Case Reports

DOI: https://doi.org/10.26676/jevtm.59273

The Modern Vascular Surgeon: Acute Embolization within the EVTM Concept

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Keywords: *Endovascular; Embolization; Embolic Agents; Embolic Materials; Vascular Surgery*

Received: 17 September 2025; Accepted: 14 November 2025

INTRODUCTION

Uncontrolled hemorrhage remains a leading cause of preventable death in trauma patients [1,2]. Historically, definitive control of bleeding relied on surgical laparotomy, a strategy associated with substantial morbidity and mortality [3,4]. Despite advances in trauma systems, mortality after emergent laparotomy remains high, highlighting the need for less invasive approaches [5].

Over the past two decades, vascular surgery has transitioned from a predominantly open specialty into one that routinely employes advanced endovascular techniques [6,7]. The EVTM (EndoVascular resuscitation and Trauma Management) concept provides a framework for rapid and definitive hemorrhage control in unstable patients by integrating open surgery, endovascular interventions, and resuscitation strategies within hybrid settings [8–10].

In most centers, acute embolization is performed by interventional radiologists. Current guidelines strongly recommend transarterial embolization as first-line therapy for parenchymal organ hemorrhage [11–15]. Given their expertise in both open and endovascular surgery, vascular surgeons are uniquely positioned to incorporate embolization into emergency care.

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CASE PRESENTATION

To illustrate the practical application of vascular surgeon-led embolization within the EVTM framework, we present four cases of artery embolization performed at Örebro University Hospital (Table 1). All procedures were performed by vascular surgeons trained in endovascular techniques within the Swedish national vascular surgery curriculum, without additional interventional radiology fellowship training. Their endovascular competence is maintained through elective practice, EVTM workshops, and simulation-based training. Trauma cases are initially managed in a hybrid emergency room (ER) with computed tomography (CT) capability, where vascular surgeons function as integrated members of the trauma team.

Case 1: Endovascular Control of Penetrating Splenic Injury via Aberrant Superior Mesenteric Artery (SMA) Origin

A 16-year-old male presented to the emergency department (ED) after stab wounds to the back, left flank and thigh. Upon arrival in the hybrid ER, he was hemodynamically unstable but responded to transfusion with two units of whole blood. Given the multiple injury sites and his transient stabilization, CT angiography (CTA) was performed. The CTA revealed a left sided hemothorax and a grade IV splenic injury.

Because the hybrid suite was initially unavailable, the patient was transferred to the operating room, intubated, and a thoracic drain was inserted. Resuscitation continued with a total of six units of packed red blood cells, five units of plasma, and two units of platelets before the patient was moved to the hybrid suite for further management.

Technical approach

The CTA demonstrated an aberrant splenic artery originating from the SMA at the level of the L2 vertebra

Table 1 Summary of four cases of vascular surgeon-led embolization for traumatic and non-traumatic hemorrhage. Each case highlights the indication, anatomical or technical challenges, embolic agents used, techniques applied, and the clinical rationale or benefits of the chosen strategy.

Case	*Indication*	*Anatomy/challenge*	*Embolic(s)*	*Technique*	*Rationale/Benefits*
1	Penetrating splenic injury (aberrant SMA origin)	Variant anatomy, unstable trauma	Penumbra coils	Progreat microcatheter selective coiling (aberrant SMA origin)	Avoided SMA dissection; targeted perfusion reduction preserved splenic viability
2	Pelvic fracture with arterial bleeding	Multiple possible bleeding sites; delayed instability; fragile iliac anatomy	Covera stent graft	Stent graft from external iliac to common femoral artery	Provided rapid, definitive hemostasis while preserving limb perfusion; minimized risk of further hemorrhage in frail vessel walls
3	Bleeding splenic artery aneurysm post-bypass	Unstable access, dual wire technique	Coils + Squid 34LD	Dual 0.018″ wire stability technique; coils + Squid 34LD packing	Dual-wire technique achieved stability in tortuous anatomy; coil + liquid combination ensured complete aneurysm exclusion
4	Massive GI bleed + REBOA	Shock, multivessel bleed	Squid 34LD + coils	Zone I–II REBOA + sequential vessel embolization with Squid 34LD and coils	REBOA enabled temporary proximal control; sequential embolization addressed multiple bleeding sources without losing hemodynamic stability

GI, gastrointestinal; LD, low density; REBOA, Resuscitative Endovascular Balloon Occlusion of the Aorta; SMA, Superior Mesenteric Artery.

