

Embolization for Splenic Trauma

Healing the spleen with curative and preventive embolization.

BY FRÉDÉRIC THONY, MD

The spleen is a sponge-like organ with fragile conjunctive tissue. As a result, it is prone to contusions and rupture during trauma. Until recently, the preferred management of spleen traumas was surgery, but nonoperative management (NOM) is increasingly preferred. NOM increases spleen salvage and thus improves patients' immunity to infection (vs those with a compromised immune system due to splenectomy); however, there is a risk of immediate or late bleeding leading to secondary splenectomy. The success rate of NOM may be increased by introducing endovascular treatment into the management strategy, including curative embolization of ongoing bleeding and preventive embolization of high-grade trauma without obvious bleeding lesions.

Nonetheless, emergency physicians and trauma surgeons should be aware that the aim of NOM is to preserve the immunity of patients without threatening survival. Consequently, everyone should keep in mind that patients presenting with hemorrhagic shock must still be promptly referred for urgent splenectomy.

TRAUMA ASSESSMENT

CT contrast media extravasation does not preclude embolization, whereas in certain trauma without bleeding, it should be indicated. The CT scan is the cornerstone imaging modality for assessing trauma. It should be carried out at patient admission whenever possible. Imaging after contrast media injection at the arterial and parenchymal phases is mandatory for every patient with severe injuries, but also for minor trauma that displays abdominal tenderness during clinical examination.

As with every other solid organ trauma, contrast medium extravasation that collects at the arterial phase with reinforcement at the late phase (or coursing to the perisplenic space) is a sign of ongoing bleeding

(Figure 1) and may lead to transarterial embolization if the hemodynamic status of the patient is stable. Conversely, as a characteristic feature of the spleen, some bleeding will be reabsorbed into the sinusoidal network of the parenchyma. During a CT scan, it will appear as an irregular blurry extravasation of contrast medium at the arterial phase (blush) that disappears at the late phase (Figure 2). The hemorrhagic risk of these lesions is low, and they merely need to be monitored.

For high-grade trauma (grades 3–5 on the American Association for the Surgery of Trauma classification scale) without bleeding lesions, Haan et al¹ and Gaarder et al² have demonstrated that proximal occlusion of the splenic artery decreases the risk of splenectomy by 16% to 18%. The occlusion of the main artery lowers distal systolic arterial pressure by 40 mm Hg on average, enhancing the healing process.



Figure 1. Arterial leakage of contrast medium coursing to the subcapsular space indicating an arterial bleed.

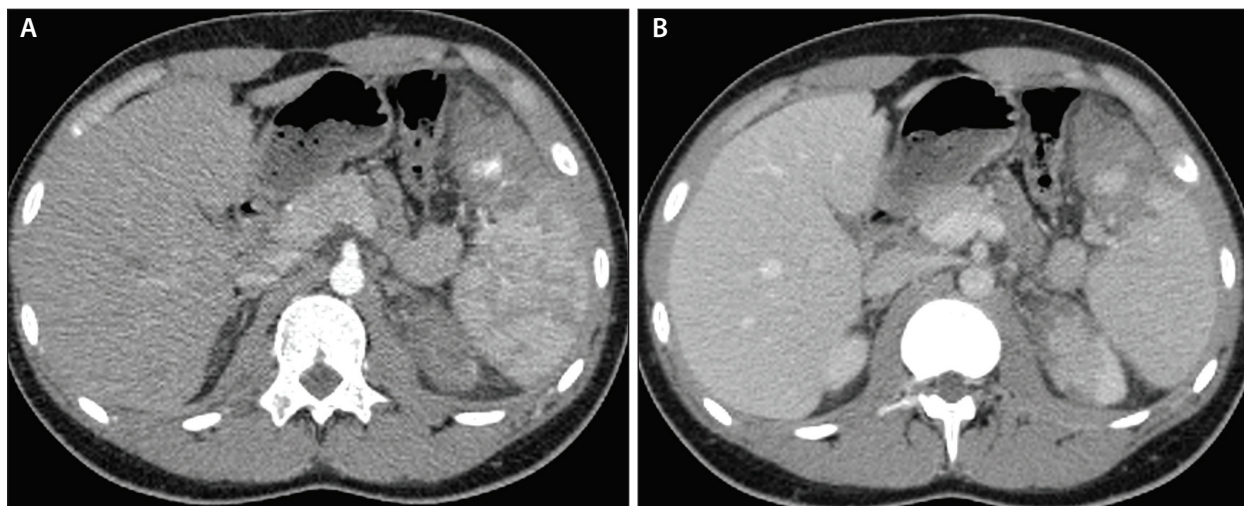


Figure 2. Arterial leakage of contrast medium diffusing into the parenchyma with blurry contours. Arterial phase showing contrast enhancement inside a low-density area (A). Late-phase disappearance of contrast enhancement due to reabsorption of blood into the sinusoidal network (B).

