Management of aneurysms involving branches of the celiac and superior mesenteric arteries: A comparison of surgical and endovascular therapy

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Objective: **Aneurysms involving branches of the superior mesenteric and celiac arteries are uncommon and require proper management to prevent rupture and death. This study compares surgical and endovascular treatment of these aneurysms and analyzes outcome.**

Methods: **Patients at the Mount Sinai Medical Center in New York who were treated for aneurysms in the branches of the celiac artery and superior mesenteric artery were identified through a search of the institution's medical records and endovascular database. Patient demographics, history, clinical presentation, aneurysm characteristics, treatments, and follow-up outcome were retrospectively recorded. Significant differences between patients treated by surgical or endovascular therapy were determined by using Student's *t* test and χ^2 analysis.**

Results: **Between January 1, 1991, and July 1, 2005, 59 patients with 61 aneurysms were treated at a single institution. Twenty-four patients had surgical repair, and 35 underwent endovascular treatment, which included coil embolization and stent-graft therapy. Splenic (28) and hepatic (22) artery aneurysms predominated. Eighty-nine percent of splenic artery aneurysms were true aneurysms and were treated by endovascular and surgical procedures in near equal numbers (14 and 11, respectively). Pseudoaneurysms were significantly more likely to be treated by endovascular means ($P < .01$). The technical success rate of endovascular treatment for aneurysms was 89%, and failures were successfully treated by repeat coil embolization in all patients who presented for retreatment. Patients treated by endovascular techniques had a significantly higher incidence of malignancy than patients treated with open surgical techniques ($P = .03$). Furthermore, patients treated by endovascular means had a shorter in-hospital length of stay (2.4 vs 6.6 days, $P < .001$).**

Conclusion: **Endovascular management of visceral aneurysms is an effective means of treating aneurysms involving branches of the celiac and superior mesenteric arteries and is particularly useful in patients with comorbidities, including cancer. It is associated with a decreased length of stay in the elective setting, and failure of primary treatment can often be successfully managed percutaneously. (J Vasc Surg 2006;44:718-24.)**

Visceral artery aneurysms are an uncommon entity that most commonly affect the splenic, hepatic, and superior mesenteric arteries.[1,2] With the increasing use of imaging studies for a variety of nonvascular abdominal disease processes, the diagnosis of visceral artery aneurysms is increasing in the asymptomatic patient population.[1,3] Although the natural history of these lesions has not been well documented, elective repair is advocated given the high morbidity and mortality associated with repair after rupture.

With the advent of endovascular techniques, the treatment options for visceral artery aneurysms have been greatly expanded beyond the conventional options of excision, bypass, and simple ligation.[4] Owing to the less invasive nature of endovascular repair, patients with medical comorbidities that prohibit open repair can now be considered for alternative methods to treat these aneurysms. Despite the perioperative advantages of endovascular repair, the unknown long-term durability of these repairs and the occasional need for secondary interventions has led to uncertainty of its role in the treatment of visceral artery aneurysms.

This study reviews a single-institution's experience with surgical and endovascular treatment of visceral artery aneurysms during a 15-year period to determine differences in patient characteristics and clinical outcomes between the two groups.

METHODS

The study was approved by the Institutional Review Board of the Mount Sinai School of Medicine. Patients who were diagnosed and treated for aneurysms involving branches of the celiac and superior mesenteric arteries at Mount Sinai Medical Center over the past 15 years (1991 to 2005) were identified from hospital records using International Classification of Disease (9th revision) codes and an endovascular database.

Surgical management consisted of aneurysm excision with revascularization, laparoscopic clipping, and end-organ resection. Endovascular management included coil embolization with platinum or stainless steel coils and

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Competition of interest: none.

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stent-graft therapy. Patients treated by endovascular means were monitored with magnetic resonance angiography (MRA), which reduces the artifact induced by coil embolization. In the endovascular group, the first imaging study was performed ≤1 month of the procedure. The current follow-up protocol for endovascular management of visceral aneurysms includes subsequent imaging at 3-month intervals for the first year and yearly thereafter.

Technical success for endovascular management was determined by the lack of aneurysm filling on completion angiography immediately after the procedure, and on follow-up MRA. In select cases, duplex ultrasound imaging was used to assess flow in the aneurysm.

