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# Transcatheter arterial embolization for small-bowel bleeding: technical and clinical outcomes and risk factors for early recurrent bleeding

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## Abstract

**Background** This study evaluated the technical and clinical outcomes of transcatheter arterial embolization (TAE) in patients with acute small-bowel bleeding (SBB) and aimed to identify potential risk factors for early recurrent bleeding after TAE.

**Methods** Thirty-one patients with SBB managed with TAE between January 2006 and December 2021 were included. Technical and clinical success was defined as angiographic occlusion of the bleeding artery and disappearance of clinical or laboratory signs of persistent bleeding without major complications. Complications were classified according to the Society of Interventional Radiology's guidelines. Kaplan-Meier estimates assessed overall survival, and logistic regression models determined risk factors for clinical success and early rebleeding.

**Results** Technical and clinical success were achieved in 30/31 (97%) and 19 (61%), respectively. Early recurrent bleeding was present in 9 (29%) patients, and was treated by repeat embolization in 4 patients, conversion to surgery in 4, and comfort therapy in 1 patient. TAE-related small bowel ischemia requiring surgery was found in 2 (6.5%) patients. Thirty-day and in-hospital mortality were 19% (6/31) and 23% (7/31), respectively; overall 5-year estimated survival was 60%. Thrombocytopenia and elevated prothrombin time (PT)/activated partial thromboplastin time (aPTT) levels prior to TAE were identified as risk factors for clinical failure (P=0.0026 and P=0.027, respectively), and for residual or early recurrent bleeding (P<0.001 and P=0.01, respectively).

**Conclusions** TAE is safe and effective for managing severe SBB; however, early recurrent bleeding was found in nearly one third of patients. Thrombocytopenia and elevated PT/aPTT levels were risk factors for early recurrent bleeding.

**Keywords** Gastrointestinal bleeding, small bowel, angiography, embolization

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Conflict of Interest: None

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## Introduction

Small-bowel bleeding (SBB) is defined as lower gastrointestinal bleeding (LGIB), arising between the ligament of Treitz and the ileocecal valve; it accounts for 5-10% of all cases of gastrointestinal bleeding (GIB) [1,2]. Acute SBB can be clinically identified as red blood loss *per annum* (RBPA), melena or even hematemesis. Occult or chronic SBB manifests as mild hemorrhage with hemoccult-positive feces, scant hematochezia or iron deficiency anemia [3,4].

A variety of lesions may result in SBB, and the etiology of bleeding is different in various age groups. The most common lesions are vascular anomalies, while other causes include diverticular bleeding, ulcers and inflammatory lesions, gastrointestinal tumors and post-surgery bleeding [5,6].

The first choice of diagnostic modality in patients with a suspicion of GIB is endoscopy. After negative gastroscopy and

colonoscopy, the additional endoscopic diagnostic workup can be challenging and may include capsule endoscopy or deep endoscopy; however, these tools are not useful in the acute setting and capsule endoscopy is not therapeutic. Most often, multiphase, contrast-enhanced computed tomography (CT) is the diagnostic modality of choice in the acute setting, followed by catheter-directed selective mesenteric angiography. The results of transcatheter arterial embolization (TAE) for SBB are scanty, and in most of the reports a mix of small bowel and colon bleeding cases are included [7,8]. In addition, prognostic factors for recurrent SBB after TAE are not well understood. Therefore, we conducted a retrospective analysis of a cohort of 31 patients who presented with clinical and radiological signs of SBB in a tertiary university care center, and we evaluated the technical and clinical outcomes, as well as risk factors for early rebleeding.

## Patients and methods

### Patients and study design

This was a retrospective, observational study, that was approved by the local Ethics Committee (MP018217) and included consecutive patients who presented with SBB and were treated with TAE between January 2006 and December 2021 in the authors' institution. Demographic, clinical, laboratory and imaging data were collected from patients' electronic medical files and a picture archive and communications system (Agfa Gevaert, Mortsel, Belgium), respectively.

### Pre-interventional workup

After resuscitation, patients underwent an upper gastrointestinal endoscopy at the discretion of the attending gastroenterologist to exclude a bleeding source proximal to the ligament of Treitz; the patient was subsequently referred for a CT study to identify the lower gastro-intestinal bleeding point; CT was performed before and after intravenous injection of 100 mL nonionic iodized contrast medium at an injection rate of 3 mL/sec. CT scans were obtained in both the arterial phase, 10 sec after reaching the threshold of 100 Hounsfield units (HU), with the trigger in the abdominal aorta, and the portal venous phase, 90 sec after reaching the HU threshold. Axial, coronal and sagittal images were reconstructed.

