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# Clinical Outcome of the Visible Coil During Endoscopy After Transcatheter Arterial Embolization for Gastrointestinal Bleeding

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## Abstract

*Purpose* This study was designed to evaluate the clinical outcome of the visible coil during endoscopy after transcatheter arterial embolization (TAE) for gastrointestinal bleeding.

*Methods* We retrospectively reviewed the medical records of 1415 patients who underwent TAE for gastrointestinal bleeding between 2001 and 2017. Among these 1415 patients, 70 underwent TAE using coils and consecutive follow-up endoscopy. Finally, 11 patients with an extravascular coil seen on follow-up endoscopic examination were included in this study. We evaluated the underlying cause of the gastrointestinal bleeding, the technical and clinical success rates, the type of extravascular coil after TAE, and the clinical outcomes of the extravascular coil seen on follow-up endoscopic examination.

*Results* Of the 11 patients, the most common underlying cause of gastrointestinal bleeding was a duodenal ulcer ($n = 7$). On angiography, the bleeding artery was most commonly found in the gastroduodenal artery ($n = 6$). The technical success and clinical success rates of TAE were 100% and 90.9%, respectively. The type of extravascular coil found on endoscopic examination was classified by submucosal migration ($n = 6$) and protrusion ($n = 5$). On second-look endoscopic evaluation, 10 of 11 (90.9%) patients showed healing ulceration. On the final-look endoscopic evaluation, healing ulceration without further bleeding was seen in one (9.1%) patient and scar formation was seen in ten (90.9%) patients.

*Conclusions* Extravascular coil after TAE for gastrointestinal bleeding is rare, and the most common underlying cause is duodenal ulcer bleeding. The extravascular coils eventually show a healing process with adequate treatment of underlying bowel pathologies.

**Keywords** Gastrointestinal bleeding · Transcatheter arterial embolization · Extravascular coil · Endoscopy

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## Introduction

Acute gastrointestinal bleeding is a life-threatening condition that requires immediate attention and expeditious management [1]. The standard treatment for upper gastrointestinal bleeding is endoscopic hemostasis [2, 3]. However, severe bleeding or rebleeding despite conservative treatment, such as volume replacement, the administration of proton pump inhibitors, and endoscopic therapy, occurs in 5–10% of patients and requires alternative treatment such as surgery [4]. Although surgery is the

traditional treatment of choice following failure of endoscopic hemostasis, many patients are not amenable to surgery due to their poor general condition. Transcatheter arterial embolization (TAE) has been proposed as a reasonable and less hazardous alternative to surgery, especially for high-risk patients, and it is now considered in many medical institutions as the first-line intervention for massive gastrointestinal bleeding after failed endoscopic treatment [5, 6].

Coils are known one of most frequently used embolization materials and are used alone or in combination with other materials. However, migration of the coils or their protrusion into the gastrointestinal tract lumen after embolization has been reported in case reports or small case series [7–17]. Furthermore, detailed clinical outcomes of coil migration or protrusion into the gastrointestinal tract lumen has not been reported based on long-term follow-up and a large patient cohort. The purpose of the present study was to evaluate the clinical outcome of extravascular coil after TAE for patients with gastrointestinal bleeding.

## Materials and Methods

This single-center, retrospective study was approved by our institutional review board. The requirement for informed consent was waived due to the retrospective nature of the study.

### Patients

From January 2001 to July 2017, 1415 patients underwent TAE at our hospital for their gastrointestinal bleeding. The records of patient follow-up were excluded from this study: (1) 1184 patients underwent TAE for gastrointestinal bleeding with another type of embolic material such as absorbable gelatin sponge particles (Gelfoam; Upjohn, Kalamazoo, MI, USA), polyvinyl alcohol particles (Contour PVA; Boston Scientific, Marlborough, MA, USA) particles, and N-butyl cyanoacrylate (Histoacryl; B.braun, Melsungen, Germany); (2) 73 patients had bleeding from jejunum or ileum that made endoscopic evaluation impossible; (3) 88 patients had not undergone endoscopic examination after the procedure due to unfit general condition to receive endoscopic examination or patient's refusal; and (4) among the 70 patients who underwent upper and lower gastrointestinal tract endoscopic evaluation to check for rebleeding after the coil embolization for gastrointestinal bleeding, 59 were finally excluded if they did not have an extravascular coil on endoscopic examination following the procedure. As a result, 11 patients with an extravascular coil seen on endoscopic examination after TAE for gastrointestinal bleeding were included this study (gastric bleeding, $n = 2$; duodenal bleeding, $n = 9$).

