



# Superior rectal artery embolization for bleeding internal hemorrhoids

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## Abstract

**Background** The aim of the present study was to evaluate clinical efficacy and safety of superselective embolization of the superior rectal artery (SRA) for the treatment of internal hemorrhoidal bleeding.

**Methods** Patients with stage II and stage III internal hemorrhoids, treated by interventional embolization of the SRA in our department between January 2017 and June 2019 were retrospectively evaluated. All patients suffering from disabling chronic hematochezia and some with relative contraindications for operation ( $n = 17$ ) or rejection of conventional hemorrhoidectomy ( $n = 15$ ). Superselective SRA branch embolization was performed using gelatin sponge particles (350–560  $\mu\text{m}$ ) and metallic coils (2–3 mm). This treatment process was planned by a multidisciplinary team consisting of proctologist, gastroenterologist and radiologist. The surgical efficacy, postoperative complications and follow-up outcomes were observed.

**Results** There were 32 patients (18 males, mean age  $52 \pm 12$  years, range: 22–78 years), 12 (37%) with stage II hemorrhoids and 20 (63%) with stage III hemorrhoids. Embolization was successful in all patients, and bleeding symptoms resolved in 27 (84.4%) patients. The remaining 5 (15.6%) patients underwent either stapled hemorrhoidopexy ( $n = 4$ ) or sclerotherapy ( $n = 1$ ). Some patients experienced different degrees of pain ( $n = 4$ ; 12.5%), low fever ( $n = 11$ ; 34.4%), and tenesmus ( $n = 17$ ; 53.1%), which all spontaneously regressed without further treatment. All patients were followed up for at least 1 year. There were no serious complications, such as infection, intestinal ischemia or massive hemorrhage. Four patients (14.8%) had rebleeding during the first months of follow-up. All patients with re-bleeding were successfully treated with internal iliac arteriography and branch embolization and did not experience further bleeds after a minimum follow up 3 months follow-up.

**Conclusions** The short-term efficacy of superselective SRA embolization for grade II–III internal hemorrhoids is good, and this method is safe and feasible.

**Keyword** Hemorrhoids · Superior rectal artery · Intervention · Embolization · Angiography

## Introduction

Hemorrhoidal disease (HD) is a common benign anorectal disease. In recent years, the incidence of HD has shown an upward trend. The symptoms of HD vary depending on the location and type of HD. Hematochezia is one of the main clinical symptoms, with or without hemorrhoidal prolapse, causing a decrease in the quality of life of patients [1]. Currently, the etiology of HD is still unclear. With the in-depth study of the pathogenesis of HD, the treatment strategy for HD has changed from “resection and radical treatment” to the elimination or relief of symptoms.

Morinaga and colleagues first reported the application of Doppler-guided hemorrhoid artery ligation (DG-HAL) for the treatment of grade II–III internal hemorrhoids in 1995 [2]. DG-HAL reduces the blood flow of internal hemorrhoids by ligating the superior hemorrhoidal artery (SRA),

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and the bleeding control rate can reach 90%. This surgical procedure has been included in the treatment guidelines for HD published by the National Institute for Health and Care Excellence (NICE), United Kingdom.

Based on the pathophysiological concept of arterial network hypertrophy in the hemorrhoidal region, accurate localization by angiography and superselective embolization of the feeding artery in this region should also achieve good clinical outcomes. Visualization during interventional embolization is good, with full display of anastomoses of all branches and collaterals of the SRA. Additionally, the procedure involves minimal trauma and will not cause damage to normal structures such as the anal sphincter, intraoperative and postoperative pain is reduced, and rapid postoperative recovery is facilitated. Therefore, interventional embolization has gradually been applied and recognized in clinical practice.

Rectal vascular anatomy and hemodynamic studies have shown that as the main feeding artery of hemorrhoids, the SRA is split into three to five large branches, and then each branch divided into five to seven lesser subdivisions penetrating the intestinal wall [3], which are the primary target of interventional embolization. The aim of the present study was to evaluate the clinical efficacy and safety of superselective embolization of the SRA in treating grade II–III internal hemorrhoids in a retrospective cohort of patients with no prior surgical history.

