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Minimally Invasive Treatment of Advanced Hemorrhoids and Ultrasound Imaging of Hemorrhoids

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Review Article

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Abrreviations: ALTA: Aluminum Potassium Sulfate and Tannic Acid; THD: Transanal Hemorrhoidal Dearterialization; DGHAL: Doppler-Guided Hemorrhoidal Artery Ligation; RAR: Recto-Anal Repair; ACL: Anal Cushion Lifting

ABSTRACT

This review discusses the physiology, current non-operative and operative treatments and ultrasound imaging of hemorrhoids. Hemorrhoids are defined as the symptomatic enlargement and distal displacement of the normal anal cushions. The most common symptom is painless fresh rectal bleeding, but patients may also experience pruritus, swelling, prolapse, discharge, or soiling. The current patho-physiologies of hemorrhoids include the degenerative change of supportive tissue within the anal cushions, vascular hyperplasia, and hyper perfusion of the hemorrhoidal plexus. On the one hand hemorrhoidectomy has been the mainstay of surgical treatment, while more recently other approaches have been employed including stapled hemorrhoidopexy and Doppler-guided hemorrhoidal artery ligation (DGHAL). In Japan, on the other hand aluminum potassium sulfate and tannic acid (ALTA) sclerotherapy has been the mainstay for all Goligher grade internal hemorrhoids as a minimally invasive non-operative treatment since 2000. As well, ultrasound imaging of hemorrhoids is improving and useful for the evaluation of treatment.

CORE TIP

The current patho-physiologies of hemorrhoids include the degenerative change of supportive tissue within the anal cushions, vascular hyperplasia, and hyper perfusion of the hemorrhoidal plexus. On the one hand hemorrhoidectomy has been the mainstay of surgical treatment, while more recently other approaches have been employed including stapled hemorrhoidopexy and Doppler-guided hemorrhoidal artery ligation. In Japan, on the other hand aluminum potassium sulfate and tannic acid sclerotherapy has been the mainstay for all Goligher grade internal hemorrhoids as a minimally invasive non-operative treatment since 2000. As well, ultrasound imaging of hemorrhoids is improving and useful for the evaluation of treatment.

INTRODUCTION

Hemorrhoids are the most common ano-rectal disease. When hemorrhoidal tissue gives rise to symptoms such as bleeding, prolapse, or pruritus, one can employ the term “hemorrhoidal disease” [1]. Prolapsing internal hemorrhoids are classified into four

degrees under Goligher classification, which grades hemorrhoids from I to IV according on their severity. First-degree haemorrhoids (grade I): The anal cushions bleed but do not prolapse; Second-degree haemorrhoids (grade II): The anal cushions prolapse through the anus on straining but reduce spontaneously; Third-degree haemorrhoids (grade III): The anal cushions prolapse through the anus on straining or exertion and require manual replacement into the anal canal; and Fourth-degree haemorrhoids (grade IV): The prolapse stays out at all times and is irreducible. Acutely thrombosed incarcerated internal haemorrhoids and incarcerated, thrombosed haemorrhoid involving circumferential rectal mucosal prolapse are also fourth-degree haemorrhoids [2].

The true prevalence of hemorrhoids in the general population is unknown and probably differs from country to country [3]. Recently, it has been reported from Austria that 39% of the adult general population had hemorrhoids and about half of them were symptomatic [4].

The etiology is still controversial. The cause is multifactorial and includes prolonged straining, irregular bowel habit and heredity. Supporting connective tissue degenerates and the hemorrhoidal cushions slide as a consequence. Microscopically, hemorrhoids are sinusoids (vascular structures without a muscular wall) [5].

Although conservative treatment based on dietary and lifestyle changes can help the majority of patients, and rubber band ligation, sclerotherapy and phlebotonic drugs can effectively treat grade I and II hemorrhoids, surgery is required for the most advanced stages. Conventional hemorrhoidectomy is considered to be the gold-standard approach for grade IV hemorrhoids [6].

Since hemorrhoidectomy is associated with intense post-operative pain and may cause serious complications, such as anal stricture and fecal incontinence, the current treatment of hemorrhoids is moving towards non-operative approaches and non-excisional surgical techniques [7].

This article firstly reviewed the patho-physiology and other clinical backgrounds of hemorrhoidal disease, followed by the current approaches to non-operative and operative management. Finally, current hemorrhoidal ultrasound imaging is reviewed.