All splenic artery aneurysms >2 cm and all those found in liver transplant recipients, or women of childbearing age, were treated. Additionally, all hepatic, celiac trunk, superior mesenteric artery (SMA) trunk, gastroduodenal, and pancreaticoduodenal aneurysms were treated in appropriate risk patients.

Patients were considered candidates for endovascular management if inflow and outflow vessels to and from the aneurysm could be accessed by a catheter-based system and if end-organ perfusion could be maintained by collateral blood flow or stent-graft therapy. Candidacy for endovascular therapy was determined by a 2-mm-cut computed tomography (CT) scan or thin-cut magnetic resonance imaging (MRI).

Hemodynamic instability at the time of presentation was defined as transfusion requirements of ≥2 U packed red blood cells. Endovascular management was used in cases of hemodynamic instability if the patient had a known visceral artery aneurysm that was documented on either CT scan or MRI and if the aneurysm met criteria for catheter-based treatment. Ultimately, the decision to use endovascular vs surgical management of these aneurysms was left to the discretion of the surgeon.

Charts were reviewed for age, gender, medical and surgical history, medications, aneurysm characteristics, presenting symptoms, imaging findings at diagnosis and at each follow-up, type of procedure(s), mode of anesthesia, transfusion requirements, complications, reinterventions, and mortality. Patients were considered lost to follow-up if they did not have at least one follow-up imaging study after endovascular management, if they did not appear for a postoperative visit, or if records documenting follow-up were not available.

Comparisons were made between patients treated using endovascular techniques and those treated by surgery in regards to age, gender, major medical comorbidities (coronary artery disease, pulmonary disease, diabetes, end-stage renal disease, end-stage liver disease, and cancer), previous surgery, aneurysm characteristics, presenting symptoms, complications, reinterventions, and mortality. Student's *t* test and χ^2 were used to assess statistical significance.

RESULTS

From 1991 to 2005, 59 patients with 61 aneurysms involving branches of the celiac and superior mesenteric arteries were treated by surgical or endovascular techniques. The demographics and clinical data of the patients are summarized in Table I. Endovascular techniques were used to treat 35 patients for 36 aneurysms (Figs 1, 2, and 3). The most common endovascular technique to manage the aneurysms was catheter-based coil embolization of all inflow and outflow vessels to the lesion (n = 31). In one patient with a splenic artery aneurysm and in two patients with hepatic artery aneurysms, stent-grafts were placed to exclude the aneurysm and preserve blood flow through the primary artery. In one patient with a known superior mesenteric artery pseudoaneurysm, angiography confirmed thrombosis of the aneurysm and no further intervention was performed.

Most of the endovascular procedures (n = 34) were performed in an angiography suite under sedation and local anesthesia. One patient was treated in the operating room with coil embolization during a laparotomy for evacuation of a hematoma.

Surgical management was used to treat 24 patients with 25 aneurysms. The procedures performed for these patients are described in Table II. Before 2000, 14 patients (58%) were treated surgically compared with 10 (28%) who were treated by endovascular means (P = .02). Patients who underwent endovascular management were more likely to have an associated malignancy than were surgically treated patients (P = .03). The mean age, gender, and number of patients with previous abdominal surgery did not significantly differ between the two groups.

Table I. Demographics and clinical status of patients who underwent either open or endovascular repair of an aneurysm involving the celiac and superior mesenteric arteries are shown

Demographics	*Endovascular (n = 35)*	*Open (n = 24)*
Age	56.6	51.9
Females	13	8
Comorbidities*†	10	6
Cirrhosis	2	1
CAD	2	1
ESRD	2	1
Pulmonary	5	0
Diabetes mellitus†	9	1
Malignancy	20	10
Hypertension	4	0
Pancreatitis	4	2
Other aneurysms	0	1
Pregnancy		
Patients with previous abdominal surgery	14	7
Aneurysms of celiac origin (n)	32	24
Aneurysms of SM origin (n)	4	1

CAD, Coronary artery disease; *ESRD,* end-stage renal disease; *SMA,* superior mesenteric.

*Comorbidities in bold-face were used to calculate the number of major comorbidities per patient.