### Endoscopy and CT Examinations

Endoscopy was the primary diagnostic and therapeutic option for patients with suspected gastrointestinal bleeding and who were treated in our hospital. Endoscopic clipping or sclerotherapy was initially considered for lesions with active bleeding. Contrast-enhanced computed tomography (CT) was performed before angiography when endoscopy was not applicable, gastrointestinal bleeding was still suspected despite negative endoscopic results or bleeding recurred after the endoscopic hemostasis.

### Transcatheter Arterial Embolization

Celiac and superior mesenteric arteriography was routinely performed using 5-F catheters (Rösch; Cook, Inc, Bloomington, IN, USA). If bleeding signs were not definitive, further selective angiography of the left gastric, right gastric, short gastric, posterior gastric, gastroduodenal or pancreaticoduodenal arteries with forceful contrast medium injection was performed in order to rule out a false-negative result. Superselective cannulation in bleeding arteries was performed using a 2.0–2.4-F microcatheter (Progreat, Terumo Inc.; Renegade, Boston Scientific, Marlborough, MA, USA).

After the selective catheterization of a bleeding artery, embolization was performed under fluoroscopic monitoring using microcoils (MicroNester or Tornado; Cook, Inc., Bloomington, IN, USA). Additional use of different types of embolic material was considered depending on the manifestation of bleeding signs or the operator's preference. Complete angiograms were performed in order to confirm that the bleeding had been successfully controlled.

### Follow-Up

After the TAE, follow-up endoscopic examination was performed after 1–5 days in order to evaluate its efficacy as well as the possibility of procedure-related complications. If on endoscopic examination a patient showed recurrent bleeding from a previously treated lesion, they underwent additional sclerotherapy. After the confirmation of complete hemostasis without rebleeding on endoscopic examination, regular follow-up was scheduled in the outpatient clinic 1–3 months later by each patient's circumstances.

### Definition and Data Analysis

The technical success of the procedure was defined as complete occlusion of the bleeding vessel without any

evidence of residual active bleeding on post-TAE angiography. The clinical success was defined as the achievement of hemostasis without the need for repeat embolization, additional endoscopic treatment or surgery due to rebleeding. On endoscopic examination after the TAE, the extravascular coil was classified by protrusion and submucosal migration. Protrusion was defined as penetration into the gastrointestinal tract lumen without mucosal lining at the surface of coil, and submucosal migration was defined as a visible coil covered with translucent mucosa of the gastrointestinal tract.

The extravascular coils were evaluated by regular follow-up endoscopic examinations, and the results were recorded as follows: active ulceration with rebleeding, healing ulceration, and scar formation. Complications were reported according to the CIRSE classification system for complications from grade 1 to grade 6 [18]. We defined grade 4 (complication causing a permanent mild sequelae, resuming work and independent living), grade 5 (complication causing a permanent severe sequelae, requiring ongoing assistance in daily life), and grade 6 (death) complications as major complications. All of the other complications were considered as minor.

## Results

The clinical characteristics and outcomes of the 11 patients who had an extravascular coil after the TAE due to gastrointestinal bleeding are summarized in Table 1. The most common underlying cause of gastrointestinal bleeding was a duodenal ulcer ($n = 7$), followed by a gastric ulcer ($n = 1$), pancreatic cancer with vascular invasion ($n = 1$), breast cancer with malignant biliary obstruction ($n = 1$), and iatrogenic bleeding after endoscopic resection of a gastric subepithelial tumor ($n = 1$). All of the patients presented the symptoms and signs of gastrointestinal bleeding, such as hematemesis, hematochezia, and melena. Active arterial bleeding was confirmed on endoscopic examination or on contrast-enhanced CT as extravasation.

On angiography, a bleeding artery was most commonly found in the gastroduodenal artery ($n = 6$), pancreaticoduodenal arterial arcade ($n = 3$), and gastric arteries ($n = 2$). Selective embolization for a bleeding artery was performed using multiple coils, and the median number of used coils was five (range 1–8). Additional use of different type of embolic agents was adjusted in six patients, i.e., gelatin sponge particles ($n = 2$) and N-butyl cyanoacrylate ($n = 4$).

