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CLINICAL INVESTIGATIONS

Stent-Graft Treatment of Patients with Acute Bleeding from Hepatic Artery Branches

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Abstract

Purpose: To present a new treatment option in patients with acute bleeding from the hepatic artery branches.
Methods: Four male patients, 23–49 years old (mean 36.3 years), were treated for acute bleeding and subsequent transient hypotension. Bleeding episodes were secondary to hepatic artery pseudoaneurysms in two patients and surgical suture insufficiency in one patient. In the remaining patient, anastomotic leakage occurred following thrombolysis for hepatic artery thrombosis. Patients were treated by endovascular placement of one or two balloon-expandable stent-grafts, ranging from 17 to 28 mm in length.
Results: All procedures were carried out without serious complications. All stent-grafts were deployed in the intended position with immediate cessation of bleeding and initial preservation of satisfactory blood flow.
Conclusions: Bleeding from the hepatic artery can be treated by insertion of balloon-expandable stent-grafts in the acute setting.

Key words: Hepatic artery aneurysm—Liver transplant—Stent-graft—Surgical complications—Upper gastrointestinal bleeding

Acute intraperitoneal bleeding from the hepatic artery and/or its branches can be life-threatening and frequently requires emergent treatment. Bleeding can be secondary to trauma, inflammatory disease, rupture of an aneurysm, may appear following surgery, particularly after liver transplantation, or have an iatrogenic origin [1, 2]. Ultrasonography or computed tomography can demonstrate intraperitoneal blood, but angiographic evaluation is necessary for definitive diagnosis of the bleeding source. Surgical treatment can be difficult in acute situations and carries added risks of postoperative complications; transcatheter therapy is a less invasive alternative.

Infusion of vasoconstrictors can be used in cases of focal bleeding [3] but has been almost completely replaced by embolization [4]. Embolization of the bleeding artery has an immediate impact on patient survival [5] but often excludes the distal circulation, which can compromise function of vital organs.

We report four cases of acute arterial bleeding from the hepatic or gastroduodenal artery related to previous surgery. Due to anatomic circumstances, embolization could have had a negative impact on patient status; treatment with covered stent-grafts was considered the best alternative.

Case Reports

Case 1

A 43-year-old man developed intra-abdominal bleeding the day after pancreatico-duodenal surgery which was performed for suspected malignancy. The patient was referred for angiographic evaluation, which showed occlusion of the celiac axis at the origin. Through the superior mesenteric artery (SMA) and inferior pancreatico-duodenal artery, selective catheterization of the anterior branch of the pancreatico-duodenal artery was performed using a 5 Fr Cobra catheter (Cordis/Johnson & Johnson, Miami, FL, USA) and 0.035 inch glide-wire (Terumo, Tokyo, Japan). Contrast injection showed retrograde flow in the large-diameter gastroduodenal artery, which supplied the hepatic, splenic and phrenic arteries. Extravasation of contrast medium from the stump of the dorsal pancreatico-duodenal artery branch was also seen (arrow, Fig. 1). Embolization of this short arterial stump was considered technically difficult and embolization of the gastroduodenal artery on both sides of the bleeding branch would have compromised blood flow to the liver, spleen and diaphragm. The Cobra catheter was then exchanged over an Amplatz guidewire (Boston Scientific, Natick, MA, USA) for a 7 Fr introducer sheath. Subsequently, an 18 mm long balloon-expandable stent-graft (Jomed, Helsingborg, Sweden) was mounted over a 6 mm × 20 mm Ultrathin angioplasty balloon (Boston Scientific) and advanced to the gastroduodenal artery. The stent-graft was balloon-expanded, but its caudal edge became

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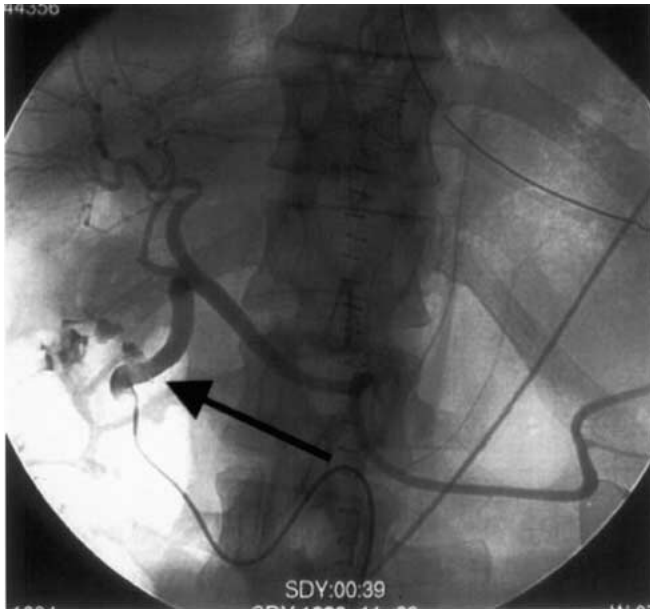

