Transarterial embolization of visceral aneurysms

Hiro Kiyosue, MD
Department of Radiology, Oita University Hospital, Oita, Japan

Introduction

Visceral arterial aneurysms (VAAs) represent a rare, clinical entity with an estimated incidence of approximately 1% on autopsy studies (1) (2). The VAAs are usually asymptomatic, but they can cause a life-threatening hemorrhage. The incidence and true risk of rupture of the VAAs has not been well recognized. Several study cohorts published includes both true aneurysm and pseudoaneurysms (3). These two types of aneurysms are quite different in their etiology, risk of rupture, and management. This presentation is focused on the true VAAs. The splenic artery aneurysms (SAAs) are the most common VAAs (approximately 33%-60%), followed by the renal artery aneurysms (RAAs) (approximately 20%) and the hepatic artery aneurysms (HAAs) (approximately 17-20%) (3) (4). Other locations are relatively rare, which include the superior mesenteric artery (5-7%), celiac artery (4-20%), and gastroduodenal and pancreaticoduodenal arteries (4-8%) (3)(4).

The SAAs are more common in women (3-4:1), and often associated with a high-flow state such as portal hypertension, liver cirrhosis and pregnancy (5) (6) (7). Rates of rupture in a SAA is approximately 2%-5% (with 0.25-0.4% annual rate of rupture), with a mortality rate of 29-36% (8) (9). The RAAs are found at 0.1%-0.3% on renal angiography, and they are often associated with fibromuscular dysplasia (10) (11). The RAAs have an equal incidence in men and women. Rates of rupture in a RAA at presentation ranged from 0% to 5% (0.3% in a large multicenter series), and the risk of rupture is thought to be extremely low in a small RAA (<2cm) (12) (13) (14). Pregnancy is a risk factor of rupture of RAAs, and the mortality is high as 35 % in mothers and 60 % in fetuses (15). The growth rate of the RAAs is 0.6-0.86mm/y (13) (16). The HAAs is reported as the second common VAAs in several literatures; however, the half of the HAAs are pseudoaneurysms. Therefore, the true HAAs are less common in VAAs, and the rates of rupture of true HAAs is still unclear. Mortality rates of ruptured HAAs including pseudoHAAs ranges from 21% to 35% (17). The HAAs can cause obstructive jaundice, hemobilia, and right upper abdominal pain. The gastroduodenal artery aneurysms (GDAAs) and the pancreaticoduodenal artery aneurysms (PDAAs) are often associated with the steno-occlusion of the celiac trunk mainly due to the compression of the median arcuate ligament (18). The increasing the blood flow in the small pancreaticoduodenal collateral arteries from the superior mesenteric artery to the hepatic artery may affect the formation of GDAAs and PDAAs. PDAAs are rare but have a higher risk of rupture regardless of their size. Mortality from rupture of these aneurysms reaches 12-40%.
Treatment

Treatment options of VAAs includes conservative management, surgery, and endovascular techniques, which depends upon the symptoms, patient’s age, the size and location of the VAAs, and skill of the physicians. General indications for surgical or interventional treatments include symptomatic aneurysms, large (> 2 cm in diameter) or rapid growing aneurysms, and aneurysms in women of child-bearing age. The majority of small asymptomatic VAAs less than 2 cm diameter are usually conservatively managed or observed without treatment. However, GDAAs and PDAAs should be aggressively treated regardless of their size because of the higher risk of rupture. Surgical managements, including ligation, resection of the VAAs and arterial reconstruction, have been used. However, endovascular treatments (EVTs) are replacing the surgical procedures because of its less invasiveness.

Several techniques of EVT are applied for exclusion of VAAs. Endovascular trapping (parent artery occlusion) with or without packing of the aneurysmal lumen is commonly used for the treatment of VAAs especially for the SAAs. Detachable or pushable coils are generally used for occlusion of the parent artery and packing of the aneurysmal lumen. Amplazer vascular plug (AVP) can be used for occlusion of the proximal side of the parent artery alternative to the coils, but the use of the AVP is limited due to size and rigidity of the delivery system. Glue (NBCA-lipiodol mixture) has been used solely or combined with coils for occlusion of the parent artery. The use of glue can reduce the number of coils required and can achieve complete occlusion immediately. However, it has a potential risk of migration of fragments of glue which can cause ischemic damage to the adjacent organs. Flow control technique using a balloon guiding catheter is useful to prevent distal migration of coils or glue during embolization procedure. Complications after parent artery occlusion for SAAs include splenic abscess, postembolization syndromes and pleural effusion which account for 3-6% and 10-37%, and 3% respectively. Endosaccular packing with detachable coils is another promising option for unruptured VAAs, which can preserve the patency of the parent artery. Recanalization or coil compaction may occur in approximately 30% of cases after packing, therefore, dense packing of the aneurysmal lumen at least 20-24% is required for stable occlusion. The VAAs usually have a large neck, and often involve a few branches in the neck or body, therefore, several adjunctive techniques including multiple catheter technique, balloon-assist technique, and stent assist technique are required for safe and sufficient packing of the aneurysmal lumen with preserving the parent artery and branches. Stent graft is an alternative technique of excluding VAAs with preserving the parent artery. Stent graft is limited to use for aneurysms with a relatively large parent artery (approximately 6-10mm diameter), located proximal portion of the main trunk or major branch. Stent graft is not favorably to use for the VAAs located at the distal portion on the tortuous parent
Transarterial embolization of visceral aneurysms (Hiro Kiyosue, MD)

artery or at the bifurcation of the major branches. Stent graft thrombosis and recanalization of the aneurysm due to endoleak are rare problems but can occur after treatment.

