Austin Journal of Radiology

Open Access

Austin Publishing Group

Special Article - Interventional Radiology

Splenic Trauma: Role of Embolization in a Tertiary Care Center

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Received: October 20, 2020; **Accepted:** November 12, 2020; **Published:** November 19, 2020

Abstract

Purpose: The purpose of this study was to review the outcomes of Splenic Artery Embolization (SAE) in splenic trauma management in a tertiary trauma centre hospital.

Methods: We conducted a retrospective analysis of all patients admitted in the trauma center that underwent subsequent SAE. All patients were managed from a dedicated trauma team. Data review included splenic injury grading, embolization technique, embolic materials employed and patient outcome.

Results: Between May 2015 and December 2019 a total of 37 patients underwent SAE in NOM setting for AAST Injury III 3 patients (8%), IV 28 patients (76%) or V in 6 cases (16%). Embolization technique was selected on the ground of angiographic findings. Proximal, distal or combined embolization was performed respectively in 20 (54%), 12 (32%) and 5 (14%) cases. Procedural technical success was 100% with a splenic salvage rate at discharge of 97%. Overall complication rate was 21%. Only 1 (2.5%) major complication occurred resulting in splenectomy.

Conclusion: Splenic artery embolization is an effective treatment as adjunctive tool to NOM in the management of high grade blunt splenic injury.

Keywords: Splenic trauma management; Embolization technique

Introduction

Spleen is amongst most involved organ in Blunt Abdominal Trauma (BAT) representing up to 50% of all abdominal solid organ injuries. Mistreatment of a splenic injury might result in poor outcome with an increased mortality up to 18% [1,2].

The management of Blunt Splenic Injuries (BSI) has evolved in the last 2-3 decades with progressive trend from open surgery to Non Operative Management (NOM) [3].

This paradigm shift has been prompted on the need to preserve splenic function in order to maintain full immunological competence and avoid potentially lethal Overwhelming Post Splenectomy Infection (OPSI) [4].

Splenic Artery Embolization (SAE) is a minimally invasive technique that allows for a fast occlusion of splenic vascularization, originally reported as part of splenic trauma management, in the mid 90' by Sclafani [5].

Following the reported encouraging results, SAE gradually spread out worldwide becoming part of BSI management in many trauma centers [6]. However, adjunctive SAE has been employed in BSI not without controversies. An open discussion still exist on which patient should be managed with SAE and which technique should be preferred [7].

Indication to SAE, in stable patients with BSI, has been grounded mainly on splenic injury grading evaluated by Contrast Enhanced Computed Tomography (CECT) in accordance with the American Association for the Surgery of Trauma (AAST), relying mainly on parenchymal laceration (number of lesions and extension).

In order to create common criteria on treatment indications, in 2018 this classification has been updated with the inclusion of vascular splenic lesion (i.e., pseudo-aneurysm) in high-grade injuries. (IV-V) As a consequence, a new classification has been introduced by the World Society of Emergency Surgery (WSES). In order to achieve a more global assessment of the traumatic injury AAST grading has been integrated with patient's hemodynamic status (stable/unstable). However, the clinical outcomes, correlated to these classifications, still need to be fully validated in practice [8].

Due to the lack of uniform criteria of application and standardization, selection of the most appropriate embolization technique (proximal *vs*. distal), and material is still unclear.

In the majority of the cases, technique and material selection are based on operator's preference [9].

Aim of this study is to analyse management and outcomes of SAE in case of splenic trauma in a tertiary trauma centre hospital.

Materials and Methods

This is a retrospective, physician-initiated study. Patients with confirmed diagnosis of BSI treated with SAE between May 2015 and December 2019 in a tertiary trauma centre hospital were retrospectively analysed.

All patients were managed by a multidisciplinary "trauma team" involving abdominal surgeons, anaesthesiologists and interventional

Citation: Citone M, Falcone G, Mondaini F, Prosperi P, Alemanno G, Leoncini A, et al. Splenic Trauma: Role of Embolization in a Tertiary Care Center. Austin J Radiol. 2020; 7(3): 1116.

radiologists. Pillars of the decision process were the hemodynamic status of the patient and the CECT evaluation Table 1.

