Transcatheter Arterial Embolization of Gastrointestinal bleeding

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Objective
Illustration of the basic knowledge of gastrointestinal (GI) bleeding and embolization technique.

Introduction
GI bleeding can occur in various diseases, such as GI ulcers, diverticulosis, malignancy, and angiodysplasia. Massive GI bleeding can be a life-threatening condition and requires urgent intervention. GI bleeding is divided into upper and lower GI bleeding, and the treatment strategies are different, respectively.
The European Society of Gastrointestinal Endoscopy (ESGE) Guideline recommends the GI endoscopy as the primary diagnostic method for upper GI bleeding [1]. In this guideline, the endoscopic hemostasis is recommended when the upper GI endoscopy demonstrate the high-risk endoscopic stigmata (active spurting, pulsatile arterial bleeding, active oozing, and nonbleeding visible vessel), and transcatheter arterial embolization (TAE) is recommended when two sessions of endoscopic hemostasis failed.
The treatment strategy for lower GI bleeding depends on the patient's hemodynamic status [2]. For the hemodynamically unstable patient, the CT angiography should be performed after the hemodynamic resuscitation, and TAE within 60 minutes is recommended as the primary treatment method. For hemodynamically stable patient, colonoscopy is recommended as the first diagnostic modality, and endoscopic intervention is recommended as the primary treatment method. TAE is a treatment of option in patients with brisk and ongoing bleeding not amenable to or not effectively treated by endoscopic interventions.

TAE for upper GI bleeding
Vessel anatomy
Understanding vessel anatomy is essential to perform TAE for upper GI bleeding. The left gastric artery provides branches to the distal esophagus and fundus of the stomach. These communicate with distal branches of the small, short gastric arteries from the splenic artery and branches of the right gastric artery which originate from the left or common hepatic artery. The other part of stomach and duodenum are supplied by branches from the gastroduodenal artery (GDA). The superior mesenteric artery (SMA) may supply portions of the duodenum through the pancreaticoduodenal anastomoses. These vessels are associated with a rich collateral supply for the stomach and duodenum.

General TAE procedure
Generally, 4-5F catheter is used to selective catheterization. Once the catheter is advanced to celiac artery or SMA, the arteriogram is performed to evaluate the vessel anatomy and extravasation of contrast media. If the extravasation is demonstrated, a microcatheter is inserted and advanced to the bleeding point, and embolized with coils or glue[3; 4]. If the extravasation is not demonstrated, selective angiography using a microcatheter should be performed. When the bleeding site is in the dual supply area, especially GDA, both arterial sources must be embolized (isolation technique) to avoid rebleeding through the collaterals. If the extravasation is not demonstrated even on

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the selective angiography, the blind embolization, the embolization without angiographic findings of active bleeding, under the guidance of endoscopic information, is considered. Coils and gelatin sponge are usually used for the blind embolization[3; 4].

Embolic material
The best choice of embolic material is still debatable. Lang et al. reported that a high rate of bleeding recurrence was observed when PVA particles or gelatin sponge were used alone[5]. Another report revealed that the use of gelatin sponge alone was associated with a low success rate [6]. These data indicates that the gelatin sponge as the only embolic material guarantees only short-term results and should be avoided. Recently, the safety and efficacy of superselective embolization for upper GI bleeding with n-butyl cyanoacrylate (NBCA) were reported in several reports [7; 8]. The superselective embolization with NBCA would be useful for the treatment of patients in the hemodynamically unstable or coagulopathic condition. However, the use of NBCA requires training and considerable experience to avoid the severe complications.

Efficacy of TAE for upper GI bleeding
Previous review article reported that the technical, complication, and clinical success rate of endovascular treatment for upper GI bleeding were 93%, 9%, and 67%[4]. The ischemia of the upper GI tract is a rare complication because of the rich collateral supply. However, the history of surgery within the same area or embolization using liquid material would be associated with increased ischemic risk.

TAE for lower GI bleeding
Vessel anatomy
The marginal artery is an important connection between the SMA and inferior mesenteric artery (IMA) and provides collateral flow when the vessel occlusion or severe stenosis occurs. The vasa recta pass to the colon from the marginal artery and enter the intestinal wall and compose the submucosal vascular plexus. The vasa recta can be grouped into short or long branches. Each vas rectum has branches ranging from one to many [9].

Ischemic complications
TAE for lower GI bleeding has a potential risk of ischemic complications, resulting in the bowel stenosis, ulcer, and necrosis. Previous experimental studies reported that TAE of three or fewer vasa recta was tolerable, whereas embolization of the marginal artery and four or more vasa recta resulted in an increased risk of severe bowel ischemia [10; 11]. Kodani et al. also reported that TAE using NBCA of ≥ 3 vasa recta can induce bowel ischemia requiring treatment, and TAE using NBCA of one vas rectum with ≥ 2 branches could also induce ischemic complications, which were silent and self-limited [12].

Embolic material
Traditionally, coil embolization has been a standard procedure for the treatment of lower GI bleeding [13; 14]. Seyferth et al. investigated the safety and efficacy of particle embolization as second-line to coil embolization for the treatment of lower GI bleeding. Their result showed that the clinical success was better for coils alone than particles with or without coils, and embolization-induced bowel ischemia occurred only in the

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patients performed particle embolization [15]. Thus, the superselective coil embolization of 1-2 vasa recta would be the best TAE procedure for lower GI bleeding [16]. When the patient was in the hemodynamically unstable or coagulopathy, the TAE using NBCA would be effective. In that case, the operator must be careful for the un-target embolization of the marginal artery or many vasa recta.