Figure 1 Computed tomography angiography (CTA) in Case 1 demonstrating an aberrant splenic artery (arrow) arising from the proximal superior mesenteric artery (SMA) at the level of the L2 vertebra.

(Figure 1). Ultrasound guided retrograde puncture of the right common femoral artery was performed. A 0.035″ Terumo Advantage guidewire was advanced, over which a 6 Fr Destination (45 cm) introducer and a mini SOS-Omni 4 Fr catheter were placed. By carefully reversing the SOS-Omni catheter at the level of L2, the SMA was directly catheterized without angiography and the guidewire was advanced into the splenic artery. Owing to the aberrant origin and potential risk of SMA dissection, the introducer was not advanced into the SMA and splenic

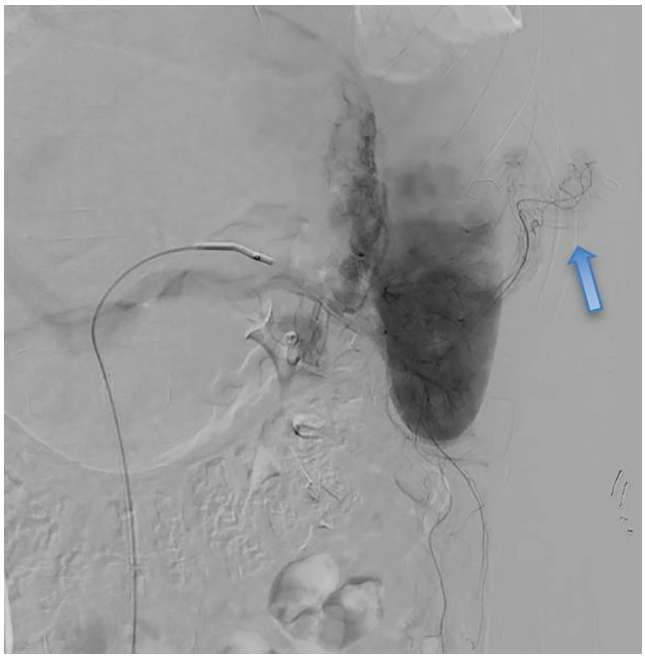

Figure 2 Angiography in Case 1 confirming selective catheterization of the aberrant splenic artery with active extravasation (arrow) before coil embolization.

artery to place a proximal plug, the otherwise standard procedure in these cases at our center. Instead, a Prograte microcatheter was used for selective access. Angiography confirmed splenic artery catheterization and active splenic hemorrhage (Figure 2). Four standard Penumbra coils were deployed proximally to reduce splenic perfusion

and control bleeding while preserving partial parenchymal viability. Completion angiography demonstrated decreased perfusion with no ongoing extravasation.

No closure device was used owing to the patient's young age and vessel size. Instead, hemostasis was achieved with manual compression (15 minutes) and FemoStop (2 hours). A follow-up CTA at day seven showed a partial splenic infarct with an estimated 50% viable tissue.

Case 2: Endovascular Management of Pelvic Hemorrhage from a Pelvic Fracture

An 80-year-old woman was admitted to the ED following a ground-level fall. She had experienced dizziness while standing and fell backward, striking her right hip and head. On examination, she was alert, oriented, and hemodynamically stable. CTA demonstrated a minimally displaced fracture of the right superior pubic ramus accompanied by a surrounding hematoma and focal contrast extravasation. Her hemoglobin level decreased from 109 g/L to 91 g/L within four hours of admission.