For each patient clinical and hemodynamic status were evaluated at hospital admission: patients with an unstable hemodynamic condition, with peritoneal bleeding detected at Focus Assessment with Sonography for Trauma (FAST) examination, were selected for surgical management. Patients hemodynamically stable (systolic blood pressure>90mmHg, heart rate<100bpm), including initially unstable fast fluid resuscitation responder, underwent chest and abdominal CECT, according to our trauma protocol.

In the absence of concomitant traumatic injuries requiring surgery, a probation of NOM was set.

Patients with low-grade splenic injuries underwent close surveillance of hemodynamic/clinical status and serial hemoglobin concentration/hematocrits evaluation.

If SAE was selected as adjunctive treatment to NOM, embolization procedure was performed within one hour from the initial CECT.

Procedures were performed in a dedicated angio-suite with a state-of-the-art angiographer.

All interventions were done via a common femoral artery access; in case of severe tortuosity of the celiac trunk, evaluated on the pre-treatment CECT images, a brachial approach was preferred. Selective catheterization of the splenic artery was achieved using a 0.035" standard, angled hydrophilic guidewire (Radio focus; Terumo, Tokyo Japan) in combination with a 4Fr shaped catheter (SIM 1, Cobra 2) (Cordis East Bridgewater, NJ USA).

Digital Subtraction Angiography (DSA) was performed in order to evaluate the arterial anatomy and splenic injury characteristics.

Embolization technique was selected according to our standard protocol

In the presence of areas of devitalized spleen, without angiographic evidence of active contrast media extravasation or pseudo aneurysm, proximal embolization was performed with intentional occlusion of the splenic artery between the dorsal and pancreatic magna arteries (Figure 1).

If active bleeding or unstable vascular injury (pseudo aneurysm, arterio-venous fistula) were present, distal embolization was preferred (Figure 2). Super selective catheterization was done using a 2.7Fr microcatheter (Progreat-Terumo, Tokyo, Japan) with occlusion of the vessel as close as possible to the injured area.

In case of high-grade splenic lacerations, associated with other vascular injuries, a combined approach was selected.

Choice of embolic agent (coil, plug, POD, etc) was at operator discretion.

Embolization of concomitant traumatic injury of other organs was performed in the same session.

In all patients, 2g of Cefazolin were administered i.v during the procedure.

Follow-up evaluation was conducted with CECT and clinical evaluation, 48 hours after the intervention.

In all patients, included in the study, we analysed

- Immediate technical success intended as successful occlusion of the target vessel (main splenic artery or damaged intra-parenchymal vessel).
- Procedural successful outcome defined as effective haemostasis (absence of recurrent bleeding requiring additional procedure).
- Splenic salvage rate at discharge.
- Intra-procedural and peri-procedural complications according to CIRSE standards for classification of complications Table 2 and [10].
- Procedure related mortality.

Statistical analysis

All analyses were performed using SPSS for Windows (SPSS, Chicago, IL, USA). Categorical (nominal) variables are described as frequencies or percentages. Association between nominal variables were assessed using the X^2 or Fisher Exact Test.

Significance was assumed at $p<0.05$.

Results

Between May 2015 and December 2019, 37 patients, 23 (62%) male with a mean age of 51 years (range 15-91 years) underwent adjunctive SAE in NOM setting.

The predominant mechanisms of injury were motor vehicle collisions N=18 (49%), falls from height N=14 (38%), work-related injuries N=3 (8%), and sport injuries N= 2 (5%) Table 3. Indications to treatment, according to the 2018 revised AAST classification, were: grade III in 3 patients (8%), grade IV in 28 patients (76%) and grade V in 6 cases (16%).

Vascular injuries (pseudoaneurysm/AV fistula or active bleeding) were determinant for the indication in 11 (29%). In 8 patients (21,5%) the vascular lesion was confined to the spleen parenchyma or to the subcapsular space (grade IV of the revised classification) while in 3 patients (8%) peritoneal active bleeding was detected (grade V of the revised classification).

