

# MANAGEMENT OF SPLENIC COLLECTION AFTER SPLENIC ARTERY EMBOLISATION- INFARCTION OR INFECTION?

M Junaid Khalid+, Alison Cheung+, Siva Muthukumarasamy\*

*+Radiology Registrars*

*\*Consultant Radiologist*

*Department of Radiology, Hull University Teaching Hospitals NHS Trust*

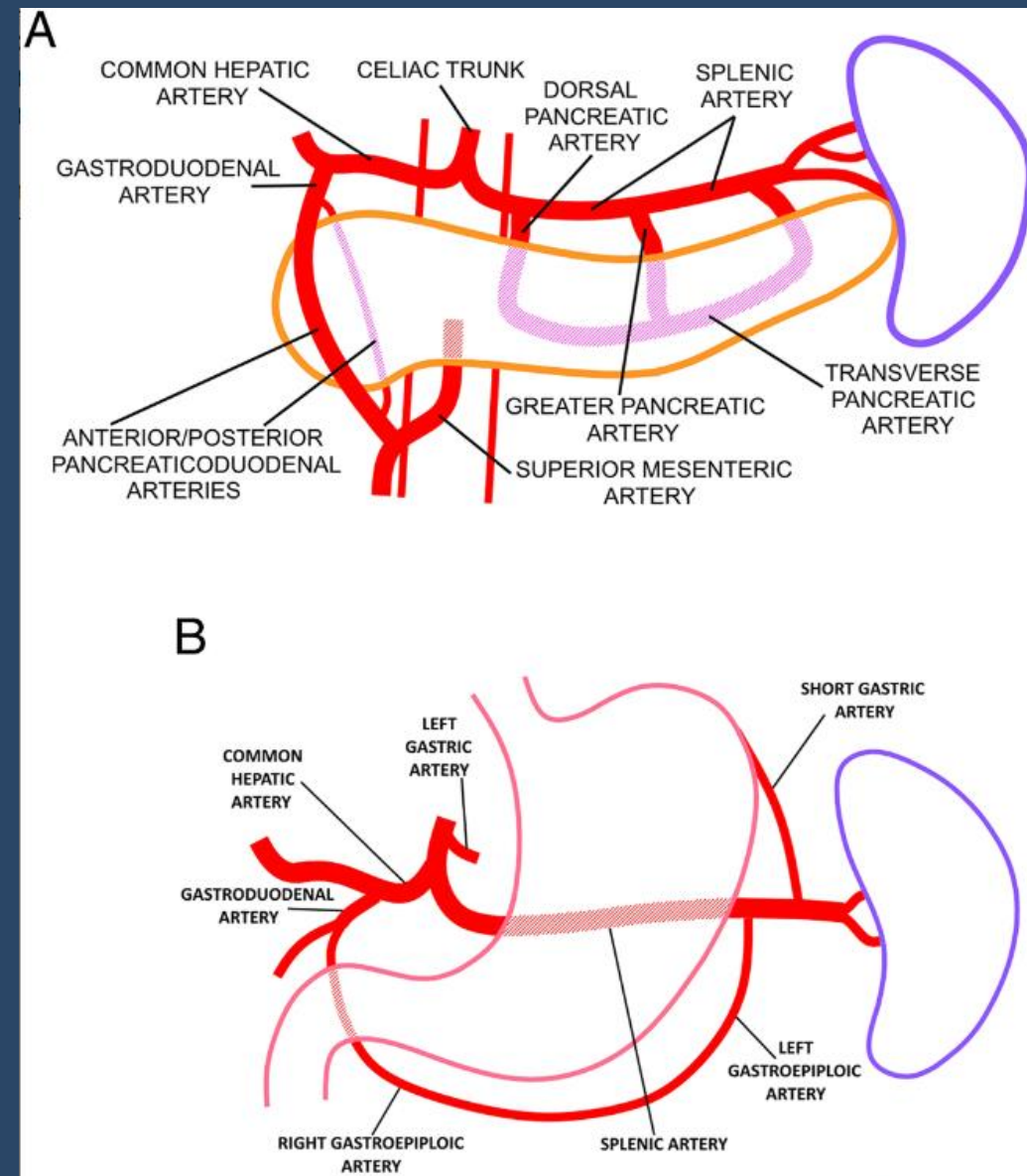


# BACKGROUND

- Splenic artery embolisation (SAE) is a valuable non-operative management of splenic injuries
- It is indicated in haemodynamically stable patients with blunt splenic trauma, if there is CT evidence of active bleeding, pseudoaneurysm, an arteriovenous fistula or other vascular injury.\*
- Also indicated in hypersplenism and portal hypertension

# SPLENIC ARTERY ANATOMY

- Splenic artery originates from the coeliac trunk.
- First large branch is typically the dorsal pancreatic artery, which bifurcates into left and right branches.\*
- Left branch continues as the transverse pancreatic artery.
- Second large branch is the greater pancreatic artery.
- Most distal branch is the caudal pancreatic artery.
- Collateral supplies from the left gastric artery and gastroepiploic arteries. Therefore, infarction is often incomplete.



Splenic Artery Anatomy\*\*

\*Quencer KB, Smith TA. Review of proximal splenic artery embolization in blunt abdominal trauma. CVIR Endovasc. 2019 Dec;2(1):11.

\*\*Image credit: Napier D. Splenic artery aneurysm rupture in the pregnant patient: The importance of utilising ultrasound to differentiate the acute abdomen from obstetric causes of abdominal pain. Sonography. 2019 Sep;6(3):122-9

# TECHNIQUES OF SPLENIC ARTERY EMBOLISATION IN BLUNT SPLENIC TRAUMA

- Through femoral artery access, coeliac artery is selected with a curved catheter.
- Coeliac angiography is performed to evaluate the splenic artery anatomy and collateral supply to the spleen.

