Novel use of the Surefire antireflux device in subtotal splenic embolization

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An unstable patient presented with an enlarging splenic hematoma, for whom splenectomy was contraindicated. The decision was made to treat this patient with subtotal splenic embolization. Initial attempts at embolotherapy using a conventional end-hole catheter resulted in a false angiographic end point with reflux into short gastric arteries, likely due to splenic parenchymal pressurization from the hematoma. The Surefire antireflux device (Surefire Medical Inc, Westminster, Colo) was therefore employed. The Surefire device allowed successful subtotal splenic embolization. Whereas it is currently primarily used in hepatic interventional oncology, we have shown that it can be successfully used in other settings to increase embolization efficiency while mitigating nontargeted embolization. (J Vasc Surg Cases 2015;1:242-5.)

Transcatheter embolization is an accepted standard of care in the treatment of numerous visceral pathologic processes ranging from trauma to neoplasia. A unique circumstance arises when a space-occupying entity develops adjacent to and exerts mass effect on a solid organ that requires embolization, such as can be seen when a hemorrhaging renal angiomyolipoma results in a large perinephric hematoma. This may result in elevated parenchymal pressurization of the organ, increasing the likelihood of incomplete embolization as well as nontargeted embolization. We present such a scenario, in which a patient with an enlarging subcapsular splenic hematoma required subtotal splenic embolization, and discuss the novel use of the Surefire antireflux device (Surefire Medical Inc, Westminster, Colo) to overcome the limits of conventional end-hole catheter embolotherapy. The patient's consent for potential publication of his therapy was obtained.

CASE REPORT

A 50-year-old white male Jehovah's Witness presented to a peripheral hospital with an 8-day history of abdominal pain and in hypovolemic shock. Initial assessment including standard biochemical markers and computed tomography (CT) revealed a history compatible with acute-on-chronic pancreatitis complicated by a large subcapsular splenic hematoma. This is a known albeit rare complication of pancreatitis that has been described in the literature.[1,2] A multiphase CT examination at our institution demonstrated further enlargement of the splenic hematoma, although there was no evidence of active arterial extravasation.

Because of ongoing hemodynamic instability, worsening symptoms, enlargement of the hematoma, and a contraindication to splenectomy due to concerns of potential blood loss coupled with the patient's refusal to receive blood products because of his religious beliefs, the decision was made by his clinical team to proceed with pre-emptive subtotal splenic embolization.

TECHNIQUE

After fluid resuscitation, informed consent was obtained and moderate sedation was initiated. The right common femoral artery was accessed, and a 45-cm Ansel 2 vascular sheath (Flexor; Cook Medical Inc, Bloomington, Ind) was placed. A 100-cm C2 glide catheter (Terumo Medical Corporation, Somerset, NJ) and hydrophilic wire (Terumo Medical Corporation) were used to select the splenic artery to near the splenic hilum. A focal non-flow-limiting dissection was inadvertently created during catheter placement, which was successfully navigated across (Fig 1, *a*).

After administration of half of a vial of 100- to 300-μm Bead Block particles (Biocompatibles Inc, Oxford, Conn), apparent stasis was achieved, with injected contrast material refluxing into adjacent short gastric arteries (Fig 1, *b*). Such an early apparent end point was not typical of our usual experience, and with such a low volume of delivered embolic, it was highly unlikely that much splenic tissue had been truly embolized. The situation was most compatible with a false angiographic end point from splenic parenchymal pressurization due to the subcapsular hematoma.

As a result, exchange and subsequent introduction of a Surefire LT proximal protection device through a 65-cm 5F Axis catheter (Surefire Medical Inc) with a 180-cm Fathom-16 guidewire (Boston Scientific, Natick, Mass) was performed with the intent of improving embolic delivery efficiency (Fig 1, *c* and *d*).

