Complications arising from splenic embolization after blunt splenic trauma

Akpofure Peter Ekeh, M.D.*, Mary C. McCarthy, M.D., Randy J. Woods, M.D., Earl Haley, B.S.

Department of Surgery, Wright State University, Miami Valley Hospital, 1 Wyoming St., CHE 7000, Dayton, OH 45459, USA

Presented at the 47th Annual Meeting of the Midwest Surgical Association, Mackinac Island, Michigan, August 15–18, 2004

Abstract

Background: Nonoperative management (NOM) of splenic trauma is now the standard in stable trauma patients. Splenic artery embolization (SAE) is an increasingly used adjunct to NOM. We examined complications arising from SAE.

Methods: Patients admitted to a level I trauma center with splenic trauma over a 26-month period were identified. Management method, operative or nonoperative, was noted. SAE patients were analyzed in detail.

Results: There were 284 splenic trauma admissions. Ninety-three patients underwent operative management, and 191 received NOM. Fifteen patients (7.8%) underwent SAE. Embolization was proximal in 10, distal in 1, and combined in 4 patients. No NOM failures occurred. Major complications (27%) included splenic bleeding, splenic infarction, splenic abscess, and contrast-induced renal insufficiency. Minor complications of fever, pleural effusions, and coil migration occurred in 53% of patients. No relationship between SAE location and the presence of complications was noted.

Conclusions: SAE is an effective and safe procedure. Both major and minor complications can arise after SAE. © 2005 Excerpta Medica Inc. All rights reserved.

Keywords: Complications; Embolization; Spleen; Trauma

Nonoperative management (NOM) of blunt splenic injuries has become the standard of care for hemodynamically stable trauma patients during the last 2 decades. Originally practiced solely in the pediatric population, observational treatment of splenic injuries has been widely applied to patients of all ages [1,2]. This trend has been fueled by the potential benefits of splenic preservation including elimination of laparotomy and the decrease of overwhelming postsplenectomy infections (OPSI).

Splenic artery embolization (SAE) is a valuable adjunct to nonoperative management. Hemostatic coils are inserted into the splenic artery through an angiographic catheter for the purpose of decreasing blood flow to the spleen. This modality was initially described for hematologic indications in the 1970s [3,4]. Its use in splenic injury was first reported in the early 1980s [5].

Splenic angiography has been liberally employed at some large level I trauma centers, and embolization performed when active extravasation (indicating bleeding) or a pseudoaneurysm is visualized [6,7]. Other centers have expanded the use of SAE to patients with American Association for the Surgery of Trauma (AAST) grades III, IV, and V splenic injuries even in the absence of a contrast blush or pseudoaneurysm on abdominal computed axial tomography (CAT) scan [8].

Evaluating the risk-to-benefit ratio of a new procedure requires full knowledge of all risks. This study was designed to assess complications that have arisen from the increasing use of SAE in a Midwestern American College of Surgeons (ACS)—verified level I Trauma Center.

Methods

Trauma registry (TraumaBase, Clinical Data Management, Evergreen, Colorado) and medical record information...
of patients with splenic injuries admitted to Miami Valley Hospital (MVH), an ACS-verified adult and pediatric trauma center, between January 2000 and February 2004 were reviewed. Patients were grouped by management method of their splenic injury: operative or nonoperative. Individuals who underwent SAE were selected for detailed analysis. Age, sex, length of stay, associated injuries, Injury Severity Score (ISS), details of angiography, and complications were abstracted. No formal protocols regarding SAE were in place at the time of this study. Angiography and SAE were ordered at the discretion of the admitting trauma surgeon and were performed by interventional radiologists in the angiography suite. The site of splenic artery occlusion was determined by review of the radiology reports. The agent used for embolization—coils, Gelfoam (Pharmacia, Kalamazoo, Michigan), or microspheres—was also noted in each case. “Proximal” SAE was defined to be the placement of the hemostatic coils or gel foam in the main trunk of the splenic artery. “Distal” embolization was defined as embolization involving ≥1 of the individual terminal branches of the splenic artery. No prophylactic antibiotics were used specifically for SAE as described in some series[9]. Statistical analysis was performed using GraphPad Instat Version 3.05 software (GraphPad Software, San Diego, California).