## EMBOLISATION MATERIAL

- Coil and gelatin foam (Gelfoam) can be used alone or in combination.
- Systemic review showed that the choice of embolization material does not affect success rate.<sup>5</sup>
- Coil has a lower incidence of life-threatening complication than Gelfoam.
- Gas may present within an infarct after embolization with Gelfoam.<sup>6</sup>

## PROXIMAL ARTERY EMBOLISATION

- Preferred due to the multifocal injury pattern of blunt splenic trauma<sup>3</sup>
- Performed in patients with high risk of re-rupture
- Decreases systolic arterial pressure in the spleen to promote healing and haemostasis
- Blood flow to the spleen maintained by collaterals

## DISTAL ARTERY EMBOLISATION

- Performed in focal vascular injuries (eg. pseudoaneurysm, focal extravasation)<sup>2</sup>
- Aims to preserve splenic parenchyma perfusion and function
- Causes occlusion of the smaller end arteries, increasing the risk for parenchymal wedge infarction or abscess formation.<sup>1, 3</sup>
- Associated with a higher rate of minor infarcts.<sup>1, 4</sup>

1. \*Quencer KB, Smith TA. Review of proximal splenic artery embolization in blunt abdominal trauma. CVIR Endovasc. 2019 Dec;2(1):11.

2. Madoff DC, Denys A, Wallace MJ, Murthy R, Gupta S, Pillsbury EP, et al. Splenic arterial interventions: anatomy, indications, technical considerations, and potential complications. Radiographics. 2005 Oct;25 Suppl 1:S191-211

3. Hoppe H, Kos S. Endovascular Today. Bryn Mawr Communications; [cited 2024 Jan 18]. Splenic Artery Embolization: Proximal or Distal? Available from: <https://evtoday.com/articles/2018-apr/splenic-artery-embolization-proximal-or-distal>

4. Ekeh AP, Khalaf S, Ilyas S, Kauffman S, Walusimbi M, McCarthy MC. Complications arising from splenic artery embolization: a review of an 11-year experience. The American Journal of Surgery. 2013 Mar 1;205(3):250-4

5. 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 May 30;4:17.

6. Quadeer AR, McLennan G, Rodman G. Abstract No. 117: Outcomes Following Gelfoam Versus Coil Embolization for the Treatment of Traumatic Splenic Injury in Adults. Journal of Vascular and Interventional Radiology. 2008 Feb;19(2):S46

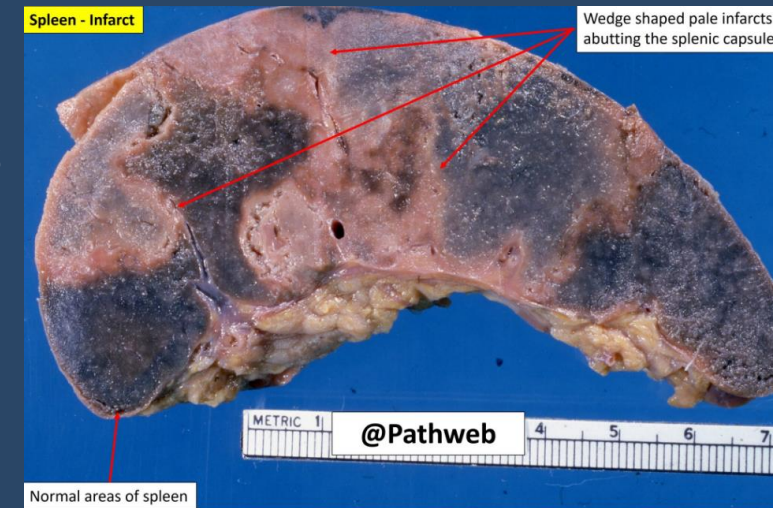
# COMPLICATIONS OF SAE

- Splenic abscess, splenic infarction and post embolization syndrome are most common.<sup>1</sup>
- Splenectomy may be required
- Patients would re-present with left upper quadrant pain post-procedure, prompting CT
- If the imaging features are suspicious for a splenic abscess, US-guided drainage may be necessary to improve symptoms and to perform microbiology analysis

## INFARCT vs ABSCESS

- The difficulty of differentiating splenic infarct and abscess on CT is well recognised.<sup>2,3</sup>
- This is due to the pathophysiological processes result in collections that could be indistinguishable on CT.

	Coagulative Necrosis	Liquefactive Necrosis
Condition	Infarction	Bacterial Infection
Relevant Pathophysiology	Dead cells maintain its architecture for a few days (10)	Viscous liquid mass formed as dead cells are digested
Resultant collection	Gel-like consistency	Abscess



Wedge-shaped subcapsular infarct in an enlarged spleen<sup>4</sup>

1. Ahuja C, Farsad K, Chadha M. An Overview of Splenic Embolization. American Journal of Roentgenology. 2015 Oct;205(4):720-5.  
 2. Killeen KL, Shanmuganathan K, Boyd-Kranis R, Scalea TM, Mirvis SE. CT Findings after Embolization for Blunt Splenic Trauma. Journal of Vascular and Interventional Radiology. 2001 Feb;12(2):209-14.  
 3. Balthazar E, Hilton S, Naidich D, Megibow A, Levine R. CT of splenic and perisplenic abnormalities in septic patients. American Journal of Roentgenology. 1985 Jan 1;144(1):53-6.  
 4. Image credits: NUS Pathweb [Internet]. [cited 2024 Jan 18]. Spleen - Infarct - NUS Pathweb : Available from: <https://medicine.nus.edu.sg/pathweb/virtual-pathology-museum/04690-2/>

# CURRENT LITERATURE

- Published studies show an incidence of 1-3% of splenic abscess after SAE
- This is used as a reference for our study

## Splenic embolization revisited: a multicenter review

James M Haan <sup>1</sup>, Walter Biffi, M Margaret Knudson, Kimberly A Davis, Tomomi Oka, Sarah Majercik, Rochelle Dicker, Shelley Marder, Thomas M Scalea;

