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Splenic Artery Embolisation: An Institutional Case Series

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ABSTRACT

Abstract: Pancreatitis is one of the common causes of acute abdomen, with vascular complications being the most dangerous life-threatening ones. They include the formation of vessel thrombosis, erosion of vessel walls, and formation of pseudoaneurysms due to the release of activated pancreatic enzymes. Pseudoaneurysms most commonly affect the splenic, gastro-duodenal, pancreaticoduodenal, gastric, and hepatic arteries. The rupture of these pseudo-aneurysms can be fatal due to massive bleeding. Hence, prompt diagnosis and treatment of these lesions are necessary to prevent further catastrophe.

KEY WORDS Pancreatitis, Pseudoaneurysms, Splenic Artery, Embolisation

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Case 1: A 45-year-old male patient was admitted with severe abdominal pain and distention. He had a history of chronic pancreatitis. Serum Lipase (750 IU/L) and Amylase (620 IU/L) levels were elevated in the present admission leading to the diagnosis of acute pancreatitis. Upon examination, there was tachycardia (pulse 112 bpm/min), and hypotension (BP 86/66 mmHg) with the presence of an abdominal mass and guarding. Hemoglobin (Hb) was low (5 gm/dl). CT scan revealed hyperdense peri-splenic hematoma (Fig. 1a) along with a large pseudo-cyst with internal hemorrhage (Fig. 1b & 1c). The patient was taken for emergency angiography embolisation. A selective celiac angiogram revealed no obvious pseudo aneurysm from the splenic artery (Fig. 1d). However, considering the location of the pseudocyst and the high suspicion of a bleeding source from the splenic artery, it was decided to proceed with mid-splenic artery embolisation with micro-coils (Fig. 1e). Post embolisation, the patient was transferred to the intensive care unit (ICU) for further monitoring. There was no further drop in Hemoglobin (Hb) and vasopressor supports needed before embolisation was also weaned off. The patient was discharged from the hospital on postoperative day 7.

Case 2: A 38-year male patient, with acute pancreatitis, was admitted with a sudden drop in Hb (4.5 gm/dl). Upon physical examination, there was tachycardia (Pulse 108bpm/min) and hypotension (BP 90/60 mmHg). CT angiography did not reveal any obvious pseudoaneurysm from the splenic artery (Fig. 2a), but there was a large pseudocyst on the right side of the abdomen (Fig. 2b). The patient was taken for emergency angiography embolisation. Selective splenic artery angiogram revealed a small pseudoaneurysm arising from the proximal splenic artery (Fig. 2c). Splenic artery embolisation was done proximal and distal to the site of the pseudoaneurysm – Sandwich technique (Fig. 2d). Post embolisation, the pseudoaneurysm was excluded from circulation suggesting successful treatment. The patient had no further drop in Hb levels and was discharged from the hospital on postoperative day 6.

Case 3: A 17-year-old male patient with recurrent pancreatitis was admitted with severe left hypochondriac pain for 2 days. Serum Lipase (850 IU/L) and Amylase (700 IU/L) levels were elevated diagnosing acute pancreatitis. There was tachycardia (pulse 120/min) and hypotension (BP 78/66 mmHg) with a severe drop in Hb (4.2 mg/dl). CT Abdomen revealed a large splenic and peri-splenic hematoma (Fig. 3a & 3b) along with atrophic pancreatic parenchyma and peri-pancreatic fat stranding. Considering the presence of acute pancreatitis, surgical splenectomy was not considered as a first-line therapy. The patient was taken for emergency Angiography embolisation. Selective celiac angiogram revealed punctuate areas of parenchymal blush in the intra-splenic arteries suggestive of splenic contusions (Fig. 3c). Splenic parenchymal embolization was done using 150–250-micron Polyvinyl alcohol particles. This was followed by distal and mid-splenic artery embolisation using micro-coils (Fig. 3d). Post embolisation, the patient was shifted to ICU, and he had no further drop in Hb with gradual weaning off of vasopressor supports. However, on postoperative day 4, he developed high-grade fever and recurrent pain in the left upper hypochondrium for which a CT abdomen was done. It revealed an abscess formation at the site of the splenic and peri-splenic hematoma post-embolization, which was drained using ultrasound-guided insertion of a pigtail drainage catheter (Fig. 3e). However, the patient eventually underwent surgical splenectomy after the resolution of acute pancreatitis. The patient was discharged from the hospital after 25 days.

