Splanchnic Artery Aneurisms - A Radiologic Review

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Learning objectives

The objective of this poster is to review imaging features of the different types of splanchnic artery aneurysms with reference to a series of cases. The different forms of treatment and management are not the focus of this poster and will not be reviewed.
Background

Splanchnic Artery Anatomy

The splanchnic circulation comprises the celiac, superior mesenteric and inferior mesenteric arteries, which arise from the abdominal aorta. The **celiac artery** is the most proximal artery and divides into three branches: the **left gastric** (supplies the fundus and proximal lesser curvature of the stomach), **splenic** (supplies the spleen, pancreas and stomach through the short gastric and left gastroepiploic artery) and **common hepatic** (divides into the gastroduodenal and proper hepatic) arteries. The gastroduodenal artery provides collateral circulation and is particularly important when the celiac or superior mesenteric arteries are occluded proximally. The right gastric artery arises from either the common hepatic or the left hepatic artery and provides blood to the distal lesser curvature of the stomach. The proper hepatic artery supplies the liver by dividing into a right and left hepatic artery. However, the right hepatic artery may arise from the superior mesenteric artery and the left hepatic artery may also arise from the left gastric artery. The **superior mesenteric artery**, originating from the aorta 10 to 20 mm distal to the celiac trunk, supplies the head and uncinated process of the pancreas by means of the inferior pancreaticoduodenal artery, the small intestine through its jejunal and ileal branches and the ascending and transverse colon through its ileocolic, right colic and middle colic branches. Finally, the **inferior mesenteric artery** originates 50 to 60 mm distal to the superior mesenteric artery, supplying the splenic flexure and the descending colon via the left colic artery. It terminates caudally as the superior haemorrhoidal arteries [1].

As such, splanchnic artery aneurysms (SAA) include those arising from the celiac axis and its branches, as well as from the superior mesenteric artery (SMA) and inferior mesenteric artery (IMA) and their respective branches (figure 1).

Epidemiology

SAA are uncommon, with an estimated incidence of 0.1-2% in the adult population [2-4]. However, their identification has augmented particularly in the aging population due to the use of improved thin-sliced cross-sectional imaging, reconstruction imaging techniques and Magnetic Resonance imaging (MRI), allowing for the diagnosis of asymptomatic lesions.

The most commonly reported aneurysms [1,5] involve, in decreasing order of frequency, the splenic (60%), proper hepatic (20%), superior mesenteric (5.5%) and celiac (4%) arteries. Pancreaticoduodenal and gastroduodenal aneurysms represent 2% and 1.5%
of all SAA, respectively (figure 1) [1,5]. Multiple aneurysms have been described in approximately one third of patients [1]. The visceral arteries are the sixth most common site for arterial aneurysmal degeneration [6]. Visceral artery pseudoaneurysms are even more uncommon, with the most frequently reported also involving the splenic artery [6].

Even though the above prevalence figures have been established [1], some authors [7] believe that the real incidence is still unknown due to the fact that most cases are asymptomatic. In fact, in the past many SAA were diagnosed in rupture. In present days, many SAA are still only discovered on autopsy.

In a review of the English literature, Stanley et al. [8] highlighted the high mortality related to rupture of SAA, which varied from 21% for hepatic artery aneurysms to 100% for celiac artery aneurysms. They also reported that 22% of all SAAs presented as emergencies resulting in an overall 8.5% mortality rate [8]. As a result, incidentally discovered asymptomatic SAA have been managed with either frequent imaging surveillance or early elective repair to prevent the high morbidity and mortality associated with rupture. There is still no consensus in literature regarding precise indications for SAA repair or the best type of surgical treatment [9].
Findings and procedure details

SAA are generally defined as a localized dilatation of the mesenteric vasculature greater than 1.5 times the normal diameter of an artery involving all 3 layers of the vessel wall [1,5,7]. Most splanchnic artery aneurysms are asymptomatic and detected incidentally. Symptomatic aneurysms present with either abdominal pain or intra-abdominal or gastrointestinal bleeding. Common causes of true aneurysms are arteriosclerosis, fibromuscular dysplasia, cystic medial necrosis and portal hypertension. A full list of common and uncommon aetiologies is provided in table 1. Although potential complications depend on the location and size of the aneurysm, many share a range of complications which are summarized in table 2.

