Introduction

Depending on the application, endoluminal occlusion of vessels may require coils, glue, and/or metallic plugs. Occlusion should be complete and, in case of emergencies such as blunt trauma and brain tumors, immediately after deployment of the occlusion device. Devices may be detachable such as an Amplatzer plug or non-detachable, and devices may be immediately occlusive (e.g. glue), or do occlude only with a certain unintended delay. Preferably, embolization is performed with a detachable device that occludes immediately. In the past, we postulated, we report on the application of a new endoluminal occlusion system (EOS) for complete, immediate and permanent occlusion of peripheral vasculature.

Design and deployment of the EOS

A new device was used in this study: the ArtVentive EOS (ArtVentive Medical Group Inc, Carlsbad, CA, USA). This plug combines a nitinol scaffold with an ultrathin impermeable spiral nitinol scaffold (P=proximal site, D=distal site). The guiding catheter is performed to assess the vessel patency and to confirm total occlusion.

After catheterization of the vessel trajectory that needs to be occluded, the guiding catheter should be advanced into the location of interest. The guiding catheter is left in place and the guide wire is removed. Next, the device is backloaded into the guiding catheter and advanced towards the distal end of the guiding catheter. The guiding catheter is then retracted until the EOS plug is in place. The plug can now be released. For deployment, the yellow clip is removed to unlock the device. The inner plug is deployed using 70/30 mixed saline and contrast agent mixed 70/30, injected through the flush port of the device. To detach the plug from the device, the blue clip is removed and the distal handle is pulled. After removing the delivery system, a contrast injection through the guiding catheter is performed to assess the vessel patency and confirm total occlusion.

Applications

We treated various pathologies with this newly developed EOS (currently over 15 cases). The indications include both low and high-flow vascular trajectories such as portal vein embolization and additional hepatic veins before ventriculoatrial shunting, preoperative metastasis embolization of a brachiocephalic trunk, common hepatic artery aneurysm embolization, splenic artery embolization in trauma and aneurysms, mesenteric vein embolization in portal congestion syndrome and ICAAV. In all cases, the device could be positioned and deployed in the required position. The plug was clearly visible under fluoroscopy before and after deployment. Occlusion was immediate and complete in all cases. We encountered no complications. In one portal vein embolization case, the plug was slightly undeployed and subsequently moved distally, however without sequelae and complete occlusion was still achieved. In 10 cases, follow-up CT was available and showed complete occlusion of the target vessel.

Case 1: Portal vein embolization (before hemihepatectomy)

A 67 y old female presents with history of biliary liver cancer in which a large cholangiocarcinoma developed. The MIBI depicts an irregular lesion in the right liver lobe with several satellite lesions. The lesion was hyperdense on T1, iso to hypointense on T1 and caused capsule indentation. After guided wire navigation, the lesion showed peripheral enhancement (Figure 3A) with gradual enhancement in late phases, all of which is consistent with cholangiocarcinoma. Only surgery with a right sided liver resection was considered a curative option provided with a right portal vein embolization to induce liver hypertrophy.

To this end the right portal vein was punctured with a Chiba needle and a 0.035” wire was introduced in the portal vein using a J-tip guidewire. The wire was advanced over the J-wire and the embolization was performed using regular coils as an ArtVentive EOS plug (Figure 3B). The follow up CT 7 weeks after the portal embolization showed complete occlusion of the right portal vein. The left liver hypertrophy was sufficient to permit a right liver heptectomy and the patient went for surgery.

Case 2: Ovarian and internal iliac vein embolization in pelvic congestion syndrome

A 55 y old female presents with lower abdominal pain on the right side as well as palpable masses in the left lower quadrant. A CT scan revealed a large pelvic mass and the patient underwent surgery on the left side with ligation and suture of the left internal iliac vein. A diagnostic venography was performed with evaluation of both ovarian, internal iliac and superior vena cava veins. The angiogram showed hyperactive and no embolization was performed using a combination of Aetoxyskerol and deployment of ArtVentive EOS plugs (Figure 4A). Right femoral embolization showed complete occlusion.

Case 3: Preoperative embolization of bone metastasis from HCC

A 73 y old male with generalized bone metastases from HCC metastasis. For a 70 y old male with pancreatic cancer with a large feeding artery, a preoperative embolization was performed using regular coils and embolization with EOS (*).

Case 4: Embolization of a complex dissecting aneurysm arising from the celiac, common hepatic and gastroaduodenal artery

A 60 y old male presented with recurrent upper abdominal pain with a history of a complex dissecting aneurysm arising from the celiac, common hepatic and gastroaduodenal artery. A follow-up CT scan showed highly growth of the aneurysm. After multiple interdisciplinary consultation we decided to treat the aneurysm. A 60 mm plug was placed in the right common femoral artery and the hepatic artery was catheterized through the ICA (Figure 5A). At first a branch of the proper hepatic artery was occluded. Subsequently the aneurysm was excluded with a 6 mm and 11 mm ArtVentive EOS plug (Figure 5B). A remaining aneurysm was left untreated. Posterior circulation of the right and left hepatic artery was maintained through collateral filling from the left gastric artery follow-up CT after 2 months showed complete exclusion of the aneurysm with an unchanged small dissecting aneurysm of the celiac artery remaining (Figure 5C).

Conclusions

We successfully applied the ArtVentive EOS in various vascular trajectories as mentioned above. When applications are appropriate, these devices may be used to avoid a larger number of procedures and therefore reduce radiation exposure and use of contrast agent. Since larger than 6 mm should be allowed to expand, their applications are anticipated.