†The *P* values for malignancy comorbidities were not significant, except for malignancy (P = .03).

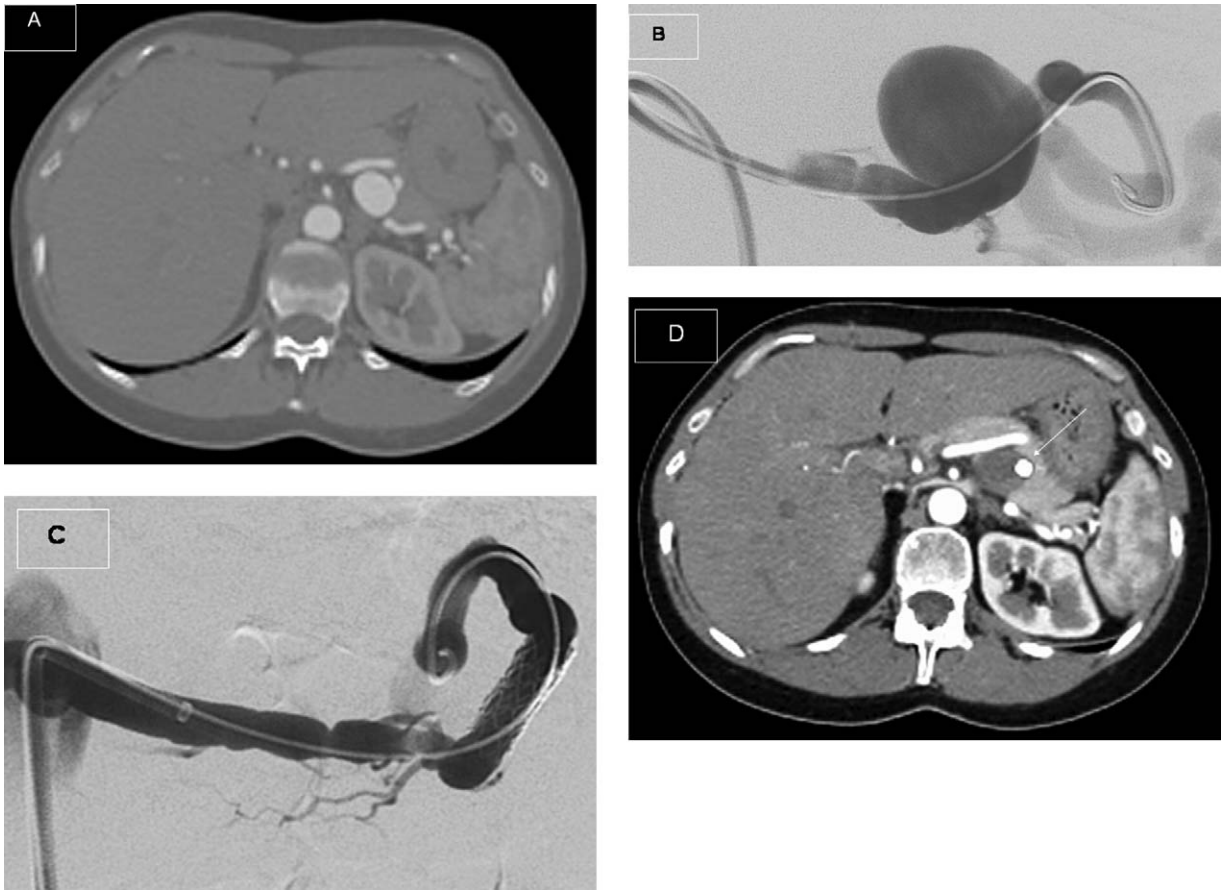

Fig 1. A, Computed tomography angiography (CTA) demonstrates a 2.6 cm splenic artery aneurysm. **B,** Angiogram of splenic artery aneurysm before stent deployment. **C,** Angiogram of splenic artery aneurysm after stent-graft deployment. **D,** Postoperative CTA demonstrating aneurysm exclusion by stent-graft (arrow). Heterogeneity of splenic tissue represents differences in flow dynamics between arterial supply and venous sinusoids.