Western Trauma Association Multi-Institutional Trials Committee

Affiliations + expand

PMID: 15128125 DOI: 10.1097/01.ta.0000114069.73054.45

- Incidence of splenectomy due to splenic abscess post SAE was 3%
- 6 out of 155 patients developed splenic abscess, 3 patients required splenectomy
- Clostridia perfringens and alpha-hemolytic Streptococcus were grown in 2 patient's operative culture

## CT findings after embolization for blunt splenic trauma

K L Killeen <sup>1</sup>, K Shanmuganathan, R Boyd-Kranis, T M Scalea, S E Mirvis

Affiliations + expand

PMID: 11265885 DOI: 10.1016/s1051-0443(07)61827-2

- Incidence of splenectomy due to splenic abscess post SAE was 1.25%
- 1 out of 80 patients had a splenic abscess at laparotomy

# OBJECTIVES OF THE STUDY

## PRIMARY OBJECTIVES

- To assess the incidence of splenic collection post SAE
- To assess the incidence of positive microbiology cultures within the splenic collection in those undergoing percutaneous drainage

## SECONDARY OBJECTIVES

- To evaluate the incidence of splenectomy post-SAE
- To examine the CT imaging features suspicious of abscess prompting percutaneous drainage



# MATERIALS & METHODS

## INCLUSION CRITERIA

Patients who underwent Splenic Artery Embolisation


---

At Hull University Teaching Hospitals (HUTH) between January 2019 – September 2023

---

Had subsequent imaging and interventions performed at HUTH

---

- Retrospective analysis
  - Incidence of splenic collection was noted, and imaging features suspicious of abscess prompting percutaneous drainage.
  - Subsequent microbiology analysis was reviewed
- 



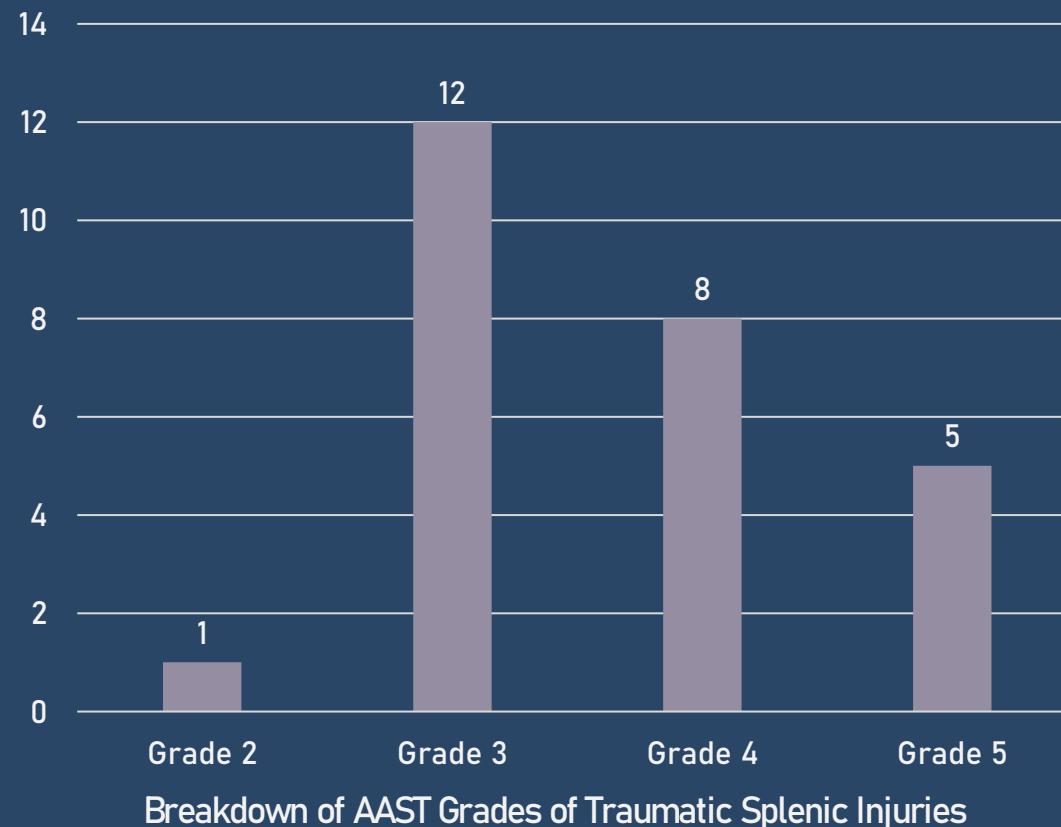
# RESULTS

## *Patient Presentation*

42 patients underwent splenic artery embolization during our study period.