Technical success was achieved in all 11 patients (100%), with complete occlusion of the bleeding artery seen on post-embolization angiography. Clinical success was achieved in 10 patients (90.9%), all of whom had no

further bleeding seen on endoscopic examination. One patient (No. 3) showed rebleeding on follow-up endoscopy seven days after the embolization procedure and, therefore, underwent additional endoscopic sclerotherapy with epinephrine injection.

The type of extravascular coil used on endoscopic examination after the TAE was submucosal migration ($n = 6$, Fig. 1) and protrusion ($n = 5$, Fig. 2). The time interval between the TAE and detection of the extravascular coil by endoscopy was within 5 days (median 2; range 1–5) in all patients. After the detection of the extravascular coil on endoscopic examination, follow-up second-look endoscopic evaluation was performed 1 week later. On second-look endoscopic evaluation of the extravascular coil, 10 of 11 (90.9%) patients showed healing ulceration and the only one patient (No. 3) showed active ulceration with rebleeding and, therefore, received additional endoscopic sclerotherapy. Regular endoscopic examination was performed during the follow-up period (mean 123 days; range 5–2093 days) and the final-look endoscopic evaluation revealed healing ulceration without further bleeding ($n = 1$) and scar formation ($n = 10$). There were no major complications associated with TAE or extravascular coil during the follow-up period in any of these patients.

## Discussion

The choice of embolic agent depends on the combination of the vascular anatomy, angiographic findings, the achievable catheter position, and the operator preference. Metallic coils are one type of the most commonly used embolic materials for gastrointestinal bleeding embolization due to the variety of their size, ease of use, and good fluoroscopic visibility [19]. However, coil migration is one of the rare complications following TAE, and the clinical outcome and rebleeding rate after coil migration remains unknown as there are very few reports documenting the migration of endovascular coils from visceral arteries. This patient information is summarized in Table 2.

According to a cumulative review of the literature and our study, most patients with coil migration or protrusion into the gastrointestinal tract lumen occurred after embolization due to peptic ulcer bleeding or embolization of a visceral artery pseudoaneurysm resulting from pancreatitis. Therefore, we suspect that the reason for coil migration or protrusion after embolization using coils is a combination of mucosa or tissue fragility caused by a peptic ulcer or pancreatitis, the strong irritation effect of coils more than that of other embolic agents, and peristalsis of the gastrointestinal tract. According to the results of literature [11, 14–17] and our study, most of the coil

**Table 1** Patient characteristics and clinical outcomes of extravascular coil after TAE for gastrointestinal bleeding

| No/sex/age (years) | Underlying cause of GI bleeding | Clinical presentation | Bleeding artery | Technical success | Embolic material | Clinical success | Type of extravascular coil | Second-look endoscopy | Final-look endoscopy |
|---|---|---|---|---|---|---|---|---|---|
| 1/M/28 | Duodenal ulcer | Hematemesis | PDA | Yes | 1 Coil + NBCA | Yes | Submucosal migration | Healing ulceration | Scar formation |
| 2/M/52 | Duodenal ulcer | Hematemesis | PDA | Yes | 4 Coils | Yes | Submucosal migration | Healing ulceration | Scar formation |
| 3/F/82 | Duodenal ulcer | Hematochezia | GDA | Yes | 6 Coils | No | Submucosal migration | Active ulceration with rebleeding | Healing ulceration |
| 4/M/41 | Gastric ulcer | Hematemesis | Both GAs | Yes | 8 Coils + Gelfoam | Yes | Submucosal migration | Healing ulceration | Scar formation |
| 5/M/45 | Duodenal ulcer | Hematemesis | GDA | Yes | 6 Coils | Yes | Protrusion | Healing ulceration | Scar formation |
| 6/M/51 | Duodenal ulcer | Hematemesis | PDA | Yes | 4 Coils | Yes | Protrusion | Healing ulceration | Scar formation |
| 7/F/61 | Pancreatic cancer | Hemobilia & melena | GDA | Yes | 7 Coils + NBCA | Yes | Submucosal migration | Healing ulceration | Scar formation |
| 8/F/60 | Breast cancer | Hematochezia | GDA | Yes | 7 Coils | Yes | Protrusion | Healing ulceration | Scar formation |
| 9/F/55 | Gastric SET | Procedure-related bleeding | Left GA | Yes | 5 Coils + Gelfoam | Yes | Protrusion | Healing ulceration | Scar formation |
| 10/F/74 | Duodenal ulcer | Hematochezia | GDA | Yes | 2 Coils + NBCA | Yes | Submucosal migration | Healing ulceration | Scar formation |
| 11/M/75 | Duodenal ulcer | Hematemesis | GDA | Yes | 2 Coils + NBCA | Yes | Protrusion | Healing ulceration | Scar formation |

