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CLINICAL OUTCOMES OF SPLENIC ARTERY EMBOLIZATION IN THE MANAGEMENT OF SPLENIC INJURIES AND PATHOLOGIES

Radio-Diagnosis

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ABSTRACT

Introduction: Splenic artery embolization (SAE) is a minimally invasive procedure increasingly used in the management of traumatic splenic injuries and non-traumatic splenic pathologies, such as aneurysms or hypersplenism. It offers a spleen-preserving alternative to surgery, particularly in hemodynamically stable patients. This study evaluates the indications, techniques, and outcomes of SAE performed at our institution. **Materials and Methods:** This retrospective study included patients who underwent SAE in a tertiary care hospital in between January 2020 and December 2024. Data were collected on patient demographics, indication for embolization (trauma vs non-trauma), embolization technique (proximal vs distal vs combined), embolic agents used, procedural success, complications, and clinical outcomes. Technical success was defined as successful catheterization and embolization of the target vessel. Clinical success was defined as resolution of bleeding or target pathology without need for surgical intervention **Results:** A total of 52 patients underwent SAE during the study period: 34 for blunt abdominal trauma and 18 for non-traumatic indications (e.g., splenic artery aneurysm, hypersplenism). Technical success was achieved in 100% of cases. Clinical success was noted in 92.3% (48/52) of patients. Four patients required subsequent surgical intervention due to ongoing bleeding or complications. Minor complications occurred in 5 patients (9.6%) including transient post-embolization syndrome. There were no procedure-related mortalities. **Conclusion:** Splenic artery embolization is a safe and effective procedure for both traumatic and non-traumatic splenic pathologies. It provides high rates of technical and clinical success with a low complication profile. SAE should be considered as a first-line, spleen-preserving option in appropriately selected patients.

KEYWORDS

Splenic Artery Embolization (SAE), Digital Subtraction Angiography (DSA), Micro-coil, NBCA (N butyl 2 cyanoacrylate) Glue, Gel-foam, Minimally Invasive, Clinical Outcome.

INTRODUCTION

The spleen, a highly vascular organ, is prone to injury and pathological enlargement in various conditions. Traditionally, splenectomy was the definitive treatment for splenic trauma and certain hematologic disorders. However, the paradigm has shifted with the advent of splenic artery embolization (SAE), a minimally invasive, image-guided procedure that offers both hemostasis and parenchymal preservation. SAE is increasingly favored due to its efficacy, safety profile, and ability to preserve immune function. (1)

Indications for SAE

1. Splenic Trauma: SAE is commonly used in hemodynamically stable patients with grade III-V splenic injuries. Both proximal and distal embolization techniques have shown success in reducing hemorrhage while avoiding splenectomy.
2. Hypersplenism and Portal Hypertension: In patients with liver cirrhosis or hematologic disorders leading to hypersplenism, partial SAE reduces spleen size and improves cytopenias, often obviating the need for surgery.(2)
3. Aneurysms and Pseudoaneurysms: SAE is effective in treating splenic artery aneurysms and pseudoaneurysms, particularly those secondary to pancreatitis or trauma, minimizing the risk of rupture
4. Preoperative Embolization: Embolization may be employed before splenectomy to reduce intraoperative blood loss, especially in complex or highly vascular spleens.

Technique and Materials

SAE is performed under fluoroscopic guidance via femoral or radial arterial access. Depending on the indication, embolization can be proximal (main splenic artery) or distal (segmental branches). Common embolic agents include:

- Coils (for mechanical occlusion)
- Gelatin sponge particles (temporary occlusion)
- Polyvinyl alcohol (PVA) particles
- N-butyl cyanoacrylate (glue), especially in pseudoaneurysms

The choice of agent and technique is influenced by the clinical scenario, vascular anatomy, and desired duration of embolization.

Table 1: Common Embolic Agents Used in Splenic Artery Embolization

Embolic Agent	Type	Mechanism of Action	Common Indications	Key Considerations
Coils	Mechanical (permanent)	Induce thrombosis by slowing flow and promoting clotting	Aneurysms, pseudoaneurysms, proximal SAE	Precise placement needed; risk of migration
Gelatin sponge (Gelfoam)	Temporary particulate	Mechanical obstruction; reabsorbed in weeks	Trauma, hypersplenism (partial embolization)	Temporary effect; often used for partial SAE
Polyvinyl alcohol (PVA)	Particulate (permanent)	Particles lodge in distal arterioles	Distal SAE in hypersplenism, trauma	Non-target embolization risk if not carefully used
N-butyl cyanoacrylate (NBCA)	Liquid adhesive (permanent)	Polymerizes upon blood contact, causing occlusion	Pseudoaneurysms, bleeding in coagulopathic patients	Requires experienced handling; rapid action
Microspheres	Spherical particulate	Occlude microvasculature uniformly	Research use in selective embolization	More predictable occlusion; costlier

Clinical Outcomes

Numerous studies have demonstrated high technical and clinical success rates (>85%) for SAE, particularly in trauma patients and those with hypersplenism. (3)Partial embolization allows preservation of splenic function, reducing the risk of overwhelming post-splenectomy infection (OPSI).