The locations and types of aneurysms that were treated are described in Table III. Computerized tomography scans were available for re-review in 47 patients for the purpose of this study. In 12 of the 14 patients who presented with rupture, an aneurysm measurement could not be accurately determined. In the remaining patients with complete studies, the mean aneurysm size was 3.28 ± 1.60 cm in the endovascular group and 4.35 ± 1.98 cm in the surgical group ($P = .08$).

Pseudoaneurysms in this study were more likely to be treated by endovascular means: 18 (86%) of 21 were treated using endovascular techniques, whereas only three (14%) were treated by surgery ($P < .01$). Hepatic artery pseudoaneurysms were the predominant false aneurysms in both groups (62%) and occurred as a complication of liver transplantation in 4 patients, other general surgery procedures in 4 patients, percutaneous liver interventions in 3 patients, and trauma in 1 patient. The remaining hepatic artery pseudoaneurysm occurred in the setting of hepatocellular carcinoma.

The presenting symptoms of patients in both groups are shown in Table IV. There were no significant differences in presentation in patients who were treated by surgery or endovascular techniques. The aneurysm was identified as an incidental finding in 27 patients (46%). The most common presenting symptom was rupture, which occurred in 14 patients and was associated with hemodynamic instability and transfusion requirements of ≥2 U of packed red blood cells. Ruptured visceral artery aneurysms treated by endovascular techniques occurred in pseudoaneurysms involving the hepatic (n = 6), splenic (n = 1), and superior mesenteric arteries (n = 3). The ruptures treated by open surgery involved true aneurysms of the splenic artery in three patients and the hepatic artery in one patient. Length of stay for elective cases treated by endovascular means averaged 2.4 ± 1.6 days and was significantly less than the average length of stay for elective cases treated surgically (6.6 ± 4.7 days, $P < .001$).

Follow-up information, including postprocedure imaging in the endovascular group and postoperative outpatient assessment in the surgical group, was available in 29 patients (83%) and 12 patients (46%), respectively ($P < .01$) The average length of follow-up was 10.2 months (range, 1 to 65 months) in the endovascular group and

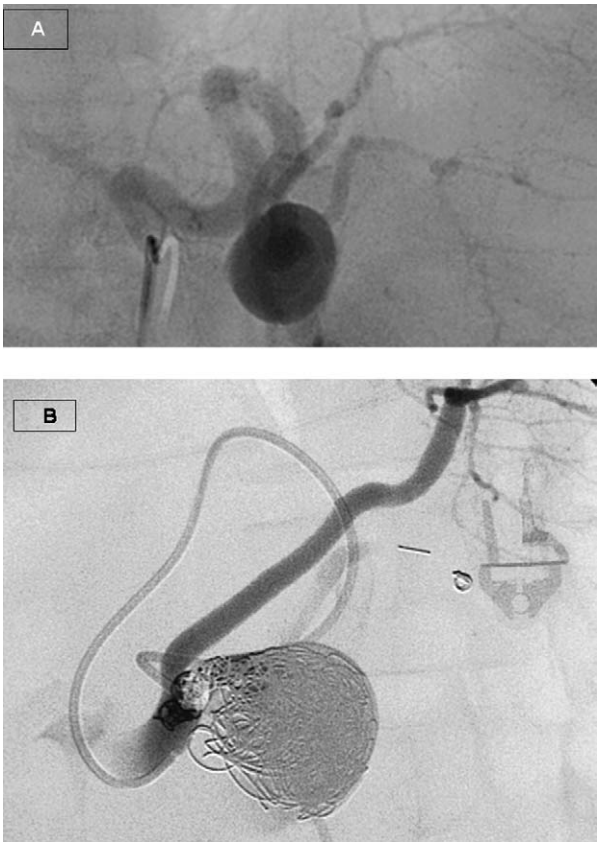

Fig 2. A, Angiogram of splenic artery aneurysm before coil embolization. **B,** Angiogram of splenic artery aneurysm after coil embolization.