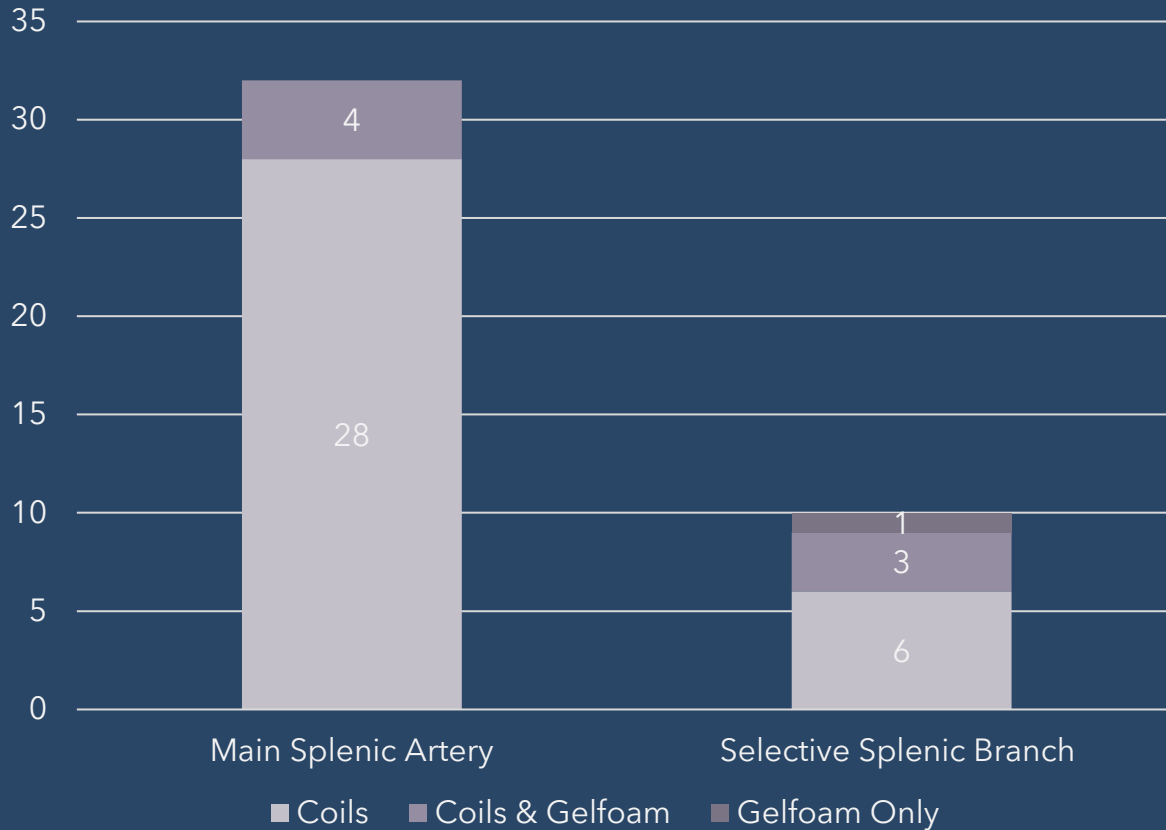
Patient presentation (n =42)	N (%)
<b>Gender</b>	
Male	10 (23.8%)
Female	32 (66%)
<b>Indication</b>	
Trauma	26 (62%)
Splenomegaly	2 (4.7%)
Pancreatitis	3 (7.1%)
Splenic artery psuedoaneurysm	3 (7.1%)
Splenic artery aneurysm	2 (4.7%)
Splenomegaly ?spontaneous rupture	3 (7.1%)
Iatrogenic (secondary to a recent procedure)	3 (7.1%)

Breakdown of indications for SAE after initial presentation CT

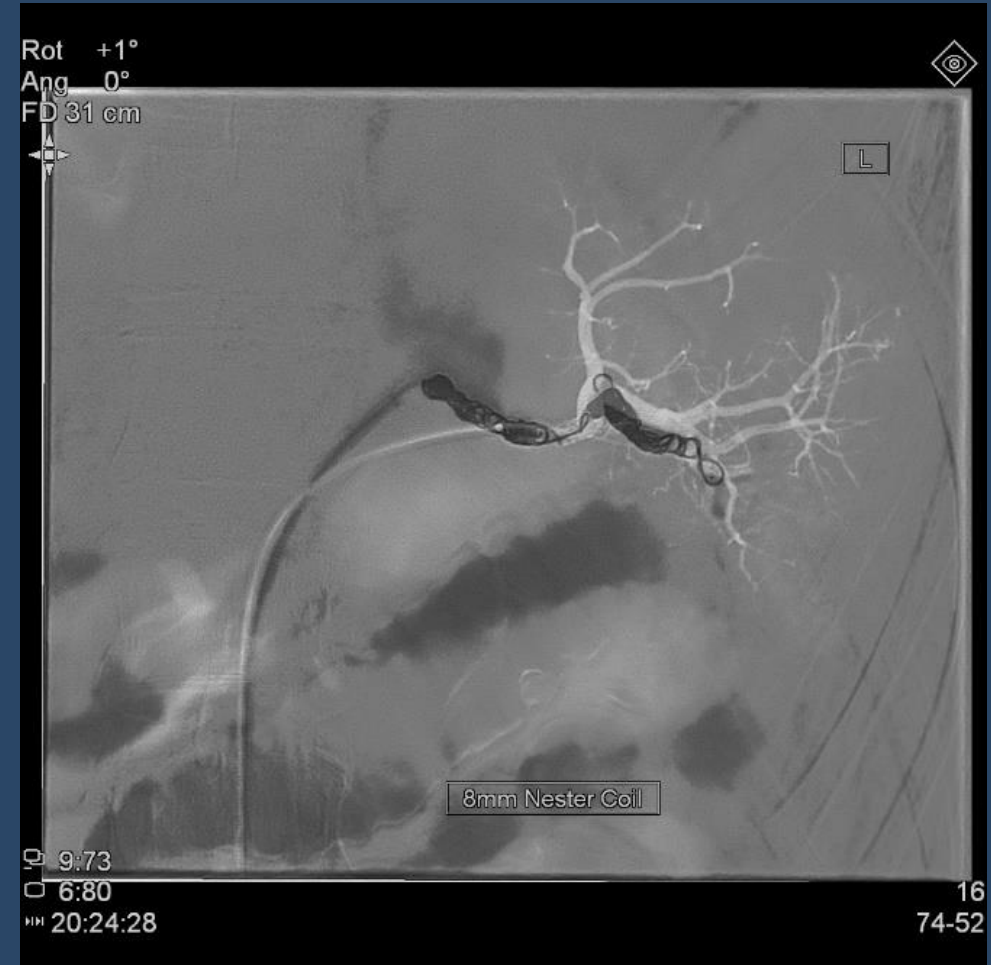


# RESULTS *(cont...)*

## Embolisation



Breakdown of Embolisation Targets and Agents used



Fluoroscopic image post splenic embolization.  
Successful embolization performed with 6mm and 8mm Nester coils.