The trauma and orthopedic teams jointly assessed the patient and, in consultation with the on-call vascular surgeon, initially chose conservative management. Overnight, however, she developed progressive hemodynamic instability, and repeat CTA demonstrated hematoma expansion. The vascular surgeon was re-consulted, and a decision was made to proceed with embolization.

Technical approach

Ultrasound-guided puncture of the left common femoral artery was performed. A Universal Flush catheter was advanced over a guidewire into the contralateral iliac system. Angiography demonstrated active extravasation at the level of the femoral head. Selective angiography of several internal iliac artery branches was performed using a Glide and Progreat microcatheter, with no active bleeding identified. The catheter was withdrawn to the common iliac artery for repeat angiography, which suggested possible extravasation from the external iliac system.

Selective angiography of the external iliac artery revealed a very thin, thread-like vessel near the origin of the inferior epigastric artery with medial contrast leakage (Figure 3*a*). Given the frailty of the arterial wall, a covered stent graft was used to exclude the bleeding. The sheath was upsized to 8 Fr, and a Rosen guidewire was advanced to provide stable support. A Covera stent graft (7 × 46 mm, Bard) was deployed and completion angiography confirmed exclusion of the bleeding site (Figure 3*b*). Hemostasis at the puncture site was achieved with a ProGlide closure device.

Case 3: Dual-wire Technique for Splenic Artery Aneurysm Embolization

A 64-year-old woman with a history of gastric bypass surgery presented with hematemesis. CTA demonstrated varicose vessels surrounding the gastric pouch

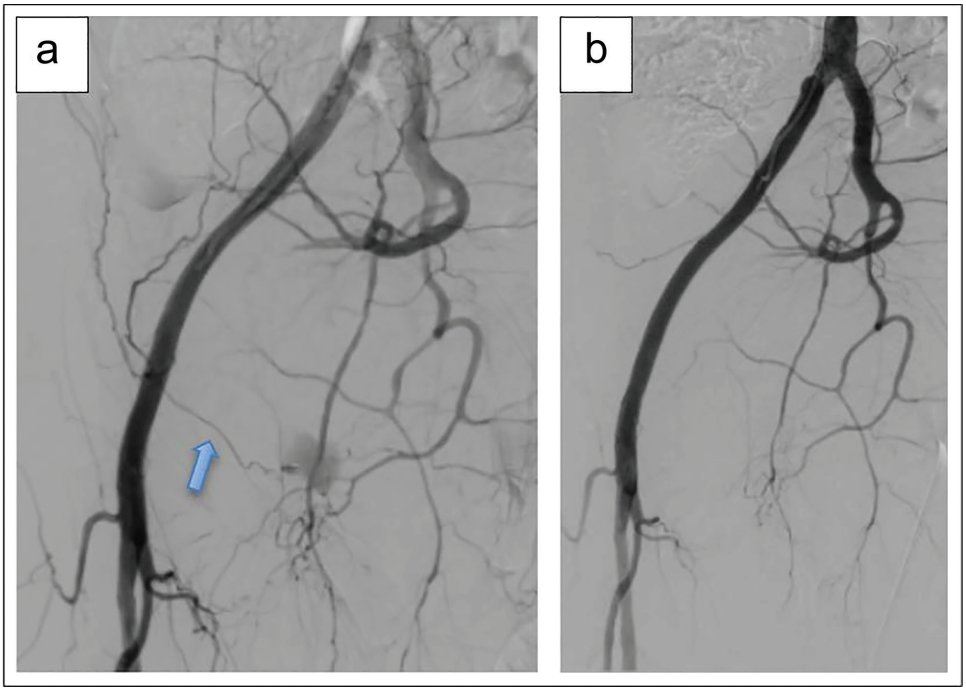

Figure 3 Angiography in Case 2 demonstrating a thin, thread-like branch (arrow) arising from the external iliac artery with active extravasation near the level of the inferior epigastric artery. **(a)** Angiography prior to stent graft placement. **(b)** Completion angiography after deployment of a Covera stent graft, showing successful exclusion of the bleeding vessel.

as well as a splenic artery aneurysm with an associated pseudoaneurysm. Emergency gastroscopy identified a pulsatile gastric ulcer bleed, but endoscopic hemostasis was unsuccessful, and the procedure was further complicated by cardiac arrest. Following cardiopulmonary resuscitation and return of spontaneous circulation, the senior general surgeon consulted the on-call vascular surgeon, and the patient was transferred to the hybrid suite for embolization.