*GI* gastrointestinal, *PDA* pancreaticoduodenal arterial arcade, *GDA* gastroduodenal artery, *GA* gastric artery, *SET* subepithelial tumor, *NBCA* N-butyl cyanoacrylate
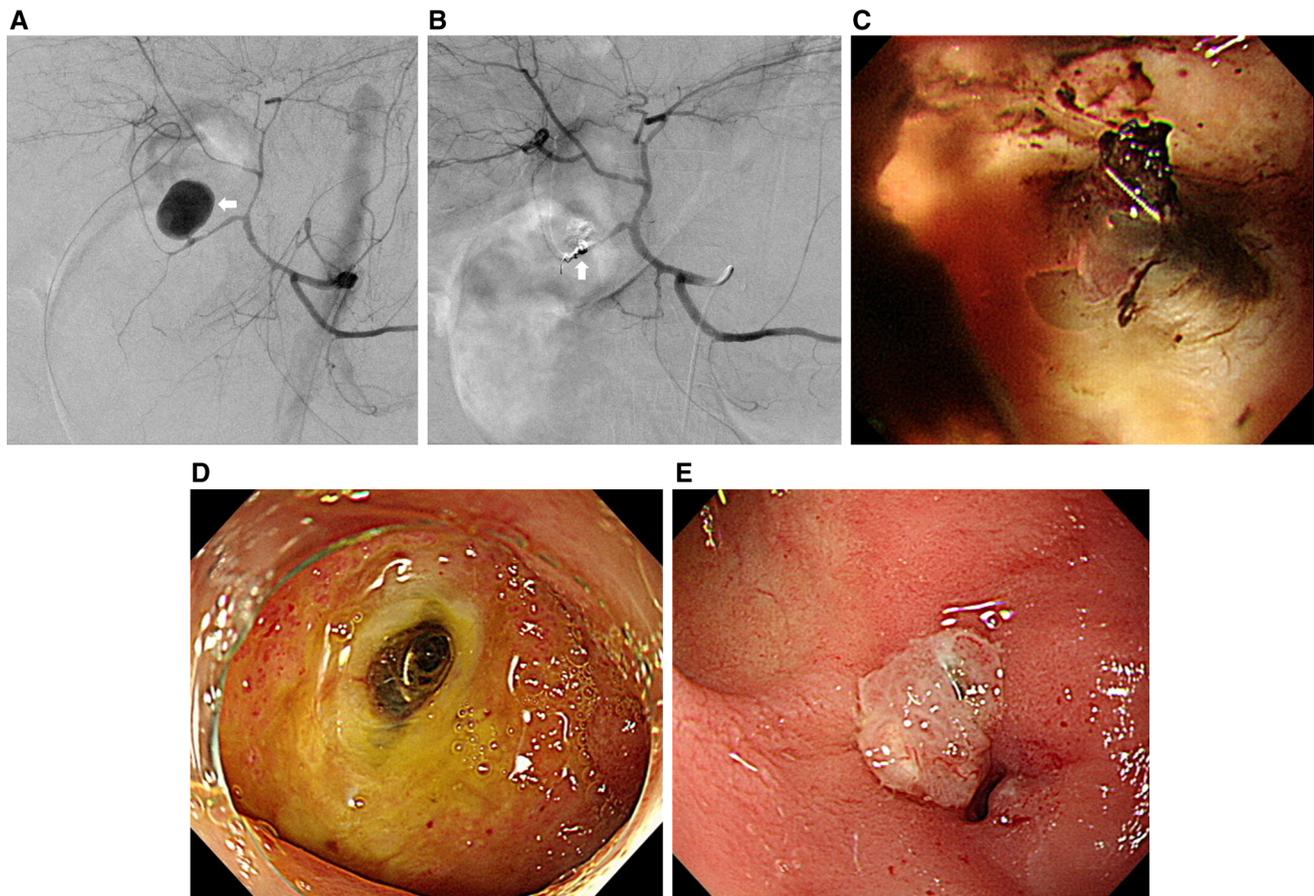
**Fig. 1** A 74-year-old woman (Patient No. 10) presented with massive hematochezia. **A** Celiac arteriography reveals a large pseudoaneurysm (arrow) from a branch of the gastroduodenal artery. **B** Transcatheter arterial embolization (TAE) was performed with multiple coils (arrow) and additional NBCA. **C** Endoscopy performed the day after TAE shows the presence of duodenal ulcers and a metal coil in the duodenal mucous membrane. **D** Endoscopy performed 5 days after TAE demonstrates that the coil is only slightly visible and covered by epithelium of the mucous membrane. **E** Endoscopy performed 179 days after TAE shows that the epithelial regeneration had scar change and a barely visible coil

