

# Arterial Embolization as a Prominent Option in the Treatment of Hemorrhoid Diseases

Rasit Dinc\*

INVAMED Medical Innovation Institute, Ankara/Turkey

\*Corresponding Author

Rasit Dinc, INVAMED Medical Innovation Institute, Turkey

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## Abstract

Hemorrhoidal disease (HD) is the most common anorectal disease, affecting millions of people worldwide. The most common clinical picture is rectal bleeding, which significantly impairs the quality of life of patients. Treatment of HD varies from diet and lifestyle changes to radical surgery, depending on the degree and severity of symptoms. Endovascular embolization of superior rectal artery (SRA), known as emborrhoid technique, has recently emerged as a promising minimally invasive approach. Because hemorrhoidal plexuses are almost entirely fed through the SRA. They are also fed less by middle rectal artery (MRA) and rarely inferior rectal artery (IRA). Due to some anastomoses and unpredictable variations, vascular structures must be examined before the procedure. So far, there have been reports of studies involving a small number of patients regarding the use of coils and particles as embolization agents. Some of these used particles and coils alone, while others used a combination of particles and/or coils. The studies demonstrated similar clinical efficacy with satisfactory results, and no significant complications such as ischemic necrosis were observed. The use of liquid embolic agents such as N-butyl-cyanoacrylate (NBCA) and ethylene vinyl alcohol copolymer (EVOH) has also recently been suggested to be effective. In conclusion, the current data support the feasibility, effectiveness, and safety of rectal artery embolization for hemorrhoidal disease. However, there is no guideline or consensus in the selection of embolic materials. More randomized controlled studies are needed. This review aims to evaluate the effectiveness and feasibility of embolization applications in hemorrhoidal diseases.

**Keywords:** Hemorrhoid, Embolization, Particles, Coils, Polyvinyl Alcohol (PVA), n-Butyl Cyanoacrylate (NBCA)

## 1. Introduction

Hemorrhoidal disease (HD) is the most common anorectal disease, with a reported prevalence of 4.4-39.0% depending on various variables [1,2]. The age group with the highest incidence is between the ages of 45-65 [3]. Affecting millions of people worldwide, HD constitutes a major medical and socioeconomic issue [4]. The most common clinical picture is rectal bleeding, which causes anemia in the long term and significantly impairs the quality of life of patients. Although rectal bleeding is generally painless, the patients may experience excruciating pain in the case of thrombosis or fissure [5].

Although the disease comes to mind when hemorrhoids are mentioned, hemorrhoids are normally found in the anus of everyone from birth, in the form of blood lakes associated with small arterial and venous vessels in the lower rectum [4]. Hemorrhoid disease is defined as distal displacement and symptomatic enlargement of these blood lakes known normal as anal cushions [5]. In this article, the term hemorrhoid disease is used for pathological conditions of hemorrhoids.

Treatment of HD varies from diet and lifestyle changes to radical

surgery, depending on the degree and severity of symptoms [5]. Although only about 10% of patients require surgical treatment, adverse events associated with surgery have given impetus to new minimally invasive procedures. These procedures primarily target the hemorrhoidal plexus and ultimately reduce bleeding [3]. In this regard, Doppler-guided hemorrhoidal artery ligation (DGHAL) is a minimally invasive procedure that ligates the feeding arteries within the anal canal [6]. Clinical results showed that DGHAL provided a more favorable outcome in terms of pain and overall morbidity compared to hemorrhoidectomy [7]. More recently by Vidal et al, endovascular embolization of superior rectal artery (SRA), known as emborrhoid technique, has been introduced as a promising minimally invasive solution [8].

The purpose of this review is to evaluate the effectiveness and feasibility of embolization applications in hemorrhoid disease based on published studies.