Splenic Artery Aneurysms

Due to their asymptomatic nature, the real prevalence of true splenic artery aneurysms has been difficult to define. A review of 3,600 nonselective angiograms demonstrated this incidental finding in 0.78% of the patients studied [8]. Patients typically present in the sixth or seventh decade of life [10]. There is a 4:1 female-to-male predominance [11] and they are most frequently found in women with multiple pregnancies [11], possibly due to the structural weakening resulting from the increase in hormones and exacerbated wall stress from portal congestion leading to a combination of medial hyperplasia and fragmentation of the elastic lamina [8]. Curiously, while many splenic artery aneurysms demonstrate calcification as seen in atherosclerosis, these appear to be secondary to the arterial degeneration rather than primarily to due atherosclerosis [12]. Most frequently, splenic aneurysms are identified incidentally on plain film, computed tomography (CT) or arteriogram (figures 4 and 5). Differential diagnosis includes tortuous splenic artery, calcified lymph nodes, renal artery aneurysm and calcified cysts of the spleen or adrenal gland.

True splenic aneurysms are most commonly located in the distal third of the splenic artery (in 75% of cases), followed by the middle third in 20% of cases [12]. Concomitant non-splenic but splanchnic artery aneurysms are seen in 3% of patients [11].

The majority of patients presenting with acute symptoms relating to their aneurysm are confirmed to have frank rupture. There can be a delayed onset of rapid blood loss due to the "double rupture phenomenon", resulting from an initial tamponade of the bleeding within the lesser sac and therefore delayed intraperitoneal hemorrhage [13]. However,
rupture occurs in less than 2% of patients [10]. Growth of these lesions is reported to be modest, averaging less than 1 mm/year [11].

Most splenic artery aneurysms are smaller than 20 mm [1]. Even though no consensus regarding size criteria for aneurysm repair in asymptomatic patients has been achieved, most clinicians agree with the repair independent of size in pregnant patients or after liver transplantation due to the increased risk of rupture and high associated mortality. The standard recommendations are that splenic artery aneurysms greater than 25mm should be repaired [17]. Aneurysms measuring between 10 and 25mm in diameter should be monitored closely with imaging studies every 6 months [1].

Pseudoaneurysms of the splenic artery are less prevalent than true aneurysms and usually arise from previous trauma or infection. They most commonly occur in association with severe pancreatitis and pseudocyst development [11]. They most commonly present with intermittent bleeding into a pseudocyst, pancreatic duct or the duodenum [14]. Treatment should be initiated without delay, regardless of size.

Fig. 4: Splenic Artery Aneurysm. A. Grayscale ultrasound showing an anechoic saccular lesion communicating with the splenic artery. B. Corresponding arterial-phase MR image depicting the splenic aneurysm. C. Splenic arteriogram from the same patient.

References: Centro Hospitalar de Lisboa Ocidental - Lisboa/PT
**Hepatic Artery Aneurysms**

The hepatic artery is the second most common site of splanchnic aneurysms. However, almost 50% of hepatic artery aneurysms are pseudoaneurysms, reflecting the increased use of interventional procedures of the biliary tract [1]. There is an approximate 3:2 male predominance [15] and most hepatic artery aneurysms are diagnosed incidentally by CT or angiography [15]. True hepatic aneurysms (figure 6) are more commonly found in the extra-hepatic arteries, involving the common hepatic artery. 20% have combined intra and extra-parenchymal involvement and 3% are exclusively intrahepatic [15].

They are mainly associated with arteriosclerosis and acquired medial degeneration [1]. More than 50% of patients present with right upper abdominal pain radiating to the back. 20 to 30% of hepatic artery aneurysms may rupture into the peritoneal cavity, manifesting with pain and hypovolemic shock [8,11].

Intervention is currently recommended only when the aneurysm is symptomatic or when risk factors, such as multiple aneurysms and a nonatherosclerotic etiology, are present [1].
Fig. 6: Angiography showing a post-biopsy pseudoaneurysm of the proper hepatic artery

References: Centro Hospitalar de Lisboa Ocidental - Lisboa/PT

Celiac Artery Aneurysms

Celiac artery aneurysms (figures 7 and 8) are extremely rare and represent approximately 4% of all splanchnic artery aneurysms [1]. Common causes are arteriosclerosis and medial degeneration, other less common causes being trauma, dissection and Takayasu arteritis. Symptomatic aneurysms manifest initially by epigastric pain or upper gastrointestinal hemorrhage. Recent series have reported a lifetime risk of rupture of around 6% [16]. Calcification, aneurysm size and thrombus formation are not risk factors for rupture. Current guidelines for celiac artery aneurysm repair suggest considering repair of lesions >25 mm in patients deemed for operation [17].
**Fig. 7:** Celiac trunk "tip" aneurysm. A. Sagittal view contrast-enhanced CT (bone window) showing a large aneurysm with eccentric mural thrombosis at the tip of the celiac trunk located immediately before its bifurcation (arrow). The patient presented to the ER with intense right upper abdominal pain. B. Corresponding 3D reconstruction depicting the aneurysm.