Fig. 1. Case 1. Selective arteriogram of an anterior branch of the pancreatico-duodenal artery shows retrograde flow through the gastroduodenal artery. There is extravasation of contrast medium from the stump of the dorsal pancreatico-duodenal branch (arrow).

Fig. 2. Case 1. Good flow through the stent-grafts. There is no extravasation of contrast medium from the arterial stump.

positioned close to the origin of the bleeding artery. Therefore, another similar stent-graft was placed coaxially in the first one, in a caudal direction. Post-deployment angiography showed exclusion of the bleeding stump and good blood flow through the stent-grafts (Fig. 2). Bleeding stopped immediately and the patient remained stable during the following 2 days. After 2 days the patient underwent surgical exploration due to abdominal pain and ultrasonographic findings of an intra-abdominal fluid collection. During surgery new bleeding occurred, probably caused by dislodgment of the stent-grafts as a result of surgical manipulations. The patient was treated by surgical revision of the stump and was in a stable condition until discharge from the hospital 1 week later.

Case 2

A 30-year-old man developed hepatic artery aneurysm, 1 week after unsuccessful surgical placement of a hepatic artery catheter for infusion of cytostatic drugs. The patient was referred for angiographic evaluation and possible embolization of the aneurysm. Hepatic artery angiogram verified an aneurysm 15 mm in diameter (Fig. 3). During attempted selective catheterization of the hepatic artery distal to the aneurysm, a 0.035 inch glide-wire (Terumo, Tokyo, Japan) was accidentally advanced through the wall of the aneurysm, causing rupture and extravasation. The catheter was immediately exchanged for a 5 mm × 20 mm balloon catheter, which was inflated in the proximal portion of the common hepatic artery, to tamponade the bleeding. The patient experienced transient abdominal pain and hypotension during these maneuvers. Contrast injection through the balloon catheter showed extravasation of contrast into the peritoneal cavity (Fig. 4). Through the balloon catheter a 0.014 inch Spartacore guidewire (Guidant, Indianapolis, IN, USA) was subsequently advanced to a peripheral branch of the right hepatic artery. The balloon catheter was then exchanged for a 6 Fr, 55 cm long sheath and a 26 mm long stent-graft (Jomed), mounted over a 5 mm × 30 mm coronary dilation balloon, was advanced to the level of the ruptured aneurysm. The stent-graft was balloon-expanded, and to secure its position and cover an irregular proximal portion of the hepatic artery, another similar stent-graft was placed in a coaxial manner. Following placement of the second stent-graft, angiography showed exclusion of the aneurysm and good blood flow to the liver through the stent-grafts (Fig. 5). The patient was discharged and lost to further follow-up.

Case 3

A 23-year-old man was referred for hepatic angiography 2 weeks after liver transplantation, due to Doppler-confirmed diagnosis of hepatic artery thrombosis. A selective hepatic arteriogram showed total occlusion of the proper hepatic artery (Fig. 6). Thrombolytic therapy was requested despite the short interval after surgery, as the only possibility for salvaging the liver graft.

A coaxial 3 Fr Tracker catheter (Boston Scientific) was placed into the thrombosed hepatic artery and infusion of Retavase (Centocor, Malvern, PA, USA) initiated at a rate of 0.5 units/hr. A follow-up angiogram performed after 21 hr showed an open donor hepatic artery, but also extensive extravasation of contrast from the site of arterial anastomosis (Fig. 7). A 26 mm long stent-graft (Jomed) was mounted over a 4 mm × 40 mm angioplasty balloon and advanced over a 0.014 inch guidewire to the site of the anastomosis and deployed. Repeat arteriography demonstrated no hemorrhage but very low flow distal to the stent-graft, probably related to dissection extending distal to the stent-graft. To stabilize the lumen of the artery, an 18 mm Herculink stent (Guidant) mounted over a 4 mm × 20 mm balloon was advanced and deployed. A repeat angiogram verified remaining thrombus in the proximal hepatic artery (of the recipient), therefore thrombolysis (as described above) was continued for a further 24 hrs. At follow-up angiography there was no extravasation of contrast medium and