MODERN PATHO-PHYSIOLOGY OF HEMORRHOIDS

Hemorrhoidal vascularization appears to play a central role in the patho-physiology of hemorrhoidal disease. Hyperplasia of the arterio-venous network within the ano-rectal sub-mucosa, that is, the corpus cavernosum recti (CCR), results in increased vascular pressure. Ratto and colleagues reported that 2D Doppler ultrasound allowed the identification of hemorrhoidal arteries related to the rectal wall layers and the calculation of arterial depth [8]. Schuurman et al. investigated the inner wall of the distal rectum and its relationship to the superior rectal artery in their study into the anatomy of cadavers [9]. About 2 to 3 cm above the dentate line, twisting arteries of a maximum diameter of 2 mm were seen to emerge towards the mucosal surface. These continued in the sub mucosa down to the dentate line where they diverged into smaller branches to form, to some degree, a plexus in the CCR area. In recent study, the hemorrhoidal plexus, or CCR, was shown in the sub mucosal layer of the anal canal in a 3D-power Doppler angiography image by trans-anal ultra-sonography [10].

It is remarkable that Mile's description of three terminal branches from the superior rectal artery (SRA), two rights and one left that correspond to the distribution of the anal cushion should be accepted, without evidence, as others so often disagree. Several anatomical studies have investigated the arterial blood supply to the rectum and the distribution patterns of the different rectal arteries and their frequencies [11]. Thomson et al. reported that the distribution of SRA terminal branches varies widely in both number and position [12]. An average of five (5) branches (a range from one (1) to eight (8)) reaches the hemorrhoidal zone. Ratto et al. reported that under Doppler guidance an arterial signal was found at 6 to 7 cm from the anal verge at 1, 3, 5, 7, 9 and 11 o'clock of the rectal circumference [13]. Elmer et al. similarly reported six (6) terminal branches of the SRA (located at 1, 3, 5, 7, 9 and 11 o'clock of the rectal circumference) were identified and ligated by trans-anal hemorrhoidal de-arterialization (THD) [14]. Toh et al. reported that the medial number of hemorrhoidal arteries was four (4) and the hemorrhoidal artery was recognized positioned in 58.6 % of cases at 1 o'clock of the rectal circumference [15].

Based on trans-perineal color Doppler studies, Aigner et al. demonstrated that increased caliber and arterial blood flow of the terminal branches of the artery were correlated with the appearance of hemorrhoids [16]. By trans-anal power Doppler ultra-sonography, blood flow significantly increased following the growth of the hemorrhoid [10].

MINIMALLY INVASIVE MODERN TREATMENT OF GRADE III OR IV HEMORRHOIDS

While some surgical techniques address the reduction of arterial inflow to hemorrhoids, the treatment of hemorrhoids has moved away from excisional techniques to less traumatic procedures. Recently, hemorrhoidal disease has often been treated using non-excisional procedures. Traditional hemorrhoidectomy is painful and with the development of technology alternative procedures are now available. Minimally invasive techniques for the treatment of hemorrhoids aim to minimize the post-operative pain normally associated with conventional hemorrhoidectomy. In general, they avoid an open wound.

The management of grade III hemorrhoids is controversial. An increasing number of minimally invasive treatment options, including mucopexy with or without mucosal resection and hemorrhoid artery ligation, have now been proposed for the management of grade III hemorrhoids. These approaches aim to correct the underlying patho-physiological mechanisms involved

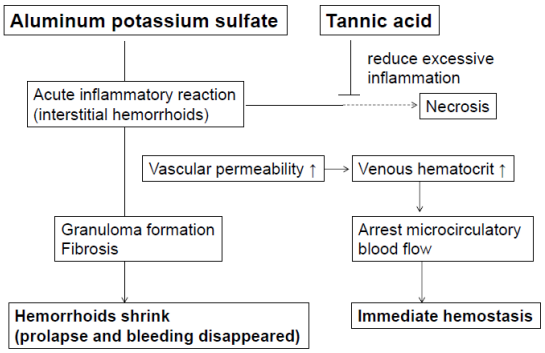
in the aetiology of hemorrhoids. An increased risk of recurrence is the price to pay for these minimally invasive and less painful treatments, but the sparing of the sensitive anoderm and a rapid return to normal life without pain are greatly appreciated by patients [17].

