Splenic Artery Embolization: Proximal or Distal?

A review of when proximal or distal embolization should be used, optimal technique, and results of studies evaluating outcomes.

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The spleen is a fragile organ prone to traumatic rupture and bleeding with potential life-threatening consequences. Surgery was previously the preferred treatment option; however, splenectomy is not organ preserving.[1] Nonoperative management of splenic rupture is increasingly performed to salvage the spleen, resulting in improved patient immunity.

Splenic embolization has been shown to increase the success rate of nonoperative management. This article discusses when proximal or distal embolization should be used in splenic rupture, embolization technique and follow-up, and results from studies that have evaluated either technique and subsequent outcomes.

TRAUMA ASSESSMENT AND TRIAGE

A hemodynamically unstable patient should go straight to surgery. If the patient is stable, a CT scan with intravenous contrast should be performed as soon as possible, which is important for decision-making and further patient triage. Splenic embolization should be performed in patients with high-grade splenic injury (American Association for the Surgery of Trauma grade IV–V), those with American Association for the Surgery of Trauma grade III splenic laceration when a large hemoperitoneum is present, and in those with any vascular splenic injury such as contrast extravasation, vessel rupture, parenchymal blush, or pseudoaneurysm.

Figure 1. An 84-year-old trauma patient with peripheral contrast extravasation at the lower pole of the spleen (arrow) and hematoperitoneum on contrast-enhanced CT (A). A selective celiac arteriogram confirmed peripheral contrast extravasation (arrow) from a lower pole segmental branch of this patient's tortuous splenic artery (B). Distal embolization of the lower pole segmental artery was performed with pushable coils (arrow) using a coaxial system consisting of a 5-F VS2 diagnostic catheter and a 2.7-F microcatheter (C).

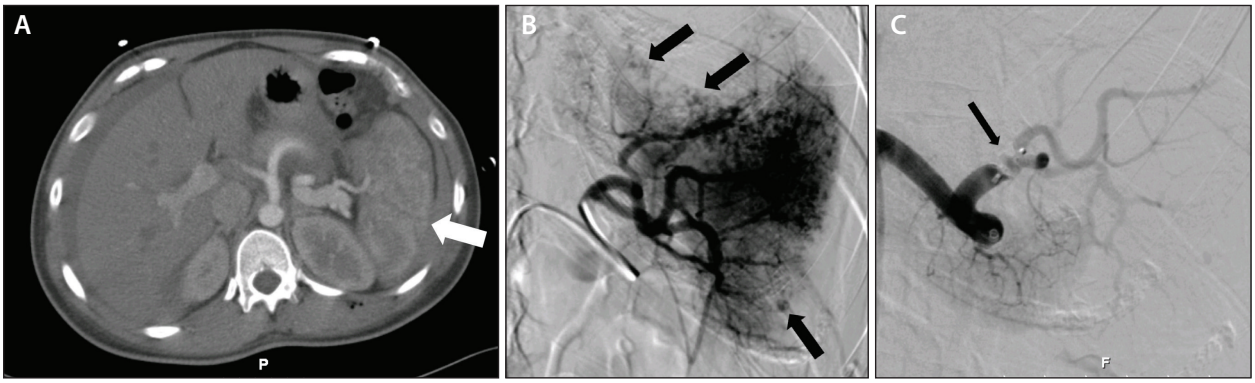

Figure 2. A trauma patient with splenic laceration (arrow) and hematoperitoneum on contrast-enhanced CT (A). A selective splenic artery angiogram demonstrated splenic laceration with multiple parenchymal blushes indicative of parenchymal bleeds (arrows) (B). Despite a tortuous splenic artery, a 5-F sheath could be advanced to the mid splenic artery, and a vascular plug (arrow) was deployed for proximal splenic artery embolization (C). Shortly after vascular plug deployment, there was collateral flow to the distal splenic artery.

PROXIMAL OR DISTAL EMBOLIZATION?

In patients with a single parenchymal lesion (blush or contrast extravasation), distal curative embolization should be performed as close as possible to the site of injury to reduce the risk of splenic parenchymal infarction (Figure 1). In patients with multiple parenchymal lesions, proximal embolization should be carried out to reduce arterial pressure (Figure 2). Embolization should be performed in the mid splenic artery between the dorsal pancreatic and pancreatica magna arteries to reduce potential pancreatic complications such as ischemic pancreatitis. Proximal embolization should also be performed to prevent splenic hemorrhage in high-risk patients aged 50 years or older, those with multiple trauma, those with intraperitoneal bleed, or in patients with planned prolonged surgery for other reasons such as neurosurgery or orthopedic surgery.