Case 4: a 52-year-old male patient, a chronic alcoholic, with a history of chronic pancreatitis, was referred to the hospital with the diagnosis of acute pancreatitis and a sudden drop in Hb. He had a history of surgical splenectomy 1 year ago due to abscess formation. Blood investigations revealed low Hb (4 mg/dl), elevated Serum Lipase (600 IH/L), and Amylase (580 IU/L) levels. CT Angiography revealed a large pseudo aneurysm arising from the mid-splenic artery [Figure 4a & 4b]. Selective splenic artery angiogram revealed a large pseudo aneurysm arising from the mid-splenic artery (Fig. 4c). Splenic artery embolisation was done using microcoils, proximal and distal to the site of the pseudoaneurysm – Sandwich technique (Fig. 4d). Post embolisation, the patient was shifted to ICU for further care and was discharged from the hospital on postoperative day 8.

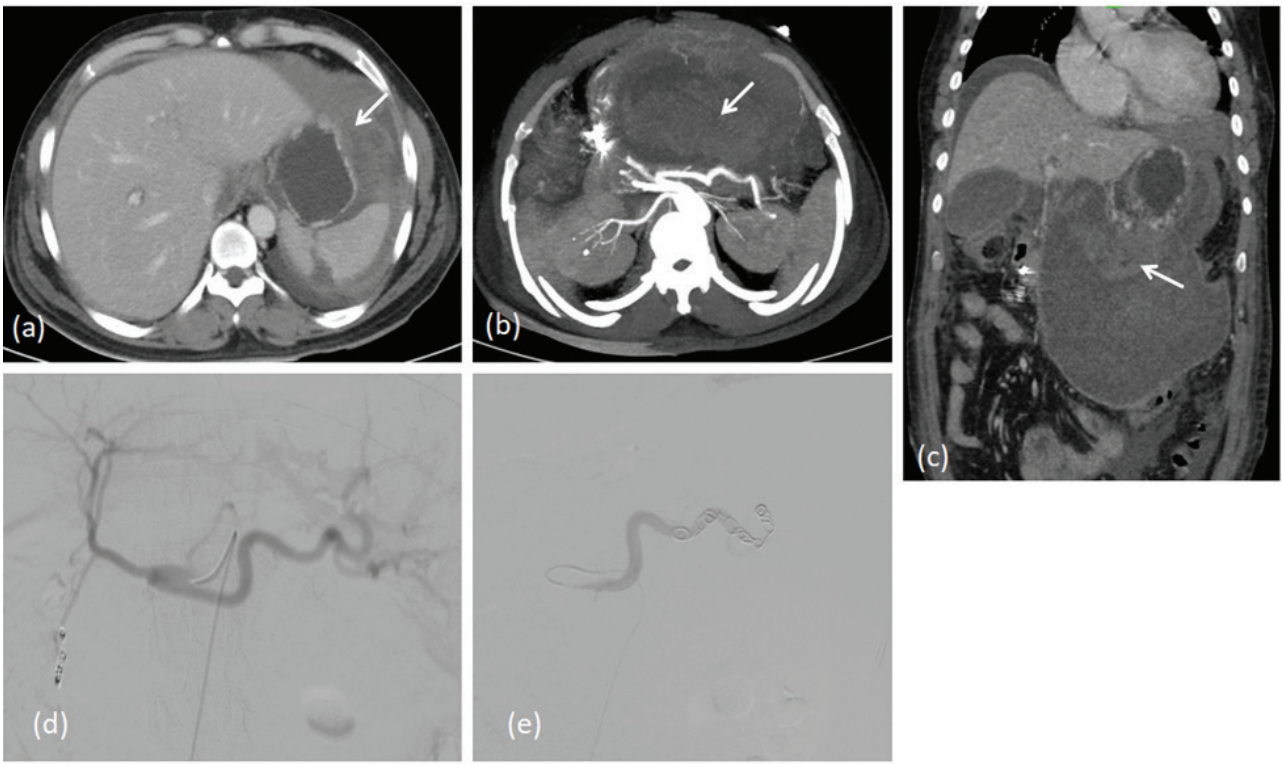

Figure 1. a. *Axial post-contrast CT scan image shows peri-splenic hematoma with non-enhancing focal area in spleen likely infarct. b. Axial CT Angiography image showing large pseudocyst with internal hemorrhage. c. Sagittal CT scan image showing large pseudocyst with internal hemorrhage. d. DSA image showing selective celiac artery angiogram. e. Post embolization selective celiac artery angiogram DSA image showing micro-coils within the splenic artery with non-contrast opacification of its lumen.*