**Imaging follow-up**
CT and/or ultrasonography are usually performed within a few days after endovascular treatment to evaluate the complications including ischemic damage of the target organs, ascites, pleural effusion, and hemorrhage. Occluded vessels or the aneurysms with coils is difficultly assessed by the CT or US due to significant metal artifact. MR angiography including contrast-enhanced MR angiography and time resolved MR angiography is a useful tool for evaluation of residual lumen of the packed aneurysms with coils and hemodynamics after parent artery occlusion (25) (26). As described before, recurrent aneurysm can occur after endosaccular packing and stent graft. Long-term and scheduled imaging follow-up is mandatory.

**Conclusion**
The majority of VAAs can be treated by EVT, but there is some risks of procedure-related complications. The risk of rupture of the true VAAs are different in individuals mainly depend on the size and locations. Indication for EVT and selection of the endovascular techniques should be carefully considered in each individual.

**References**
8) Carr SC, Mahvi DM, Hoch JR, Archer CW, Turnipseed WD. Visceral artery
23. Transarterial embolization of visceral aneurysms (Hiro Kiyosue, MD)


23. Transarterial embolization of visceral aneurysms (Hiro Kiyosue, MD)

Surg (Torino) 2016 Oct;57(5):625-33


Figure 1
Schematic drawing of the techniques of endovascular trapping of the VAA
A) Coils are placed in the distal portion of the parent artery via two microcatheters under flow-control by balloon catheter.
B) Proximal portion of the parent artery is also occluded with coils.
C) Aneurysmal lumen is loosely packed with coils
D) Aneurysmal lumen is filled with glue
Figure 2 70 year-old female with asymptomatic giant splenic artery aneurysm
A) B) 3D and axial images of 3DCT angiography show a giant splenic artery aneurysm (5cm in diameter) at the mid portion of the splenic artery.
C) Left anterior oblique view of the splenic angiography shows a giant aneurysm. The splenic artery is completely involved with the aneurysm.
D) Two guiding catheters are placed in the origin of the splenic artery. A microcatheter was advanced beyond the aneurysm into the distal portion of the parent artery, and then coils (white arrows) are placed into the distal segment under flow control by proximal balloon catheter (arrow).
E) Proximal portion of the parent artery is occluded with coils via the balloon catheter (arrows). White arrow indicate a microcatheter remaining in the aneurysmal lumen.

F) Glue (25% NBCA-lipiodol mixture) is injected via the microcatheter. Celiac angiography immediately after injection of the glue shows glue cast (white arrows) in the aneurysmal lumen.

G) Celiac angiography after embolization shows disappearance of the splenic aneurysm. Note collateral flow to the distal portion of the splenic artery via the gastric and gastroepiploic arteries.
Figure 3: Asymptomatic right renal artery aneurysm (63 year-old female) treated by endosaccular packing using double microcatheter technique. A-C) Axial (A,B) and 3D images of the CT angiography shows a left renal artery aneurysm at the bifurcation of the major branch.
D) Left anterior oblique image of the right renal angiography shows a wide neck aneurysm involving the major branches.

E) Two microcatheters are placed in the aneurysmal lumen, and detachable coils are placed via the two microcatheter to stabilize the frame of the coils covering the neck.

F) Angiography after framing with two coils shows sufficient frame of the coils in the aneurysmal lumen.

G) Fluoroscopic image after embolization shows the aneurysm is densely packed with coils.

H) Angiography immediately after endosaccular packing shows minimal neck remnant of the aneurysm.
I) Follow-up angiography one year after embolization shows stable occlusion of the aneurysm.

J) Contrast enhanced MR angiography shows stable occlusion of the right renal artery aneurysm (minimal neck remnant: white arrow).
Figure 4 Asymptomatic renal artery aneurysm (57 year-old female) treated by endosaccular packing using balloon-assist technique
A) 3DCT angiography shows an aneurysm at the origin of the superior branch.
B) C) 2D and 3D DSA image of the left renal angiography show a wide neck aneurysm.
D) Fluoroscopic image during embolization procedure shows coils are placed densely in the aneurysmal lumen under protection of the parent artery with balloon (white arrow).
E) Left renal angiography immediately after embolization shows nearly complete occlusion of the aneurysm with good patency of the parent artery.

F) Follow-up MR angiography one year after embolization shows stable complete occlusion of the left renal artery aneurysm.
Figure 5  Asymptomatic inferior pancreatic artery aneurysm associated with occlusion of the celiac trunk by compression with the median arcuate ligament.

A) Contrast enhanced MR angiography shows an aneurysm at the dilated pancreaticoduodenal artery.

B) Lateral view of the CT angiography shows a large aneurysm involve the inferior pancreaticoduodenal artery. Occlusion of the celiac trunk (arrow) and stenosis of the superior mesenteric artery (white arrow) are also noted.

C) D) Superior mesenteric angiography (C) and inferior pancreaticoduodenal angiography (D) shows a large aneurysm arising on the collateral pathway from the superior mesenteric artery to the celiac artery via the pancreatic arcade. The proximal portion of the inferior pancreaticoduodenal artery is completely involved in the aneurysmal lumen.
E) A microcatheter is placed in the aneurysmal lumen and a coil is placed in the aneurysmal lumen. Another microcatheter is advanced beyond the aneurysm, and then a flexible stent (neuroform2) is placed via the microcatheter as crossing over the aneurysm.

F) Fluoroscopic image after embolization shows dense packing of the aneurysm. Arrows indicate the stent in the pancreaticoduodenal artery.

G) Angiography of the inferior pancreaticoduodenal artery after embolization shows complete occlusion of the aneurysm with preserving the parent artery.