Since 2000, aluminum potassium sulfate and tannic acid (ALTA) sclerotherapy has been frequently performed for internal hemorrhoids as a minimally invasive treatment in Japan [18-21]. ALTA sclerotherapy for all Goligher grade internal hemorrhoids has been performed in over three hundred thousand (300,000) cases in Japan since the year 2000.

ALTA sclerotherapy

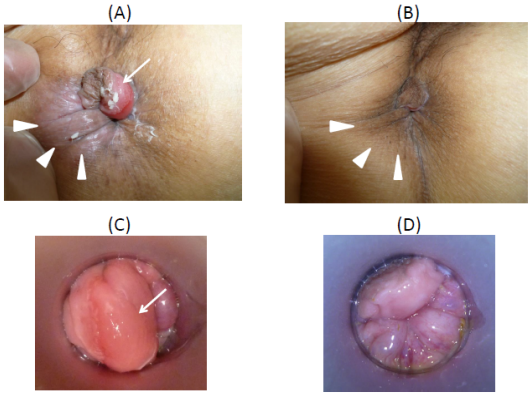
Sclerotherapy has been currently recommended as a treatment option for first (I) and second (II) degree hemorrhoids. However, ALTA is a new promising sclerosant. ALTA is different from past sclerosants and might be able to cure third (III) or fourth (IV) degree hemorrhoids [20].

ALTA is used to reduce the inflow and induce persistent fibrosis, and promote the adhesion and fixation of mucosal and sub mucosal layers to the muscular layer, leading to non-invasive sclerosis and involution of the hemorrhoid [22,23]. **Figure 1** showed action mechanism of ALTA.



ALTA compounds with aluminum potassium sulfate and tannic acid. The aluminum ion induces a strong local inflammatory reaction, resulting in fibrosis. Tannic acid has a strong astringent effect on tissue, promoting protein coagulation and the contraction of blood vessel, while reducing exudation into tissue from the inflammatory reaction. These actions tend to prevent tissue necrosis, and promote scrolosis and adhesion of hemorrhoidal tissue and immediate hemostasis.

Figure 1. "Action mechanism of ALTA."



Inspection: Before (A) and After (B)
Prolapsed haemorrhoid (white arrow) disappeared and perianal dermatitis (white arrow head) improved.
Anoscopic findings: Before (C) and After (D)
Prolapsed haemorrhoid (white arrow) disappeared.

Figure 2. "Effect of ALTA sclerotherapy."

ALTA sclerotherapy is an out-patient based treatment under local anesthesia. Furthermore, the clinical results of the ALTA sclerotherapy are very promising. Grade IV prolapsed internal hemorrhoids disappeared immediately after ALTA sclerotherapy. Perianal dermatitis also improved **(Figure 2).** No evidence of recurrence has been for two years after ALTA sclerotherapy.

In a recent study, ALTA sclerotherapy is proposed as an effective treatment of third (III) degree hemorrhoids. ALTA sclerotherapy for six hundred and three (603) patients, (Goligher grade II one hundred and sixty-nine (169) and grade III four hundred and thirty-five (435)), had a high success rate for Grade II (90%) and III (80%) haemorrhoids during five (5) years post treatment [23]. No serious or life-threatening complications occurred and all cases improved through conservative treatment [24]. ALTA sclerotherapy had little serious complications, especially no delayed hemorrhage requiring an operation. Yano et al reported that the presence

or absence of anti-thrombotic treatment did not affect the efficacy rate or the occurrence of complications, including delayed hemorrhage, with ALTA sclerotherapy [25].

ALTA sclerotherapy has proved to be a less invasive procedure for internal hemorrhoids and most of the patients were satisfied with this treatment [26]. The visual analogue scale (VAS) score after ALTA sclerotherapy was 1.7 on day one (1) post-operatively [18]. It was reported that the VAS score on day one (1) post-operatively after stapled hemorhoidopexy and THD was 5.1 and 3.1 respectively [1].

Moreover, the cost/effectiveness of this sclerotherapy is very high. The cost of ALTA sclerotherapy is very cheap. The price of ALTA sclerosant is about 5000 ($ 40, € 35, £ 30) per one (1) vial. One operation needs one (1) to two (2) vials. Beside disposable syringe and needle, this sclerotherapy doesn't have to use the disposable equipment.