DSA Angiography Technique: The angiography and embolisation procedure was done in Cathlab. The patient was kept nil-by-mouth for 4-6 hours before the procedure, and all necessary blood investigations were done. Under ultrasound guidance and local anesthesia, right femoral artery access was taken using an 11 cm, 5F vascular sheath (Cordis Medical). Selective celiac artery angiograms were taken using a 5 F SIM 1 catheter (Cordis Medical). When needed, selective access was taken in the splenic artery using a 2.7 F micro-catheter (Progreat, Terumo). For splenic parenchymal embolisation, 150-250 microns of Polyvinyl alcohol particles (Cook Medical) were utilized. For splenic artery embolisation, microcoils were utilized (Cook Medical). Post embolisation, the femoral arterial puncture site was closed by manual compression for 20 – 25 minutes, hemostasis was confirmed, and the patient was shifted to ICU for observation and further management. 6 – 8 hours of supine immobilization was advised to prevent bleeding from the arterial puncture site.

Discussion

The spleen has multiple important functions in the human body such as Infection prevention, storage of red blood cells & platelets, hematopoiesis, phagocytosis of senescent RBCs, etc. [1]

The splenic artery arises from the celiac trunk along with common hepatic and left gastric arteries. The first branch of the splenic artery is the dorsal pancreatic artery from the proximal part, the second branch is arteria pancreatica magna from the mid portion and the third branch is the caudal pancreatic artery from the distal part of the splenic artery. The