Technical approach

Ultrasound-guided retrograde puncture of the right common femoral artery was performed, and a 5F introducer was inserted. A 0.035″ Advantage guidewire was advanced, over which a 6F Ansel (45 cm) introducer and Mini SOS-Omni catheter were positioned. Selective catheterization of the splenic artery proved challenging, as the wire repeatedly prolapsed into the hepatic artery. To overcome this, a double 0.018″ wire technique was employed. Two 0.018″ Advantage guidewires were advanced: one positioned in the hepatic artery to provide counter-support, while the second was manipulated into the splenic artery (Figure 4). A Glide catheter was advanced over both 0.018″ wires to the celiac trifurcation, after which the hepatic wire was withdrawn and redirected into the splenic artery alongside the first wire. This maneuver allowed the Glide catheter to track securely over both wires. Despite this, the 6F Ansel could not be advanced into the celiac trunk. The sheath was therefore exchanged for a short 8F Cordis introducer, through which a 5F Ansel catheter was introduced and advanced into the celiac trunk and further into the splenic artery.

The 0.018″ wires were exchanged for a Progreat microcatheter, which was navigated distally beyond the two splenic artery aneurysms. Angiography revealed active extravasation from the distal aneurysm (Figure 5*a*). Embolization was performed using a combination of Penumbra standard coils (5 × 30 mm), POD coils (14 mm and 12 mm), additional packing coils, and Squid 34 low density (LD) liquid embolic.

Completion angiography demonstrated exclusion of the aneurysms with no bleeding (Figure 5*b*).

Case 4: Endovascular Balloon Occlusion of the Aorta (REBOA) as a Bridge to Definitive Multivessel Embolization in Severe Gastric Hemorrhage

A 49-year-old man with a complex surgical history, including gastric bypass, duodenal ulcer perforation, and percutaneous endoscopic gastrostomy (PEG) dependence, was admitted with gastrointestinal bleeding. He became progressively hypotensive. CTA demonstrated active extravasation near the gastric remnant.

The patient was taken emergently to the operating theatre for gastroscopy, but endoscopic hemostasis was unsuccessful. At this point, he was in hemorrhagic shock.

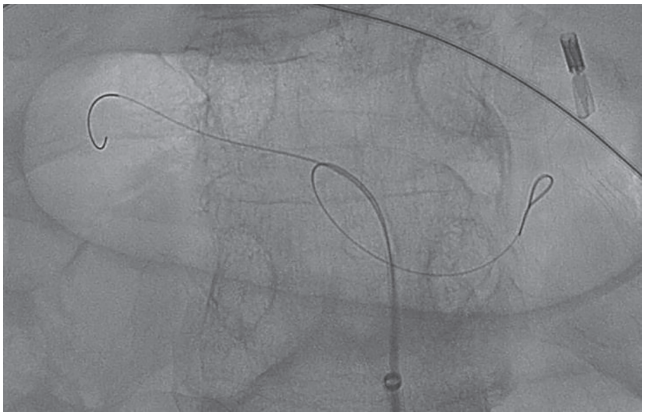

Figure 4 Illustration of the dual 0.018″ wire technique in Case 3. One wire was positioned in the hepatic artery to provide counter-support while the second wire was advanced into the splenic artery, enabling stable access for embolization.

