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ORIGINAL ARTICLE

Transarterial embolization in acute colonic bleeding: review of 11 years of experience and long-term results

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Abstract
Background Lower gastrointestinal bleeding represents 20 % of all gastrointestinal bleedings. Interventional radiology has transformed the treatment of this pathology, but the long-term outcome after selective embolization has been poorly evaluated. The aim of this study is thus to evaluate the short-term and long-term outcomes after selective embolization for colonic bleeding.
Methods From November 1998 to December 2010, all acute colonic embolizations for hemorrhage were retrospectively reviewed and analyzed. The risk factors for post-embolization ischemia were also assessed.
Results Twenty-four patients underwent colonic embolization. There were 6 men and 18 women with a median age of 80 years (range, 42–94 years). The underlying etiologies included diverticular disease (41.9 %), post-polypectomy bleeding (16.7 %), malignancy (8.2 %), hemorrhoid (4.1 %), and angiodysplasia (4.1 %). In 23 patients, bleeding stopped (95.8 %) after selective embolization. One patient presented a recurrence of bleeding with hemorrhagic shock and required urgent hemorrhoidal ligature. Four patients required an emergent surgical procedure because of an ischemic event (16.7 %). One patient died of ileal ischemia (mortality, 4.1 %). The level of embolization and the length of hypoperfused colon after embolization were the only risk factors for emergent operation. Mean hospital stay was 18 days (range, 9–44 days). After a mean follow-up of 28.6 months (range, 4–108 months), no other ischemic events occurred.
Conclusion In our series, selective transarterial embolization for acute colonic bleeding was clinically effective with a 21 % risk of bowel ischemia. The level of embolization and the length of the hypoperfused colon after embolization should be taken into consideration for emergent operation.

Keywords Colonic hemorrhage · Arteriography · Embolization · Ischemia · Surgery

Introduction

Traditionally, lower gastrointestinal bleeding (LGIB) is defined as bleeding occurring distal to the ligament of Treitz, and it accounts for 20 % of all gastrointestinal hemorrhage [1]. Concerning the etiology, colonic diverticula seems to be the most frequent source of hematochezia, followed by angiodysplasia, inflammatory bowel disease, and post-polypectomy bleeding [2]. Acute LGIB stops spontaneously in 80–85 % of cases, and the overall mortality rate is around 10 % [3]. Localization is mostly performed by colonoscopy, but endoscopic therapeutic intervention is successful in only a minority of patients [1–7].

Given that emergency surgery typically results in significant morbidity and even death [8], angiography and embolization transformed the management of LGIB, in particular with the introduction of super-selective embolization, minimizing the risk of ischemia [9]. Several recent reports describe the safety and efficacy of super-selective angioembolization, but the long-term outcomes after selective embolization remain poorly evaluated [10–13].

The present study is a retrospective analysis of 24 patients treated for LGIB of colonic origin with embolization. The aim

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of the study is to evaluate the short-term and long-term clinical success of embolization as a primary therapeutic modality in the control of LGIB.

Methods

Study population

From November 1998 to December 2010, all colonic embolizations for acute bleeding were retrospectively analyzed. Patients who underwent only a diagnostic angiography without any radiological intervention were excluded from this study. The data collected included age, gender, localization and cause of bleeding, other treatments after embolization, length of stay, and long-term follow-up.

Twenty-four patients formed the study group. The median age was 80 years (range, 42–94 years). There were 18 women and 6 men. All 24 patients underwent angiography and embolization. Of note, these patients were considered as poor surgical candidates and/or the preoperative computed tomography (CT) scan did not localize the bleeding source. Long-term results were analyzed with a mean follow-up of 28.6 months (range, 4–108 months).

Technique of embolization

All patients were transferred to the angiography room with the assistance of an anesthesia team for monitoring and resuscitation. After local anesthesia, the right or left femoral artery was punctured and a 5-Fr introducer sheath was inserted. Superior and inferior mesenteric angiography was performed in each patient, using digital subtraction imaging and standard 5-Fr catheters. After identifying a contrast media extravasation, a 2.7-Fr (Progreat, Terumo, Tokyo, Japan) or a 1.4-Fr (Excel 10, Boston, MA, USA) coaxial microcatheter system was positioned as close as possible to the bleeding site. Then, super-selective embolization was achieved through the microcatheter using different embolic agents at the operator's discretion.

Data were analyzed according to the guidelines for transcatheter embolization [14]. Technical success was defined as the immediate cessation of contrast media extravasation as identified by a post-procedural angiography, while clinical success was defined as the termination of bleeding per rectum and the stabilization of hemoglobin levels that required no more than 2 U of packed red blood cells within 30 days of the procedure. Two interventional radiologists (ST and RB) reviewed the procedure reports and imaging of all patients to register the embolic materials and to evaluate the level of arterial embolization (first-order or second-order branch, marginal artery, or vasa recta) and the length of hypoperfused bowel on post-procedural angiography (Fig. 1).