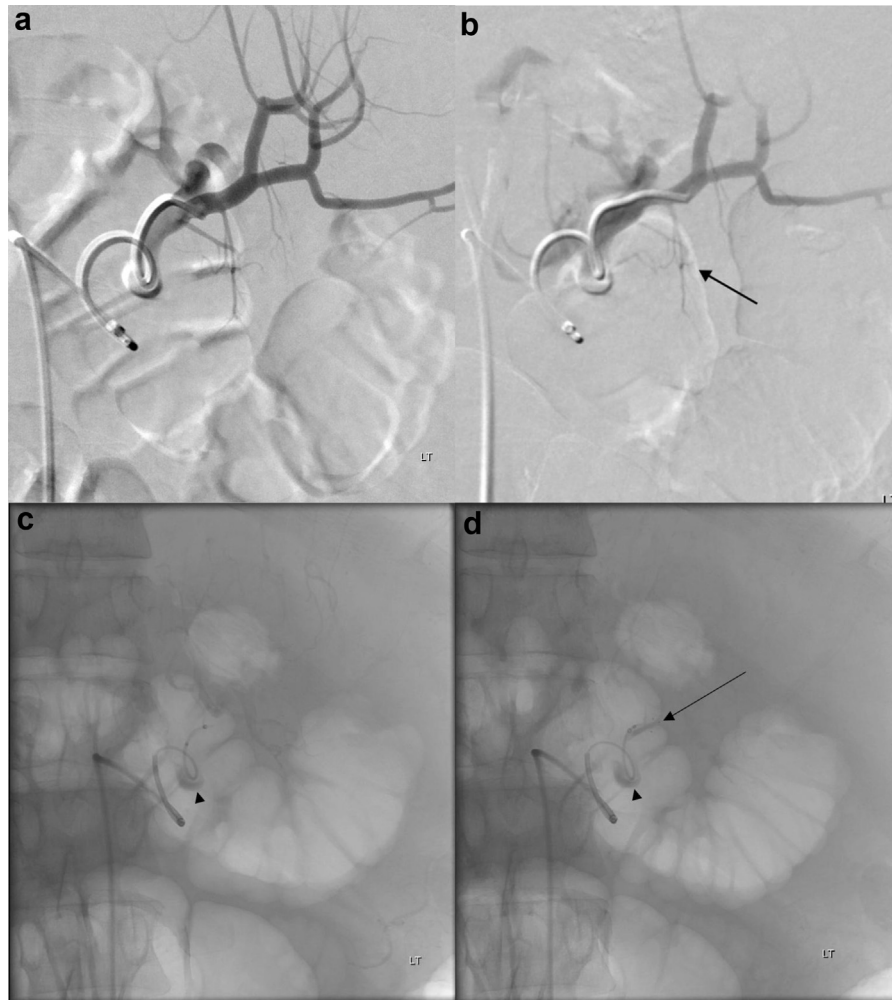http://dx.doi.org/10.1016/j.jvsc.2015.07.005

Fig 1. Splenic artery angiographic appearances before any embolization (**a**) and after administration of half a vial of 100- to 300-μm Bead Block particles through an end-hole catheter (**b**), showing apparent subtotal splenic embolization with truncation of distal splenic branches and proximal reflux into short gastric arteries (*arrow*). Positioning of a Surefire antireflux infusion catheter into the splenic artery undeployed (**c**) and with the expandable tip deployed (**d**; *arrow*). Residual small dissection in the mid splenic artery (*arrowhead*).

With the aid of the Surefire system, an additional 2.5 vials of 100- to 300-μm Bead Block particles and 1 vial of 300- to 500-μm Embosphere particles (Merit Medical Systems Inc, South Jordan, Utah) were delivered without evidence of reflux (Fig 2, *a*). After sluggish flow was perceived within the more central splenic branches, embolization was ceased. Contrast-enhanced cone beam CT was performed on the procedural table; this showed persistent patchy enhancement of a minority of splenic tissue and verified that a subtotal splenic embolization (rather than complete splenic embolization) was successfully achieved (Fig 2, *b*). The procedure was completed with no immediate complications. A vascular closure device was used to achieve hemostasis.

A CT examination performed 5 days later demonstrated successful subtotal splenic embolization, with no increase in size of the hematoma, indicating technical success (Fig 2, *c* and *d*).