migration or protrusion occurred after gastroduodenal artery embolization, probably because the duodenal ulcer is the most common cause of gastrointestinal bleeding. The duodenum has relatively thin wall and is exposed to bile acid, these factors also contribute the mucosal fragility in patients with duodenal ulcer. For this reason, we suppose that the development of coil migration or protrusion is more common in patients with peptic ulcer in the duodenum than stomach.

Rebleeding seems the most important issue because rebleeding is theoretically possible secondary to the dislodgement of coils. In the literature review, there is a case report regarding fatal rebleeding due to coil migration after TAE using coils, [7] although such cases are very rare. Takahashi et al. [8] reported a case of upper gastrointestinal bleeding due to a splenic artery pseudoaneurysm resulting from chronic pancreatitis. They performed TAE, and 27 steel-wire coils were placed in the aneurysmal cavity. This procedure produced immediate bleeding cessation; however, several weeks later some of the coils were found to have become dislodged through a gastropseudocystic fistula, although there was no rebleeding. Shah et al. [9] reported a case of a splenic artery pseudoaneurysm caused by a pancreatic pseudocyst due to chronic pancreatitis. The aneurysm was embolized distally using 13 coils to the distal splenic artery. Three weeks after embolization, a plain abdominal radiograph showed part of coils in the rectum, although with neither a sign of perforation, intestinal obstruction or rebleeding. In other cases that occur coil protrusion or submucosal migration into gastrointestinal tract lumen after gastroduodenal artery embolization due to duodenal ulcer bleeding, there was no bleeding complication related to coil migration [11, 14–17]. In our study, rebleeding occurred in only one patient among the 11 with coil migration or protrusion and there was no patient with major complications.