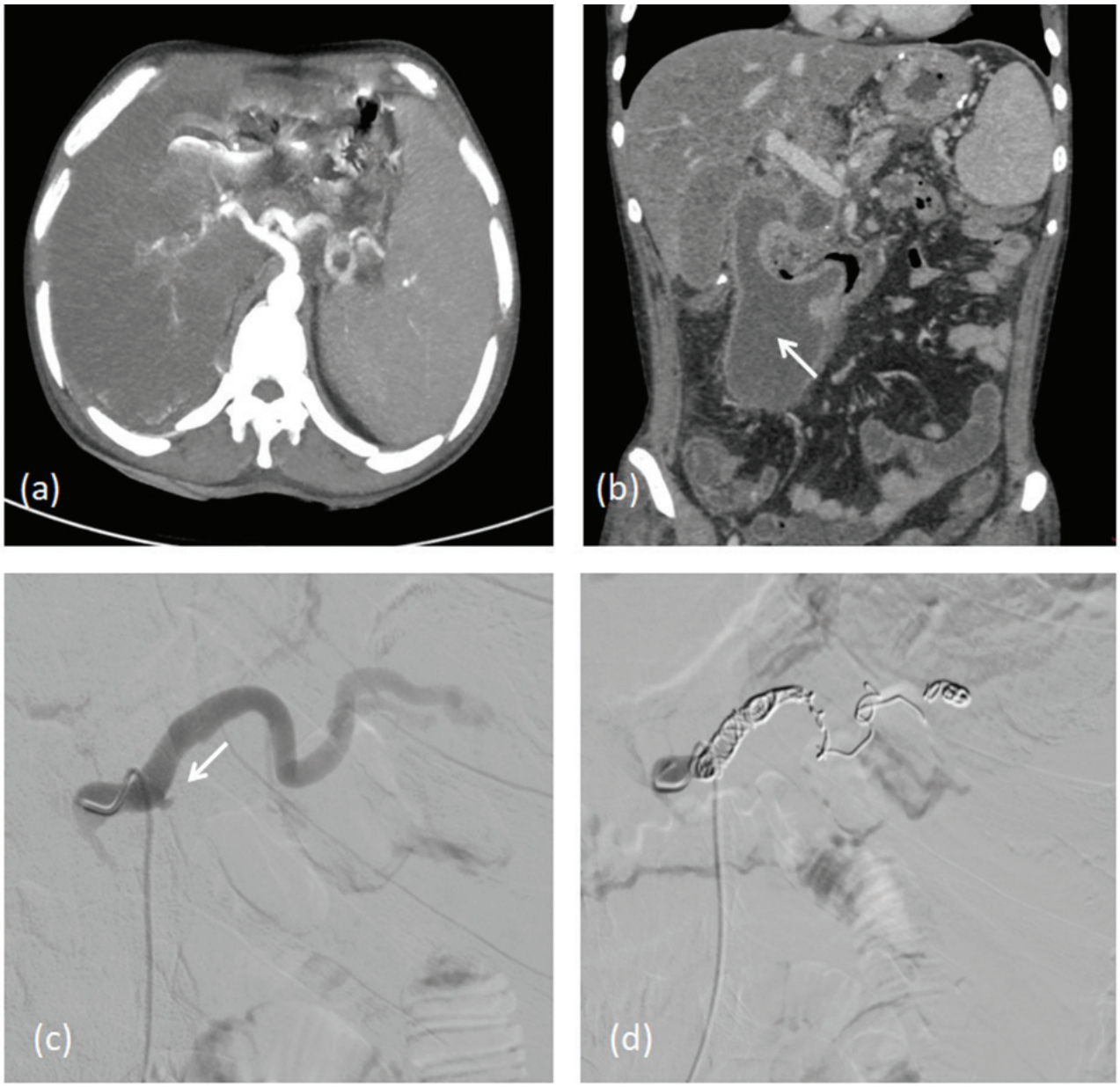

Figure 2. a. Axial CT Angiography image showing celiac trunk, common hepatic artery, and splenic artery. b. Sagittal CT scan image showing pseudo cyst on right side of abdomen. C. Angiography image of selective celiac artery angiogram showing pseudo aneurysm arising from the proximal splenic artery. d. Post embolization selective splenic artery angiogram DSA image showing micro-coils within the splenic artery with non-contrast opacification of its lumen.

splenic artery supplies the spleen, body & tail of the pancreas, and part of the stomach.

Therefore, preservation of functional splenic parenchyma is a priority while managing splenic artery pseudoaneurysm or splenic parenchymal injuries [1,2]. A pseudoaneurysm is a leakage of arterial blood from inside the vessel into adjacent tissue and is usually contained by overlying media, adventitia of the artery, or surrounding soft tissue structures [3]. In some cases, these pseudoaneurysms may be asymptomatic due to their small size and they are detected incidentally [3]. However, they may present