## Materials and methods

Patients with stage II–III internal hemorrhoids who underwent superselective embolization of the SRA from January 2017 to June 2019 at the department of Interventional Medicine, Gastroenterology, and Anorectal Surgery were retrospectively evaluated. All patients met Goligher's diagnostic criteria for HD (Table 1) [4]. Hematochezia was the main symptom in all patients, and 15 (46.9%) patients had visibly bloody stools per day and 6 (18.8%) patients had severe anemia (hemoglobin level < 7 g/dL) requiring blood transfusions. All patients had failed conservative treatment

**Table 1** Patient characteristics ( $n = 32$ )

Characteristics	Value
Age (years), mean, SD	52 ± 12
Sex	
Male	18 (56%)
Female	14 (44%)
Stage of prolapse (Goligher)	
Stage II	12 (37%)
Stage III	20 (63%)

consisting of oral or topical drug and dietary or lifestyle adjustments and some of them had obvious surgical contraindications such as poor cardiopulmonary function and blood coagulation disorders, and some refused conventional hemorrhoidectomy. All patients provided written informed consent before procedure.

Preoperative examinations were performed (digital rectal examination, rectoscopy, complete blood count and coagulation tests). The patient was given local anaesthesia. A modified Seldinger method was used to cannulate the femoral artery, and then a 4-Fr catheter sheath was inserted and a pigtail catheter was used to perform abdominal aortic angiography to determine rectal blood supply. Then, the inferior mesenteric artery was catheterized using a 4-Fr Simmons catheter, and superselective angiography was performed to visualize the SRA and its branches (Figs. 1a, 2a). Superselective angiography of the SRA and its branches was performed using a 2.7-Fr microcatheter. First, an appropriate amount of gelatin sponge particles (350–560 µm) was injected, and then, several 2 to 3-mm metallic coils were used to embolize the proximal end of the left and right branches of the SRA; the end point of embolization was the lack of vascular bed detected in the hemorrhoidal area by angiography (Figs. 1b, 2b).

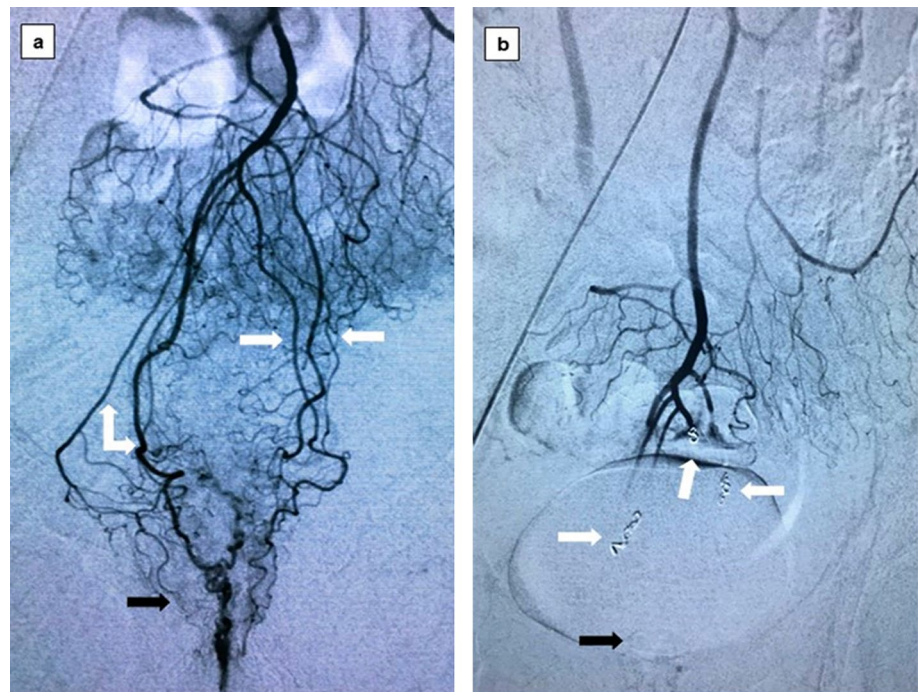
After the operation, the catheter sheath was pulled out, the puncture site of the femoral artery was pressed for 15 min, and then bandaged with pressure. The lower limb on the side of the puncture was immobilized, and the bandage was removed 24 h later. If there was no bleeding or hematoma at the puncture site, no special treatment was needed. Rehydration after embolization can facilitate the excretion of iodine contrast medium, and patients should be encouraged to do back extension and plantar flexion during bed rest to prevent deep vein thrombosis.

All patients were hospitalized for 3 days after embolization and discharged without obvious complications such as fever, severe pain and massive bleeding.

