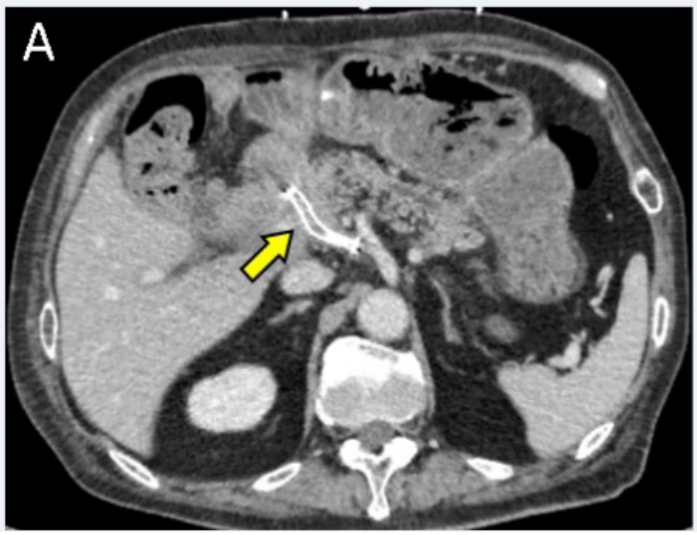

Figure 2(A): Contrast-enhanced computed tomography scan showing an occluded stent-graft in the common hepatic artery 13 days after stent-graft placement.

Figure 2 (B): After 4 months, the migrated stent-graft was found in the intestinal tract.

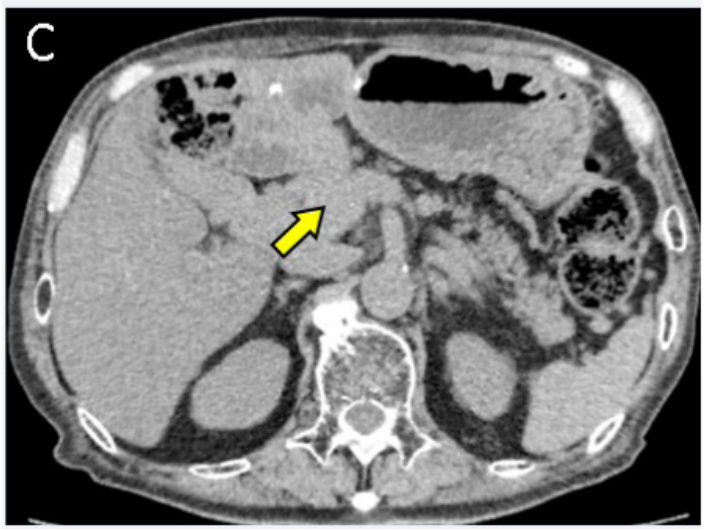

Figure 2 (C): Eleven months later, the stent-graft has disappeared.

5. Discussion

Pseudoaneurysm is a potentially fatal complication, which reportedly has an incidence of 0.9%–16% after abdominal surgery, depending on the surgical site [1] [2]. Early postoperative hemorrhages are generally known to be caused by intraoperative arterial injury or improperly ligated vessels. On the other hand, the predisposing factors for delayed postoperative hemorrhage include marginal ulcer, anastomotic leakage, localized infection with abscess formation, and sepsis [3]. Among the 17 pseudoaneurysm cases of our study, 16 were cases of delayed postoperative hemorrhage with intraabdominal complications. In contrast, patient #13 was bleeding from a gallbladder artery after laparoscopic whole-layer cholecystectomy, which was caused by improper sealing of the artery. The recently reported technical and clinical success rates of endovascular management for pseudoaneurysms after abdominal surgery are 95%–100% and 76%–82%, respectively [3] [4] [5]. Kajiwara et al. [6] described that the prolonged interval from the onset of bleeding to angiography may cause high mortality. In our study, the short interval from the detection of bleeding to angiography (1.5 h) might have contributed to the clinical success in 94% of cases.

On the other hand, abdominal visceral true aneurysms are rare, with an incidence of 0.01%–0.2% in cadavers [7]. There are a few reports on the treatment of aneurysms after abdominal surgery. Inokuma et al. [8] previously described a case of TAE for hepatic artery aneurysm detected 7 years after pancreaticoduodenectomy.

Distal organ ischemia, especially liver failure, is a serious postembolization complication. A normal liver can tolerate arterial embolization because of collateral arteries, such as the inferior phrenic artery, adrenal artery, pancreatic arcade artery, and epicholedochal arterial plexus. In patients with poor collateral blood supply due to postoperative status or impaired liver function, stent-graft placement should be a good option because of its advantage in preserving the feeding artery. In 2016, the GORE VIABAHN Endoprosthesis (W. L. Gore & Associates, Inc., Flagstaff, Arizona, USA) was approved for use in the Japanese national insurance coverage in treating iatrogenic vascular injuries. This allowed us to perform stent-graft placement using the GORE VIABAHN Endoprosthesis to achieve hemostasis with confirmed arterial patency in 7 cases. Stent occlusion occurred after few days in 3 patients without any antithrombotic therapies, which were not administered because we were apprehensive of recurrent bleeding. There are some previous reports discussing covered stent occlusion [4] [9] [10]. No clinical symptom was observed in all previous cases and in our cases probably because the distal organs were perfused by collaterals. Muramoto et al. [11] and Nakajima et al. [10] reported cases of stent-graft placement followed by combination antiplatelet therapy with clopidogrel and aspirin and described the necessity of these antiplatelet therapies. On the other hand, Cui et al. [5] described that antithrombotic drugs are not always necessarily because these are not needed in stent-grafts, which are larger in diam-

eter. To determine the necessity of antithrombotic therapies, future research with a larger sample size is needed.

In our study, there were 3 cases wherein the occluded stent-grafts migrated, and 2 eventually disappeared; these might have been dislodged from the gastrointestinal fistula. There are a few previous reports of visceral stent-graft migration. Hassold et al. [12] reported 16 cases of covered stent implantation, which includes 3 cases of stent migration, with 1 that disappeared without symptoms. Rebonato et al. [9] reported a case of stent-graft migration into the stomach with epigastric pain and melena, which occurred 3 years after the repair of a splenic artery pseudoaneurysm. They described that it is important to consider the possibility of these late complications in patients with gastrointestinal symptoms.

6. Conclusion

In our study, both TAE and stent-graft placement were effective in the management of postoperative pseudoaneurysms and an aneurysm. Stent-graft placement should be especially suitable for cases with poor collaterals or impaired liver function because it preserves arterial patency. The use of antithrombotic treatment and the risk of stent-graft migration should be taken into consideration, and further research is needed to confirm the appropriate antithrombotic treatment regimen.

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