Efficacy of TAE for lower GI bleeding
Kinoshita et al. reported that the technical and clinical success rate of ultraselective TAE with coils for lower GI bleeding were both 100% without major complications [16]. Hur et al. reported that the rate of early recurrent bleeding, major complications, clinical success, and in-hospital mortality of TAE for lower GI bleeding were 17.4%, 4.6%, 74.5%, and 25.0%, respectively [17]. In addition, they reported that hematologic malignancy, immobilization status, and coagulopathy were significant factors for clinical outcomes.

Summary
・TAE is one of the treatment of choices for GI bleeding which did not respond to endoscopic intervention and can be the primary treatment option when the patient is in the hemodynamically unstable or coagulopathic condition.
・To perform TAE for upper GI bleeding, it is important to understand that the rich collaterals of upper GI tract and the TAE technique to avoid the rebleeding through the collaterals.
・Understanding the vessel anatomy of lower GI tract and the TAE technique to decrease the risk of ischemic complication is the key to perform successful TAE for lower GI bleeding.
・In this lecture, the basic knowledge of GI bleeding and embolization technique and the knack for the successful embolization will be presented.

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Figure 1.
A man in his sixties, who was waiting a surgery for the gastric cancer, was transferred to our hospital because of massive hematemesis. The vital signs at ER were following; systolic blood pressure, 112 mmHg; heart rate, 155/min; Glasgow Coma Scale, E4V1M5; body temperature, 38.8℃. The hemoglobin level was 10.2 g/dL.
a: The non-contrast-enhanced CT image revealed that the large hematoma in the stomach. The clip in the gastric angle was shown (arrow).
b: The coronal reformatted image of contrast-enhanced CT showed the extravasation of contrast media (arrow) in the gastric angle.
c: The celiac angiography revealed the spastic left gastric artery (arrow) and extravasation arrow head).
d: The bleeding point was superselectively embolized with glue (arrow head).

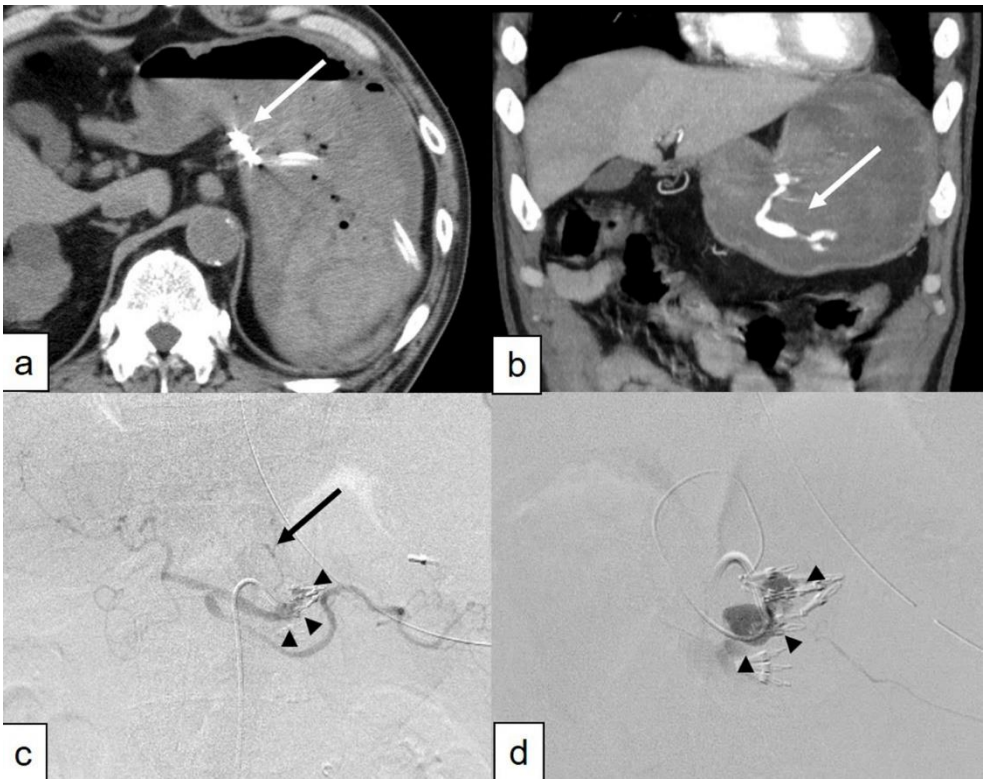

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Figure 2.
79-year-old man who had history of diverticular hemorrhage treated by the coil embolization presented out hospital due to melena. He was diagnosed as diverticular hemorrhage and underwent the endoscopic intervention, which failed. The embolization was performed.
a: Superior mesenteric arteriogram showed no extravasation around the clip which was placed for the diverticular hemorrhage in the ascending colon.
b: The selective angiogram in the ileocolic artery revealed no extravasation. The image showed a coil in a vas rectum which was used for the treatment of previous diverticular hemorrhage.
c: Superselective angiogram showed extravasation of contrast media (arrow head).
d: Coil embolization of a vas rectum was performed and stopped the bleeding.