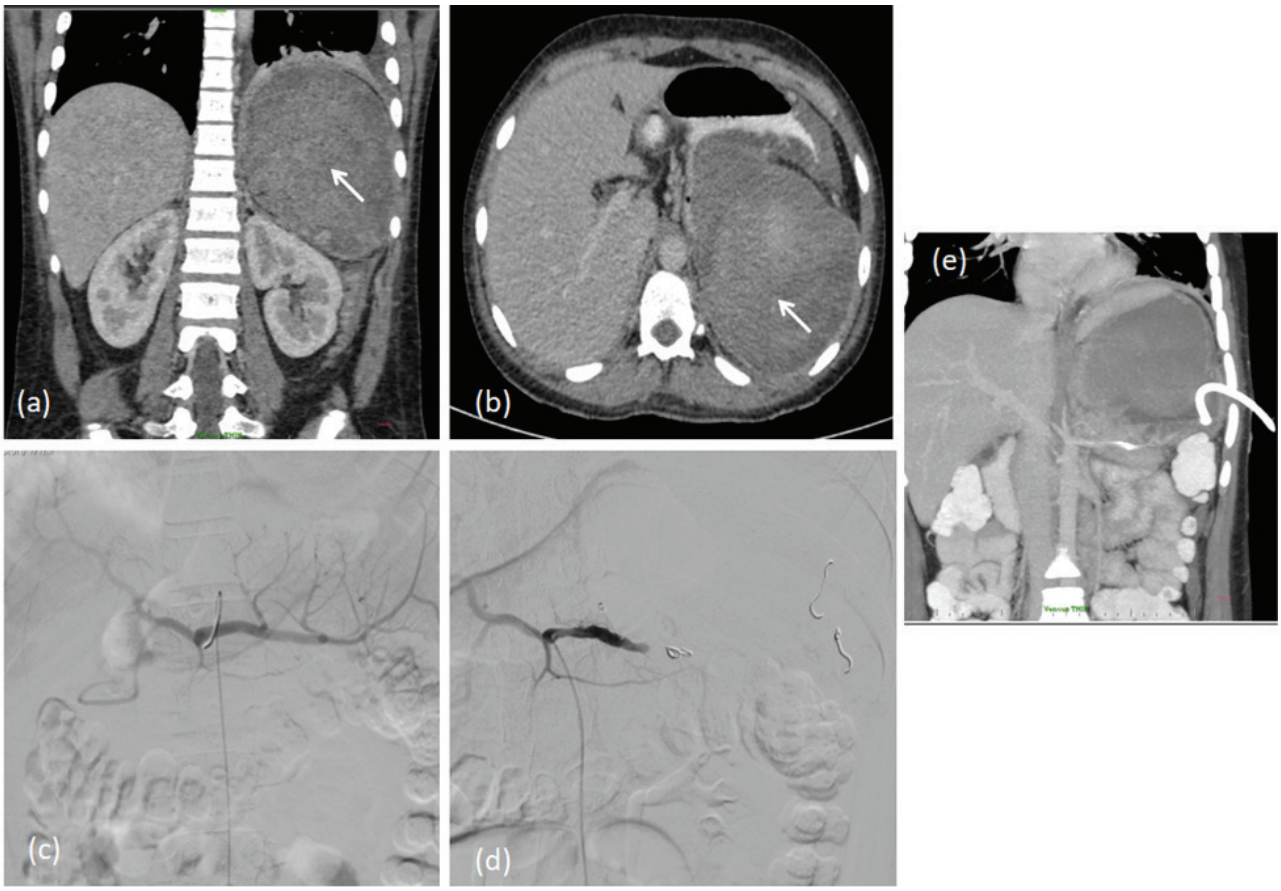

Figure 3. a. *Sagittal post-contrast CT scan image showing large splenic and peri-splenic hematoma. b. Axial post-contrast CT scan image showing large splenic and peri-splenic hematoma. c. DSA Angiography image of selective celiac artery angiogram showing punctuate areas of parenchymal blush in the intra-splenic arteries suggestive of splenic contusions. d. Post embolization selective celiac artery angiogram DSA image showing micro-coils within the proximal & distal splenic artery with non-contrast opacification of its lumen. e. Post-contrast Axial CT scan image showing large non-enhancing abscess formation within the splenic hematoma post-embolization. It was treated with ultrasound guided insertion of 14 F pigtail drainage catheter.*

with a mass effect on adjacent neuro-vascular structures or life-threatening hemorrhage due to rupture [3]. The mortality post-rupture of a splenic artery pseudo-aneurysm approaches 100% [4,5]. Therefore, all pseudoaneurysms, whether symptomatic or not, need treatment.

