The Vascular Nature of Hemorrhoids

Felix Aigner, M.D., Gerd Bodner, M.D., Hannes Gruber, M.D., Friedrich Conrad, M.D., Helga Fritsch, M.D., Raimund Margreiter, M.D., Hugo Bonatti, M.D., Ph.D.

The arterial blood supply of the internal hemorrhoidal plexus is commonly believed to be associated with the pathogenesis of hemorrhoids. Ultrasound-supported proctoscopic techniques with Doppler-guided ligature of submucosal rectal arteries have been introduced for the therapy of hemorrhoids. The present investigation focuses on caliber and flow changes of the terminal branches of the superior rectal artery (SRA) supplying the corpus cavernosum recti (CCR) in patients with hemorrhoids. Forty-one outpatients (17 female, 24 male; mean age 48 years) with hemorrhoids of Goligher grades I–IV were compared with 17 healthy volunteers (nine female, eight male; mean age 29 years) by means of transperineal color Doppler ultrasound. The mean caliber of the arterial branches in the study group with hemorrhoids was 1.87 ± 0.68 mm (range, 0.6 to 3.60 mm) and 0.92 ± 0.15 mm (range, 0.6 to 1.2 mm) in the control group ($P < 0.001$). The arterial blood flow was significantly higher in patients with hemorrhoids than in the control group (mean 33.9 vs. 11.9 cm/second, $P < 0.01$). Our findings demonstrate that increased caliber and arterial blood flow of the terminal branches of the SRA are correlated with the appearance of hemorrhoids. We suggest that the hypervascularization of the anorectum contributes to the growth of hemorrhoids rather than being a consequence of hemorrhoids. Transperineal color Doppler ultrasound (CDUS) is an appropriate method to assess these findings in patients with hemorrhoids. (J GASTROINTEST SURG 2006;10:1044–1050)

KEY WORDS: Hemorrhoids, color Doppler ultrasound, caliber, arterial blood flow, corpus cavernosum recti

Clinical-anatomical studies of the anorectal region support the various hypotheses on the pathogenesis of hemorrhoids.[1–5] The role of vascular hyperplasia, muscle tone, and tissue elasticity in the development of hemorrhoidal cushions is still controversially discussed. However, it is difficult to measure each of these contributing factors separately because they form an undistinguishable unity in clinically apparent hemorrhoids.[6]

Several studies have already demonstrated changes in anal physiology by determining, before and after hemorrhoidectomy, the anal resting pressure in patients with hemorrhoids. Overactivity of the internal anal sphincter muscle in patients with hemorrhoids is believed to be a consequence rather than a primary cause for the development of symptomatic hemorrhoids.[7–10] On the other hand, hyperplasia of the arteriovenous network within the anorectal submucosa (corpus cavernosum recti [CCR])[11] results in an increased vascular pressure within hemorrhoids that might account for the increased anal resting tone.[12] The link between increased muscular pressure and vascular hyperplasia has not been proven, however.

Traditional therapeutic strategies focused on resection of the dilated blood vessels with the covering anoderm (Milligan-Morgan,[2] Parks[13]) and ligature of the main supplying blood vessels. In contrast, newer techniques either aim to reduce the vascularity of hemorrhoidal tissue,[14,15] or aim for permanent reposition of the prolapsed hemorrhoidal tissue and amelioration of the venous drainage, rather than reduction of the arterial inflow, by clipping rectal mucosa and submucosa.[16] These modern techniques (e.g., hemorrhoidal artery ligation [HAL][14]) and the stapled hemorrhoidopexy (Longo procedure[16]) are increasingly accepted by clinicians. Nevertheless, the anatomical background of these procedures is not fully elucidated.

We have recently shown that transmural branches of the superior rectal artery (SRA) play a crucial role in the arterial blood supply of the CCR.[17] By means of standardized transperineal ultrasonography, the

From the Departments of General and Transplant Surgery (F.A., F.C., R.M.), Radiology I (G.B., H.G.), and the Division of Anatomy, Histology and Embryology (H.F.), Innsbruck Medical University, Innsbruck, Austria; and Department of Surgery, Mayo Clinic (H.B.), Jacksonville, Florida.