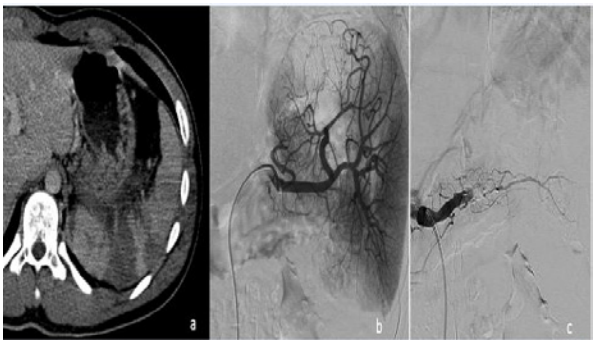

Figure 1: Proximal Embolization Technique. Male patient, 47yo. Pedestrian collision.
a) Vast traumatic splenic lacerations (grade IV) clearly evident at CECT;
b) Digital Subtraction Angiography (DSA) confirmed a wide area of devitalized spleen without active bleeding;
c) Proximal splenic artery occlusion was achieved using an Amplatzer Vascular Plug (AVP) 8mm in dimeter. Final angiogram showed complete occlusion of the main splenic artery.

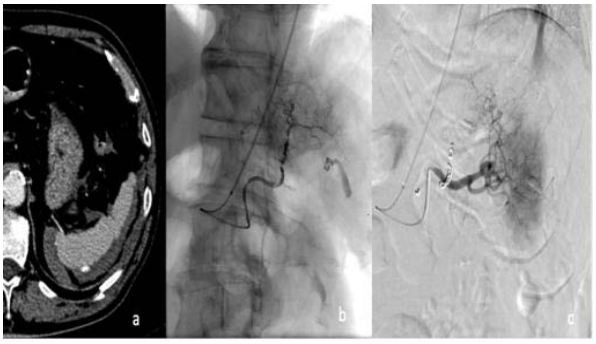

Figure 2: Distal Embolization Technique. Male patient, 72yo. fall from height.
a) Intracapsular active bleeding (Grade IV splenic injury) detected at CECT.
b) Due to a tortuous anatomy of the celiac trunk, procedure was performed via a left transbrachial access. Selective splenic angiography showed active bleeding at subcapsular level.
c) Embolization of the target vessel, feeding the damaged area, was achieved using detachable micro-coils. DSA after embolization of the target vessel showed complete occlusion of the damaged vessel with no other signs of active bleeding.

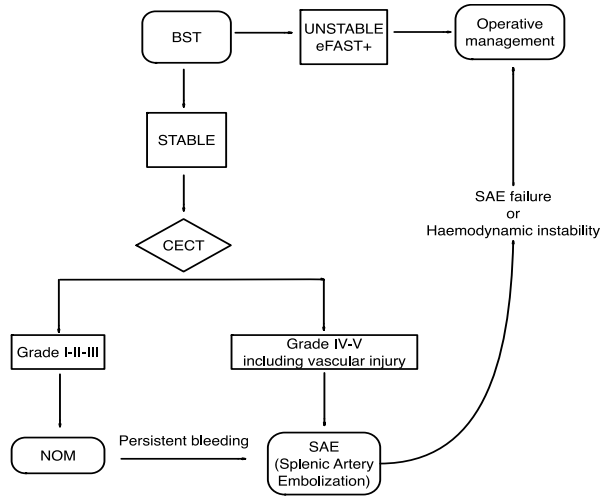

Table 1:

In all grade III injuries (3pts, 8%) indication to SAE was decided on the ground of persistent signs of ongoing bleeding. It is to be noted that 2 of these patients were under dual antiplatelet therapy.

SAE procedures were performed via trans-femoral approach in the majority of the cases (36/37-97.5 %). Only in 2.5% (1 patient) a trans brachial access was selected due to the complex anatomy of the celiac trunk.

Proximal, distal or combined embolization was performed respectively in 20 (54%), 12 (32%) and 5 (14%) cases. The different embolic agents employed are reported in Table 2.

Immediate technical success was achieved in all cases.

In one patient a concomitant embolization for traumatic injury of the kidney was required and successfully performed in the same session immediately after spleen intervention.

No bleeding recurrence was observed at discharge in all patients.

Table 2: Complications grading according to CIRSE standards.