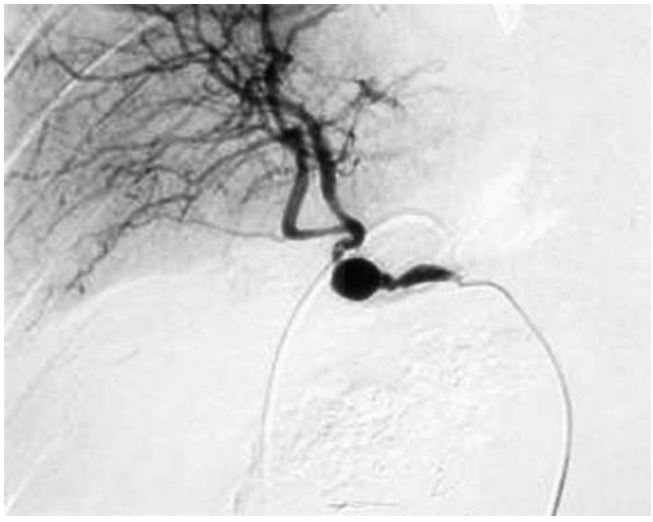

Fig. 3. Case 2. Hepatic arteriogram shows an aneurysm involving the proper hepatic artery prior to bifurcation.

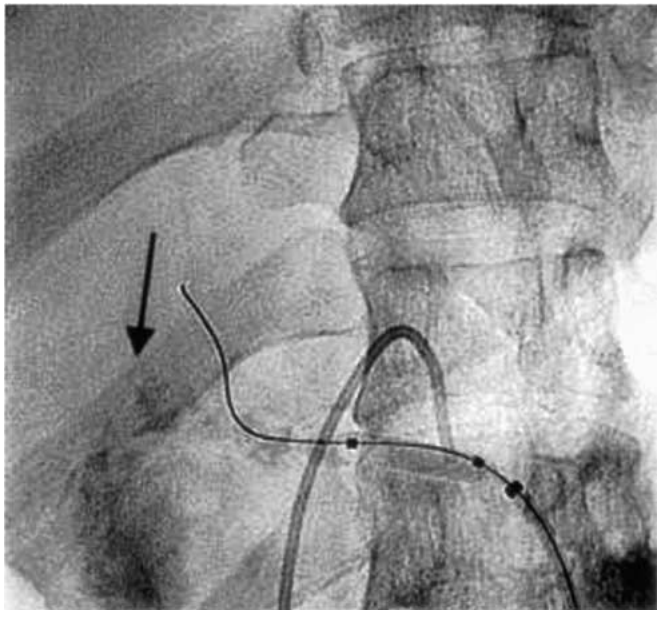

Fig. 4. Case 2. Balloon catheter inflated in the common hepatic artery to tamponade the bleeding. There is extravasation of contrast medium into the peritoneal cavity (arrow).

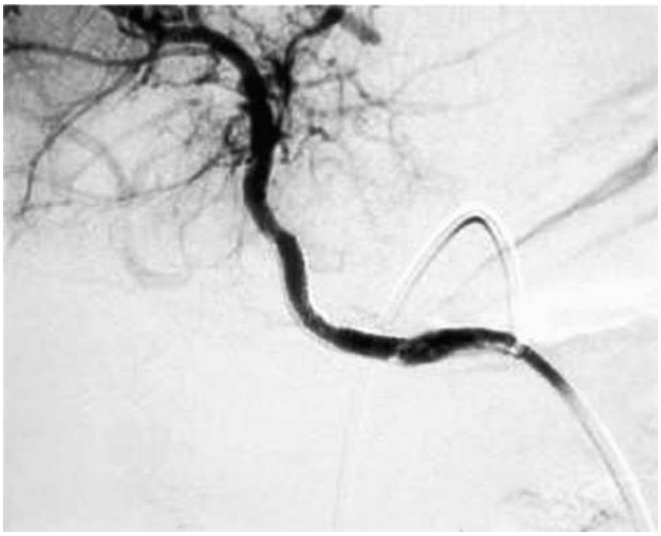

Fig. 5. Case 2. Exclusion of the aneurysm and cessation of bleeding by stent-grafts, with preservation of satisfactory blood flow.