Statistical analysis

The results of parametric and nonparametric data were expressed as the mean±standard deviation and median (range), respectively. GraphPad Software (GraphPad, La Jolla, CA, USA) was used for all statistical analyses. Confidence intervals were set at 95 %. A two-sided P value of ≤ 0.05 was considered statistically significant. Comparisons between both groups were determined using Fisher's exact test for discrete variables and Student's t test for continuous variables.

Results

From November 1998 to December 2010, more than 500 patients presented with LGIB, and among them, a total of 24 patients underwent colonic embolization for this indication. All patients were hospitalized for passing fresh blood through the rectum. Twenty patients (83.3 %) required blood transfusions. On initial angiography, contrast media extravasation was confirmed in 22 patients (92 %), whereas 2 patients did not show active bleeding but were superselectively embolized according to CT angiography.

The site of bleeding was the ileocolic artery in 11 cases (46 %), the left colic artery in 5 cases (21 %), the right colic artery in 3 cases (13 %), the middle colic artery in 2 cases (8 %), the sigmoid artery in 2 cases (8 %), and the superior rectal artery in 1 case (4 %). The most common agents used for embolization were gelatin sponge (Gelfoam, Upjohn) in eight patients (33 %) and microcoils (number range, 1–5; diameter range, 2–4 mm) in seven patients (29 %). Polyvinyl alcohol microparticles (Contour, Boston) were used in five cases (21 %), and silk threads were used in four cases (17 %). The site of embolization was the vasa recta in 11 cases (45.8 %), the marginal artery in 8 cases (33.3 %), and the lower-order branches of the superior and inferior mesenteric arteries in 5 cases (20.8 %). The causes of bleeding included diverticular disease (41.9 %), spontaneous bleeding (25 %), post-polypectomy hemorrhage (16.7 %), malignancy (8.2 %), angiodysplasia (4.1 %), and hemorrhoid (4.1 %). Table 1 summarizes the patients' characteristics.

The technical success rate was 100 %, while clinical success was achieved in 23 of 24 patients (95.8 %). One patient presented a recurrence of the bleeding after the embolization procedure, and the final therapy was the ligature of bleeding hemorrhoids that were not observed on initial endoscopy.

One patient died of ileal ischemia 11 days after embolization (mortality rate, 4.1 %). Four patients (16.7 %) required an emergent surgical operation for ischemic events. Two patients presented ischemia of the left colon after embolization of bleeding diverticula: one patient underwent a sigmoidectomy with direct anastomosis and

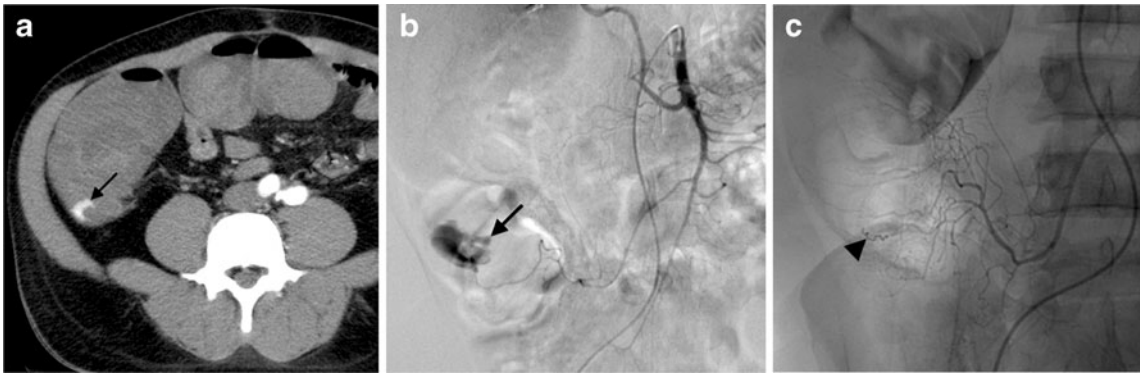

Fig. 1 In these images, we present the case of a patient who presented an acute LGIB. This patient was treated with acetylsalicylic acid and clopidogrel for a recent cardiac ischemic event. We perform an axial CT for localization of the bleeding and after an angiography with super-selective embolization. **a** Axial CT image during the arterial phase shows contrast extravasation in the cecal lumen (*arrow*). **b** Superior mesenteric angiography with subtraction confirms a large bleeding at this location (*arrow*). **c** A 1.9-Fr microcatheter is positioned in the arterial branch close to the extravasation site. After embolization of the feeding vessel with a 2-mm-diameter microcoil (*arrowhead*), the control angiogram shows cessation of bleeding and preservation of an acceptable bowel perfusion. The clinical outcome of this patient was uneventful

one patient underwent a Hartmann procedure. While patient who underwent the Hartmann procedure did well in the postoperative course, the patient who underwent sigmoidectomy developed an anastomotic leak, which necessitated a Hartmann procedure as well. The other two cases presented as right colon ischemia and as cecum ischemia; these two patients were treated surgically with emergent right colectomy.