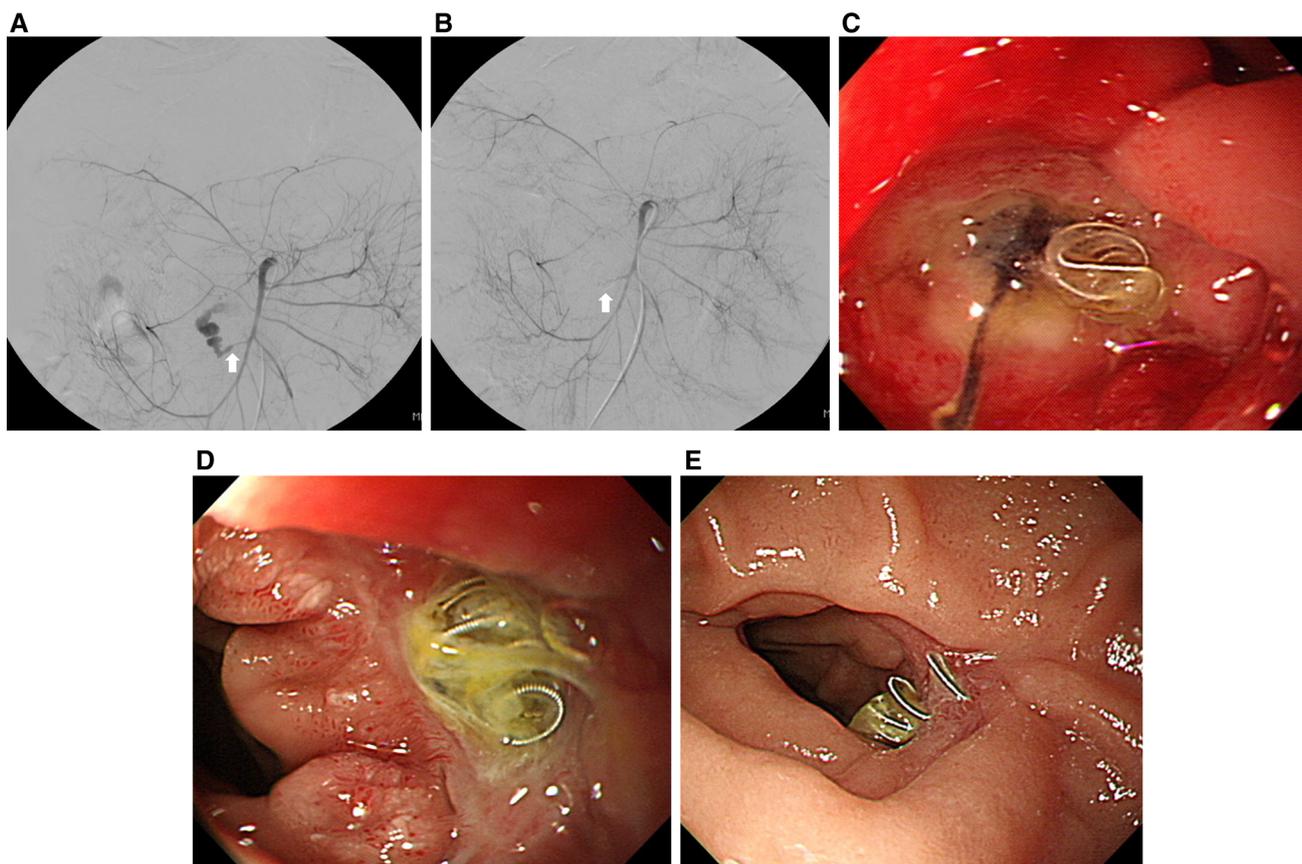Han et al. [10] reported a case of endovascular coil protrusion into the jejunal lumen after splenic artery

**Fig. 2** A 51-year-old man (Patient No. 6) presented with hematemesis and hypovolemic shock. **A** Superior mesenteric arteriography reveals contrast extravasation (arrow) from a branch of the pancreaticoduodenal arterial arcade. **B** Transcatheter arterial embolization (TAE) was performed using multiple coils (arrow), and angiography confirmed complete occlusion of the bleeding vessel. **C** Endoscopy performed 2 days after TAE shows the presence of active duodenal ulcers and a coil protruded from the duodenal surface. **D** Endoscopy performed 5 days after TAE shows more prominent protruded coils and healing duodenal ulceration. **E** Endoscopy performed 169 days after TAE shows a still visible, protruded coil and scar change in the surrounding duodenal surface

pseudoaneurysm embolization. They removed the protruded coil strands using hot biopsy forceps with an electrosurgical generator. However, some literature reports indicate that there were patients in whom coil strands protruding into the gastrointestinal tract lumen were covered by mucosa. Chosa et al. [11] documented regarding coil protrusion into the duodenal lumen after gastroduodenal artery embolization due to duodenal ulcer bleeding. Because there was no active bleeding, this patient was treated conservatively. Follow-up endoscopy performed 18 and 25 days after the embolization showed that the coil was enveloped within the duodenal mucosa and finally not detectable. Kuhara et al. [12] also reported a case of coil strands protruding into the patient's duodenal lumen covered by mucosa after gastroduodenal artery pseudoaneurysm embolization. In our study, there was one case of rebleeding and no case of major complications. Instead, the healing process was eventually achieved. Therefore, when extravascular coils are detected on endoscopy, their removal seems unnecessary and the follow-up strategy is desirable with treatment of underlying bowel pathologies such as peptic ulcer medication.