Grade	Description
1	Complication during the procedure which could be solved within the same session; no additional therapy, no post procedure sequelae, no deviation from the normal post therapeutic course
2	Prolonged observation including overnight stay (as a deviation from the normal post therapeutic course < 48 h); no additional postprocedure therapy, no postprocedure sequelae
3	Additional postprocedure therapy or prolonged hospital stay (>48 h) required; no postprocedure sequelae
4	Complication causing a permanent mild sequelae (resuming work and independent living)
5	Complication causing a permanent severe sequelae (requiring ongoing assistance in daily life)
6	Death

Table 3: Mechanism of injury.

Number of patients	N=37
Motor/vehicle collisions	18 (49%)
Falls from height	14 (38%)
Work-related injuries	3 (8%)
Sport injuries	2 (5%)

A complication was reported in 8 (21%) cases.

Only one (2.5%) major complication (grade 4) was reported. At 48 h CECT an extensive ischemia of the spleen, with clinical suspect of infection, was observed. As a consequence, splenectomy was required 3 days after SAE.

An overall splenic salvage rate of 97% (36/37) was reported.

Statistical analysis did not show significant association between major complication and AAST injury grade (p 0.08) or embolization technique employed (p 0.64).

Minor complications (grade 2), occurred in 7 (19%) cases and were correlated to minor ischemic lesions that occurred when distal technique was employed alone (5 cases, 13.5%) or after combined embolization (2 cases 5%).

However, no secondary embolization was required in any cases, and no perioperative mortality occurred.

Discussion

Splenic injuries, alone or in association with other abdominal organs, are described in up to 50% of blunt abdominal trauma with a related mortality of 18% [1,2].

Non-surgical management of splenic trauma presents several advantages especially with the preservation of the splenic immune function against encapsulated bacteria and in order to avoid OPSI, a condition with a reported mortality in up to 50% cases [2,11].

Moreover, conventional open surgery can be associated with infectious complications (such as abdominal abscess, pneumonia and septicaemia) that can occur in up to 32% of patients [12].

Since the first description of SAE in splenic trauma management by Sclafani [5], this technique has spread worldwide with beneficial results in the setting of non-surgical management of splenic trauma [2] Some authors have questioned the advantages of SAE in terms of improvement of splenic salvage rate [13]. However, the effective

Table 4: Characteristics of all population.

Patient	AAST grading	Sae technique	Device
1	III	Proximal	AVP
2	III	Proximal	Pod+Coils
3	III	Proximal	Pod+Coils
4	IV	Distal	Gelfoam+Coils
5	IV	Distal	Gelfoam+Coils
6	IV	Distal	Coils
7	IV	Proximal	Coils
8	IV	Distal	Coils
9	IV	Distal	Coils
10	IV	Distal	Glue
11	IV	Proximal	Coils
12	IV	Distal	Coils
13	IV	Distal	Coils
14	IV	Prox+Dist	AVP+Coils
15	IV	Proximal	AVP
16	IV	Proximal	AVP
17	IV	Prox+Dist	AVP+Coils+Gelfoam
18	IV	Proximal	Coils
19	IV	Proximal	AVP
20	IV	Distal	Coils
21	IV	Proximal	AVP
22	IV	Proximal	Coils
23	IV	Distal	Coils
24	IV	Proximal	Coils
25	IV	Proximal	AVP
26	IV	Proximal	AVP
27	IV	Proximal	AVP
28	IV	Proximal	AVP
29	IV	Proximal	AVP
30	IV	Dist	Coils
31	IV	Distal	AVP
32	V	Prox+Distal	AVP+Coils
33	V	Proximal	Coils
34	V	Proximal	Coils
35	V	Prox+Dist	Gelfoam+Coils
36	V	Proximal	AVP
37	V	Prox+Dist	Coils

AVP: Amplatzer Vascular Plug (Abbot Vascular, Plymouth, NM)
POD: Penumbra Occlusion Device (Penumbra, Alameda, CA)

impact of endovascular embolization on BSI management has been well documented in high volume trauma centers with a salvage splenic rate around 97% [14].

A primary success rate around 90% is reported for SAE in a large meta-analysis [15-17].

Indication to SAE are the degree of splenic trauma and the presence of contrast blush at CECT. This is considered a strong predictor of NOM failure [18].