If contrast extravasation was seen in the lumen of the small bowel or a vascular lesion was identified in the territory of the small bowel vasculature, and in the absence of hemodynamic collapse, the patient was immediately referred to the interventional radiology department for therapeutic angiography.

### Embolization procedure

Depending on the patient's general or hemodynamic status, the angiographic procedure was performed under local or general anesthesia. The procedure was performed by an interventional radiologist with 7-25 years of experience in embolization procedures. Informed consent was obtained from the patient or a relative before the start of the angiographic embolization procedure.

Percutaneous vascular access was obtained with a 4- or 5-French (Fr) sheath, inserted into the right common femoral artery using the Seldinger technique, followed by selective, diagnostic angiography of the superior mesenteric artery (SMA) with use of a 4-Fr or 5-Fr Simmons 1 or Cobra catheter (Glidecath, Terumo Europe, Leuven, Belgium). After identification of the contrast extravasation or vascular lesion, superselective catheterization of the bleeding artery was performed with use of various types of coaxial microcatheters (Progreat, Terumo Europe, Leuven, Belgium; Cantata, Cook Medical, Bjaeverskov, Denmark; Direxion, Boston Scientific, Natick, MA, USA or Maestro, Merit Medical, South Jourdan, UT, USA). The choice of embolic agent used was at the discretion of the attending interventional radiologist and included pushable microcoils (Microtornado, Cook Medical, Bjaeverskov, Denmark; Target microcoils, Boston Scientific, Natick, MA, USA), polyvinyl alcohol (PVA) microparticles (Contour 250-355 μm, Boston Scientific, Natick, MA, USA), or a mixture of ethiodized oil (Lipiodol, Guerbet, Villepinte, France) and n-butyl cyano-acrylate (Histo-acryl, B. Braun, Melsungen, Germany). At the end of the embolization procedure, completion selective SMA angiography was performed to confirm complete occlusion of the target artery. The femoral vascular sheath was fixed in the groin for 24 h; if no repeat angiography was considered, the sheath was removed and manual compression performed.

### Definitions and classification systems

Technical success was defined as complete occlusion of the bleeding artery, as confirmed by completion SMA angiography; clinical success was defined as the absence of clinical or laboratory signs of persistent or recurrent bleeding within 30 days, and absence of any procedure-related complications. Procedure-related complications were classified as minor or major according to the reporting standards of the Society of Interventional Radiology [9]. The Charlson Comorbidity Index (CCI) was determined as a method of evaluating risk of postoperative morbidity or mortality from comorbid disease [10].

Pre- and post-TAE laboratory findings included hemoglobin, blood platelets, prothrombin time (PT) and activated partial thromboplastin time (aPTT), at first presentation with signs or symptoms of SBB and 24 h after transcatheter embolization. Anemia was defined as hemoglobin of 8-9.9 g/dL, severe anemia as hemoglobin 6.5-7.9 g/dL and life-threatening anemia as hemoglobin <6.5 g/dL. Coagulopathy was defined as elevated PT (>1.5) or aPTT (>45 sec) and/or thrombocytopenia (platelet count <80,000/mL).

### Clinical follow up

Immediately after TAE, patients were followed up clinically in the medical or surgical Intensive Care Unit. In case of persistent or recurrent GIB, the decision on the next therapeutic step, including repeat TAE, endoscopy, surgery or conservative management, was made after multidisciplinary discussion between the medical intensive care physician, interventional radiologist, gastroenterologist, and abdominal surgeon. If the clinical outcome was favorable, no follow-up abdominal imaging was performed. Patients' clinical status was followed-up, based on the electronic medical records, until the end of January 2022.

### Statistical analysis

Logistic regression models were used to study the prognostic effect of several characteristics on binary outcomes such as technical success, clinical success and recurrent bleeding. Results are presented with odds ratios and 95% confidence intervals. P-values <0.05 were considered as statistically significant. Kaplan-Meier estimates were used for estimating overall survival. All statistical analyses were performed using SAS software (version 9.4 of the SAS System for Windows, Cary, NY, USA).