Since these publications, this has become a polemical topic. Although currently lacking comparative and larger studies, preventive spleen embolization seems to have potential in high-grade trauma and/or in patients who have high-risk prognosis factors (eg, age > 50 years, polytraumatism, intraperitoneal bleeding, indication for prolonged surgery of other organs [orthopedic or neurosurgery] for which patients must be hemodynamically stable).

CURATIVE AND PREVENTIVE EMBOLIZATION

The embolization indication is called *curative* when parenchymal bleeding has to be fixed (Figure 3). As intraparenchymal vascularization is terminal, the occlusion should be done as close as possible to the site of bleeding in order to limit parenchymal infarction. Intraparenchymal vascular lesions can be reached with a microcatheter. Embolization agents may be temporary (gelatin fragments) or permanent (eg, microcoils, glue, Onyx liquid embolic [Medtronic]). Permanent embolization devices are likely to give better hemostatic results than temporary devices.³

The indication is called *preventive* when the goal is to avoid secondary bleeding by decreasing blood pressure into the spleen (Figure 4). Ideally, the splenic artery should be occluded in its middle segment; that is, between the dorsal pancreatic artery and the pancreatica magna—the distal splenic artery being supplied by the pancreatic arterial network, the short gastric arteries, and the right gastroepiploic artery. In practice, these two pancreatic branches are not always visible, and the splenic artery can be occluded in its

middle part whenever possible (or in its proximal part if not). The availability of vascular plugs has significantly facilitated these proximal embolizations, allowing fast occlusion of large-diameter arteries without concerns for distal migration. Type II plugs up to 12 mm in diameter can be introduced through 5-F vascular sheaths or 6-F guiding catheters. Type IV plugs can be introduced through most 5-F diagnostic catheters. Unfortunately, their maximum diameter is only 8 mm, but this can be enough to secure a first device, and then the occlusion can be completed with coils if necessary.

When it is not possible to introduce a plug (eg, due to winding arteries), 0.035-inch coils may be used to occlude the artery. Because of their flexibility, microcoils are prone to distal migration and should be avoided.

VASCULAR ANATOMY CONSIDERATIONS

The anatomy of the celiac trunk and the splenic artery will influence the therapeutic possibilities, the vascular approach, the equipment used, and finally, the chances of success for an operator with limited experience. Therefore, anatomy should be carefully analyzed before initiating intervention.

If the celiac trunk is horizontal and the splenic artery is reasonably straight, it can be easily occluded with a type II or IV vascular plug.

However, if the celiac trunk is horizontal and the splenic artery is tortuous, reaching the middle part of the splenic artery with a sheath or a guiding catheter may be difficult. In this case, an 8-mm type IV plug may be used, with or without complementary coils, to completely occlude the artery.

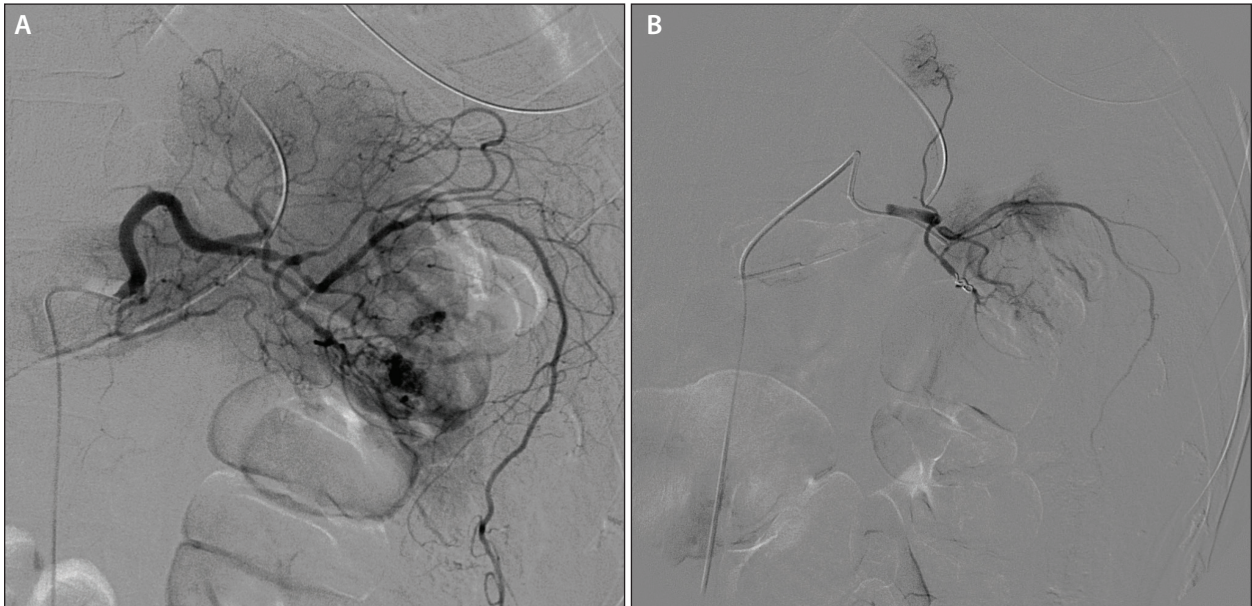


Figure 3. Distal embolization (curative) of distal arterial bleeding using a microcatheter. Angiogram before (A) and after coiling (B).