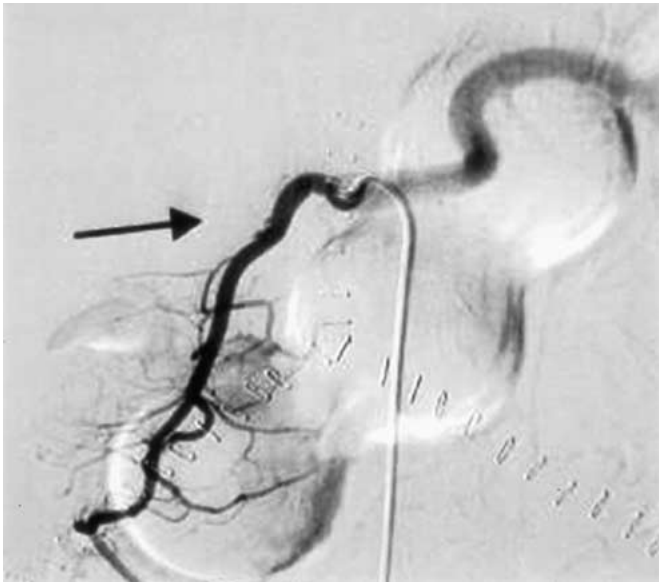

Fig. 6. Case 3. Hepatic angiogram shows complete occlusion of the proper hepatic artery with only a residual stump present (arrow).

good flow through the inserted stent-graft and stent; however, much diminished blood flow to the intrahepatic arteries was present, probably secondary to the swelling of the liver (Fig. 8). Doppler examination after 2 weeks could not verify blood flow in the hepatic artery. The patient remained in a stable condition until new liver transplantation 4 months later.

Case 4

A 49-year-old man with a second orthotopic liver transplant secondary to chronic hepatitis C had bilateral external/internal biliary drainage catheters. He was referred for angiographic evaluation of significant hemobilia from his right drainage catheter. A selective arteriogram of the hepatic artery interposition graft showed severe anastomotic stenosis at the junction of the graft and donor artery, as well as a large pseudoaneurysm arising from the base of the transplant proper hepatic artery (Fig. 9). Initially, dilation of the anastomotic stenosis was performed using a 3 mm × 20 mm angioplasty balloon. Subsequently, the pseudoaneurysm was excluded by insertion of two overlapping balloon-expandable (Jomed) stent-grafts, 5 mm × 19 mm and 5 mm × 16 mm, mounted on a 5 mm × 20 mm angioplasty balloon.

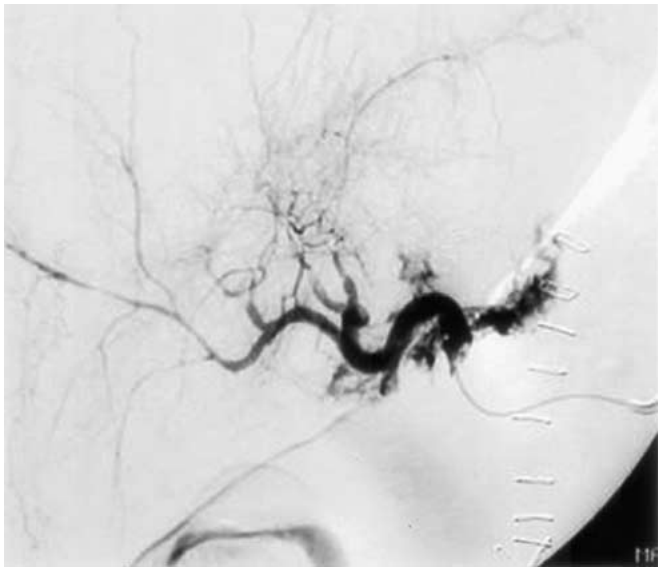

Fig. 7. Case 3. Restored flow through the hepatic artery following thrombolysis, with significant extravasation of contrast material at the site of arterial anastomosis.