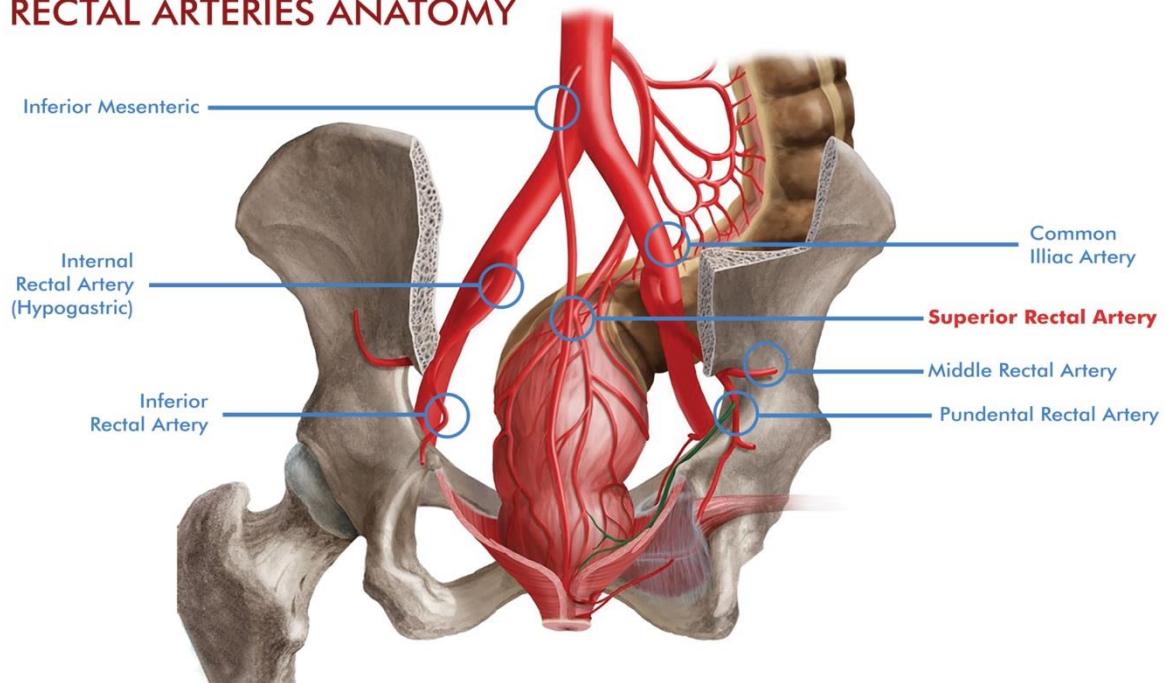
## 2. Anatomical Importance of Rectal Arteries

Hemorrhoids have a major contribution to anal continence. Development of HD is still not well known and appear to be

multifactorial [9]. To understand hemorrhoid disease and best determine the approach to its treatment, we must consider the physiology of the rectum and hemorrhoidal vascularization [1]. Corpus cavernosum recti (CCR) constitutes the functional unit of hemorrhoids [10]. Distal branches of the SRA enter the muscularis mucosa of the rectum, and some terminal branches pass directly through the corpus and fill the CCR. The corpus

presents dilated hollow spaces that communicate with each other “like a network” and are separated from each other by tough connective tissue septa, rarely muscular cells. Veins are located between these spaces and freely anastomose with each other, serving as drainage of the CCR. These veins represent the venous hemorrhoidal plexus (Figure 1) [1].

## RECTAL ARTERIES ANATOMY



**Figure 1:** Schematic illustration of arterial vascularization of hemorrhoids (adapted from ref. 4)

Accurate and detailed definition of the anatomical structure of the hemorrhoidal artery is directly related to the success of hemorrhoid embolization and the prevention of non-target embolization [4]. The hollow spaces of the CCR are feed directly by the thick-walled artery without capillaries. It acts as arterial filler, and the blood remains arterial. This is even why hemorrhoid bleeding is always bright red [1].