DISCUSSION

Transcatheter splenic artery embolization is an accepted standard of care in the treatment of numerous splenic pathologic processes, including post-traumatic and postinflammatory splenic hemorrhages.[3-5] Two widely accepted methods are used, proximal splenic artery embolization and subtotal (ie, partial) splenic embolization.[5] The rationale for proximal splenic artery embolization is based on the concept that eliminating flow from the main splenic artery will reduce splenic arterial pressure to the point at which foci of hemorrhage will cease while collateral branches continue perfusing the spleen to maintain splenic function. However, this method is limited in
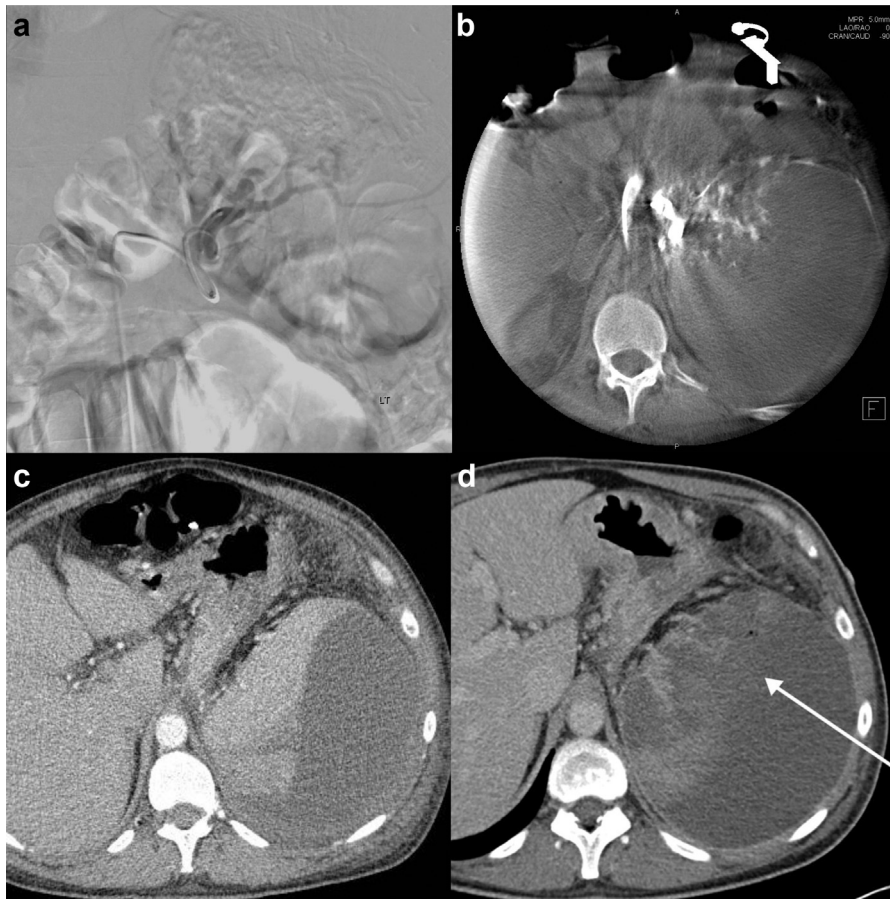
Fig 2. a, Angiographic appearance during Surefire infusion system-aided administration of an additional 2.5 vials of 100- to 300-μm Bead Block particles and 1 vial of 300- to 500-μm Embosphere particles. No reflux was seen into short gastric arteries. **b,** Axial image from postembolization contrast-enhanced cone beam computed tomography (CT) performed on the procedural table, showing persistent patchy splenic parenchymal enhancement compatible with subtotal splenic embolization. **c,** Axial image from a preprocedural contrast-enhanced CT study revealing a large subcapsular splenic hematoma. **d,** Axial image from a contrast-enhanced CT study obtained 5 days after embolization shows substantially reduced splenic parenchymal enhancement (*arrow*), although some residual viable splenic tissue was depicted, indicating successful subtotal splenic embolization.

that if splenic hemorrhage does not cease, proximal splenic artery embolism precludes any additional splenic artery embolization interventions and surgical splenectomy will be required. Alternatively, the goal of subtotal embolization is to achieve distal splenic arterial branch embolization wherein anywhere from 50% to 80% of splenic tissue is embolized, leaving a small amount of residual splenic tissue to maintain splenic function. The main limitation of subtotal splenic embolization is that small areas of splenic infarct are more likely, which have the potential to later become infected. However, its advantages over the former method include greater likelihood of embolizing distal hemorrhages and allowing additional splenic embolization procedures if necessary.

In the example outlined in this report, the most likely origin for the patient's subcapsular hematoma was from a peripheral splenic branch eroded by adjacent pancreatitis-related inflammation. This, combined with the fact that the patient did not realistically have the option of splenectomy in case embolization failed, made the choice for subtotal splenic embolization more favorable than proximal splenic artery embolization.