Most authors agree on the indication of high-grade splenic lacerations IV-V. On the contrary, controversy still exist if embolization or observation should be selected in case of grade III lesions [13].

In our experience endovascular treatment is generally applied in case of grade IV-V lesions reserving SAE for grade III lesions in those patients with signs of persistent bleeding or under antiplatelet therapy.

Selection of the embolization technique is still on debate and no consensus and no guidelines are available.

Proximal embolization is more frequently (60% of cases) employed in the setting of splenic trauma, especially in case of multiple lacerations without active bleeding [17]. The advantage of this technique is to reduce the arterial pressure in the splenic parenchyma [19]. However in case of active bleeding, proximal embolization has proven to be less effective as reported by Duchesne with a 29% of failure of NOM, even after SAE, due to persistence of bleeding distal to the main branches [20].

Conversely, in case of focal active bleeding or splenic vascular injury, such as pseudo-aneurysms, distal embolization is generally preferred. Embolization is usually performed as close as possible to the damaged vessel. We underline that this technique, although effective in the treatment of focal lesions, leave the rest of the parenchyma 'untreated'. For this reason, many authors agreed that in case of highly damaged spleen (presence of multiple lacerations) distal embolization alone is less effective in splenic preservation and combined treatment should be preferred.

A recent meta-analysis based on 23 published articles and 876 patients showed distal technique more liable to life-threatening complication when compared to proximal embolization (27% *vs* 18%, p=0.05 and OR=0.51) [17]. However as the techniques are applied to different situations and mainly selected based on the angiographic findings, the comparative evaluation may be misleading [13].

As reported in the literature, our results supported the use of SAE for BSI management with a technical success of 100% and splenic salvage rate of 97%.

Embolization can be performed using different materials, but no correlation between technical success and type of embolic agent have been demonstrated [17,21].

This study has several limitations including the retrospective nature of data collection, the heterogeneity of the embolic material employed, the lack of data concerning patients treated with Non Operative Management (NOM) without SAE and the limited dimension of sample size that prevent generalization of our conclusions.

Conclusion

Splenic artery embolization is an effective treatment as adjunctive tool to NOM in the management of high grade blunt splenic injury.

This technique, compared to open surgery, offers fast and

percutaneous management of blunt splenic trauma. It should be preferred as long as hemodynamic stability of patients is granted.

Also in our experience, as reported in the literature, an high rate of technical success and splenic salvage was observed regardless of the technique and embolic agent employed.

We underline the crucial role of the "trauma team" to define the best management of traumatized patients.