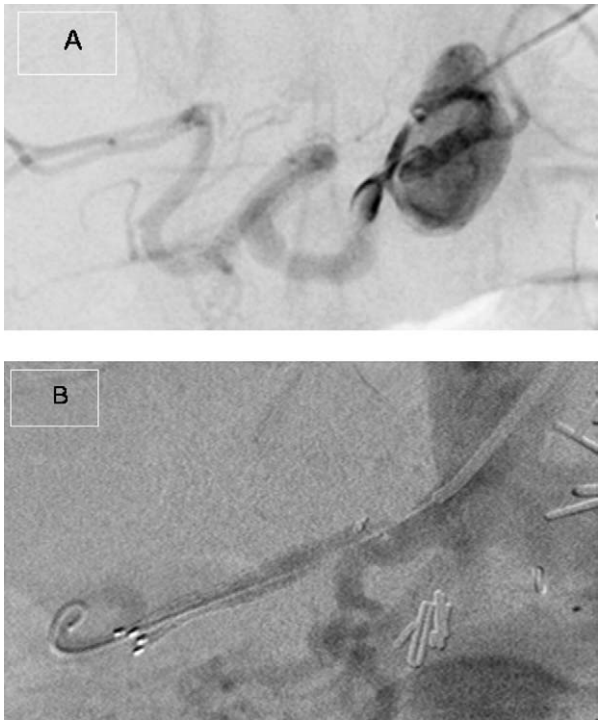

Fig 3. Before **(A)** and after **(B)** stent-graft deployment for a proper hepatic artery pseudoaneurysm originating distal to the gastroduodenal artery. The brachial artery was used for the approach.

22.3 months (range, 1 to 127 months) in the surgical group ($P = .06$).

Patients treated with surgery, when compared with those treated by endovascular techniques, did not differ significantly in 30-day mortality, complications, or need for reintervention (Table V). Elective and emergent cases in each group did not differ in morbidity or mortality. Nine patients (25%) in the endovascular group, had complications of their procedures, which included persistent aneurysm perfusion and enlargement in four, and one patient each with brachial artery hematoma, splenic artery dissection, liver abscess, infected pseudocyst, and pancreatitis.

Seven patients required one or more reinterventions. The mean time to reintervention in the endovascular group was 2.1 months (range, 0.2 to 8.1 months). Three patients underwent successful re-embolization for persistent perfusion, and one patient is scheduled for reintervention. The mean time to reperfusion was 11.7 months (range, 0.2 to 36.7 months). Other reinterventions, in one patient each, included evacuation of a brachial artery hematoma, distal pancreatectomy and splenectomy for splenic artery dissection, surgical débridement of an infected pseudoaneurysm, and percutaneous drainage of an intra-abdominal infection. One patient with advanced pancreatic cancer and pleural effusions underwent embolization of a hepatic artery pseudoaneurysm but died 2 weeks after the procedure from multisystem organ failure. The primary success rate for endovascular therapy was 89%.

Six (40%) of 15 patients with splenic artery aneurysms and follow-up imaging demonstrated splenic infarctions. One patient, as described, had splenic artery dissection with complete thrombosis of the splenic artery and infarction of the spleen, requiring splenectomy. In the remaining patients, the infarctions were of no major clinical significance, other than a source of pain that was successfully controlled by oral pain medication. Of interest, patients who presented with postprocedure splenic infarction were more likely to have splenomegaly associated with cirrhosis ($P = .02$) Three patients with infarctions had aneurysms of the distal splenic artery, two patients had aneurysms in the middle of the splenic artery, and the aneurysm involved the proximal splenic artery in one patient.

Eight patients in the surgical group had complications, of which four required reinterventions. Complications consisted of graft thrombosis and ileus in 2 patients each; and pseudoaneurysm, bile leak, intra-abdominal abscess, and wound infection in one patient each. Reinterventions in this group included, in one patient each, retransplantation of the liver for bile leak, graft thrombectomy, percutaneous drainage of an intra-abdominal infection, and coil embolization for a pseudoaneurysm arising from a branch of the

Table II. Surgical treatment of true and pseudoaneurysms of the celiac and superior mesenteric artery aneurysms