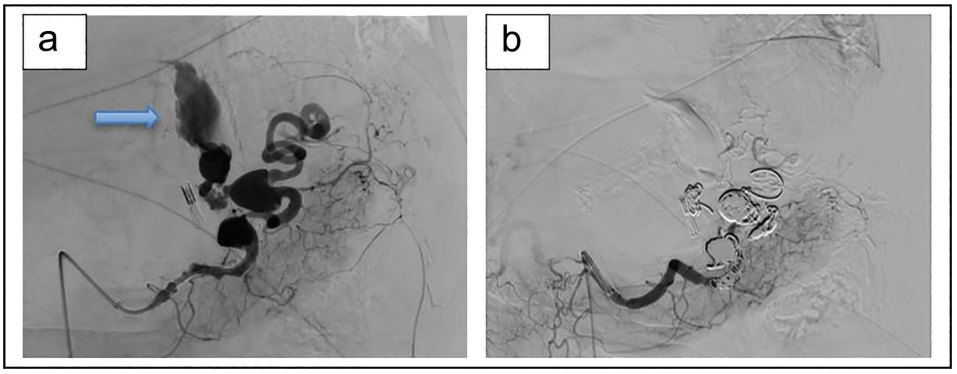

Figure 5 Angiography in Case 3. **(a)** Angiography before embolization demonstrating an ongoing hemorrhage (arrow) from the distal splenic artery aneurysms. **(b)** Completion angiography after coil and Squid 34LD embolization shows complete exclusion of the aneurysms with no residual bleeding.

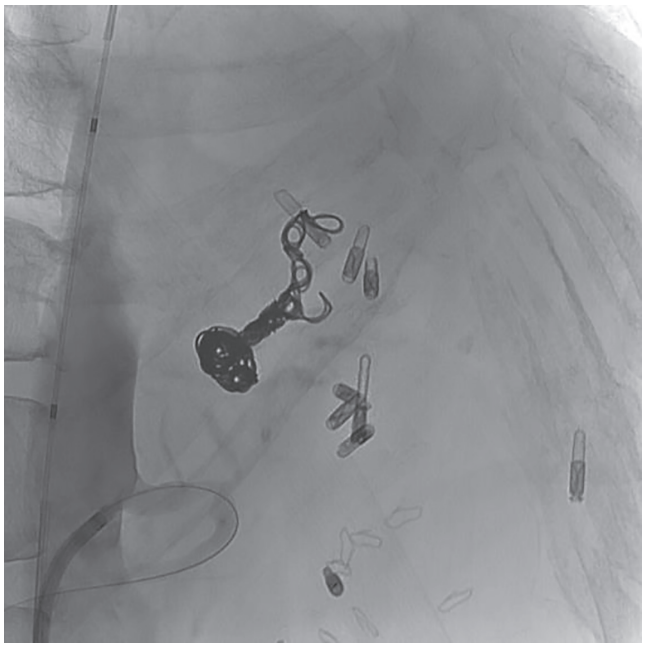

Figure 6 Angiography in Case 4 performed with concurrent Zone I–II Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA), before sequential embolization of gastric, hepatic, and splenic branches.

The on-call vascular surgeon was consulted and performed an ultrasound-guided retrograde puncture of the left common femoral artery, placed an 8F introducer, and deployed REBOA at the junction of Zones I and II. After 7–8 minutes of full occlusion, the balloon was titrated to partial occlusion, maintaining systolic pressures of 90–100 mmHg and the patient was transferred to the hybrid suite.

Technical approach

Contralateral femoral access was established with a 6.5F Aptus introducer. The inflated REBOA balloon not only provided hemodynamic stabilization but also aided catheterization of the celiac trunk by stabilizing the Aptus introducer (Figure 6). Angiography demonstrated bleeding from the proximal stomach. A small branch arising near the celiac origin, likely the left gastric artery, was selectively catheterized using a Vanshi 3 catheter and a 0.018″ Advantage guidewire, and embolization was performed with Squid Peri 34LD via a Progreat microcatheter. Persistent supply to the bleeding territory was noted from both hepatic and splenic branches. These were selectively catheterized and embolized sequentially with Squid 34LD, with Penumbra coils deployed proximally to prevent reflux into the celiac trunk. Final angiography confirmed complete exclusion of the bleeding vessels.