Complications

While SAE is generally safe, potential complications include:

- Post-embolization syndrome (fever, pain, nausea)
- Splenic infarction or abscess
- Pancreatitis (if embolic material refluxes)
- Coil migration (rare)

Careful technique and patient selection are key to minimizing risks.

MATERIALS AND METHODS

This retrospective study included patients who underwent SAE between January 2020 and December 2024. Data were collected on patient demographics, indication for embolization (trauma vs non-trauma), embolization technique (proximal vs distal vs combined), embolic agents used, procedural success, complications, and clinical outcomes. Technical success was defined as successful catheterization and embolization of the target vessel. Clinical success was defined as resolution of bleeding or target pathology without need for surgical intervention.

Embolization Techniques

All procedures were performed by trained interventional radiologists. Embolization was performed under local anaesthesia or monitored anaesthesia care, depending on patient condition. Arterial access was obtained via the common femoral artery using ultrasound guidance. Selective catheterization of the celiac trunk was performed using standard angiographic catheters. Embolization techniques and materials used were determined during the procedure based on angiographic findings, operator experience, and clinical judgment.

Embolic Agents: The choice of embolic agent was based on angiographic findings and operator preference. Embolic agents included- Pushable coils, NBCA glues and Gelfoam® particles.

Data Collection

Patient data were retrospectively collected from electronic medical records, including demographic information, clinical presentation, imaging findings, embolization technique, embolic agents used, procedural details, and clinical outcomes. Imaging studies were reviewed to assess the nature and extent of splenic injury or pathology. Procedural details were obtained from interventional radiology reports, and clinical outcomes were determined from inpatient and outpatient follow-up records.

Outcome Measures:

- Technical Success: Defined as angiographic occlusion of the target artery at the conclusion of the treatment.
- Clinical Success: Defined as resolution of bleeding or target pathology without the need for surgical intervention.
- Complications: Any adverse events occurring during or after the procedure, including infection, infarction, or rebleeding.
- Splenic Salvage Rate: Percentage of patients who retained their spleen post-procedure.

Statistical Analysis:

- Data were analysed using SPSS version 28.0 (IBM Corp., Armonk, NY). Continuous variables were expressed as mean ± standard deviation or median with interquartile range, as appropriate. Categorical variables were presented as frequencies and percentages. Comparisons between groups were performed using the chi-square test for categorical variables and the t-test or Mann-Whitney U test for continuous variables, depending on data distribution. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 52 patients underwent splenic artery embolization between January 2020 and December 2024. The mean age was 38.5 years (range: 19–72 years), with a male-to-female ratio of 3:2. Of these, 34 patients (65.4%) underwent SAE for blunt abdominal trauma, and 18 patients (34.6%) were treated for non-traumatic splenic pathologies, including splenic artery aneurysms (n=10), hypersplenism (n=5), and spontaneous splenic rupture (n=3).

Proximal embolization was performed in 28 patients (53.8%), distal embolization in 16 patients (30.8%), and combined proximal and distal in 8 patients (15.4%). Embolic materials used included coils (76.9%), gel foam (13.5%), and NBCA glue (9.6%).

Technical success was achieved in all patients (100%), while clinical success was observed in 48 patients (92.3%). Four patients (7.7%) required splenectomy due to rebleeding or infarction. Complications included minor post-embolization syndrome in 5 patients (9.6%) and major complications (splenic abscess or infarction requiring surgery) in 2 patients (3.8%).