References

1. Costa G, Tierno SM, Tomassini F, Venturini L, Frezza B, Cancrini G, et al. The epidemiology and clinical evaluation of abdominal trauma. An analysis of a multidisciplinary trauma registry. Ann Ital Chir aprile. 2010; 81: 95-102.
2. El-Matbouly M, Jabbour G, El-Menyar A, Peralta R, Abdelrahman H, Zarour A, et al. Blunt splenic trauma: Assessment, management and outcomes. JR Coll Surg Edinb Irel febbraio. 2016; 14: 52-58.
3. Stassen NA, Bhullar I, Cheng JD, Crandall ML, Friese RS, Guillamondegui OD, et al. Selective nonoperative management of blunt splenic injury: An Eastern Association for the Surgery of Trauma practice management guideline. J Trauma Acute Care Surg novembre. 2012; 73: S294-300.
4. Skattum J, Naess PA, Gaarder C. Non-operative management and immune function after splenic injury. Br J Surg gennaio. 2012; 99: 59-65.
5. Sclafani SJ, Shaftan GW, Scalea TM, Patterson LA, Kohl L, Kantor A, et al. Nonoperative salvage of computed tomography-diagnosed splenic injuries: utilization of angiography for triage and embolization for hemostasis. J Trauma novembre. 1995; 39: 818-825.
6. Gaarder C, Dormagen JB, Eken T, Skaga NO, Klow NE, Pillgram-Larsen J, et al. Nonoperative management of splenic injuries: improved results with angioembolization. J Trauma luglio. 2006; 61: 192-198.
7. Miller PR, Chang MC, Hoth JJ, Mowery NT, Hildreth AN, Martin RS, et al. Prospective trial of angiography and embolization for all grade III to V blunt splenic injuries: nonoperative management success rate is significantly improved. J Am Coll Surg aprile. 2014; 218: 644-648.
8. Patil MS, Goodin SZ, Findeiss LK. Update: Splenic Artery Embolization in Blunt Abdominal Trauma. Semin Interv Radiol marzo. 2020; 37: 97-102.
9. Madoff DC, Denys A, Wallace MJ, Murthy R, Gupta S, Pillsbury EP, et al. Splenic arterial interventions: anatomy, indications, technical considerations, and potential complications. Radiogr Rev Publ Radiol Soc N Am Inc ottobre. 2005; 25: S191-211.
10. Filippiadis DK, Binkert C, Pellerin O, Hoffmann RT, Krajina A, Pereira PL. Cirse Quality Assurance Document and Standards for Classification of Complications: The Cirse Classification System. Cardiovasc Intervent Radiol agosto. 2017; 40: 1141-1146.
11. Malhotra AK, Carter RF, Lebman DA, Carter DS, Riaz OJ, Aboutanos MB, et al. Preservation of splenic immunocompetence after splenic artery angioembolization for blunt splenic injury. J Trauma novembre. 2010; 69: 1126-1130.
12. Demetriades D, Scalea TM, Degiannis E, Barmparas G, Konstantinidis A, Massahis J, et al. Blunt splenic trauma: splenectomy increases early infectious complications: a prospective multicenter study. J Trauma Acute Care Surg gennaio. 2012; 72: 229-234.
13. Cinquantini F, Simonini E, Di Saverio S, Cecchelli C, Kwan SH, Ponti F, et al. Non-surgical Management of Blunt Splenic Trauma: A Comparative Analysis of Non-operative Management and Splenic Artery Embolization-Experience from a European Trauma Center. Cardiovasc Intervent Radiol settembre. 2018; 41: 1324-1332.
14. Sabe AA, Claridge JA, Rosenblum DI, Lie K, Malangoni MA. The effects of splenic artery embolization on nonoperative management of blunt splenic injury: a 16-year experience. J Trauma settembre 2009; 67: 565-72.
15. Rasuli P, Moosavi B, French GJ, Petrcich W, Hammond I. Splenic Artery Embolization in Blunt Trauma: A Single-Center Retrospective Comparison of the Use of Gelatin Sponge Versus Coils. AJR Am J Roentgenol dicembre. 2017; 209: W382-387.
16. Brillantino A, Iacobellis F, Robustelli U, Villamaina E, Maglione F, Colletti O, et al. Non operative management of blunt splenic trauma: a prospective evaluation of a standardized treatment protocol. Eur J Trauma Emerg Surg Off Publ Eur Trauma Soc ottobre. 2016; 42: 593-598.
17. Rong JJ, Liu D, Liang M, Wang QH, Sun JY, Zhang QY, et al. The impacts of different embolization techniques on splenic artery embolization for blunt splenic injury: a systematic review and meta-analysis. Mil Med Res. 2017; 4: 17.
18. Bhullar IS, Frykberg ER, Tepas JJ, Siragusa D, Loper T, Kerwin AJ. At first blush: absence of computed tomography contrast extravasation in Grade IV or V adult blunt splenic trauma should not preclude angioembolization. J Trauma Acute Care Surg gennaio. 2013; 74: 105-111.
19. Bessoud B, Denys A. Main splenic artery embolization using coils in blunt splenic injuries: effects on the intrasplenic blood pressure. Eur Radiol settembre. 2004; 14: 1718-1719.
20. Duchesne JC, Simmons JD, Schmieg RE, McSwain NE, Bellows CF. Proximal splenic angioembolization does not improve outcomes in treating blunt splenic injuries compared with splenectomy: a cohort analysis. J Trauma dicembre. 2008; 65: 1346-1351.
21. Wu SC, Fu CY, Chen RJ, Chen YF, Wang YC, Chung PK, et al. Higher incidence of major complications after splenic embolization for blunt splenic injuries in elderly patients. Am J Emerg Med febbraio. 2011; 29: 135-140.