## Results

There were 32 patients, (18 males and 14 females, with a mean age of  $51 \pm 12$  years, range: 22–78 years), 12 (37%) with stage II hemorrhoids and 20 (63%) with stage III hemorrhoids. The procedure was successful in all patients. The operating time was ( $45 \pm 8$ ) minutes, and there were no immediate complications. Seventeen (53.1%) patients experienced varying degrees of tenesmus postoperatively which resolved 3–7 days later. Eleven (34.4%) patients had a low fever ( $37.7 \pm 0.2$  °C) after surgery, and 4 (12.5%) patients experienced postoperative pain starting on the day of their operation. Fever and pain resolved spontaneously without antipyretics and painkillers. Bleeding symptoms of

**Fig. 1** Patient no. 1. **a** Catheterization of the inferior mesenteric artery with a Simmons catheter showing the rectal hypervascularization (white arrows) and the terminal branches of the SRA that feed the internal hemorrhoids (black arrow). **b** Embolization of both SRAs with microcoils and gelatin sponge granules (white arrows). The final arteriogram showing no visible vascularization of the inferior part of the rectum is shown (black arrow)



**Fig. 2** Patient no. 2. **a** Subtracted arteriogram showing opacification of the distal SRAs and the rectal hypervascularization (white arrows). **b** Embolization of the target artery with microcoils and gelatin sponge granules (white arrows). The final arteriogram showing reduced vascularization of the inferior part of the rectum is shown (black arrow)



all patients gradually decreased ( $n=5, 15.6\%$ ) or resolved ( $n=27, 84.4\%$ ). There were no serious complications, such as massive hemorrhage, infection or intestinal necrosis.

Follow-up visits were conducted 1 month after surgery. No complications such as ischaemic necrosis and infection had developed. Hematochezia was not observed, discomfort after bowel movements resolved and hemorrhoidal

prolapse was reduced significantly in the 27 patients, while the 5 patients still had some blood in the stool and the procedure for prolapse and hemorrhoids (PPH) or sclerotherapy was used to treat these patients (PPH in 4 cases and sclerotherapy in 1 case). At the 6-month follow-up, 4 patients (4/27, 14.8%) (stage II: 1 and stage III: 3) had a recurrence of hematochezia. These patients underwent bilateral internal

iliac arteriography, which revealed that the internal pudendal artery was involved in the blood supply to the hemorrhoidal region. Embolization was performed again using the same method as that used for SRA embolization. Symptoms resolved 3–5 days after surgery, and there was no rebleeding during the 3-month follow-up period.

## Discussion

HD treatment usually includes attention to personal hygiene and dietary adjustments, oral or topical drug treatments, and non-surgical minimally invasive treatment, such as rubber band ligation, infrared coagulation, and sclerosant injection [5]. However, 10% of patients still require surgical treatment, including hemorrhoidectomy with or without a stapler [6]. Due to the substantial trauma, postoperative pain and long recovery period associated with traditional surgery, developing a minimally invasive treatment for HD has become a hot research topic in recent years [7–9].

In 1995, DG-HAL was first reported by Morinaga et al. [2], which reduced hemorrhoidal prolapse, with 90% hemostatic efficacy and only 10%–15% recurrence rate [10]. Compared with conventional surgery, patients who underwent DG-HAL experienced less severe postoperative pain and the pain resolved more rapidly [11]. DG-HAL was developed on the basis of the vascular nature of hemorrhoids and the anatomy of the arterial supply of the corpus cavernosum recti from the branches of the SRA proposed by Aigner et al. [12]. Schuurman et al. found that the distal branch of the SRA is the main source of blood supply for hemorrhoids [3], and that intervention via intravascular embolization of the SRA is theoretically and technically feasible. First, the technique was evaluated in an animal model [13]; Vidal and colleagues were the first to apply the “Emborrhoid” technique in clinical practice in 2014 [14]. The SRA branches were accurately identified and embolized by intravascular technology to treat recurrent internal hemorrhoidal bleeding, avoiding rectal and anal damage. No ischemic events occurred, and satisfactory outcomes were obtained. In 2016, Zakharchenko et al. applied coils and polyvinyl alcohol (PVA) particles for embolization of the SRA and its branches to treat 40 patients with internal hemorrhoidal bleeding. The efficacy rate for the above method was 94% for stage I–II internal hemorrhoids and 83% for stage III internal hemorrhoids, and no complications such as rectal ischemic necrosis or infection occurred [15].

Embolization materials used by different research teams have not been identical, but the clinical efficacy has been similar, with no serious complications such as ischemic necrosis [13, 15–17]. Different embolization materials can produce different embolization effects. Metallic coils, gelatin sponge particles, PVA particles, and ethanol embolization

can all lead to different degrees of pain, tenesmus, fever and other discomfort, which can be relieved without treatment. In this study, postoperative discomfort dissipated in all patients by the 1 month follow-up, without drug treatment.

Vidal et al. found that the use of metallic coils alone for the embolization of arteries that supplied hemorrhoids resulted in a significant improvement in clinical symptoms in 72% of patients at the 5-month postoperative follow-up, but bleeding did not significantly improve in 28% of the patients [16, 18]. The reasons for this result may be related to factors such as the presence of variations in the feeding arteries in the hemorrhoidal region, anastomosing collateral vessels, and blood flow reconnection in coils [18].