The case represents a situation in which the presence of a large, contained perisplenic hematoma resulted in ineffective embolization through a traditional end-hole catheter and increased the likelihood of nontargeted embolization. The Surefire infusion system (Fig 3) is an antireflux device that has recently been brought to market and has primarily been applied in transarterial hepatic interventional oncology.[6] In the liver, its primary role is a prophylactic one—to eliminate the risk of reflux and nontargeted embolization when agents such as yttrium 90-loaded microspheres are delivered, as even minuscule amounts of such substances refluxing into vessels supplying the
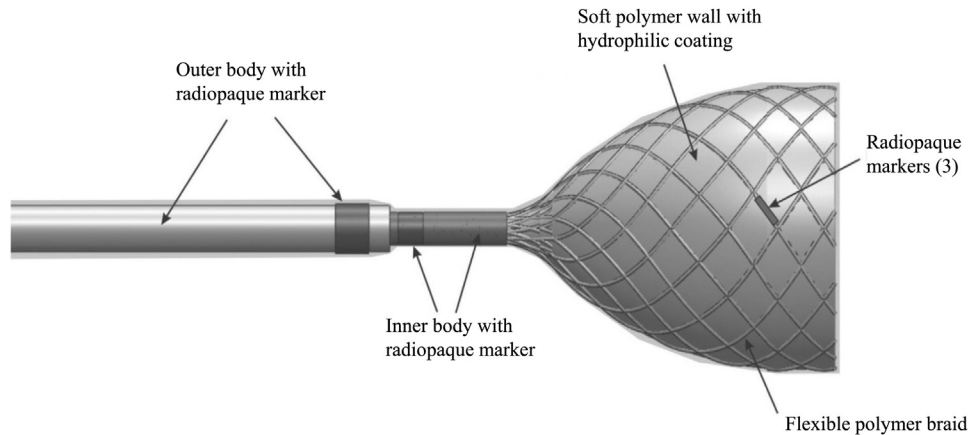
Fig 3. Illustration of the distal expandable tip of the Surefire infusion catheter, with its various components labeled (see http://surefiremedical.com/products/surefire-infusion-system-mt-lt).

gastrointestinal tract could have disastrous consequences. Herein, we describe an indication and application of the Surefire infusion system in which the primary intent was to optimize embolic load delivery and to increase embolization efficiency, with mitigation of nontargeted embolization a secondary although still important outcome.

To briefly outline the use of the Surefire system, an appropriate guiding catheter is first used that can accommodate the Surefire system (inner diameter >0.051 inch). The Surefire infusion catheter is then preloaded with a guide microwire (0.014-0.018 inch). Together, the Surefire catheter and guidewire are advanced through the guiding catheter to a position where initiation of embolic infusion is desired. The outer sheath of the Surefire catheter is then retracted under fluoroscopy until its expandable tip deploys and the radiopaque marker on the outer sheath is proximal to the radiopaque marker at the base of the expanded tip. Embolic delivery is then commenced. Because of the design of the expandable tip, when antegrade blood flow is present, the tip partially collapses to allow incoming blood to carry the embolic load distally; when retrograde flow is present, the expandable tip opens fully to mitigate any unintended reflux of embolic material.[7] Consequently, gradually reduced antegrade flow can be readily observed during embolization with the Surefire catheter, allowing greater ease in estimating when a satisfactory end point has been reached.

Rose et al[8] have in the past described the use of temporary splenic artery balloon occlusion to protect against nontarget embolization during splenic embolotherapy. A key disadvantage with temporary balloon occlusion compared with the Surefire system is that antegrade flow is often lost during the duration of balloon occlusion. As a result, the embolic load is more likely to stay deposited near the catheter tip unless saline is used to flush it distally, and assessing for a satisfactory end point becomes more difficult, with the possibility of inadvertently overembolizing and achieving unintended total splenic embolization becoming greater.

CONCLUSIONS

We have described a novel application of the Surefire antireflux device as a tool to greatly improve embolotherapy efficiency in subtotal embolization of the spleen, where traditional end-hole catheter embolotherapy was ineffective. Given its advantage of increasing embolization efficiency while at the same time mitigating nontargeted embolization, we believe this device has a role in solid visceral embolization (particularly in circumstances in which parenchymal pressurization is increased) beyond its current, primarily prophylactic application in hepatic oncology.

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