Complications were classified as major or minor. Major complications were regarded as adverse events believed to be directly arising from SAE that could potentially result in severe disability or death. Minor complications were considered adverse events not deemed to be life threatening. The Institutional Review Board of Miami Valley Hospital, Dayton, Ohio, approved the protocol.

Results

During the 26-month period of review (January 2000 to February 2004), 284 patients were admitted to MVH with blunt splenic trauma. Ninety-three patients underwent operative management (82 splenectomies, 8 splenorrhaphies, and 3 resuscitative thoracotomies), and 191 underwent NOM. Fifteen patients in the NOM group underwent SAE (7.8%). In this embolization group, there were 11 men and 4 women with ages ranging from 17 to 84 years (average 36.2). Injury was caused by motor vehicle crashes in 12 patients (80%): 9 automobile, 2 motorcycle, and 1 all-terrain vehicle. The characteristics of these 15 patients are listed in Table 1. The mean AAST splenic grade was 3.5, and grade III injuries were the most frequent (7 patients). Mean ISS was 23.8.

The indications for angiography with subsequent embo-
lization were the presence of a contrast blush on CAT scan in 8 patients (53%), AAST grade IV splenic injury in 6 patients (40%), and AAST grade III splenic injury in 1 patient. All patients were hemodynamically stable before undergoing angiography. Arterial access was obtained by way of the right femoral artery in all patients. Seven of these patients had active bleeding noted on splenic angiography, and pseudoaneurysms were seen in 2 patients. In 6 patients, no active bleeding or pseudoaneurysm was detected. All the patients underwent angiography with subsequent embolization, and no patients underwent angiography alone.

Of the 15 patients that underwent embolization, and hemo-
static stainless steel embolization coils (Cook, Bloomington, Indiana) were the agent used in 14 patients. Coils were used in combination with Gelfoam (Pharmacia) in 2 patients and in combination with microspheres (Contour–SETM, Boston Scientific, Watertown, Massachusetts) in 1 patient. Microspheres alone were used for embolization in 1 patient.

In 10 patients, embolization was performed proximally. In 4 patients, both proximal and distal embolization was performed. Distal embolization alone was performed in 1 patient. None of the patients required operative intervention caused by failure of NOM. In all these patients, SAE was performed within the first 12 hours of admission. Repeat CAT scans were performed in 7 patients at varying times after SAE ranging from 2 days to 6 weeks. Splenic infarction was detected in only 1 patient in a repeat CAT scan performed 1 week after injury. (Fig. 1) A splenic abscess was noted in another patient at 6 weeks. This patient also had an upper abdominal abscess. (Fig. 2)

Complications occurring after SAE were classified as major and minor. Major complications occurred in 4 pa-
tients (27%): postprocedure splenic bleeding (1 patient), splenic infarction (2 patients), splenic abscess (1 patient), and contrast-induced renal insufficiency (1 patient). Minor complications occurred in 8 patients (53%): fever (8 pa-
tients), left pleural effusions (4 patients), and unplanned distal coil migration (2 patients). This information is sum-
marized in Tables 2 and 3.

The patient who continued to bleed after angioemboli-
zation had a decrease in hematocrit, and increased hemo-
peritoneum was seen on CAT scan 2 days after the proce-
dure. This patient had undergone proximal embolization. Neither repeat angiography nor operative intervention was required. There was no statistically significant association between the method of embolization (proximal, distal, or combined) and the presence of complications by chi-square test for independence. ($P = 0.1225$)

The average length of stay was 9.7 days (range 4 to 23). There was 1 death in an elderly diabetic patient who had a myocardial infarction and major cerebrovascular accident after traumatic injury. This patient developed renal insufficiency after SAE. Her death was not related to the complication.