Various imaging modalities like Duplex Doppler ultrasound (US), helical computed tomography (CT) angiography, and magnetic resonance (MR) angiography can diagnose such pseudo-aneurysms [6], however, Conventional Angiography is the gold standard. It can access the hemodynamics of the source vessel on a real-time basis, identify the collateral supply decide the expendability of the donor inflow artery. The pseudoaneurysms that are not seen in ultrasonography, CT, and MR angiography can be seen in Conventional DSA angiography along with concurrent therapeutic intervention [7].

The treatment options for splenic artery aneurysms include medical treatment, endovascular treatment, and surgery depending upon age, aneurysm dimension, origin, and the severity of the clinical findings and their complications [8,9,10]. Considering the risk of post-splenectomy sepsis and the increased risk of certain infections in later life, physicians have adopted the splenic preservation

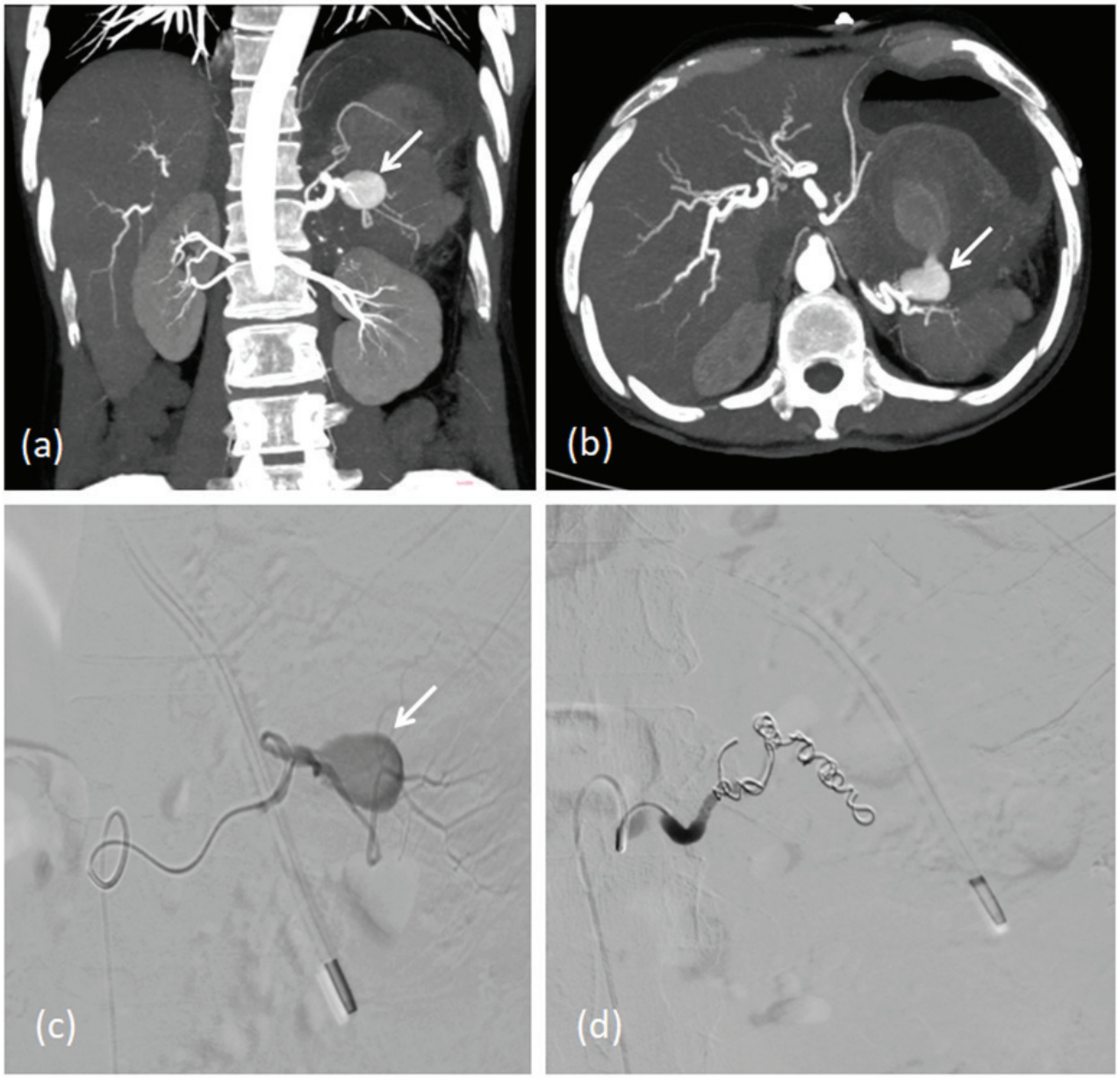

Figure 4. a. *Sagittal CT Angiography image showing large pseudo aneurysm arising from the mid-splenic artery. b. Axial CT Angiography image showing large pseudo aneurysm arising from the mid-splenic artery. c. Selective splenic artery DSA Angiography image showing large pseudo aneurysm arising from the mid splenic artery. d. Post embolization Selective splenic artery DSA image showing micro-coils within the splenic artery, proximal and distal to the site of pseudo aneurysm (Sandwich technique), with non-contrast opacification of its lumen.*

approach, whenever possible [1,2]. Medical management in adult patients with splenic trauma has high failure rates (from 2% to 52%) with the need for secondary splenectomy and hence it is not currently preferred [11,12].

In patients with trauma-related splenic injuries with unstable hemodynamics, surgery is preferred, whereas, in patients with stable hemodynamics endovascular management is the treatment of choice [13].