# RESULTS *(cont...)*

## *Post Embolisation CT imaging*

21 patients underwent post SAE CT imaging  
(Breakdown of salient features in the table on the right)

Salient features in post SAE CTs	N (%)
Presence of a splenic collection	8 (32%)
Gas within collection	4 (19%)
Abdominal collection elsewhere	5 (23.1%)
Pleural effusion	8 (32%)



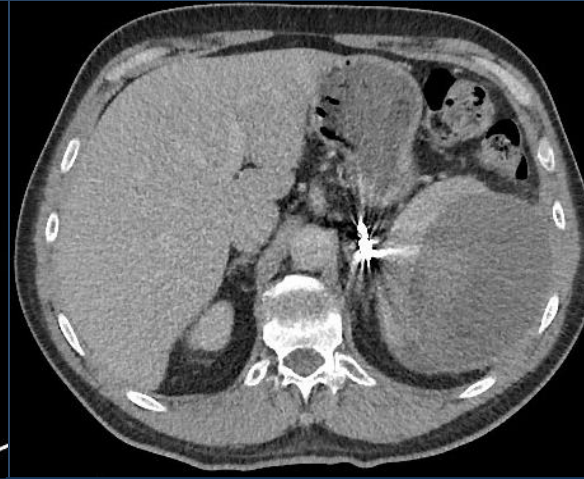
PATIENT 1

There is an established area (6.5 x 9cm) of low attenuation at the mid- lower pole of the spleen (white arrow), likely representing an area of established infarction



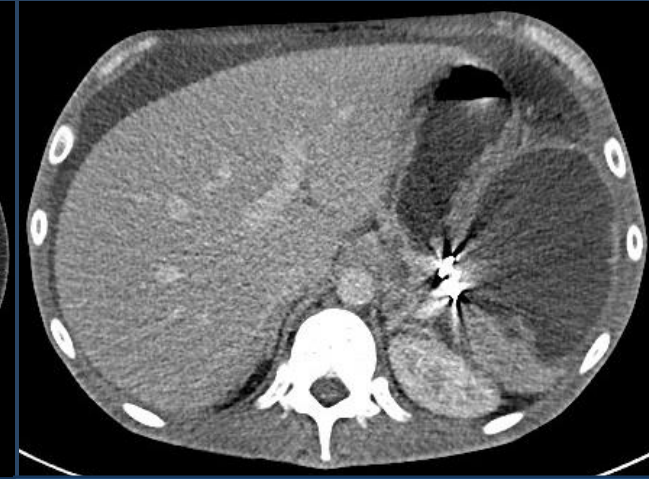
PATIENT 2

There are large wedge-shaped areas of low attenuation within the embolised spleen. Difficult to assess whether this is liquefied necrosis elsewhere or haematoma, as well as the splenic capsule



PATIENT 3

The perisplenic haematoma has liquefied and is now organised collection measuring 12 by 8.3 cm .The splenic parenchyma otherwise unremarkable.



PATIENT 4

Large left upper quadrant collection measuring 12 x 10 x 9 cm with remnants of splenic tissue in its periphery. There is peripheral enhancement but no gas within.

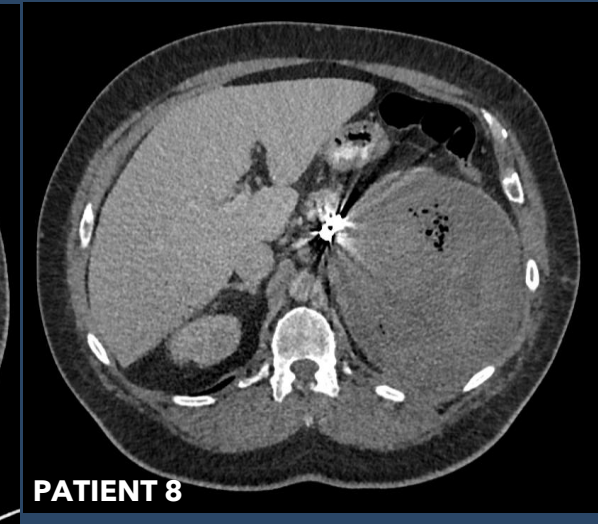
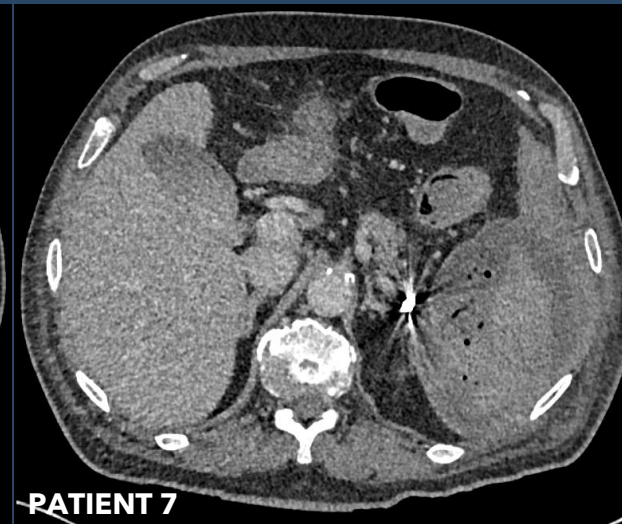
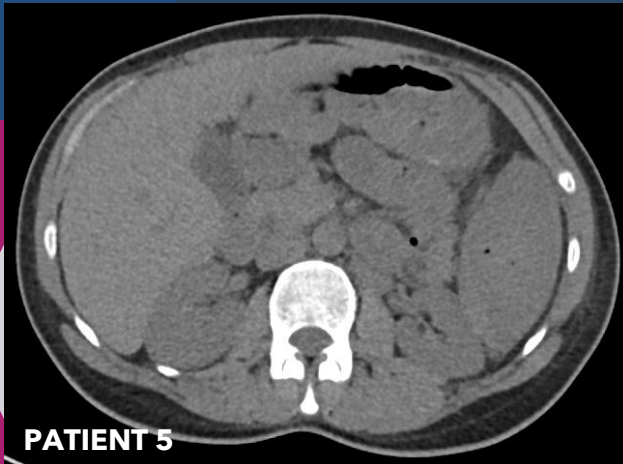
\*This patient had a positive MS&S from drainage sample of splenic collection (*S. aureus*)