The rectum is supplied primarily by three major arteries: the superior rectal artery (SRA), the middle rectal wall artery (MRA), and the inferior rectal artery (IRA). The most common arterial supply of the CCR is from the SRA, which originates from the inferior mesenteric artery (IMA) [1].

The arteries supplying the hemorrhoidal plexuses arise almost entirely from the SRA, the terminal branch of the IMA, and less commonly from the MRA and IRA [4]. The IRA supplies blood primarily to the anal canal and the anus. SRA and IRA communicate with each other. However, this connection is mainly through the submucosal layer of the rectum rather than outside the wall [11].

Pannau et al. classified hemorrhoidal arterial vascularization (HAV) into three patterns that directly affect the success of hemorrhoid embolization on angiographic anatomical basis [4]. Type 1 HAV is characterized by the presence of one or more dominant the SRA without hypertrophic the MRA. Type 2 HAV, on the other hand, is characterized as hypertrophic SRA on one

side and hypertrophic MRA on the opposite side. Type 3 HAV is defined as the presence of bilateral MRA hypertrophy without SRA hypertrophy. Anatomical variations may also occur in all three types. The prevalence of type 1, 2 and 3 HAV is around 66.5%, 27% and 6.5%, respectively.

SRA supplies the entire rectum, anal canal mucosa, and internal hemorrhoidal bundles. The SRA originates from a single trunk and then divides into right and left branches, each of which has an anterior branch and a posterior branch. Hemorrhoidal plexuses are supplied by the terminal ends of the SRA at the level of the anorectal junction [4]. IRA originates from the internal iliac artery (IIA). It offers various differences in its origin and path. The MRA may originate from different arteries such as IIA, internal pudendal artery, inferior gluteal artery. The variances of the MRA may be seen not only in its origin but also in its path [12]. In most cases, vascularization of the hemorrhoidal plexus comes from the SRA. However, in addition to the SRA, the nutrition of the hemorrhoidal plexus is provided by up to 36% from unilateral MRA and up to 12% from bilateral MRA. Blood supply from IRA is less common [13]. In order to choose the most effective embolization procedure and material, it is very important to examine the arterial structure in detail to reveal different vascularization structures, anastomoses and unpredictable variations. For example, sometimes clinical relapse may occur despite the technical success of complete SRA occlusion. When angiographic examination is performed, it can be understood that this is caused by MRAs feeding the corpus

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cavernosum. Even though it is a rare case, it can be revealed through such examinations that HD formation occurs through IRA [4]. The importance of the essential role of arteries other than the SRA in CCR perfusion can be supported by detailed vascular examination [1].

### 3. Management of Hemorrhoid Patient

In most patients, the disease is self-limiting [14]. In the remaining patients, hemorrhoid problems are generally manageable without the need for any surgical intervention. The first stage recommended is conservative medical treatments such as hygiene, lifestyle and dietary modifications. If these are inadequate, topical treatments and oral venotonic treatment can be applied. In the event of failure of these first-line treatment approaches, elastic band ligation often appears to be helpful as a nonsurgical treatment. The last part of symptomatic hemorrhoidal disease before surgical options is embolization of the rectal arteries [4]. Approximately 40% of hemorrhoid patients are asymptomatic. In symptomatic cases, it is important to take a detailed patient history to determine the treatment approach. This history should include the extent, severity and duration of symptoms; associated symptoms such as fecal incontinence and constipation; daily eating habits; defecation details such as bowel movement frequency, stool appearance, and time spent during each defecation [14]. Pre-embolization CT angiography may help identify arterial anatomy and ultimately facilitate reduction of procedure time and radiation exposure and selection of the best arterial access site [4]. To determine the severity of bleeding symptoms, a hemorrhoidal bleeding score ranging from 0 to 9 is used. 0 indicates that the severity of bleeding symptoms was not assessed, and 9 indicates daily bleeding with anemia, requiring blood transfusion [15]. The degree of internal prolapse is determined by the Goligher classification, ranging from I (no prolapse) to IV (irreducible prolapse) [16].