## Results

### Patients' characteristics

Thirty-one patients were included in the study; the majority were male (n=25; 81%), the mean age was 51 years and the CCI score was 2.8 (range 0-9), as summarized in Table 1. Recent gastrointestinal tract surgery (n=16; 52%) and an immunocompromised status (n=7; 23%) were found as most important comorbidities. Of the total, 21 patients (68%) were already in hospital at the moment of SBB onset.

Patients presented with symptoms of GIB, including RBPA in 11 (35%), melena in 5 (16%), hematemesis in 1 (3%), a combination of RBPA and melena in 10 (32%), and RBPA, melena and hematemesis in 1 (3%). Three patients (10%) had no clinical signs of GIB, except for signs of hemodynamic instability. In addition, 14 patients (45%) were hemodynamically unstable at presentation, requiring resuscitation before further diagnostic workup.

Baseline laboratory analysis revealed a mean hemoglobin level of 7.3 g/dL (range 3.8-13.7 g/dL); elevated PT or aPTT was found in 7 patients (23%) and thrombocytopenia in 6 (19%). Transfusion of packed cells was indicated in 23 (74%) patients.

### Pre-interventional workup data

Upper gastrointestinal endoscopy or deep endoscopy was performed in 23 patients (74%); the bleeding source was identified in 3 patients, but without successful endoscopic intervention. All patients subsequently underwent triphasic CT.

**Table 1** Patient and procedural characteristics

| Patient characteristics (n=31) | N (%) |
|---|---|
| Age in years, mean (SD) | 51.4 (19.3) |
| Male (%) | 25 (80.7) |
| Hemorrhagic shock (%) | 14 (45.2) |
| Charlson comorbidity index, mean (SD) | 2.8 (2.6) |
| Pre-interventional aCT (%) | 31 (100) |
| Positive findings (%) | 24 (77.4) |
| Previous endoscopy (%) | 23 (74.2) |
| Positive findings (%) | 3 (13.0) |
| **Bleeding source (n=31)** | **N (%)** |
| Postoperative gastrointestinal surgery | 7 (22.6) |
| Small bowel ulcer | 7 (22.6) |
| Small bowel diverticulum | 3 (9.7) |
| Pseudoaneurysm | 2 (6.5) |
| Malignancy | 2 (6.5) |
| Arteriovenous malformation | 1 (3.2) |
| Trauma | 1 (3.2) |
| Unknown | 8 (25.8) |
| **Intervention (n=31)** | **N (%)** |
| Embolic agent | |
| Microcoils | 10 (32.3) |
| Microparticles | 2 (6.5) |
| Glue | 6 (19.3) |
| Microcoils and microparticles | 8 (25.8) |
| Microcoils and glue | 4 (12.9) |
| No embolic agent (unsuccessful embolization procedure) | 1 (3.2) |
| Original bleeding arterial branch of the superior mesenteric artery | |
| Jejunal artery | 20 (64.5) |
| Ileal artery | 7 (22.6) |
| Ileocolic artery | 4 (12.9) |

*aCT, triphasic angio-computed tomography; SD, standard deviation*

### Origin of small bowel bleeding

Based on clinical, endoscopic and CT features, the SBB was mainly associated with recent gastrointestinal tract surgery (n=7, 23%) (Fig. 1), small bowel ulcer (n=7, 23%) or diverticula (n=3, 10%), as summarized in Table 2. In 8 patients (26%), the etiology of bleeding before angiography was unknown.

## Angiographic and embolization results

Contrast extravasation into the small bowel lumen was found in 28 patients (90%); in the remaining patients a mesenteric pseudoaneurysm (n=2; 6%) or arteriovenous malformation