Patterns of splenic collection WITHOUT GAS from patients who had a CT post-SAE

# RESULTS *(cont...)*

## *Prevalence & patterns of gas on CT in post SAE splenic collections*

- 4 patients had some form of gas within the collection, the patterns of which varied significantly



PATIENTS 5 AND 6. Axial CT slices from 2 patients show tiny locules of gas within the splenic collection

PATIENT 7. Organised splenic intraparenchymal and extracapsular haematoma with blebs of gas seen within the intraparenchymal collection. Findings reported likely due to infected haematoma. (Had subsequent drainage but no growth).

PATIENT 8. There are few small blebs of gas, reported as likely being a reflection of infection.

\*This patient had a POSITIVE MC&S from drainage sample (*Diphtheroid bacilli*)

# RESULTS *(cont...)*

## *Evaluation of post-embolization splenic collections*

➤ 8 patients had post-embolization splenic collections

N=8	Indication	SAE Target	SAE Agent/s	CT done after SAE (days)	WCC	CRP	Gas in collection	Drainage Performed	Collection MC&S	Outcome
Patient 1	Trauma (AAST 4)	Selective	Coils/Gelfoam	90	7.2	97	No	-	-	Discharge
Patient 2	Trauma (AAST 3)	Main	Coils	4	9	267	No	-	-	Discharge
Patient 3	Trauma (AAST 4)	Main	Coils	55	12.2	118	No	-	-	Discharge
Patient 4	Trauma (AAST 3)	Selective	Coils/Gelfoam	37	40	374	No	Yes	<i>S. Aureus</i>	Discharge
Patient 5	Trauma (AAST 4)	Main	Coils	5	12.6	221	Yes	-	-	Discharge
Patient 6	Iatrogenic	Main	Coils	7	17.4	82	Yes	Yes	-	Discharge
Patient 7	Trauma (AAST 4)	Main	Coils	4	28.4	224	Yes	Yes	-	Discharge
Patient 8	Spontaneous	Selective	Coils	25	12.3	216	Yes	Yes	<i>Diphtheroid bacilli</i>	Discharge

- 6 out of 8 patients had a WCC of >10 and CRP of >100
- NONE HAD POSITIVE BLOOD CULTURES
- 4 patients had gas present within the splenic collection
- 4 patients underwent drainage
- Only 2 patients (in bold) had a positive culture from splenic drainage sample
- None had splenectomy

# DISCUSSION

## *General considerations*

- Infarcts are relatively more common in distal splenic artery embolization compared to proximal.\*
- Infarct resulting in coagulative necrosis can be difficult to differentiate from infection/abscess on imaging.
- The main clinical symptoms of splenic abscess are fever, pain in the left lumbar ribs, and the increase in white blood cells. However, these symptoms are not specific and there may be no overt symptoms in some patients with splenic abscess.\*
- Recently, with the improvement in minimally invasive interventions, B ultrasound or CT-guided percutaneous catheter drainage has gradually become an alternative to deal with splenic abscess.\*

# DISCUSSION *(cont...)*

## *Common Presentations*

- The table summarises the common presentation symptoms with splenic infarction.
- It is important to note that more than 50% patients with an infarct have a raised WCC count of more than 10,000 cell/mm<sup>3</sup>.
- This is invariably a common presentation with post embolization infarction as demonstrated in our study as well in the presence of negative blood cultures.

## Splenic infarction

**Table 1** Common signs and symptoms in patients with splenic infarction (n = 49)

Signs and symptoms	n (%)
Location of pain	
LUQ pain only	16 (33)
Left flank pain only	7 (14)
LUQ and left flank pain	4 (8)
LUQ combined with other location of pain	5 (10)
Abdominal pain in other location	7 (14)
Painless presentation	10 (20)
Other common symptoms	
Nausea and vomiting	11 (22)
Constipation	3 (6)
Fever and chills	14 (27)
Physical signs	
LUQ tenderness	18 (35)
Splenomegaly	5 (10)
Laboratory	
Increased lactate dehydrogenase (>600 IU/L)	35 (69)
Leucocytosis (white blood cell count >10 000 cells/mm <sup>3</sup> )	30 (58)

Amc



EL

Ori

## Splenic infarction: 10 years of experience

Meir Antopolsky MD<sup>a,\*</sup>, Nurit Hiller MD<sup>b</sup>, Shaden Salameh MD<sup>a</sup>,  
Beth Goldshtein MD<sup>c</sup>, Ruth Stalnikowicz MD<sup>a</sup>

<sup>a</sup>Emergency Medicine Department, Hadassah Mount Scopus Hospital, Jerusalem 91120, Israel

<sup>b</sup>Radiology Department, Hadassah Mount Scopus Hospital, Jerusalem 91120, Israel

<sup>c</sup>Internal Medicine Department, Hadassah Mount Scopus Hospital, Jerusalem 91120, Israel

# DISCUSSION *(cont...)*

## *Presence of Gas*

- Gas may be present within an infarct after embolisation, but it can be difficult to ascertain radiologically whether this is due to ongoing coagulative necrosis or infection/abscess.
- A study demonstrated that gas can be present after embolization with Gelfoam which is a commonly used agent for embolization.
- The presence of an air-fluid level tends to be a better predictor of a collection being infective.