**References:** Centro Hospitalar de Lisboa Ocidental - Lisboa/PT
Fig. 8: Celiac trunk aneurysm. A. Axial view of arterial phase enhanced CT showing a small celiac trunk aneurysm (arrow). B. Corresponding sagittal view showing some calcifications in the inferior aspect of the aneurysm.

References: Centro Hospitalar de Lisboa Ocidental - Lisboa/PT

**Superior Mesentery Artery Aneurysms**

These most commonly arise from septic emboli with non-hemolytic streptococci, staphylococci, and gram-negative bacteria being the commonly implicated organisms [1]. Arteriosclerosis, pancreatitis, biliary tract disease and trauma are among other causes. More than 90% are symptomatic [1]. 50% of patients present with rupture with a mortality rate of 30% [1]. Curiously, pseudoaneurysms arising from arterial dissection most commonly involve the superior mesenteric artery [1]. Current guidelines suggest considering repair of lesions >25 mm in suitable candidates [17] (figure 9).
Fig. 9: A. Sagital view contrast-enhanced CT showing a superior mesenteric artery aneurysm. B. Corresponding 3D reconstruction of the aneurysm (white arrow).

References: Centro Hospitalar de Lisboa Ocidental - Lisboa/PT

Pancreaticoduodenal and Gastroduodenal Aneurysms

Although true aneurysms usually resulting from arteriosclerosis, polyarteritis nodosa or Takayasu arteritis, pseudoaneurysms usually result from pancreatitis or develop after pancreatoduodenectomy [1]. The main symptom is epigastric pain. Current guidelines suggest repairing all lesions at diagnosis [17].
Fig. 1: Diagram showing the distribution of SAA and their prevalence (relative percentage of all splanchnic artery aneurysms).


<table>
<thead>
<tr>
<th>Etiology of True SAA</th>
<th>Common causes</th>
<th>Uncommon causes</th>
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<tbody>
<tr>
<td>Arteriosclerosis</td>
<td></td>
<td>Autoimmune/collagen vascular diseases</td>
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<tr>
<td>Cystic medial necrosis</td>
<td></td>
<td>Hypertension</td>
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<tr>
<td>Portal hypertension</td>
<td></td>
<td>α1 Antitrypsin deficiency</td>
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<tr>
<td>Fibromuscular dysplasia</td>
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<td>Congenital</td>
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Fig. 2: Table 1

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### Potential Complications

<table>
<thead>
<tr>
<th>Complication</th>
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<tbody>
<tr>
<td>Intraperitoneal rupture</td>
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<td>Hemoperitoneum</td>
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<td>Hypovolemic shock</td>
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<tr>
<td>Retroperitoneal hemorrhage</td>
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<tr>
<td>Intrahepatic subcapsular rupture</td>
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<td>Gastrointestinal hemorrhage</td>
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<tr>
<td>Hemobilia</td>
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<tr>
<td>Hemosuccus pancreaticus</td>
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<tr>
<td>Arteriovenous fistula formation</td>
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<tr>
<td>Portal hypertension</td>
</tr>
<tr>
<td>Variceal bleeding</td>
</tr>
<tr>
<td>Ascites</td>
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<tr>
<td>Acute mesenteric ischemia</td>
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<td>Obstructive jaundice</td>
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**Fig. 3:** Table 3

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**Fig. 4:** Splenic Artery Aneurysm. A. Grayscale ultrasound showing an anechoic saccular lesion communicating with the splenic artery. B. Corresponding arterial-phase MR image depicting the splenic aneurysm. C. Splenic arteriogram from the same patient.

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**Fig. 5:** Axial (A) and coronal (B) contrast-enhanced arterial phase CT images showing a true splenic aneurysm. C. Gadolinium enhanced arterial-phase MR image from a different patient showing another splenic aneurysm.

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**Fig. 6:** Angiography showing a post-biopsy pseudoaneurysm of the proper hepatic artery

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**Fig. 9:** A. Sagital view contrast-enhanced CT showing a superior mesenteric artery aneurysm. B. Corresponding 3D reconstruction of the aneurysm (white arrow).

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Conclusion

Splanchnic artery aneurysms are uncommon but potentially life-threatening. The most commonly reported aneurysms involve, in decreasing order of frequency, the splenic (60%), proper hepatic (20%), superior mesenteric (5.5%) and celiac (4%) arteries. Mortality rates for SAA remain high since diagnosis is often delayed due to their unspecific and vague clinical presentation. Although ultrasound is often employed as the first screening tool during routine abdominal examinations, confident diagnosis of SAA can be made with CT angiography, MRI or conventional angiography, the latter offering the advantage of therapeutic intervention. Management depends on size, location and presentation of the aneurysm. Intervention is warranted for all symptomatic aneurysms and generally for those larger than 25 mm.
References