Zakharchenko and colleagues found that no obvious complications occurred by using of PVA particles (300  $\mu\text{m}$ ) to embolize the distal branch of the SRA, and metallic coils (3–5 mm) to embolize the trunk of the SRA. Ninety percent of the patients stopped bleeding 2 days after the surgery, and 10% of the patients stopped bleeding 5–7 days after the surgery. The function of the internal and external anal sphincter of the patients was normal, and pathological examination of the rectal mucosa did not show mucosal atrophy or malnutrition after embolization [15].

The bleeding symptoms of some patients were not alleviated after applying metallic coils alone for SRA embolization, and the rebleeding rate was significantly reduced after embolization with metallic coils and PVA particles [15]. The reason for this result may be due to the presence of more collateral branch anastomoses between the middle rectal artery and the SRA. The distal end of the SRA was not embolized, and collateral circulation was rapidly established, leading to incomplete hemostasis and a high recurrence rate of bleeding. PVA particles can be used to embolize the distal hemorrhoidal plexus, avoiding the formation of collateral circulation leading to secondary bleeding.

Notably, PVA particles can be used as permanent materials to embolize the distal branch of the SRA, causing an inflammatory reaction and vascular fibrosis in the vascular wall and completely blocking the arterial supply to hemorrhoids. Anastomosis cannot be established quickly for the middle and inferior rectal arteries, increasing the theoretical risk of intestinal ischemic necrosis. However, clinical studies and animal studies did not find that PVA embolization could lead to intestinal ischemic necrosis [15, 16, 19]. Therefore, intravascular SRA embolization is required to achieve the best clinical outcome, and the types and doses of embolic agents need to be further investigated.

This study used absorbable embolic agents. If the anastomosis of the middle and inferior rectal arteries could not be compensated, the theoretical risk of rectal ischaemic necrosis was low. In addition, the price of gelatin sponges is lower than that of PVA particles. Gelatin sponge particles block the blood flow in the hemorrhoidal plexus in a short period

of time to rapidly induce thrombi. The hemostatic rate for gelatin sponge particle embolization is lower than that of combined microcoil and PVA particle embolization (92.5%) [15] and higher than that for coil alone embolization (72%) [13]. The lower hemostatic effect for gelatin sponge embolization, compared with that for PVA particle embolization in our study (84.4% vs. 92.5%), might be due to the relatively large particle diameter (350–560  $\mu\text{m}$  vs. 300  $\mu\text{m}$ ) of gelatin sponge particles selected in this study, which could not completely embolize the distal vascular bed in the hemorrhoidal area. In addition, the gelatin sponge absorption process can lead to production of body heat, which was not reported by Vidal [14]. In our study, 34.4% of patients had low fever after surgery; the highest temperature did not exceed 38.0 °C (range: 37.3–38.0 °C).

There is considerable variation in the distribution of the arterial network in the rectal submucosal area, and extensive communication exists between the distal branches of the SRA and the branches of the internal iliac artery. Whether patients with branches of the internal iliac artery involved in blood supply to the hemorrhoidal area require further blood flow blocking still lacks sufficient research evidence. For 4 patients with recurrent bleeding in this study, bleeding was stopped after embolization of the internal genital artery branch involved in blood supply to the hemorrhoidal area. Therefore, bilateral internal iliac arteriography and embolization of the internal genital arteries involved in blood supply to the hemorrhoidal area were necessary. Whether this embolization will cause ischaemic events needs to be investigated by large samples in multiple centers.

This study has certain limitations. First of all, it was a retrospective study and symptoms were not graded according to a published symptom severity scale, which implies a selection and an observer bias as well as the difficulty in comparing the current series with others. The sample size was small and the study did not include a control group, did not compare the clinical effects of embolization with gelatin sponges with different particle diameters, and did not compare the clinical effects of embolization with gelatin sponge particles and PVA particles with the same particle size. Therefore this study should only be considered as a proof of concept and its value is mainly in adding clinical data in a field where publications are scarce. All these issues should therefore be addressed by future studies.

## Conclusions

The efficacy and safety of interventional embolization of the SRA for hemochezia-based internal hemorrhoids was good, and this method is feasible and easy to perform. Further studies are needed to confirm our results.

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**Author contributions** Conceptualization: FX and WW; Methodology: FX, GC and YS; Formal analysis and investigation: ZW and MZ; Writing—original draft preparation: XH and XW; Writing—review and editing: XW; Resources: FX and XW; Supervision: WW. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

## Compliance with ethical standards

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

**Ethical approval** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

**Informed consent** For this type of study, formal consent is not required.

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