A visual analog scale can be used to measure pain levels. A short-form health assessment questionnaire with 36 items can be used to evaluate the impact of chronic hemorrhoidal disease on the patient's daily life [17]. Patients with stage II-III prolapse are the best candidates for hemorrhoid embolization. Additionally,

patients with stage I whose predominant symptoms are hemorrhagic and patients with stage IV prolapse with surgical contraindications may also be evaluated for embolization. Anorectal cancer is a contraindication for embolization, and renal failure and iodine allergy are contraindications for angiography. Advanced atherosclerosis is a relative contraindication as it could lead to technical failure [4].

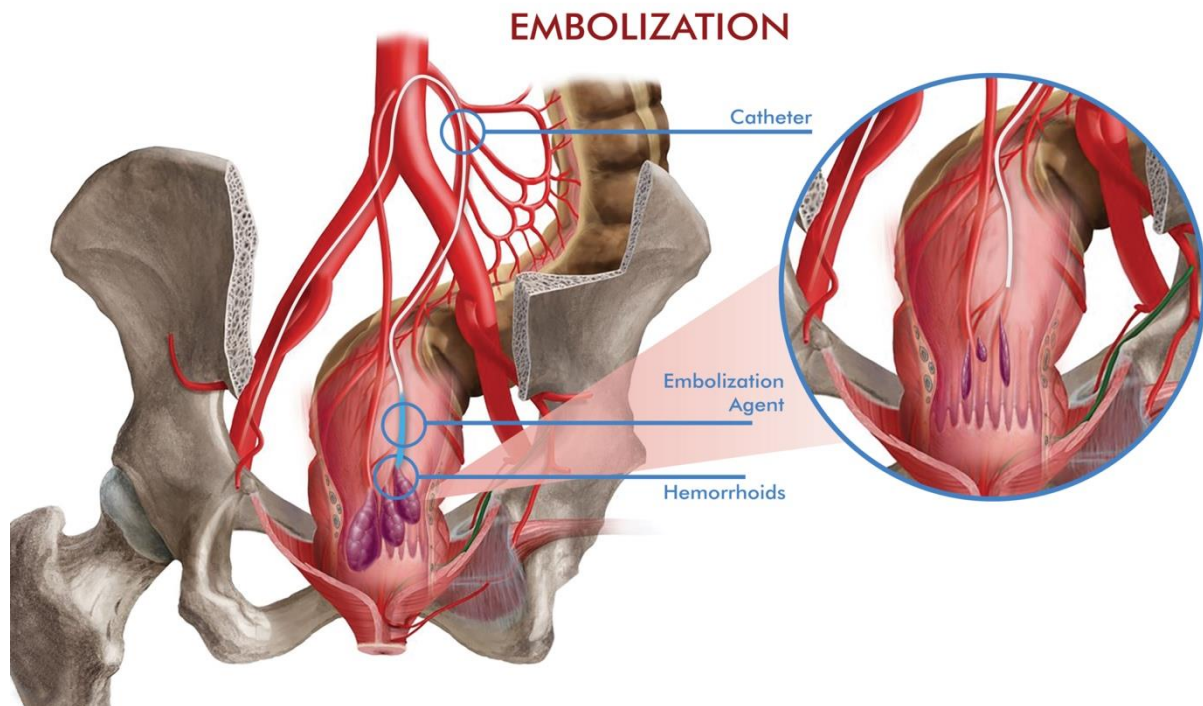
### 4. Embolizing Agents

In HD, there is an increase in hemorrhoidal blood flow secondary to increased SRA and MRA flow as well as pressure in the corpus cavernosum recti [3]. It has been observed that ligation of the terminal branches of the SRA with the DGHAL method reduces the arterial supply of the hemorrhoid plexus and is ultimately effective in reducing the short- and long-term HD clinic outcomes [18]. However, complications such as anal sphincter trauma, pain and infections may occur in DGHAL [5].