EMBOLIZATION TECHNIQUE

For procedure planning, celiac and splenic artery anatomy should be evaluated on contrast-enhanced CT images, including two- and three-dimensional formats, to help determine a vascular access route and choose adequate materials for either proximal or distal splenic artery embolization. In general, either permanent or temporary embolization materials can be used. Permanent materials include coils, vascular plugs, glue, or particles. However, glue and particles have demonstrated an increased risk of extensive splenic infarction and nontarget embolization.[2] Temporary embolization materials such as Gelfoam (Pfizer, Inc.) have inferior outcomes compared with permanent embolization materials.[2] In patients with a straight splenic artery, vascular plugs such as the Amplatzer vascular plug (AVP), AVP II, or AVP 4 (Abbott Vascular, formerly St. Jude Medical) can be used (Figure 3). The AVP II is well suited for proximal embolization and can be deployed using a 6-F sheath up to a 12-mm diameter. The AVP 4 has a maximum diameter of 8 mm and can be used for both proximal and distal embolization depending on arterial diameter[3]; however, it can be deployed using a 4-F diagnostic catheter, also facilitating distal embolization.

In patients with a tortuous splenic artery, detachable coils (eg, Detach-18 coils, Cook Medical) up to a 20-mm diameter can be deployed using a microcatheter for proximal embolization. For distal embolization, pushable coils (eg, Tornado Platinum coils, Cook Medical) up to a 10-mm diameter can be deployed using a microcatheter. A combination of vascular plugs and coils may be used if necessary, but it has been suggested that the risk of migration is higher with coils as compared with vascular plugs. To avoid migration, vascular plugs should be oversized up to 50%, because traumatized patients in hemodynamic shock may present with vasoconstriction. In patients with a challenging celiac artery, such as a vertical course with or without diaphragm compression, a brachial approach may be necessary.

FOLLOW-UP

Close clinical and imaging follow-up after splenic artery embolization is mandatory. On postinterventional day 5, a contrast-enhanced CT scan should be performed. Other than extensive splenic infarction, possible complications include ischemic pancreatitis or other nontarget embolization. However, the patient should also be monitored for pseudoaneurysm development or secondary splenic rupture. Vaccination

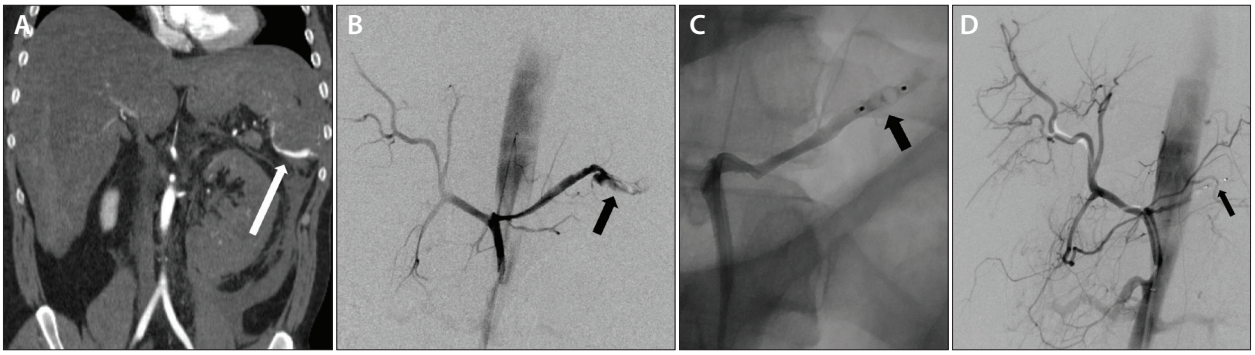

Figure 3. A 47-year-old patient presented to the emergency department after a motor vehicle accident. His vital signs were fairly stable. Contrast-enhanced CT (coronal reformat) demonstrated active contrast extravasation (arrow) below the lower pole of the spleen, indicative of splenic rupture (A). In addition, perisplenic, perihepatic, and retroperitoneal hematomas were present. Intervention was performed under conscious sedation. Access was obtained via the right femoral artery, and a long 4-F introducer sheath was inserted. A 4-F Cobra catheter was used to select the patient's celiac artery, and selective angiography was performed, which demonstrated complete splenic artery rupture (arrow) (B). The diagnostic 4-F catheter was advanced to the bleeding site, and a vascular plug (AVP 4) was deployed proximally in the mid splenic artery (arrow) (C). A final arteriogram showing the vascular plug (arrow) in the mid splenic artery demonstrated no contrast extravasation (D).