According to results of review of literature [7–17], the time at which the protrusion or migrated coil was found by endoscopy varied (1 day–10 years). In most cases, detection time is within 7 days for GDA embolization due to duodenal ulcer bleeding [11, 14–17]. In our study, the detection time of extravascular coils in all patients was within 5 days. Therefore, we suggest that follow-up endoscopy period after coil embolization should include short-term follow-up within 7 days and long-term follow-up after several years if possible.

We experienced 11 cases of an extravascular coil after TAE for gastrointestinal bleeding and 10 of 11 (90.9%) showed healing ulceration within a week after the TAE. During the regular follow-up period (mean 123 days; range 5–2093 days), all of them covered by mucous membrane and subsequently developed the scar formation. Our experience suggests that even if an extravascular coil is found in the lumen of gastrointestinal tract, it does not

**Table 2** Clinical findings of reported extravascular coil cases

| References | Age/sex | Etiology of GI bleeding | Bleeding artery | Embolic materials | Endoscopic or radiologic follow-up | Type of extravascular coil | Outcome |
|---|---|---|---|---|---|---|---|
| Dinter et al. [7] | 82/F | Gastric ulcer | CT | 6 × 300 mm tungsten coil, alcohol protamine solution | 10 years | Protrusion | Fatal hematemesis |
| Takahashi et al. [8] | 59/M | Chronic pancreatitis | SpA | 27 Coils | 3 weeks | Protrusion | Gastropseudocystic fistula, No bleeding |
| Shah et al. [9] | 65/F | Chronic pancreatitis | SpA | 19 Coils | 3 weeks | Passed per rectum | No bleeding |
| Han et al. [10] | 63/M | Advanced gastric cancer operation | SpA | 22 Coils | 9 months | Protrusion | No bleeding |
| Chosa et al. [11] | 76/M | Duodenal ulcer | GDA | 3 Coils | 4 days | Protrusion | Scar formation |
| Kuhara et al. [12] | 74/M | Bile duct carcinoma operation | GDA | 0.018-inch fibered platinum microcoils | 5 years | Submucosal migration | No bleeding |
| Skipworth et al. [13] | 55/M | Chronic pancreatitis | GDA | 20 × 3 mm coils, 12 × 3 mm coils, Thrombin | 10 months | Migration into the gastric pylorus | Gastric outlet obstruction, No bleeding |
| Rodrigues et al. [14] | 81/M | Duodenal ulcer | GDA | 3–5 mm platinum coils | 3 days | Protrusion | No bleeding |
| Shen et al. [15] | 69/M | Duodenal ulcer | GDA | Coils | 7 days | Protrusion | No bleeding |
| Singh et al. [16] | 82/F | Duodenal ulcer | GDA | Coils | 1 day | Protrusion | No bleeding |
| Valdar et al. [17] | 42/F | Duodenal ulcer | GDA | Coils | 7 days | Submucosal migration | No bleeding |
| Valdar et al. [17] | 65/M | Duodenal ulcer | GDA | Coils | 6 months | Protrusion | No bleeding |

*GI* gastrointestinal, *CT* celiac trunk, *SpA* splenic artery, *GDA* gastroduodenal artery

cause further bleeding and need to be removed. The extravascular coil eventually shows a healing process with adequate treatment of underlying bowel pathologies.

We acknowledge that this study has limitations, the major limitation being its retrospective and non-randomized study design. Therefore, the correct endoscopic follow-up regime and follow-up period were not established. Also, we could not compare with group which coil migration or protrusion did not occur after coil embolization. And massive rebleeding cases that could not endure follow-up endoscopy after coil embolization may be missing in this study. Nevertheless, our study demonstrates that if the coils migrate or protrude into the gastrointestinal tract lumen after TAE, conservative treatment seems sufficient with endoscopic follow-up, and most of these patients are expected to heal spontaneously.

In conclusion, the frequency of severe complications such as rebleeding by extravascular coils seems to be very low. But we don't know the exact fate of extravascular coils. Since the symptoms of extravascular coils rarely occur, the incidence of extravascular coils after coil embolization may be higher than our expectation. To accurately analyze the fate of the extravascular coils, we suggest that advanced studies including a well-established follow-up endoscopy period, number of coils used for embolization, and embolized vessel location are required.

**Compliance with Ethical Standards**

**Conflict of interest** The authors declare that they have no conflict of interest.

**Informed Consent** This study has obtained IRB approval from our institution and the need for informed consent was waived.

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