When dealing with a celiac trunk that runs down and a tortuous splenic artery, catheterization will be difficult, and only a diagnostic catheter with a Simmons

curve can be used. The artery will be occluded with coils. Short 8- to 10-mm coils (5- to 8-cm long) will first be used to test deployment in the artery. Subsequent coils will be chosen depending on the positioning of the first coil.

The worst-case scenario is when the celiac trunk is compressed by the diaphragm with a vertical course. In this situation, a brachial or radial approach is preferable, and the celiac trunk can be catheterized with a multipurpose or a Judkins right catheter. This technical choice should be carefully considered, ensuring it is possible before taking the patient to the cath lab.

The embolization of intraparenchymal arterial bleeding needs to reach small peripheral arteries. For this purpose, a microcatheter is necessary, supported by a flexible and hydrophilic 4-F catheter. If the splenic artery is long and winding, a triple coaxial catheterization may be required. The choice of equipment used for embolization depends on its occluding potential, the precision necessary for deployment, and the sizes available.

TRANSARTERIAL EMBOLIZATION

Transarterial embolization for spleen traumas is a reliable technique in well-
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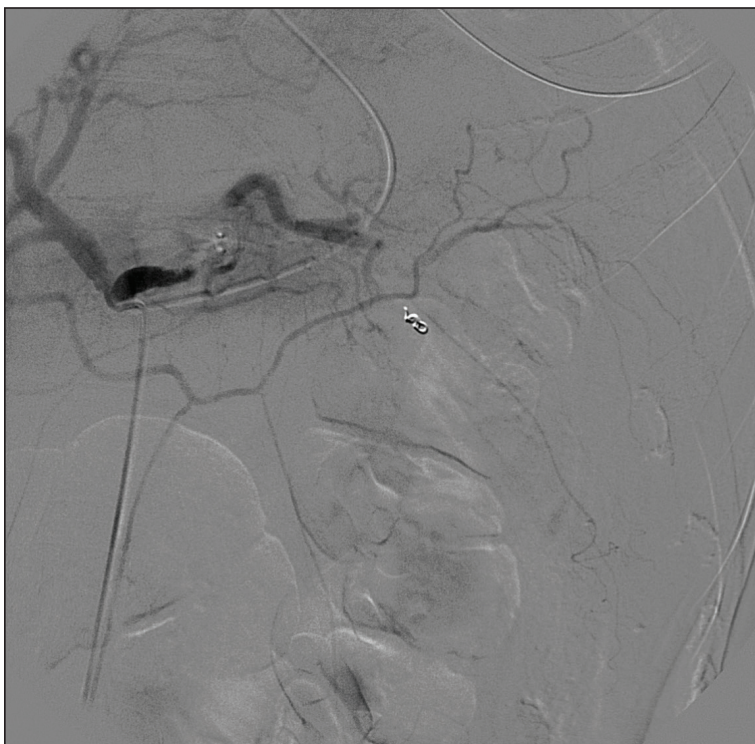


Figure 4. Proximal embolization (preventive) with a vascular plug in the same patient as in Figure 3. Note the arterial supply of the spleen downstream to the plug through the intrapancreatic and gastroepiploic arcade.

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trained hands. This treatment has long been criticized for a lack of efficiency and a high rate of complications. The first pitfall to avoid is the failure of catheterization owing to complex anatomy, thus delaying the time for splenectomy. A detailed analysis of the celiac anatomy before beginning embolization is the best guarantee of success. The second risk is a rare but severe complication of an extensive infarction of the spleen or an ischemic pancreatitis. This is caused by excessive proximal and distal embolization, especially in elderly patients, or nontargeted embolization with microparticles or glue. Other complications are rare, mostly related to the severity of the trauma rather than the type of treatment (eg, surgery, embolization, medical).⁴

MONITORING

Every patient with spleen trauma must be closely monitored until splenic lesions are completely healed. Whether the patient is monitored or embolized, close follow-up with CT scans is mandatory. Even in the absence of any new event, a systematic control must be scheduled at day 5 or before a patient's discharge, and repeated until healing is complete. This follow-up is essential as it allows the detection of late

vascular lesions such as pseudoaneurysms, which are frequent and account for secondary splenic ruptures. Unfortunately, this is not yet standard practice.⁵

Embolization has become an important treatment option for the management of splenic trauma, but it needs well-trained radiologists and close follow-up to improve patient outcome. ■

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