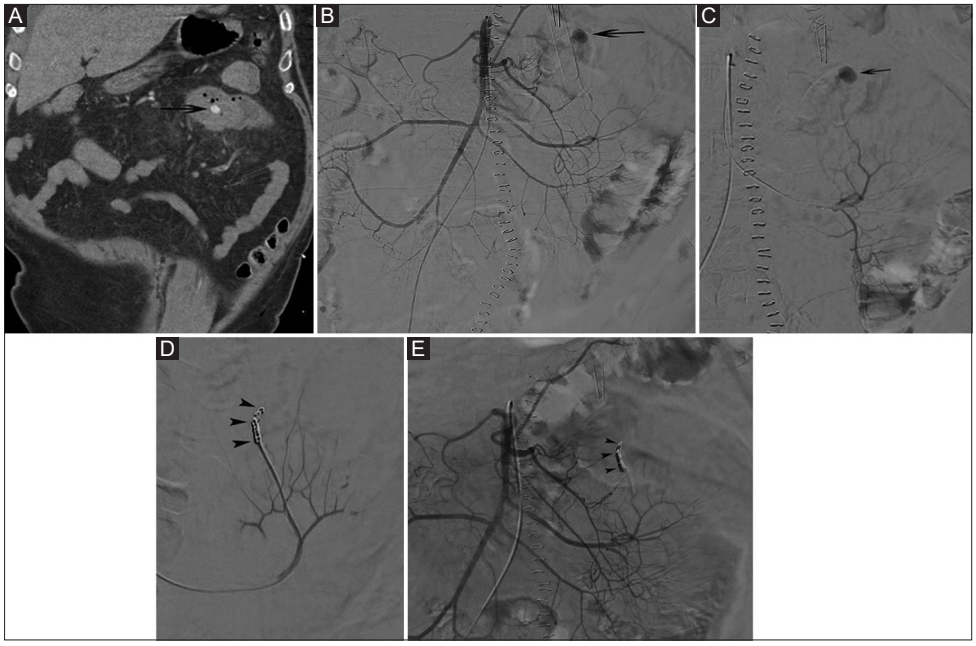


**Figure 1** A 61-year-old man presented with red blood per annum after enterectomy with jejuno-jejunostomy for small bowel ischemia associated with ischemic cardiomyopathy and shock. (A) arterial-phase, coronal, reconstructed computed tomography imaging reveals a postoperative, jejunal artery pseudoaneurysm (arrow) as active bleeding site at the small bowel anastomosis; (B) corresponding selective superior mesenteric angiography confirms the jejunal artery pseudoaneurysm (arrow); (C) superselective microcatheter catheterization of the feeding artery clearly demonstrates the pseudoaneurysm (arrow); (D) superselective angiography after coil embolization (arrowheads) of the pseudoaneurysm; (E) selective angiography after successful coil embolization (arrowheads) of the pseudoaneurysm

(n=1; 3%) was found. Microcoils (n=10; 32%) or microcoils combined with microparticles (n=8; 26%) were the most used embolic agents to stop the bleeding, as summarized in Table 1. In the majority of patients (n=20; 64%), the bleeding point was identified in an end-branch jejunal artery, as summarized in Table 1.

### Technical outcome

Technical success was achieved in 30 patients (96%). In 1 patient (3%), embolization was unsuccessful; a jejunal artery wall perforation during catheterization led to small bowel necrosis, persistent GIB, multi-organ failure and death within 48 h after the embolization procedure.

### Clinical outcome

Recurrent bleeding within 30 days after TAE was found in 9 patients (29%). In 4 patients, repeat angiography and embolization was performed 1, 1, 1 and 3 days after the initial embolization and resulted in definitive clinical success. Another 4 patients presenting with recurrent gastrointestinal bleeding were definitively managed with surgery 1, 1, 3 and 16 days after initial embolization; in 1 of these 4 patients, who was referred for surgery because of recurrent bleeding, an ischemic Meckel's diverticulum was found. In the remaining patient, who presented with recurrent bleeding associated with multiorgan failure, no additional intervention was performed except for comfort conservative management, as summarized in the treatment flow chart (Fig. 2). The patient died 6 days after the initial embolization.

Major procedure-related ischemic small-bowel complications were found in 2 patients (6%), who presented with severe small bowel ischemia 2 and 8 days after TAE. In the first patient, the ischemic bowel was related to a jejunal artery wall dissection with consecutive occlusion of 2 distal branches of the affected jejunal artery during TAE. In the second patient, initially embolized with microcoils and microparticles, a Meckel's diverticulum was identified during subsequent surgery.

The overall 30-day and in-hospital mortality were 6 (19%) and 7 (23%), respectively; the causes of 30-day mortality included bowel necrosis related to TAE (n=1), early recurrent GIB (n=1), endocarditis associated with septic emboli (n=1), terminal liver failure (n=1), and extreme malabsorption related to celiac disease (n=1). The 5-year survival was 60%, as shown in Fig. 3.