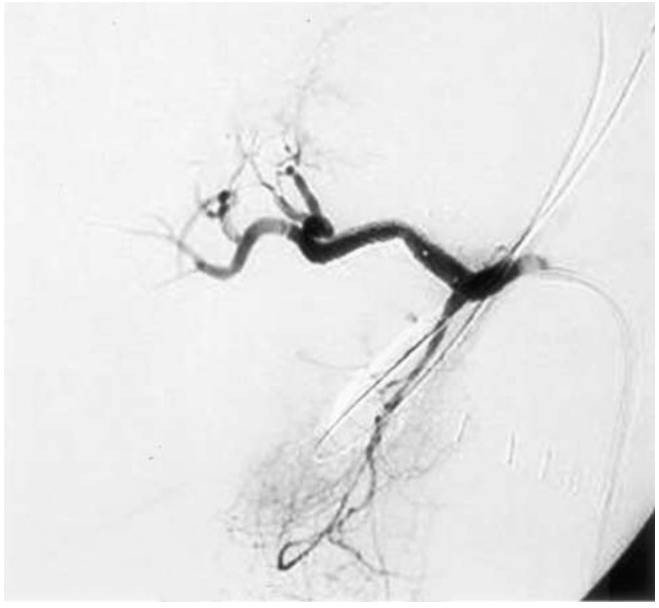

Fig. 8. Case 3. Cessation of extravasation and good flow through the deployed stent-graft and stent. However, there is much diminished flow through the intrahepatic branches.

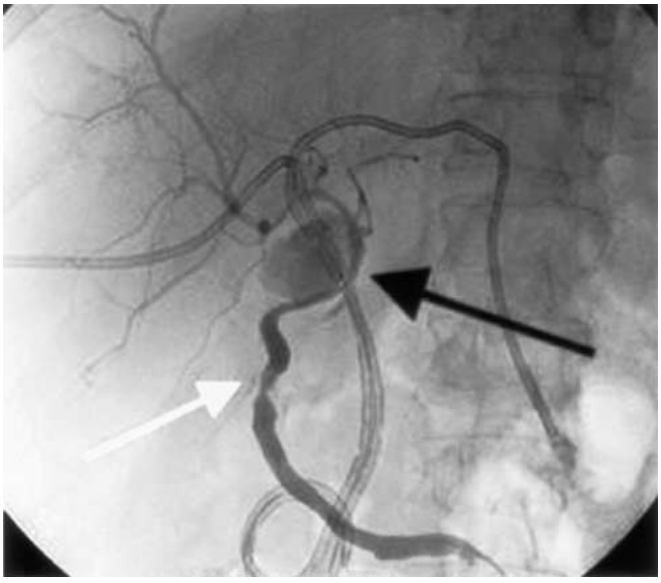

Fig. 9. Case 4. Pseudoaneurysm arising from the base of the transplant hepatic artery (black arrow) and severe anastomotic stenosis (white arrow).

Fig. 10. Case 4. Exclusion of the pseudoaneurysm by stent-grafts (black arrow). After stent placement there was a normalized lumen at the site of the anastomosis (white arrow).

Due to a persistent elevated pressure gradient across the anastomotic stenosis, dilation was done with a 5 mm × 20 mm angioplasty balloon followed by placement of two overlapping Smartstents (Cordis), 8 mm × 20 mm. Post-deployment angiography showed good flow through the stents and stent-grafts and exclusion of the pseudoaneurysm (Fig. 10). The hemobilia stopped after the procedure. A follow-up arteriogram 1 week later showed patency of the stent-grafts and bare stents, as well as continued exclusion of the pseudoaneurysm. However, the patient returned 5 days later with recurrent hemobilia, now from the left transhepatic external/internal biliary drainage catheter. Angiography revealed a subcentimeter pseudoaneurysm off of the left hepatic artery with a fistulous communication to the left biliary duct (Fig. 11). Due to the small size and peripheral location of the pseudoaneurysm, embolization with Embospheres 350–500 μm (BioSphere Medical, Rockland, MA, USA) followed by placement of a single 3 mm × 2 mm Tornado coil (Cook,

Fig. 11. Case 4. Small pseudoaneurysm off the left hepatic artery (arrow) close to the left biliary duct.

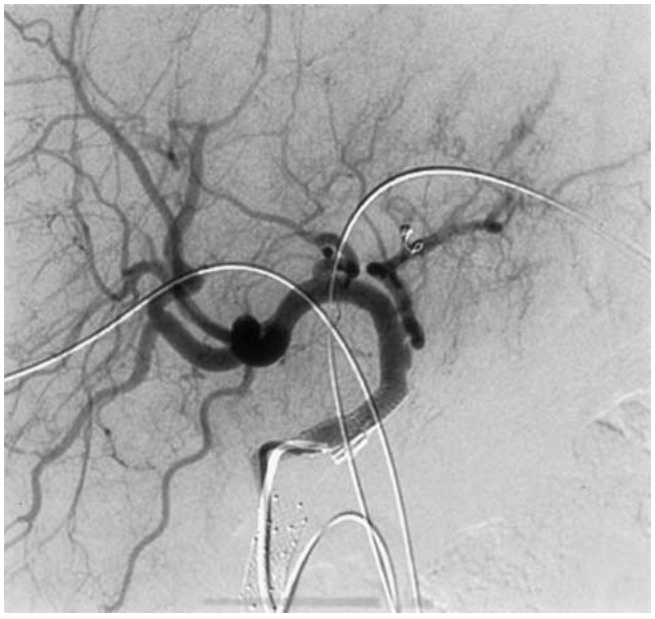

Fig. 12. Case 4. Complete exclusion of the pseudoaneurysm following coil embolization.