Splenic salvage was 100% at the time of discharge from the hospital in the patients that underwent SAE. One patient, however, required splenectomy 2 months after injury caused by the development of a splenic abscess (Fig. 2). There were no arterial access site complications, and there were no iatrogenic visceral vessel injuries.

Comments

The earliest reports of splenic embolization in the liter-
ature were in the settings of hematologic disorders [10]. Typical indications cited in the literature include splenic artery aneurysms [11], portal hypertension with hyper-
splenism [12], and just before laparoscopic splenectomy [13]. Complications noted after SAE in nontrauma patients

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Fig. 1. CAT scan of the abdomen and pelvis showing near-complete infarct of the spleen 1 week after proximal and distal SAE. CAT = computed axial tomography; SAE = splenic artery embolization.

Fig. 2. CAT scan of the abdomen showing a splenic access as well as an adjacent upper-abdominal intraperitoneal abscess 6 weeks after proximal SAE. CAT = computed axial tomography; SAE = splenic artery embolization.
include splenic abscess, rupture of the spleen, pancreatitis, pneumonia, and septicemia [14,15]. These patients undergoing SAE in nontraumatic settings typically have significant comorbidities compared with typical young and healthy trauma patients.

Sclafani [5] described the first use of SAE in the trauma population in 1981. Typical indications for the use of SAE have been the presence of a contrast blush on CAT scan or a visualized pseudoaneurysm in hemodynamically stable trauma patients [16,17]. SAE, however, has been expanded beyond these traditional indications to include situations such as significant hemoperitoneum, grade 4 or 5 splenic injury, decreasing hematocrit not explained by other injuries, and persistent tachycardia [18]. Almost half (47%) of the patients in this study had nontraditional indications. Prospective studies directed at investigating the utility of SAE in high-grade splenic injuries without the presence of contrast blush or pseudoaneurysms are needed.

Few studies have specifically addressed complications of SAE after traumatic indications. A Western Trauma Association multi-institutional study, which is the largest aggregate of SAE patients to date, reported a major complication rate of 20% and a minor complication rate of 23% [19]. Postprocedural bleeding and splenic abscesses were the most frequent complications in their series. This study classified splenic infarct (without abscess) as a minor complication. Fever was also not considered to be a complication. Fever was included as a minor complication in our study because its presence can potentially lead to increased length of stay and require additional procedures for evaluation. Persistent splenic bleeding was seen in only 1 patient in our series. This patient did not require any further intervention. The determination of the exact source of bleeding can be challenging in multiply injured patients. Our splenic bleeding rate of 7% is lower than most other studies to date. None of our patients failed conservative therapy with the use of this adjunct modality, and none returned for repeat angiography. The splenic salvage rate in this series was 94%. One patient required a delayed splenectomy for splenic abscess 2 months after injury. No vascular access site or visceral vessel injuries were noted.

Fever was noted to be a frequent occurrence in the patients in this series and occurred in 53% of patients. This resolved spontaneously in all patients without intervention. It was difficult to identify the exact source of the fever in patients with multiple injuries. The clinical significance of the fever was unclear. Although described in some studies [12], prophylactic antibiotics were not administered in these patients.

Only 1 patient required intervention for complications. The patient who developed the late splenic abscess also had a large pleural effusion that required thoracentesis. This patient underwent concurrent hepatic angiography and embolization at the time of SAE. It is not known if these simultaneous embolization procedures may have played a role in the development of