Table 1: Summary of Demographics, Techniques, and Outcomes of SAE

Parameter	Total (n=52)
Mean Age (years)	38.5 ± 14.7
Gender (M:F)	31:21
Indication	
– Traumatic Splenic Injury	34 (65.4%)
– Splenic Artery Aneurysm	10 (19.2%)
– Hypersplenism	5 (9.6%)
– Spontaneous Splenic Rupture	3 (5.8%)
Embolization Technique	
– Proximal	28 (53.8%)
– Distal	16 (30.8%)
– Combined	8 (15.4%)
Embolic Agent Used	
– Coils	40 (76.9%)
– Gel Foam	7 (13.5%)
– NBCA Glue	5 (9.6%)
Outcomes	
– Technical Success	52 (100%)
– Clinical Success	48 (92.3%)
– Splenectomy Post-SAE	4 (7.7%)
Complications	
– Minor (Post-embolization syndrome)	5 (9.6%)
– Major (abscess, infarction)	2 (3.8%)
– Procedure-related Mortality	0

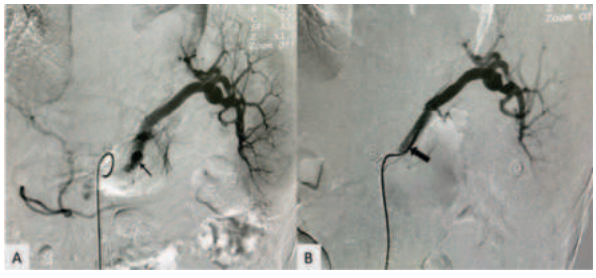

Figure 1: Case of Pancreatitis with Wide Neck Splenic Artery Pesdo-aneurysm, Managed by Stent Graft Placement Across Pesdoaneurysm with Preservation of Splenic Blood Supply.

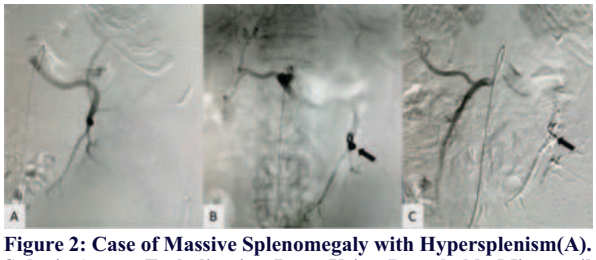

Figure 2: Case of Massive Splenomegaly with Hypersplenism(A). Splenic Artery Embolization Done Using Detachable Micro-coil and NBCA Glue (B,C)

DISCUSSION

This retrospective study reinforces the role of splenic artery embolization (SAE) as a safe and effective modality for managing both traumatic and non-traumatic splenic pathologies. The high technical success rate (100%) observed in our cohort aligns with previously reported rates in literature, demonstrating the feasibility and reliability of embolization techniques in achieving vascular control.(4)

The clinical success rate of 92.3% in our study is consistent with prior studies reporting success rates between 85% and 95%. Most failures

occurred due to ongoing haemorrhage or infarction, necessitating splenectomy. Notably, all four patients who failed SAE were managed successfully with surgical intervention, underscoring the importance of early clinical monitoring post-embolization.(5)

Proximal embolization was more commonly performed (53.8%) and associated with good outcomes, likely due to reduced splenic perfusion pressure while preserving collateral flow via short gastric vessels. Distal and combined techniques were reserved for more selective cases, particularly focal vascular injuries or aneurysms. While distal embolization offers precise control, it carries a relatively higher risk of segmental infarction, a trade-off that must be considered when selecting embolization strategy.(6)

The low rate of major complications (3.8%) and absence of procedure-related mortality reflect the safety profile of SAE. Minor complications such as post-embolization syndrome were self-limiting and managed conservatively, as described in other series. No abscess formation was observed in patients undergoing proximal embolization alone, supporting its preferred role in trauma cases.

Interestingly, non-traumatic indications—including splenic artery aneurysms (19.2%) and hypersplenism (9.6%)—were effectively managed with SAE, indicating its expanding role beyond trauma. In patients with hypersplenism, embolization led to clinical improvement in platelet counts and reduction in spleen size, although longer-term follow-up would be required to assess durability.(7)

Our findings affirm SAE as a valuable spleen-preserving intervention. However, case selection, timing of intervention, and technique optimization remain critical to maximize efficacy and minimize complications.

CONCLUSION

Splenic artery embolization is a highly effective and minimally invasive technique for managing both traumatic and non-traumatic splenic pathologies. It offers high technical and clinical success rates with a favorable safety profile, allowing spleen preservation in most cases. Proximal, distal, and combined embolization techniques should be tailored to the underlying pathology and patient condition. Given its efficacy and low complication rate, SAE should be considered a first-line treatment option in hemodynamically stable patients requiring splenic intervention. Further studies with long-term follow-up are warranted to evaluate durability and functional outcomes post-embolization.

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