Location	*Type*	*Operation*
Celiac	True	Resection; bypass
GDA	True	GDA exclusion; bypass
Hepatic	True	Resection; interposition graft
Hepatic	Pseudo	Resection; bypass
Hepatic	Pseudo	Exploration and direct repair of artery
Hepatic	True	Resection; bypass
Hepatic	True	Ligation; hepatectomy
Hepatic	Pseudo	Ligation
Hepatic	True	OLT
Hepatic	True	Resection
Hepatic	True	Ligation; bypass
Hepatic	Pseudo	Resection; bypass
PDA	True	Excision; primary repair
Splenic	True	Splenectomy, distal pancreatectomy
Splenic	True	Splenectomy
Splenic	True	Distal pancreatectomy
Splenic	True	Laparoscopic aneurysm clipping
Splenic	True	Excision
Splenic	True	Splenectomy
Splenic	True	Splenectomy
Splenic	True	Splenectomy; distal pancreatectomy
Splenic	True	Laparoscopic aneurysm clipping
Splenic	True	Resection; interposition graft
Splenic	True	Splenectomy, distal pancreatectomy

GDA, Gastroduodenal artery aneurysm; *PDA,* pancreaticoduodenal artery aneurysm; *OLT,* orthotopic liver transplant.

Table III. Location and classification of aneurysms treated by either endovascular or open techniques

*Aneurysm**	*Endovascular (n = 35)*	*Open (n = 24)*
Splenic		
True	14	11
Pseudo	3	0
Hepatic*		
True	1	7
Pseudo	10	4
Celiac trunk		
True	2	1
Pseudo	0	0
Gastroduodenal		
True	1	1
Pseudo	1	0
Superior mesenteric artery		
True	0	0
Pseudo	3	0
Pancreaticoduodenal artery		
True	0	1
Pseudo	1	0

*The *P* values for these aneurysms were not significant except for hepatic ($P = .002$).

superior mesenteric artery after a bypass from the superior mesenteric artery to the celiac artery with saphenous vein. One patient died in the perioperative period after splenectomy and distal pancreatectomy for a ruptured splenic artery aneurysm.

Table IV. Initial presentation of patients treated either with endovascular techniques or surgery for aneurysms of the celiac and superior mesenteric arteries*

Presentation	*Endovascular*	*Open*
Incidental	18	10
Symptomatic	18	14
Pain	5	7
Rupture	10	4
Gastrointestinal bleeding	1	1
Hemobilia	1	1
Infected pseudocyst	1	1

*The *P* values for these data are not significant.

Table V. Complications, reinterventions, and 30-day mortality after open or endovascular repair of aneurysms involving branches of the celiac and superior mesenteric arteries*

	Endovascular (n = 35)	*Open (n = 24)*
Complications	9	8
Reinterventions	7	4
Deaths ≤30 days	1	1

*The *P* values for these data are not significant.

DISCUSSION

The diagnosis of aneurysms originating from branches of the celiac and superior mesenteric artery has increased because of the widespread use of diagnostic imaging studies. The high morbidity and mortality associated with aneurysm rupture was, and remains, a major impetus to study their etiology, progression, and treatment. However, the increased detection of incidental aneurysms, coupled with advancements in endovascular techniques, has mandated a more extensive review of treatment options and indications.

Management options include observation for small aneurysms, endovascular treatment with catheter-based embolization, and in select patients, stent-graft therapy or surgical repair.[5-14] Symptomatic splenic artery aneurysms, those that are ≥2 cm, and those found in women of childbearing age or in liver transplant recipients should be fixed because of a high association with rupture.[1,2,15-17] Elective repair is associated with mortality rates <0.5%.[16]

All hepatic artery true aneurysms have traditionally warranted repair because of the high association with rupture and death; furthermore, patients with a nonatherosclerotic etiology and those with multiple aneurysms are at greater risk of rupture, ranging from 14% to 80% in the literature.[18] Hepatic artery pseudoaneurysms are associated with an increased risk of rupture, with mortality rates of 20%, and should be repaired.[1] Endovascular repair for hepatic artery pseudoaneurysms has been performed safely and is effective.[19] Aneurysms involving the celiac trunk, superior mesenteric artery, gastroduodenal artery, pancre-

aticoduodenal artery are uncommon, have an unpredictable rupture rate, and should be repaired if treatment can be associated with low morbidity and mortality.[12,20]

Historically, small series of ≤25 patients have predominated in the literature regarding etiology and treatment of visceral artery aneurysms. During the past 5 years, larger series have been published that detail the experience with surgical and endovascular management, as well as observation.[3,17,18,21,22] This study adds to the current literature on aneurysms of the celiac and superior mesenteric arteries, not only because it describes a large series of patients but also because all of the patients in this study received treatment. Approximately equal numbers of patients have been treated at our institution by surgical and endovascular means during the last 15 years, which enables a comparison between the two treatment options regarding patient selection, length of stay, morbidity, and mortality.