The endovascular treatment being minimally invasive can be performed under local anesthesia and has early postoperative recovery and short hospital

stay, with high success and low complication rates. Thus, it is recommended in high-risk patients with multiple co-morbidities like recent major abdominal surgery, intra-peritoneal adhesions, etc [14]. However, the limitations include the lack of availability of these high-end facilities at all places with resources for emergency procedures; access to site-related issues, contrast toxicity, and prolonged imaging surveillance [15].

Depending upon the pattern of injury, splenic artery embolisation can be Proximal (PSAE) or Distal (DSAE) [16]. PSAE decreases the systolic arterial pressure and blood flow in the spleen, promoting hemostasis and healing of injured splenic parenchyma and increasing hepatic artery blood flow in post-liver transplant splenic artery steal syndrome [16, 17]. DSAE is preferred in cases of focal arterial injuries like pseudo-aneurysms [18].

The spectrum of abnormalities that can be seen on angiography ranges from arterio-venous fistula, pseudoaneurysms, abrupt vessel truncation, and rarely seen frank extravasation [19]. Splenic contusion appears as punctuate areas of parenchymal blush in the intra-splenic arteries [19]. Splenic artery aneurysms are the most common visceral artery aneurysms [19]. Small aneurysms have a diameter of <2cm [19], whereas giant aneurysms have a diameter of>5 cm [20]. Their incidence is higher in patients with portal hypertension [19]. The other contributory factors include pregnancy, fibromuscular dysplasia, infection, pancreatitis, and congenital anomalies [19].

Percutaneous endovascular interventional procedures such as transcatheter embolisation, placement of covered stent-grafts, or percutaneous injection of coils/thrombin/glue are commonly used to manage splenic artery aneurysms [19]. When possible, the site of occlusion should be kept precise to preserve the collateral flow to the spleen via the gastric, omental, and pancreatic vessels [16].