Doppler guided haemorrhoidal arterial ligation (DGHAL) with recto-anal-repair (RAR)

Instead of excising the haemorrhoid, the procedure aims to reduce its size by ligation of the supplying arteries and to restore the anatomical position of prolapsed mucosa. DGHAL and stapled hemorrhoidopexy aim to correct the patho-physiology of hemorrhoids by reducing blood flow to the anal canal (de-arterialization) and eliminating ano-rectal mucosal prolapse (reposition), respectively.

DGHAL was originally indicated for grade II hemorrhoids and it had encouraging short-term results with low levels of post-operative morbidity at thirty (30) days [27]. A further development of this technique enabled the addition of a mucopexy through a modified anoscope, making it possible to both reduce the blood flow to the anal cushions as well as their lifting and fixation in the high anal canal. This new method, termed THD, was successfully applied to grade III haemorrhoids and reported good results even in the medium term (one (1) to five (5) years) and a 12-27% recurrence rate [28,29]. DGHAL for grade II to IV hemorrhoids reported good results and a 90.7% overall success rate [30]. A systematic review including twenty-eight (28) studies and a total of two thousand, nine hundred and four (2904) patients reported a pooled recurrence rate of 17.5% (of note, some grade IV hemorrhoids were also included); a postoperative bleeding rate of 5%; and a re-intervention rate of 6.4% [31]. This technique has now been recognized by NICE [32].

However, Pucher et al. reported that future trials must also include of cost/effectiveness analysis [31]. Hemorrhoid surgery is common with over 61000 procedures being carried out in the NHS in the UK per year. This is associated with significant cost including the cost of the disposable equipment which alone is approximately £ 500 per operation for PPH. In contrast, DGHAL disposables have been estimated at £ 420 per operation, whilst for Milligan-Morgan hemorrhoidectomy (MMH) this is markedly lower [33].

Rubber band ligation

Rubber band ligation technique is less painful but it may not be as effective for the more advanced grades of hemorrhoids.

Rubber band ligation is used for stage II and III hemorrhoids. Its efficacy is around 75% in stage II and 66% in stage III [34]. The rubber band ligature is placed under limited vision, near the dentate line leaving hemorrhoidal arteries un-ligatured, resulting in a high probability of recurrence [35].

Most large trials and a meta-analysis suggest that rubber band ligation is the most effective outpatient treatment for hemorrhoids, with some authors suggesting that up to 80% of patients are satisfied with the short term outcome [6,36].

Anal cushion lifting (ACL)

This procedure, the ACL method, is a new non resection approach to advanced hemorrhoids [37]. Instead of excising the haemorrhoid, the procedure aims to undermine an anal cushion around the anal ring and to restore the anatomical position of the prolapsed mucosa. Restoration is achieved by suturing the cranial side and middle portion of the undermined anal cushion to the internal sphincter muscles. The recurrence rate is 2.4% (3/126) during the median follow up to a period of twenty-six (26) months. There is no post-anal stricture and no severe complication.

If the congesting effect of a tight anal canal can be abolished, then the anal cushions will return to their normal state and symptoms will be prevented without the necessity to remove the cushions themselves [38].

Stapled haemorrhoidopexy (SH) and stapled transanal rectal resection (STARR)

The SH and STARR are widely operations for the management of haemorrhoids and obstructed defecation [39]. A circular stapling device is used to excise a ring of redundant rectal mucosa proximal to haemorrhoids and resuspend the haemorrhoids back within the anal canal [17]. SH does not damage the sensitive epithelium of the haemorrhoids [17]. Burch et al. reported that compared with conventional haemorrhoidectomy, SH resulted in less postoperative pain, shorter operating time, a shorter hospital stay, and a shorter convalescence, but a higher rate of prolapse and reintervention for prolapse [40].

The STARR was also demonstrated to successfully cure the association of rectal prolapse and rectocele by using two staplers [41]. Zanella et al. reported that STARR procedure leads to a lower incidence of complications and recurrences and should be considered for patients with grade III or IV haemorrhoids [42].