The initial technical success rate for the endovascular procedures was 89%, similar to that reported by others.[4,11,19,20] Secondary interventions for persistent perfusion were successfully performed in three patients, suggesting that failures of primary treatment need not require surgical management to ensure aneurysm exclusion. Persistent perfusion represented the most common complication of elective therapy, occurring in 11% of those patients. In the literature, lack of complete aneurysm exclusion ranges from 4% to 43%, and, along with infarction, is one of the major limitations of this procedure.[4,20]

The length of stay for elective cases was significantly less for the endovascular group than the open group in the present study. Currently, coil embolization of a splenic artery aneurysm is performed as an ambulatory procedure, and in most patients, it represents our initial treatment of choice for this clinical entity.

Complication rates in both groups did not differ for either elective or emergent cases, and are within the reported range in the literature.[1,18] Similarly, the reintervention rate was not significantly different between the endovascular and surgical groups, and included procedures related to persistent perfusion, graft thrombosis, distal ischemia, and infection. The number of patients with follow-up information was significantly less in the surgical group, however, suggesting that differences in the complication and reintervention rates might be underestimated. Thus, it is not possible from the data in the present study to conclude that endovascular treatment is superior to surgical management in regards to morbidity and need for secondary procedures.

Forty percent of patients who underwent endovascular treatment of splenic artery aneurysms had radiographic evidence of splenic infarctions. To date, however, none of these patients have presented with splenic abscess, or other sequelae, and most were successfully managed with pain control. Although other series have documented splenic infarctions after embolization, there is a paucity of information concerning its significance.[23,24] Other series have suggested that infarction appears to be associated with aneurysms located distally on the splenic artery.[3] In our series, splenic artery infarction was significantly associated with cirrhosis.

Patients with rupture and hemodynamic instability were successfully treated by endovascular means. The data suggest that hemodynamic instability does not preclude successful endovascular management, which may be the treatment of choice in patients with associated comorbidities. Although all of the ruptures managed by open surgery were true aneurysms, those that were treated by endovascular means were pseudoaneurysms. Pseudoaneurysms, as a group, were dominated by hepatic pseudoaneurysms and were significantly more likely to be treated using endovascular techniques. This likely reflected an attempt to avoid difficult surgery in patients with multiple comorbidities, including cirrhosis and cancer, and has been reported as an effective strategy in other series.[5,10]

CONCLUSION

In conclusion, endovascular management is an effective means of treating aneurysms involving the celiac and superior mesenteric arteries and their branches. It is associated with a decreased length of stay in the elective setting, and failure of primary treatment can be successfully managed with a repeat percutaneous procedure. Endovascular repair is particularly useful in patients with multiple comorbidities, particularly malignancy, and can be used in cases of hemodynamic instability. Further long-term data will help elucidate whether morbidity and durability truly differs between endovascular and surgical treatments.

AUTHOR CONTRIBUTIONS

Conception and design: US, DB, SE, RL
Analysis and interpretation: US, DB, SE, TJ, AC
Data collection: US, DB, RL, SE, TJ,
Writing the article: US, DB, TJ
Critical revision of the article: SE, RL, MM, TJ, AC, VT
Final approval of the article: MM
Statistical analysis: US, DS, AC
Obtained funding: Not applicable
Overall responsibility: MM