Bloomington, IN, USA) was performed (Fig. 12). The patient continues to return for periodic exchange of biliary drainage catheters and has been free of any further hemobilia during an observed period of 5 months.

Discussion

Acute bleeding from the hepatic artery or its branches is most often secondary to traumatic injury, but can also be caused by malignancy, inflammatory disease or have an iatrogenic origin. Bleeding following a complicated surgical or interventional procedure can be self-limiting or have more severe, acute onset of symptoms. Traditionally, acute bleeding has been treated by a surgical approach or by an endovascular approach with coil embolization [6, 7]. Surgical treatment is difficult, and carries risks of operative morbidity and mortality and postoperative complications. Coil embolization can compromise blood flow to the vital organs. Coil embolization of hepatic arteries can be done relatively safely, since the liver has a dual blood supply from the portal and arterial circulations. Development of collateral arterial blood flow to the liver can also be expected. An exception to this general principle is the hepatic transplant patient. Hepatic arterial occlusion can be disastrous, since the graft requires maximal blood perfusion. In the transplant patient, collateral blood flow is limited, particularly in the early postoperative period when little neovascularization is present.

In recent years stent-grafts have been increasingly used in the endovascular repair of thoracic and abdominal aneurysms. Stent-grafts have also been used for exclusion of peripheral arterial aneurysms [8], repair of traumatic subclavian and/or axillary artery injuries [9, 10], renal artery aneurysm [11] or rupture [12], in arteriovenous fistulas [13], aortocoronary saphenous vein grafts [14, 15], and other iatrogenic vascular injuries [16]. Stent-grafts are increasingly used for TIPS procedures with encouraging results [17].

Balloon-expandable stent-grafts are easily deployed given their small size and adaptability in small vessels [18]. The injured artery treated by insertion of a stent-graft maintains vessel patency, preserving organ perfusion [19]. We report the successful placement of balloon-expandable stent-grafts for the treatment of acute bleeding from the hepatic artery and its branches. All our patients required urgent treatment due to pronounced bleeding causing hypotension. In all four of our cases, embolization of the bleeding artery would have compromised the distal blood flow, which could have had serious consequences for the patients. Surgery in acute situations would delay the treatment, with substantial risks of mortality.

To decrease the risk of dislodgment from the angioplasty balloon, stent-grafts should be advanced through long sheaths. Only in one of our cases could the sheath be extended beyond the site of bleeding. In the other three cases the sheath could not be placed as far due to altered anatomy; however, the stent-grafts could be advanced over the guidewire and deployed safely in the intended location. In the acute situation exact positioning of the stent-grafts was difficult to determine, requiring placement of more than one device in overlapping fashion in three of our cases.

Bleeding stopped immediately after stent-graft placement and all patients remained in a stable condition. Long-term function of the stent-grafts was not evaluated; however, only one of the patients had re-bleeding from the treated artery.

This bleeding, which occurred during surgery, was probably secondary to dislodgment of the stent-grafts, positioned in the gastroduodenal artery, during surgical manipulations. Additional bleeding noted in others of our patients had a different origin. Two of our patients (cases 1 and 2) had malignant disease and were lost to long-term follow-up. In the third patient we made an effort to save the liver transplant, which without our intervention would have been lost anyway. Following our interventions arterial blood flow to the liver was restored; however, it became insufficient due to swelling of the liver, probably resulting in re-thrombosis of the hepatic artery. Consequently, we have documented long-term patency of the stent-grafts in only one patient (case 4).

There were no other complications secondary to treatment.

Conclusions

Placement of stent-grafts for acute hepatic arterial bleeding can be a valuable alternative to embolization and surgical intervention, particularly in patients with surgically altered vascular anatomy. Immediate exclusion of the bleeding, with possible preservation of blood flow to vital organs, can be advantageous in comparison with other treatment methods.

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