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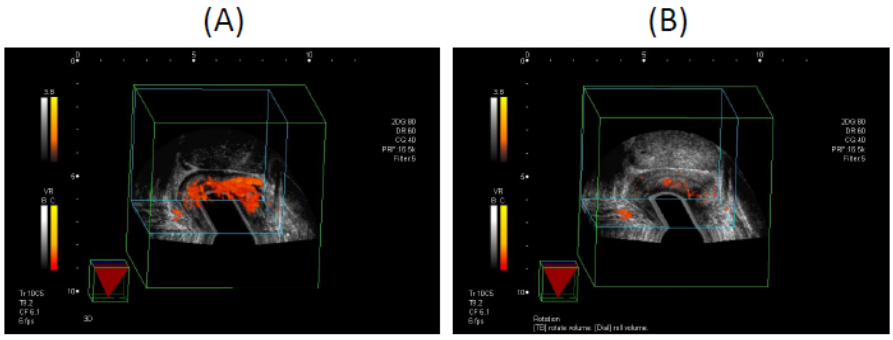
The SH should be applied only to circumferential grade III haemorrhoids when associated with a rectal internal mucosal prolapse, and performed by well-trained surgeons, as the occurrence of severe complications. Complications after SH and STARR are not infrequent and may be difficult to manage [39].

ULTRASOUND IMAGING

Visualization of the anal cushions in the undisturbed anal canal was first suggested using trans-vaginal endo-sonography by Sultan et al. with discrete measurement of the hemorrhoidal-bearing area by Nicholls et al. who recently showed, using this technique, a reduction in the measurable canal: cushion ratio in patients presenting with idiopathic incontinence [43,44].

Trans-perineal ultrasound showed marked differences between normals and patients with symptomatic hemorrhoids. There was a significant difference between pre- and post-operative cases with cushion areas of normal patients being significantly lower than post-operative cases [45]. 2D Doppler ultrasound allows in-vivo assessment of tumor vascularization, which in turns reflects tumor angiogenesis [46]. Miyamoto et al. re-purposed this technique, 2D Doppler ultrasound, to the assessment of blood flow in hemorrhoidal tissue treated by ALTA sclerotherapy [47]. Measurements of the power Doppler imaging (PDI) area were made using the cursor to outline the power Doppler signal of the hemorrhoid lesion, approximately 1 cm above the dentate line. After the Doppler guided ALTA sclerotherapy, the PDI-area drastically decreased. Cured cases, determined by clinical and ano-scopic examination, continued to show decreased PDI-areas. The PDI-area might be a useful imaging bio-marker to assess responses to treatments of internal hemorrhoids.

Furthermore, three-dimensional (3D) ultra-sonography and power Doppler angiography have been introduced as new sonographic diagnostic tools. This technology allows the acquisition of endometrial volume data and the evaluation of the vascularity of the entire endometrium using 3D power Doppler mapping [46]. Miyamoto et al. applied this technology to the evaluation of hemorrhoids [47]. The blood flow in the hemorrhoid significantly decreased after ALTA sclerotherapy **(Figure 3).**



The blood flow in hemorrhoidal tissue visualized by 3D-power Doppler angiography disappeared after ALTA sclerotherapy.
Before (A) and After (B)

Figure 3. "3D-power Doppler angiography."

CONCLUSION

Treatment of hemorrhoids ranges from dietary and lifestyle modification to radical surgery, depending on the degree and severity of symptoms **(Table 1).** The current treatment of hemorrhoids is now moving towards non-operative approaches and non-excisional surgical technique. ALTA sclerotherapy is especially promising as a minimally invasive and office-based procedure for grade III hemorrhoids. Hence, improvements in our understanding of the patho-physiology and ultrasound imaging of hemorrhoids are needed to prompt the development of novel and innovative methods for the treatment of hemorrhoids.

Table 1. "Current management of internal hemorrhoids by grade."

	grade I	grade II	grade III	grade IV
Dietary and Lifestyle Modification	○	○	○	○
Medication	○	○		
Sclerotherapy	○	○		
ALTA sclerotherapy	○	○	○	
Rubber Band Ligation	○	○		
DGHAL±RAR, THD		○	○	○
Stapled Hemorrhoidopexy			○	○
Hemorrhoidectomy		○	○	○

○: Applicable; DGHAL: Doppler-Guided Hemorrhoidal Artery Ligation; RAR: Recto-Anal Repair; THD: Transanal Hemorrhoidal Dearterialization; ALTA: Aluminum Potassium Sulfate and Tannic Acid

CONFLICT OF INTEREST

None

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