Embolization methods (figure 2), known as the emborroid technique, offer the same advantages as DGHAL. Moreover, it provides complete visualization of anastomoses with SRA, MRA and IRA [8]. This endovascular technique, may be performed by femoral or radial placement of the catheter, can also preserve anal tone without causing direct anorectal trauma and requires minimal local wound care [19,20].

In the femoral artery access, hemorrhoid embolization technique does not require any medication or special bowel preparation before or during surgery. However, when the transradial approach is used, which may provide a greater patient satisfaction, a combination of 200 µg nitroglycerin, 2.5 mg verapamil and 2000 IU heparin is administered to decrease the risk of thrombosis and prevent vasospasm [4].

Patients are discharged on the same day. Since hemorrhoid embolization is not a painful procedure, oral hydration is usually sufficient after the procedure. Non-opioid painkillers are given when necessary. Although rare, complications such as hematoma, infection and pseudoaneurysm may occur at the entry site [4].



**Figure 2:** Schematic demonstration of arterial embolization. A. application of embolization, B. decreasing in size of hemorrhoids (adapted from ref. 16)

Hemorrhoidal diseases are thought to result primarily from an increase in arterial blood flow from the SRA to the hemorrhoidal cushion [21]. Among the various embolization agents, the ones reported for use in the emborrhoid technique are mainly coils and particles [1]. Of the coils, those with a diameter of 2 or 3 mm are usually used to occlude all branches of the SRA above the pubic symphysis. However, in case of distally located SRA/MRA anastomosis, these coils cannot guarantee correct devascularization [22]. The logic of particle application is to provide embolization at the level of the hemorrhoidal plexus, more distal to the pubic symphysis. It is hypothesized that 300  $\mu\text{m}$  polyvinyl alcohol (PVA) particles will provide ischemia closer to the hemorrhoidal plexus and, possibly more importantly, embolization of anastomotic branches with the MRA and IRA. The use of particles also solves the problem of recanalization in the use of coils [19,22]. Another particulate

agent used is tris-acryl gelatin particles (TAGp). However, these studies do not yet provide sufficient data regarding the rationale for the use of TAGp and the most suitable particle diameters [19,20,23,24]. Another approach to achieve distal embolization is the combined use of particles and coils [22].

Based on their success in neurological and peripheral embolization, the use of liquid embolic agents such as N-butyl-cyanoacrylate (NBCA) and ethylene vinyl alcohol copolymer (EVOH) has recently been hypothesized to solve the problem of distal embolization in HD [21]. Although there are no case series in the literature yet, we consider these speculations about liquid agents reasonable based on our previous studies [25,26]. In this context, DuoTEN Embolization Agent (Figure 3) is a new product developed by our company (Invamed, Turkey) for HD treatment.



**Figure 3:** Ready-to-use DuoTEN Embolization Agent product containing N-butyl-cyanoacrylate (Invamed, Turkey).

### 5. Evaluations on Outcome of Hemorrhoid Embolization

Current studies show that hemorrhoid treatment may be an effective, safe and feasible alternative. However, current data are still insufficient to reach consensus on HD management [2,8,21,22,24,27-29]. In the studies, success evaluation was generally made on technical and clinical basis. Technical success in embolization treatment is defined as occlusion of all visible branches of the superior rectal artery above the pubic ramus. Clinical success was defined as improvement in clinical scores after embolization (at least 2 points for the French bleeding score) without any complications [21]. Absence of distal SRA branch flow and absence of opacification of terminal branches

in the hemorrhoid projection were defined as embolization endpoints [3].

As summarized in Table 1, studies reported immediate technical success between 93% and 100% and clinical success between 63% and 94%. The main cause of clinical failure is recurrence of bleeding and is treated with secondary procedures when necessary. Treatment failure may be largely due to the presence of the MRA, even if the SRA embolization is complete. No major complications have been reported, although minor complications have been observed in some studies.