> [J Vasc Interv Radiol. 2001 Feb;12\(2\):209-14. doi: 10.1016/s1051-0443\(07\)61827-2.](#)

## **CT findings after embolization for blunt splenic trauma**

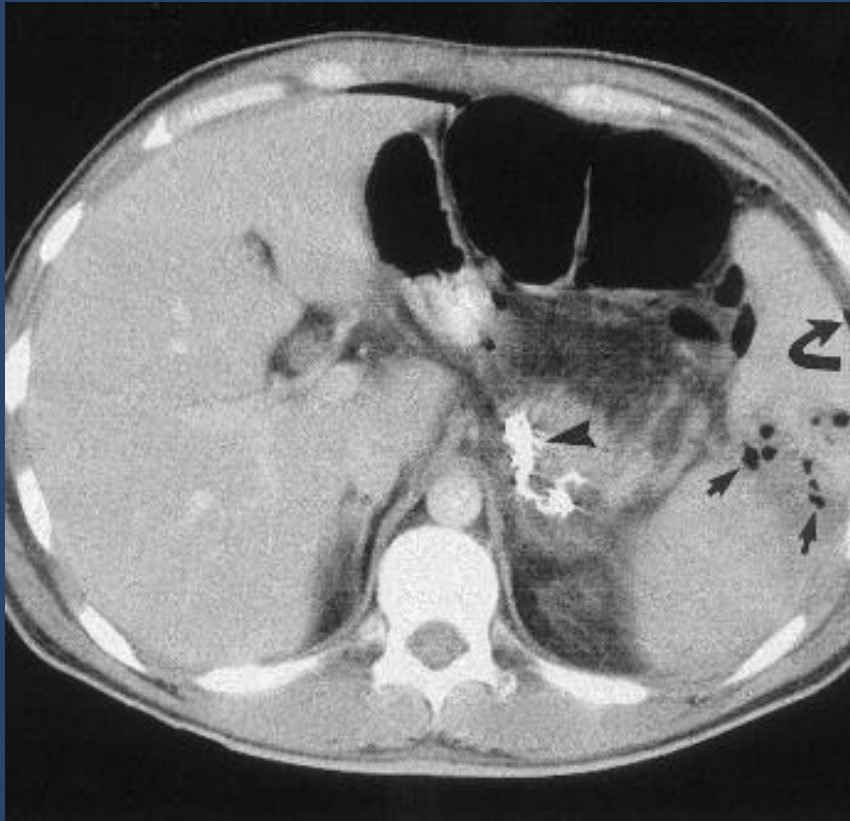
K L Killeen <sup>1</sup>, K Shanmuganathan, R Boyd-Kranis, T M Scalea, S E Mirvis



# DISCUSSION *(cont...)*

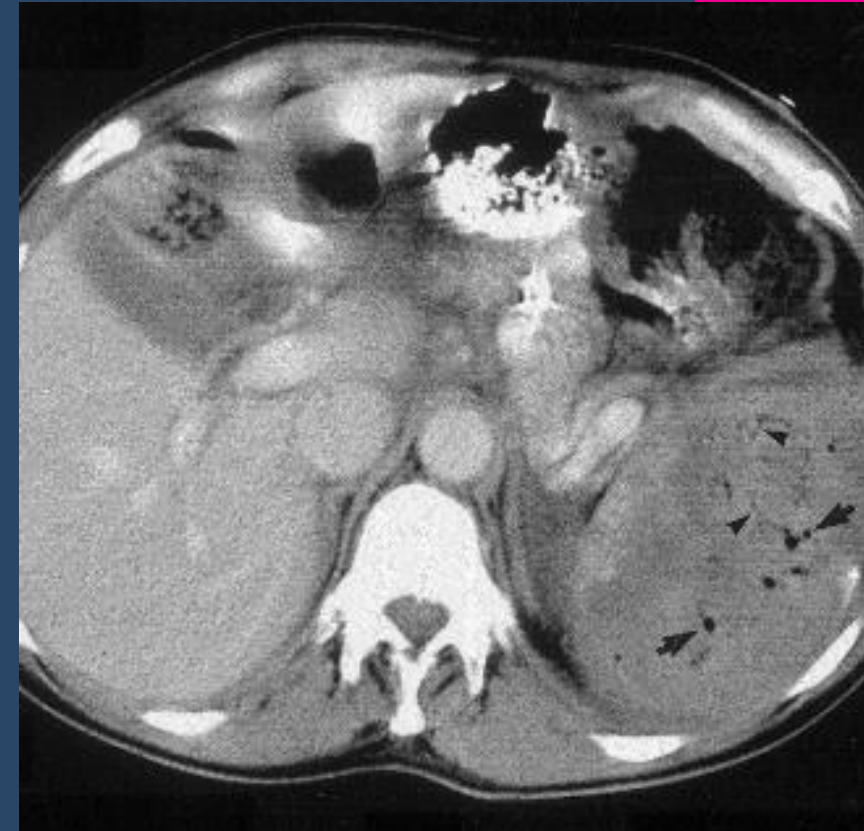
## *Patterns of Gas in literature– within spleen post SAE*

- Gas patterns within an infarct vary significantly and do not always offer a definitive diagnosis of the collection being infective



Axial CT image 3 days after embolization distally with Gelfoam and proximally with coils demonstrates multiple gas bubbles (arrows) within an infarct as well as free intraperitoneal air (curved arrow). Coils are present within the main splenic artery (arrowhead). Splenectomy was performed, which confirmed splenic abscess\*

Axial CT image shows multiple gas bubbles (arrows) as well as gas in a branching pattern (arrowheads) after proximal embolization with Gelfoam and coils\*



# DISCUSSION *(cont...)*

## *Patterns of Gas – learning from other organs*

Gas is invariably seen in other organs post embolization. The clinical presentation and gas pattern can offer clues to differentiate between necrosis and infection- however, not always possible on imaging alone.