Reprint requests: Hugo Bonatti, M.D., Ph.D., Department of Surgery, Mayo Clinic, 4500 San Pablo Road, Jacksonville, FL. e-mail: Bonatti.Hugo@mayo.edu

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vascularity of the CCR and the rectal wall can be well visualized, thus enabling a precise assessment of the blood supply of the distal anorectum before planning the surgical technique.[18]

The aim of this investigation was to determine morphological and physiological alterations of the terminal branches of the SRA in patients with various grades of hemorrhoids by means of transperineal color Doppler ultrasound (CDUS). In addition to previous studies,[19] we performed measurements of the caliber of the terminal branches of the SRA and the arterial blood flow associated with hemorrhoids. The outcome in the patient group undergoing stapled hemorrhoidopexy was analyzed with regard to the arterial blood supply of the CCR before and after the procedure.

PATIENTS AND METHODS

Forty-one outpatients (17 female, 24 male; mean age, 48 ± 12 years) with symptomatic hemorrhoids of Goligher grades I–IV[3] of several years duration (mean, 6.8 years), who were treated at the Department of General and Transplant Surgery, Innsbruck Medical University, Innsbruck, Austria were included in this study. The medical history of all the patients was carefully studied, and all patients underwent inspection, digital exploration, proctoscopy, and transperineal CDUS before intervention. Clinical symptoms of these patients according to the grade of hemorrhoids are listed in the Table 1.

Therapy was adapted according to the individual grade, including conservative treatment for grade I, rubber band (Barron) ligature for symptomatic grade II, and HAL, stapled hemorrhoidopexy, or Milligan-Morgan[2] for grades III–IV. Patients with anorectal disorders such as colorectal cancer, chronic inflammatory bowel disease, or perineal trauma were excluded from this study.

Seventeen healthy volunteers served as control group (n = 17; nine female, eight male; mean age, 29 ± 15 years). Symptomatic hemorrhoids and other anorectal disorders were excluded by physical examination. Both groups underwent standardized transperineal CDUS examination (HDI 5000, Philips, Hamburg, Germany) as for preoperative assessment, which was performed by a single radiologist who was blinded to whether the subject was in the study group or was one of the controls. Informed consent was obtained before inclusion in the study.

Table 1. Clinical symptoms of different grades of hemorrhoids

	Symptoms (ranked by prevalence)
Grade I	Bleeding, anal pruritus
Grade II	Bleeding, anal pruritus, burning, moistening, anal pain
Grade III	Bleeding, burning, anal pruritus, anal pain, moistening
Grade IV	Anal pain, bleeding, anal pruritus

A broadband linear transducer working at 4–7 MHz (HDI 5000, Philips) was positioned in a longitudinal scan at the perineum, with the patient or volunteer in a lateral position. Using CDUS, the distal rectum and the anal canal were investigated for arterial vessels in and around the rectum based on the following anatomical criteria: All vessels draining into the CCR, including submucosal branches and the previously described external arterial branches perforating the rectal wall right above the levator ani muscle,[17] were included in this study. The extremely variable middle rectal artery and the inferior rectal artery, which do not contribute to the blood supply of the CCR, were excluded. Arterial blood flow was measured in centimeters per second. In addition, calibers of the respective terminal branches of the SRA were determined. In the subgroup of patients who underwent stapled hemorrhoidopexy (n = 9), the outcome of the technique with regard to the arterial blood supply of the CCR before and after the procedure was analyzed. Patients were reinvestigated at 4 weeks postoperatively.

Statistical Analysis

Values are expressed as range and means with standard deviations (SD). Differences in caliber and arterial blood flow between patients and the control group were tested by the two-tailed unpaired Student's *t* test for continuous, normally distributed data. The nonparametric Kruskal-Wallis test was applied whenever indicated. Statistical significance was defined as $P < 0.05$. SPSS for Windows 11.0 software (SPSS Inc., Chicago, IL) was used for all analyses.

RESULTS

In both groups, arterial flow measurements corresponded in a linear way with the caliber of the arterial vessels as shown in Fig. 1. Both the flow and the caliber of the vessels increased with age in the study group (Fig. 2, *A*, *B*).

Healthy individuals (control group, n = 17) showed the following findings, which were used as gold standard. The mean caliber of visible arterial branches of the SRA in the control group was 0.92 ± 0.15 mm (range, 0.6 to 1.2 mm), and the mean arterial blood flow was 11.9 ± 4.0 cm/second (range, 5.0 to 21.0 cm/second). In 75% of the volunteers, a clearly