No clinical parameter, type of medication or embolic agent was predictive of clinical success or recurrent bleeding, as shown in Table 2. However, pre-TAE thrombocytopenia and elevated PT/aPTT levels were associated with poor clinical success (P=0.0026, P=0.0327, respectively) and a higher risk for post-TAE rebleeding (P=0.003, P=0.01, respectively), as summarized in Table 2. In addition, severe anemia and thrombocytopenia 24 h after TAE were also associated with poor clinical success (P=0.0119, P=0.0051, respectively) and residual post-TAE bleeding (P=0.0372, P=0.0013, respectively).

**Table 2** Predictors for clinical outcome after TAE

| A. Clinical variables | | | | |
|---|---|---|---|---|
| Clinical variables | Clinical success (n=22; 71%) | | Residual bleeding (n=9; 71%) | |
| | Odds ratio (95%CI) | P-value | Odds ratio (95%CI) | P-value |
| Age | | | | |
| >50 years | 1.019 (0.232-4.466) | 0.9806 | 1.021 (0.218-4.772) | 0.9791 |
| >60 years | 0.750 (0.165-3.3399) | 0.7091 | 1.600 (0.324-7.905) | 0.5642 |
| >70 years | 2.786 (0.256-30.273) | 0.4000 | 0.533 (0.049-5.862) | 0.6073 |
| Charlson comorbidity index +1 point | 1.236 (0.916-1.667) | 0.1656 | 0.936 (0.703-1.247) | 0.6513 |
| Medication | | | | |
| Inotropics | * | 0.2626 | * | 0.1813 |
| Anticoagulants | 2.000 (0.396-10.089) | 0.4013 | 0.381 (0.063-2.290) | 0.2916 |
| NSAID | 0.375 (0.030-4.635) | 0.4446 | 0.850 (0.068-10.610) | 0.9663 |
| Steroids | 0.786 (0.132-4.680) | 0.7911 | 2.000 (0.327-12.238) | 0.4533 |
| **B. Technical variables** | | | | |
| Technical variables | Clinical success (n=22; 71%) | | Residual bleeding (n=9; 71%) | |
| | Odds ratio (95%CI) | P-value | Odds ratio (95%CI) | P-value |
| Embolic agent | | | | |
| Microparticles | 0.410 (0.088-1.917) | 0.2573 | 2.333 (0.488-11.166) | 0.2888 |
| Microcoils | 8.888 (0.894-88.383) | 0.0623 | 0.097 (0.009-1.028) | 0.0528 |
| Glue | 2.500 (0.403-15.501) | 0.3250 | 3.047 (0.534-17.370) | 0.2096 |
| **C. Blood test variables before TAE** | | | | |
| Blood test before procedure | Clinical success (n=22; 71%) | | Residual bleeding (n=9; 71%) | |
| | Odds ratio (95%CI) | P-value | Odds ratio (95%CI) | P-value |
| Anemia | | | | |
| Anemia | * | 0.2626 | * | 0.4390 |
| Severe anemia | 1.042 (0.219-4.956) | 0.9591 | 1.050 (0.197-5.603) | 0.9543 |
| Life-threatening anemia | 0.733 (0.159-3.379) | 0.6907 | 0.808 (0.169-3.858) | 0.7889 |
| Thrombocytopenia | * | 0.0026 | * | <0.001 |
| Elevated PT/aPTT | 0.083 (0.009-0.815) | 0.0327 | 21.598 (2.086-223.61) | 0.0100 |
| **D. Blood test variables 24 h after TAE** | | | | |
| Blood test after procedure | Clinical success (n=22; 71%) | | Residual bleeding (n=9; 71%) | |
| | Odds ratio (95%CI) | P-value | Odds ratio (95%CI) | P-value |
| Anemia | | | | |
| Anemia | 5.416 (0.551-53.259) | 0.1183 | * | 0.0372 |
| Severe anemia | 8.400 (1.600-44.104) | 0.0119 | 0.204 (0.041-1.008) | 0.0512 |
| Life threatening anemia° | ° | ° | ° | ° |
| Thrombocytopenia | * | 0.0051 | * | 0.0013 |
| Elevated PT/aPTT | 0.208 (0.19-2.290) | 0.1996 | 6.750 (0.605-75.268) | 0.1207 |

°No life-threatening anemia was observed 24 h after TAE

*CI, confidence interval; TAE, transcatheter arterial embolization; NSAID, nonsteroidal anti-inflammatory drugs; PT, prothrombin time; aPTT, activated partial thromboplastin time*