Table 1 Characteristic of the 24 patients with LGIB treated by embolization

Characteristic	Results
Mean age in years (range)	74.3 (42–94)
Gender	
Male	6 (25 %)
Female	18 (75 %)
Localization of bleeding	
Right colon	16 (66.6 %)
Transverse colon	2 (8.3 %)
Left/sigmoid colon	5 (21 %)
Rectum	1 (4.1 %)
Cause of bleeding	
Diverticular disease	10 (41.9 %)
Spontaneous	6 (25 %)
Post-polypectomy	4 (16.7 %)
Tumors	2 (8.2 %)
Angiodysplasia	1 (4.1 %)
Hemorrhoid	1 (4.1 %)
Blood transfusion	
Yes	20 (83.3 %)
No	4 (16.7 %)
Mean follow-up in months (range)	28.6 (4–108)

When comparing the group of patients with ischemic events to patients without, the former group stayed in the hospital for longer (p=0.003). However, there were no statistical differences between those both groups in terms of age, gender, indications, location, degree of atheromatosis, and follow-up (p>0.05). On the other hand, when analyzing the patients who presented an ischemic event requiring an emergent operation, several risk factors were found. The level of embolization was seen more proximal for those patients (third-order branches of mesenteric arteries in three cases and marginal artery in one case), while for patients without an ischemic event, 55 % had an embolization of the vasa recta and 35 % of the marginal artery. Only two patients without ischemia had more proximal embolization (third-order and fourth-order branches). In addition, there was a statistically significant difference in terms of the length of devascularized bowel on post-procedural angiography between both groups (13.4 cm for the ischemic group vs. 3.2 cm; p=0.0001).

Adverse events included a groin hematoma at the puncture site in one patient and acute renal failure related to contrast nephropathy in another patient, which was treated medically with full recovery of renal function after 10 days.

Concerning the long-term results after an average follow-up of 28.6 months (range, 4–108 months), one patient presented a new episode of bleeding after 84 months. This patient was known for heart transplantation and for important vascular comorbidity. It was decided not to perform a second angiography because of the major risk of ischemia in a patient who had already been embolized once. The final treatment consisted of a right hemicolectomy. The final diagnosis was a right colonic diverticula. The postoperative course was uneventful. Lastly, no ischemic event occurred during the follow-up period. Table 2 summarizes the patients' outcomes.

Table 2 Short-term and long-term outcomes

Parameters	Results
Short-term outcomes	
Clinical success	23 (95.8 %)
Failure with urgent surgery	1 (4.1 %)
Hematoma at puncture site	1 (4.1 %)
Urgent surgery for post-embolization ischemia	4 (16.7 %)
Right colectomy	2 (8.2 %)
Left colectomy	1 (4.1 %)
Hartmann procedure	1 (4.1 %)
Mortality	1 (4.1 %)
Long-term outcomes	
Colonic ischemia	0
Late surgery[a] for recurrence of bleeding	1 (4.1 %)

[a] After 84 months

Discussion

The first description of angiographic diagnosis and treatment of gastrointestinal hemorrhage was published in 1974 [15]. The results of the initial attempts were associated with high recurrence rates and complications [15, 16].

Significant advances in the embolization technique and devices (super-selective, microcatheters) and increased technical expertise have improved the adoption of this procedure for the treatment of lower gastrointestinal hemorrhage. Numerous studies reported that using multiphasic contrast-enhanced CT in the diagnosis and localization of acute LGIB could quickly determine who may benefit from super-selective embolization [17–21]. In the meantime, flexible endoscopy is still considered the mainstay for the evaluation of LGIB [9]. Usually, it is recommended as the first diagnostic step in a stable patient, with the possibility to locally treat bleeding. Additionally, identifying the source of bleeding has been demonstrated to be very useful to show the radiologist the target artery before the angiography. Recent reports have demonstrated the safety and efficacy of this procedure [22–24].

Different methods exist to treat an ongoing bleeding discovered during an arteriography: microcoils, Gelfoam, and particles [9]. The success rate is usually higher than 70 % [9]. The short-term results in our study are very close to other experiences reported in the literature. For example, Lipof et al. [13] reported immediate hemostasis in 97 % of the patients, with short-term rebleeding in 16 % of patients and acute ischemia in 7 % of patients. Table 3 resumes the short-term results reported in the literature.