<table>
<thead>
<tr>
<th>Complication</th>
<th>No. of patients (%)</th>
<th>Outcome</th>
<th>Location of coils</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Splenic infarction</td>
<td>2/15 (13)</td>
<td>Near-total infarction of spleen (Fig. 1); no intervention required; discovered at autopsy in second patient</td>
<td>Distal Proximal and distal</td>
<td>Patient had history of chronic renal failure and was on dialysis</td>
</tr>
<tr>
<td>Splenic abscess</td>
<td>1/15 (7)</td>
<td>Patient underwent splenectomy 6 weeks after discharge; also had peripancreatic abscess (Fig. 2)</td>
<td>Proximal</td>
<td>Had concurrent hepatic embolization; history of chronic pancreatitis, concurrent intra-abdominal abscess</td>
</tr>
<tr>
<td>Contrast-induced renal insufficiency</td>
<td>1/15 (7)</td>
<td>BUN and creatinine reverted to normal, however patient died from myocardial infarction and CVA</td>
<td>Proximal</td>
<td>78-year-old patient with history of hypertension and diabetes</td>
</tr>
<tr>
<td>Bleeding</td>
<td>1/15 (7)</td>
<td>Patient received blood transfusions, no need for repeat embolization or surgery</td>
<td>Proximal</td>
<td>Significant decrease in hemoglobin; increased hemoperitoneum seen on repeat CAT 2 days post-SAE</td>
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</tbody>
</table>

Table 3

<table>
<thead>
<tr>
<th>Complication</th>
<th>No. of patients (%)</th>
<th>Outcome</th>
<th>Location of coils</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pleural effusion</td>
<td>4/15 (27)</td>
<td>No intervention in 3 patients drainage of 750 mL fluid from left pleural space in 1 patient</td>
<td>2 proximal and distal 2 proximal</td>
<td></td>
</tr>
<tr>
<td>Fever</td>
<td>8/15 (53)</td>
<td>Resolved spontaneously in all</td>
<td>4 proximal, 2 proximal and distal, 2 distal</td>
<td></td>
</tr>
<tr>
<td>Distal coil migration</td>
<td>2/15 (13)</td>
<td>No untoward sequelae</td>
<td>2 proximal</td>
<td></td>
</tr>
</tbody>
</table>

BUN = blood urea nitrogen; CAT = computed axial tomography; CVA = cerebrovascular accident; SAE = Splenic artery embolization.
complications in this patient. All other complications in the other patients resolved spontaneously.

Contrast-induced nephropathy occurred in 1 patient. (7%) The incidence of contrast-induced nephropathy is generally lower than in the past. This is believed to be caused by the abundant use of nonionic contrast media for imaging studies [20,21]. Patients undergoing SAE typically receive an additional intravenous contrast load after CAT scans. Care and attention to patients with pre-existing renal problems and to diabetic patients is needed. A recent study reported that use of sodium bicarbonate solution rather than normal saline infusion for contrast studies decreases the incidence of related nephrotoxicity [22]. This should be considered in high-risk patients.

Limitations of this study include its retrospective nature, small size, and relatively short follow-up period. Most of these patients were followed-up in the trauma clinic at least 1 month after the injuries. Potential long-term complications resulting from SAE are unknown in the trauma population. A Swedish series evaluating patients who had undergone SAE for non-traumatic indications showed no major long-term sequelae after periods as long as 5 years [23]. No long-term follow-up has been described in the literature to date with regard to trauma patients. The status of splenic immunologic function after SAE is unknown. This area also requires further study.

Only 7 patients in our study underwent postprocedure CAT scans, which could evaluate for the presence of infarcts. The clinical significance of infarcts is unclear. In a study from the Maryland Shock Trauma Center, Baltimore, Maryland, in which CAT scans after SAE were performed, infarcts were found in 63% of patients after proximal embolization and in 100% after distal embolization [24]. CAT scan noted only 1 patient to have an infarct after SAE in our series. This was a near complete infarction of the spleen. The other splenic infarct was noted at autopsy of the single trauma patients. The status of splenic immunologic function after SAE is unknown. This area also requires further study.

Overall, as indicated in other studies, SAE is a safe and useful adjunct to NOM of splenic trauma. In this series, major complications occurred in 27% and minor complications in 53% of patients. The site of embolization is not related to the presence of complications. Prospective studies evaluating complications related to specific indications for splenic embolization as well as the proximal or distal location of SAE are needed.

References