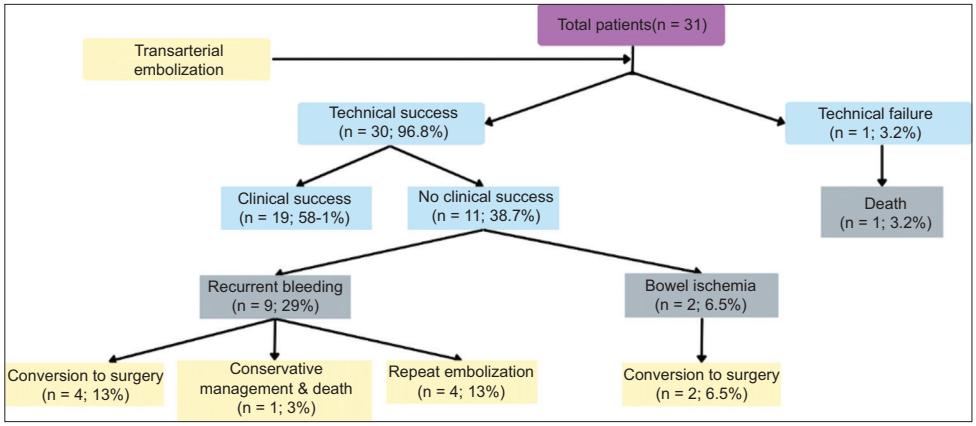


**Figure 2** Patients' treatment flow chart shows clinically successful embolization in 23 patients (74%) after initial (n=19; 58%) or repeat (n=4; 13%) embolization. Surgery was performed in 6 patients (19%), related to post-embolization bowel ischemia (n=2; 6.5%), or persistent or early repeat bleeding (n=4; 13%)

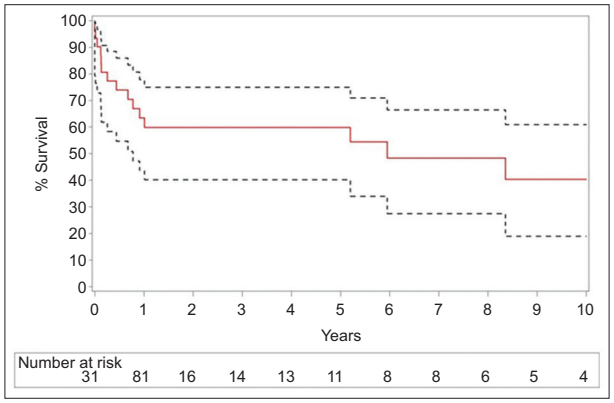


**Figure 3** Kaplan-Meier survival curve demonstrates estimated survival of 60%, 60% and 40% at respectively 2, 5 and 10 years of follow up

## Discussion

This study demonstrated a very high technical success rate of selective embolization for SBB, which is in line with other studies [7,8,11-15]. Procedure-related complications were relatively rare, and mainly included post-embolization bowel ischemia requiring surgical enterectomy, found in 2 (6.5%) patients. Kim *et al* [11] reported irreversible bowel ischemia in 10 of 72 patients (14%) and Hur *et al* [12] in 2 of 36 (5.5%) after SBB embolization procedures; both groups mainly used n-butyl cyanoacrylate as the embolic agent of choice. In the presented study, microcoils were used in the majority of cases without a higher rate of ischemic complications. Kwak *et al* [14] used only microcoils for SBB and did not encounter any post-embolization bowel ischemia [4]. Lastly, Tan *et al*, in a small case series of 6 patients using mainly microcoils as embolic agents, did not encounter post-embolization bowel ischemia [16].

In our study, coils were the preferred embolic agent, based on their visibility on fluoroscopy and the accurate deployment. The type of embolic agent did not seem to be a predictive factor for better or worse outcomes; however, the small patient sample size and the heterogeneity of embolic agents used in this study do not allow relevant conclusions to be drawn as to the superiority of one embolic agent over another.

In our study group, TAE complicated with bowel ischemia was related in 1 patient to a procedure-related vessel wall dissection and concurrent ischemia in the perfusion area. Another patient had bowel ischemia after superselective coil and microparticle embolization of SBB with consecutive segmental enterectomy and anatomopathological confirmation of a diverticulum of Meckel [17]. The typical vasculature of a Meckel's diverticulum was not identified during angiographic evaluation. Patients with a Meckel's diverticulum are susceptible to bowel ischemia due to the presence of an end-organ vitelline artery, an embryologic remnant of the omphalomesenteric system, which presents as an elongated vessel with few or no side branches and usually arises from a distal ileal branch of the superior mesenteric artery [17].