Large infarcted fibroids containing serpiginous gas with branching pattern (arrowheads) which is an expected finding following umbilical artery embolisation. Laboratory and clinical findings showed no evidence of infection.<sup>1</sup>



Axial contrast enhanced CT image of the pelvis shows distended endometrial canal with globular foci of gas (arrowheads). Clinical findings and growth on blood culture were consistent with infection.<sup>1</sup>

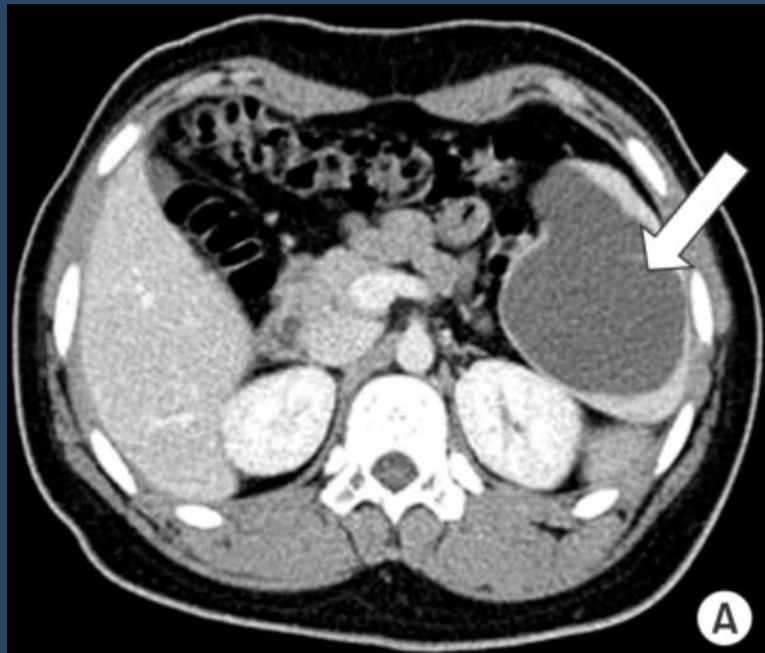


Nonenhanced CT scan obtained 1 month after chemoembolisation shows extensive gas (arrows) in the treated tumour due to liver infarction and abscess formation.<sup>2</sup>

# DISCUSSION *(cont...)*

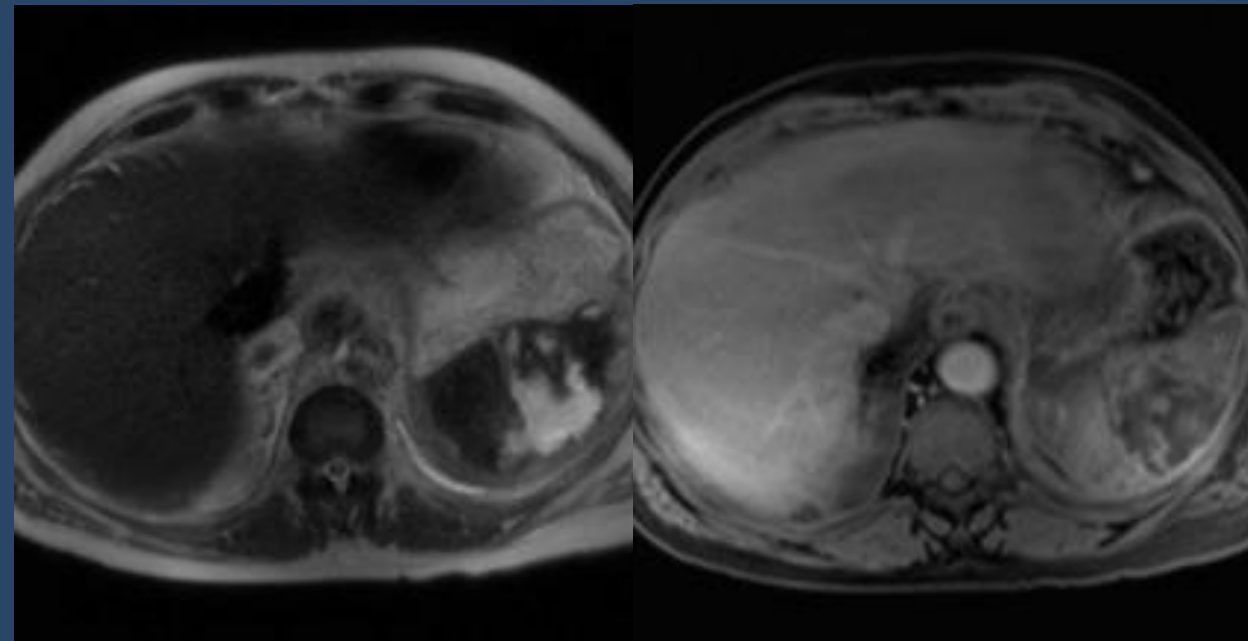
## *Post-traumatic Splenic Collections– other differentials to consider*

### Post traumatic splenic pseudocyst



low-density, non-enhancing cystic mass located in the inferior pole of the spleen, which does not contain an enhancing solid portion nor gas locules.\*

### Haemorrhagic transformation of Splenic Infarct



MR images demonstrate a large area of T2 hyperintense infarction in the spleen (left). T1 weighted images(right) demonstrate subtle areas of hyperintensity, compatible with haemorrhagic transformation.\*\*



# CONCLUSION

- It can be difficult to differentiate splenic infarction from splenic abscess, both from clinical and imaging features.
  - Other fluid collections to consider are post-traumatic splenic pseudocyst and haemorrhagic transformation of infarcted tissue.
  - Presence of gas is not reliable in determining whether collection is infective.
  - Compared with the traditional splenectomy, minimally invasive intervention can preserve the function of the remaining spleen, reducing the traumatic stress response, and reducing the time of hospitalization
  - Careful clinical judgement is required when assessing suitability for percutaneous drainage taking into consideration patient clinical history and presentation along with biochemical markers.
- 