REFERENCES

1. Berceli SA. Hepatic and splenic artery aneurysms. Semin Vasc Surg 2005;18:196-201.
2. Messina LM, Shanley CJ. Visceral artery aneurysms. Surg Clin North Am 1997;77:425-42.
3. Saltzberg SS, Maldonado TS, Lamparello PJ, Cayne NS, Nalbandian MM, Rosen RJ, et al. Is endovascular therapy the preferred treatment for all visceral artery aneurysms? Ann Vasc Surg 2005;19:507-515.
4. Gabelmann A, Gorich J, Merkle EM. Endovascular treatment of visceral artery aneurysms. J Endovasc Ther 2002;9:38-47.
5. Rami P, Williams D, Forauer A, Cwikiel W. Stent-graft treatment of patients with acute bleeding from hepatic artery branches. Cardiovasc Intervent Radiol 2005;28:153-8.
6. Moyer HR, Hiramoto JS, Wilson MW, Reddy P, Messina LM, Schneider DB. Stent-graft repair of a splenic artery aneurysm. J Vasc Surg 2005;41:897.
7. Larson RA, Solomon J, Carpenter JP. Stent graft repair of visceral artery aneurysms. J Vasc Surg 2002;36:1260-3.

8. Hossain A, Reis ED, Dave SP, Kerstein MD, Hollier LH. Visceral artery aneurysms: experience in a tertiary-care center. Am Surg 2001;67: 432-7.
9. Dave SP, Reis ED, Hossain A, Taub PJ, Kerstein MD, Hollier LH. Splenic artery aneurysm in the 1990s. Ann Vasc Surg 2000;14:223-9.
10. Banga NR, Kessel DO, Patel JV, White SA, Pollard SG, Prasad KR, Toogood GJ. Endovascular management of arterial conduit pseudoaneurysm after liver transplantation: a report of two cases. Transplantation 2005;79:1763-5.
11. Sessa C, Tinelli G, Porcu P, Aubert A, Thony F, Magne JL. Treatment of visceral artery aneurysms: description of a retrospective series of 42 aneurysms in 34 patients. Ann Vasc Surg 2004;18:695-703.
12. Stone WM, Abbas M, Cherry KJ, Fowl RJ, Gloviczki P. Superior mesenteric artery aneurysms: is presence an indication for intervention? J Vasc Surg 2002;36:234-7; discussion 237.
13. Reardon PR, Otah E, Craig ES, Matthews BD, Reardon MJ. Laparoscopic resection of splenic artery aneurysms. Surg Endosc 2005;19: 488-93.
14. Grego FG, Lepidi S, Ragazzi R, Iurilli V, Stramana R, Deriu GP. Visceral artery aneurysms: a single center experience. Cardiovasc Surg 2003;11:19-25.
15. Heestand G, Sher L, Lightfoote J, Palmer S, Mateo R, Singh G, et al. Characteristics and management of splenic artery aneurysm in liver transplant candidates and recipients. Am Surg 2003;69:933-40.
16. Stanley JC. Mesenteric arterial occlusive and aneurysmal disease. Cardiol Clin 2002;20:611-22, vii.
17. Abbas MA, Stone WM, Fowl RJ, Gloviczki P, Oldenburg WA, Pairolero PC, et al. Splenic artery aneurysms: two decades experience at Mayo clinic. Ann Vasc Surg 2002;16:442-9.
18. Abbas MA, Fowl RJ, Stone WM, Panneton JM, Oldenburg WA, et al. Hepatic artery aneurysm: factors that predict complications. J Vasc Surg 2003;38:41-5.
19. Kasirajan K, Greenberg RK, Clair D, Ouriel K. Endovascular management of visceral artery aneurysm. J Endovasc Ther 2001;8:150-5.
20. Chiesa R, Astore D, Guzzo G, Frigerio S, Tshomba Y, Castellano R, et al. Visceral artery aneurysms. Ann Vasc Surg 2005;19:42-8.
21. Tessier DJ, Abbas MA, Fowl RJ, Stone WM, Bower TC, McKusick MA, et al. Management of rare mesenteric arterial branch aneurysms. Ann Vasc Surg 2002;16:586-90.
22. Stone WM, Abbas MA, Gloviczki P, Fowl RJ, Cherry KJ. Celiac arterial aneurysms: a critical reappraisal of a rare entity. Arch Surg 2002;137: 670-4.
23. Ekeh AP, McCarthy MC, Woods RJ, Haley E. Complications arising from splenic embolization after blunt splenic trauma. Am J Surg 2005; 189:335-9.
24. Nores M, Phillips EH, Morgenstern L, Hiatt JR. The clinical spectrum of splenic infarction. Am Surg 1998;64:182-8.

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