The risk for procedure-related bowel ischemia in lower GIB, and in particular in SBB, seems to be determined by technical aspects and anatomic variants, rather than by which embolic agent is used.

The rebleeding rate after TAE is substantial, being 29% in the presented series, which is greater than reported in other series of SBB (Table 3); however, additional intervention, including repeat TAE or surgery, was indicated in 4 and 4 patients, respectively, demonstrating that finally 26 patients (84%) were definitely treated with TAE.

Both pre-TAE thrombocytopenia and elevated levels of PT/aPTT were risk factors for rebleeding, which confirms the findings of Hur *et al* showing coagulopathy as a risk factor for early rebleeding [12]. These authors also identified immobilization status and hematologic malignancy as risk factors for rebleeding [12], which were not examined in the present study. Therefore, pre-, peri- and post-interventional optimization of a patient's coagulation is strongly recommended. In addition, persistent severe anemia, thrombocytopenia and elevated PT/aPTT levels 24 h after TAE, were indicative of a poor clinical outcome. The overall in-hospital mortality rate was 23%, consistent with those of prior studies, which ranged from 0-31% (Table 3).

**Table 3** Summary of the largest reported studies reporting the outcome of transcatheter arterial embolization in small bowel hemorrhage

| Author [ref.] | Number of included patients | Technical Success | Clinical Success | Rebleeding | Major complications | In-hospital mortality |
|---|---|---|---|---|---|---|
| Kim *et al* [11] | 74 | 72/74 (97.3%) | 56/72 (77.8%) | 7/57 (12.3%) | 15/71 (21.1%) | 18/72 (25%) |
| Kwon *et al* [8] | 72 | Not reported | 46/72 (63.8%) | 15/61 (24.6) | 15/70 (21.4%) | Not reported |
| Hur *et al* [12] | 36 | 35/36 (97.2%) | 26/35 (74.2%) | 5/28 (17.9%) | 2/33 (5.7%) | 11/36 (30.6%) |
| Waugh *et al* | 19 | 19/19 (100%) | 19/19 (100%) | Not reported | Not reported | 1/19 (5.3%) |
| Kwak *et al* [14] | 17 | 17/17 (100%) | 15/17 (88.2%) | 3/14 (21.4%) | 0/17 (0%) | 1/17 (5.9%) |
| Huang *et al* [15] | 9 | 9/9 (100%) | 7/9 (77.8%) | 2/9 (22.2%) | 0/9 (0 %) | 1/9 (11.1%) |
| Tan *et al* [16] | 6 | 6/6 (100%) | 6/6 (100%) | 0/6 (%) | 0/6 (%) | 0/6 (0%) |
| Present study | 31 | 30/31 (96%) | 19/31 (61%) | 9/31 (29%) | 2/31 (6%) | 7/31 (23%) |

This study also had some limitations. First, the retrospective study design might have biased some outcome results. Second, 31 patients, included over a time interval of 15 years, is a relatively small sample size spread over a relatively long study period; however, severe SBB, treated with embolization, is still a rare disease. Third, a variety of underlying bleeding etiologies were found. Finally, no randomization was performed for the embolic agents used.

In conclusion, this retrospective study demonstrates a very high technical success rate for SBB embolization, associated with a relatively low ischemic complication rate. However, rebleeding seems to be substantial after TAE and might occur more in patients with pre-interventional thrombocytopenia and elevated PT/aPTT levels.

### Summary Box

**What is already known:**

- Small-bowel hemorrhage can be managed with catheter-directed embolization
- Short-term results of embolization for small bowel hemorrhage are promising, with acceptable rates of early recurrent bleeding
- Complications related to the embolization procedure are infrequent
- Different types of embolics have been used

**What the new findings are:**

- Thirty-day and in-hospital mortality were 19% (n=6/31) and 23% (7/31), respectively
- Overall 5-year estimated survival was 60%
- Thrombocytopenia and elevated prothrombin time/activated partial thromboplastin time levels prior to embolization were identified as risk factors for clinical failure and residual or early recurrent bleeding
- The type of embolic used was not predictive of clinical success or recurrent bleeding

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