prophylaxis for overwhelming postsplenectomy infection remains controversial. A recent meta-analysis that included 12 studies demonstrated preserved splenic function in all 199 embolized patients.[4]

CLINICAL OUTCOME

Earlier studies have demonstrated that splenic artery embolization in patients with blunt splenic trauma significantly reduces the risk of splenectomy by up to 18%.[5,6] This finding was confirmed by Frandon et al in their study comparing operative management, nonoperative management without splenic artery embolization, and nonoperative management with splenic artery embolization.[7] A spleen salvage rate of 91% was reported for nonoperative management with splenic artery embolization. Clinical outcomes were worse for patients who underwent operative management; however, severity of the primary injury was found to be the main predictor of clinical outcome.

In a single-center study that included 50 patients, proximal and distal splenic artery embolization were compared in patients with blunt splenic trauma.[8] Performing either embolization method, the technical success rate was 98%, and the clinical success rate in terms of achieved hemostasis and spleen salvage was 92%. The rate for major adverse events was 4%, including major splenic infarction or abscess formation, and the rate for minor adverse events was 65%, including pancreatitis, pseudocyst formation, or pleural effusion. However, these adverse events may also be attributable to the primary injury and not exclusively to splenic artery embolization. It is of interest that there was no statistically significant difference between proximal and distal embolization methods, as has been described by other studies.

Two large meta-analyses by Rong et al and Schnüriger et al evaluated splenic embolization methods and included 876 and 479 patients, respectively.[2,9] The largest meta-analysis by Rong et al compared proximal (52%), distal (25%), and combined proximal and distal (5.5%) embolization methods. The success rate was higher for proximal splenic artery embolization, but it was not significantly different from distal embolization. However, the major complication rate was significantly lower for proximal embolization than distal embolization (18% vs 29%, respectively).[2] This was confirmed by a meta-analysis by Schnüriger et al, which reported a significantly lower splenic infarction rate for proximal compared with distal embolization (< 8.4% vs 14.4%–19.8%, respectively).[9] Regarding embolization materials, success with coils was significantly higher (92%) than with Gelfoam (84%), and fewer severe complications occurred using coils (20%) compared with Gelfoam (34%), especially with regard to demand for additional surgical management.[2]

Proximal splenic artery embolization achieves hemostasis by reducing arterial pulse pressure and decreasing distal arterial flow in splenic parenchyma, which is beneficial for peripheral clot formation rather than stopping parenchymal hemorrhage directly. Because the entire spleen is affected by proximal splenic artery embolization, multiple splenic injuries may be controlled using this technique. The risk of splenic infarction is low because there is an extensive network of arterial collaterals supplying the spleen from the left

gastric artery and gastroepiploic artery (such as pancreatic and omental branches supplying splenic parenchyma) to preserve splenic function.

Distal splenic artery embolization leads to occlusion of smaller segmental branches. Because these branches are end arteries, the risk for parenchymal wedge infarction or abscess formation may increase. In some patients, multiple bleeding sites are present but may be overlooked due to vasospasm caused by traumatic injury. This may cause rebleeding of sites that were not selectively embolized, which was less likely to occur after proximal splenic artery embolization. Some authors find distal splenic artery embolization to be technically more challenging than proximal embolization because the catheter needs to be navigated through the entire splenic artery, which may be tortuous, and segmental branches need to be catheterized using a microcatheter. Distal splenic embolization may also be more time consuming than proximal splenic embolization, which can be counterproductive in a potentially life-threatening trauma setting. In addition, more contrast medium may be used, potentially increasing a trauma patients' risk of impaired renal function.

CONCLUSION

Nonoperative, organ-preserving management is increasingly being performed in patients with blunt splenic trauma. Splenic artery embolization has shown increased success rates and reduced rates for secondary splenectomy in patients with high-grade splenic trauma. In patients with a single parenchymal lesion, curative distal splenic artery embolization should be performed, whereas proximal splenic artery embolization should be performed in patients with multiple parenchymal lesions. Preventive proximal splenic artery embolization should be performed in high-risk patients (ie, patients > 50 years, those with an intraperitoneal bleed, and those scheduled for prolonged surgery for other reasons). Interestingly, distal splenic artery embolization is associated with a higher risk of splenic infarction, and permanent embolization materials have superior outcomes compared with temporary embolization materials. ■

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