Study ref. (n)	Embolizing Agent	Goligher's Grade	Clinical Success (%)	Technical Success (%)
[8] (14)	Coils	II-IV	72	100
[22] (40)	Coils+PVA	II-III	94 (for grade-III) 83 (for grade-I or II)	100
[21] (30)	Coils	I-IV	72	93
[29] (25)	Coils	II-III	72	96
[23] (33)	TAGp	II-III	97	100
[19] (38)	Coils	II-III	63	
	Coils+TAGp		68	100
[24] (42)	TAGp	I-IV	93	100
[2] (41) *	Coils+gelfoam particles	II-III	87	100
	Coils+microparticles		89	

\* Two groups: Coils+gelfoam particles and Coils+microparticles, PVA: polyvinyl alcohol

**Table 1. Evaluations on some selected hemorrhoid embolization studies.**

Zakharchenko et al. observed the clinical success rate as 83% in patients with Goligher's score III and 94% in patients with the score I-II [22]. Musa et al. and Tradi et al. stated that vasospasm

occurred during application in patients with technical failure [19,29].

Kucukay et al. reported some minor complications in the application area, such as small-sized ulcerations and small fibrotic scar tissue [24]. Moussa et al. 15% of patients experienced complications, including mild pain and bleeding. However, these patients recovered with supportive treatment approximately three days after embolization [29]. Importantly, there have been no reports of sphincter dysfunction to date [4]. In the evaluation of the study conducted by Musa et al., the French bleeding score, quality of life, general symptom score and prolapse score values increased from 7, 12, 2, 4 before treatment to 4, 6, 2, 2 after embolization treatment, respectively [21].

## 6. Discussion and Conclusion

Blocking the artery that feeds the hemorrhoid is the key to successful endovascular treatment. Transmural branches of the SRA play a crucial role in the arterial blood supply of the CCR. In this regard, many researchers have applied a series of endovascular treatments based on the vascular nature and anatomy of hemorrhoids [2,8,21,22,24,27-29].

The various SRA embolizing agents used in the studies demonstrated similar clinical efficacy with satisfactory results, and no significant complications such as ischemic necrosis were observed [2,30]. Coils have the advantage of precisely controllable embolization at the bleeding site. However, it is often difficult to completely occlude the hemorrhoidal plexus with coils because they lack the ability to reach deep into the hemorrhoidal vascular bed [29]. There is no guideline or consensus in the selection of embolic materials. This choice generally depends on the operator's preference in the current circumstances [2].

Chronic hemorrhoidal disease remains an important health problem that significantly affects the quality of life all over the world. Available data support the feasibility, effectiveness, and safety of rectal artery embolization for hemorrhoidal disease, with high technical and significant clinical success rates. Major complications have not been reported so far. Study data is currently available on the use of particles and coils. Studies are ongoing to increase clinical success, including combinations of the two. More randomized controlled studies are needed to further demonstrate the role of embolization in hemorrhoid diseases and to help select patients who will benefit most from this procedure.

## Limitation of the Study

This study has some limitations. Firstly, the studies evaluating the traditional therapies and embolization methods used in the treatment of hemorrhoidal diseases in detail to date are limited. Secondly, the sample sizes in the studies are quite small and are insufficient to compare in detail the effects of different types of embolic agents as well as the same type of agents with different properties. Lastly, this study is also a traditional review type, not a systematic review and meta-analysis.

## Acknowledgement

Not applicable.

## Statement of Ethics

This manuscript, which is a review article, does not include studies with human or animal participants.

## Conflicts of Interest Statement

RD is the president of Invamed (Ankara, Turkey). AFA has no conflict of interest.

## Authors' Contributions

RD conceptualized, designed, searched for data, wrote and finalized.

## Data Availability Statement

The authors confirm that data supporting the findings of this study are available in the article.

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