Concerning the risk factors, advanced age, intestinal ischemia, and comorbidity are the strongest predictors of mortality. Conversely, the presence of colorectal polyps or hemorrhoids is associated with a lower risk of mortality [24].

Table 3 Short-term outcomes in the literature

Authors	Results
Bandi et al. [11]	35 patients
Immediate hemostasis	94 %
Ischemia rate	24 %
Rebleeding rate	34 %
Burgess et al. [21]	15 patients
Immediate hemostasis	93 %
Ischemia rate	60 %
Rebleeding rate	53 %
Silver et al. [23]	11 patients
Immediate hemostasis	91 %
Ischemia rate	63 %
Lipof et al. [13]	71 patients
Immediate hemostasis	97 %
Ischemia rate	7 %
Rebleeding rate	16 %
Tan et al. [24]	32 patients
Immediate hemostasis	97 %
Ischemia rate	1 %
Gillespie et al. [27]	38 patients
Immediate hemostasis	100 %
Ischemia rate	8 %
Rebleeding rate	24 %
Koganemaru et al. [28]	4 patients
Immediate hemostasis	100 %
Ischemia rate	0 %
Rebleeding rate	0 %

In fact, LGIB is common in elderly patients, as confirmed by our series in which the median age was 80 years old. Frequently, these patients present several associated comorbidities, such as coronary artery disease and peripheral vascular disease, which decrease their collateral blood flow. The main problem in these patients is that the peripheral colonic vessels are necessary for the blood supply and embolization may cause ischemia [24].

Our series demonstrated an important immediate clinical efficacy, given that 95.8 % of bleeding was stopped after embolization. Yet, the short-term outcomes showed 21 % of post-embolization ischemia (five patients) that is relatively high. Four patients were surgically treated with success, and one died. These results compare favorably to the outcomes after emergent colectomy in general (mortality, 14 %; morbidity, 36 %) [25] and specifically for LGIB with a mortality rate that can be as high as 27 % [8].

As we have seen in our study, the level of embolization is one of the main risk factors for post-embolization ischemia, as well as the length of hypoperfused bowel at the end of the embolization procedure. These factors should be considered for prompt surgical intervention in those high-risk patients.

Finally, ischemia remains the main problem, and the risk decreased with better embolization technique. Recently, Tan et al. [26] described only one patient (3 %) suffering from ischemic complications that required immediate surgical intervention. However, the procedure resulted in an anastomotic leak, similar to what we report here. The leak rate in their series was 22 %, with two of nine patients that required an operation. The rebleeding rate in this study was 22 % [26].

The risk of ischemia has been decreased with the introduction of new materials and techniques, but this risk still remains and could require immediate surgical intervention with high risk of an anastomotic leak, as was the case in one patient in our series. Perhaps, it would be wiser not to perform primary anastomosis in patients that present an ischemia after an embolization because of the possibility of compromising bowel blood supply. However, there are several techniques to check the vascularization of an anastomosis (Doppler, fluorescein, or indocyanine green), and these tools could help to decide whether to perform anastomosis.

While not new, the data reported herein show the analysis of long-term follow-up with only one patient presenting a rebleeding after 84 months. It also demonstrates the efficacy of this procedure as a definitive treatment for LGIB. In the literature, Lipof et al. [13] reported 15 % of recurrences of hemorrhage (8 patients out of 71) with a mean follow-up of 32 months. Tan et al. [25] reported 13 % of rebleeding at 30 days or more after the first episode (4 of 32 patients). These data finally confirm the safety of the procedure, even after long-term follow-up.

However, some limitations of this study deserve to be mentioned. First, the decision to perform an embolization or a surgical exploration remains at least debatable. Today, clear indications for a transarterial embolization are still under evaluation in most centers. In our series, we have evaluated retrospectively this approach for poor surgical candidates in whom the localization of the bleeding source was not always done preoperatively by angio-CT. We consider that a good risk surgical patient, in whom the source of bleeding was localized, should undergo a surgical exploration. On the other hand, a blind segmental resection carries a high mortality rate and is associated with significantly higher rebleeding rates [8]. This type of approach should be reserved for critically unstable patients in whom all the diagnostic methods have failed to localize the bleeding source.

Secondly, this is a retrospective series, and thus, by the nature of the study, the selection criteria were not strict and could render the interpretation of the results more difficult. A large prospective study with a defined algorithm, as proposed by others [8], is required before drawing definitive conclusions.

Conclusion

In our series, selective transarterial embolization for colonic bleeding was highly effective during the short-term and long-term follow-up. However, the risk of ischemia is significant (21 %) and is related mainly on the level of embolization and the length of the resulting hypoperfused colon. This risk should be taken into consideration for emergent operation.

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