Ethical Approval and Informed Consent

Ethical approval and informed consent was not required for this case report in accordance with local institutional policy.

DISCUSSION

In most institutions, acute embolization is performed by interventional radiologists. In contrast, our center has adopted a model in which vascular surgeons are responsible for all emergency embolizations. Embedded within the EVTM framework, this approach streamlines workflows, minimizes inter-specialty hand-offs, and ensures immediate readiness for hybrid conversion [8,10].

The evolution of vascular surgery into an endovascular specialty, parallels international recommendations. In a European guideline on endovascular hemorrhage management, transarterial embolization is strongly endorsed as the first-line therapy for parenchymal organ bleeding [15]. This is consistent with World Society of Emergency Surgery (WSES) guidelines for splenic, hepatic, renal, and pelvic trauma, all of which support embolization as an essential treatment strategy [11–14]. Similarly, Hörer et al. emphasized embolization as a cornerstone of the EVTM concept, increasingly applied even in hemodynamically unstable patients when combined with adjuncts such as REBOA and performed in hybrid settings [8]. For patients with life-threatening hemorrhage, having a single team responsible for resuscitation, definitive endovascular control, and immediate readiness for open surgery ensures a seamless continuum of care. In Case 4, for example, a massive gastrointestinal bleed was managed entirely by the vascular team, transitioning directly from REBOA placement to multivessel embolization without delay. Such continuity of care minimized critical time to hemostasis in a situation where minutes determined survival.

From a hospital perspective, consolidating responsibility for diagnosis, embolization, and surgical intervention within one specialty enhances efficiency and resource use. It reduces dependence on multiple on-call specialists, simplifies logistics, and guarantees hybrid readiness. Unlike interventional radiology, which is often available only during working hours, the vascular surgery service provides continuous 24/7 coverage. In addition, the vascular team's ability to perform both endovascular and open procedures within the same setting ensures hybrid readiness and minimizes the risk of fragmentation of care.

The feasibility of such models has been validated elsewhere. Kwon et al. demonstrated that trauma surgeons with vascular training performed emergency embolization with outcomes equivalent to those of interventional radiologists, with no differences in rebleeding, reintervention, or mortality [16]. Other studies confirm that trained acute care or trauma surgeons can perform catheter-based hemostatic procedures safely and effectively, expanding access to embolization in time-critical scenarios [6,17–19].

Finally, repeated exposure to acute embolization reinforces technical proficiency across vascular surgery. Skills developed in emergency settings, wire manipulation, catheter navigation, and decisive hemostatic strategies, translate directly into elective procedures with high hemorrhagic risk, such as aortic repairs [20–22].

CONCLUSION

Our experience demonstrates that vascular surgeon-led acute embolization within the EVTM framework is a safe and effective approach for managing both traumatic and non-traumatic hemorrhage. Vascular surgeons can perform endovascular procedures with outcomes comparable to interventional radiologists, while offering additional advantages such as faster decision-making, hybrid readiness, immediate conversion capability and continuity of care. This model has proven effective in our institution and may serve as a framework for other centers, complementing interventional radiology and strengthening multidisciplinary emergency care.

Ethics Statement

(1) All the authors mentioned in the manuscript have agreed to authorship, read and approved the manuscript, and given consent for submission and subsequent publication of the manuscript.
(2) The authors declare that they have read and abided by the JEVTM statement of ethical standards including rules of informed consent and ethical committee approval as stated in the article.

Conflicts of Interest

Rami Hammadi declares that he has no conflicts of interest. David McGreevy is a member of the editorial board of the JEVTM. He had no involvement in the peer review, editorial decision-making, or handling of this manuscript.

Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

Author Contributions

David McGreevy and Rami Hammadi drafted the manuscript.

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