The commonly utilized embolisation technique for pseudoaneurysms is the “Sandwich Technique” in which the embolisation is done distally and proximally to the site of the pseudoaneurysm to prevent forward and backflow from any collateral circulation [3,21].

Coils are commonly used permanent embolic agents which are available in different sizes (diameter and length). For adequate embolisation, the diameter of coils used in transcatheter embolisation should be 20-30% larger than the diameter of the artery [22]. The possible complications after coil embolisation are non-target embolisation due to coil migration, pseudoaneurysm rupture, and infection [22,23]. Coils depend upon the body’s coagulation system to achieve complete embolisation [22,23].

N-butyl cyanoacrylate (glue) is a liquid permanent embolic agent. It polymerizes rapidly to form a cast when in contact with blood [22,23]. Therefore it has to be diluted with Ethiodized oil to slow the rate of polymerization and achieve optimal embolisation [22]. Ethiodized oil also provides radio-opacity to the solution. However, this technique requires adequate expertise as potential complications like non-target embolisation and catheter trapping is frequent [23].

A Gelatin sponge is a temporary, low-cost embolic agent that is made into gel foam slurry after mixing with an iodinated contrast agent [23]. It is mainly used in emergencies [23]. The main complication is the high risk of infection [23].

An amplatzer vascular plug is a three-dimensional nitinol mesh device that is used to occlude the pseudoaneurysm from medium-sized arteries [23]. They are oversized by 30-50% with respect to the vessel diameter [22]. The advantages are high success rates and controlled deployment [23].

In cases when the aneurysmal neck is wide and the parent artery diameter optimally large, stent graft placement to exclude the aneurysm from circulation has been effective in preserving the splenic arterial blood flow [24, 25].

When the transcatheter embolisation is not possible or fails, percutaneous 22G Chiba needle placement into the aneurysmal sac followed by coil/thrombin injection has been successfully performed [26,27]. Thrombin injection caused activation of the coagulation cascade which converts fibrinogen to fibrin with the formation of the clot. The complications of thrombin injection are non-target embolisation, allergic reaction, infection, and recurrence from collateral supply [26, 27].

The complications of endovascular interven-

tions can be divided into puncture site, procedure site, and post-embolisation complications [28,29]. Bleeding, hematoma, pseudoaneurysms, arterial dissection and thrombosis, and arterio-venous fistula formation are puncture site-related complications [28,29]. Procedure site complications include rupture of pseudoaneurysm, arterial dissection, non-target embolisation, coil migration, and infection [30,31]. Post-embolisation syndrome seen as pain, fever, and vomiting is usually transient [29]. Suboptimal embolisation may result in the recurrence of pseudoaneurysm [32].

The indications for surgery are patients with unstable hemodynamics, pseudoaneurysms causing significant mass effects, infected pseudo-aneurysms, and cases in which endovascular management has failed [3]. Open laparotomy with aneurysm ligation with/without splenectomy was the Gold standard of management, however, recent development in laparoscopic surgery has made lesser morbidity and faster recovery possible [33]. The Surgical mortality approaches 16% for pseudoaneurysm in the head of the pancreas and 50% for lesions in the tail [34].

Zoppo et al study shows that there was no statistically significant difference in the adverse events or 30-day post-splenic artery embolization (SAE) survival rates between patients who were hemodynamically stable (HDS) and hemodynamically unstable (HDU) with acute splenic injury (ASI). They show that SAE can be a safe and effective treatment option for patients who are HDU with ASI, including high-grade splenic injury [35].

Conclusion

Considering the high mortality post-rupture, all visceral artery pseudo-aneurysms need immediate management. In the recent era, minimally invasive interventional radiology techniques are preferred over surgery. They have high success rates with lower morbidity and complications. **R**

Conflict of interest

All authors declare that they do not have any conflict of interest.

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Ethical approval

The institutional ethics committee waived the requirement to obtain written informed consent due to the case series.

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