Int J Colorectal Dis (2010) 25:259–265
DOI 10.1007/s00384-009-0810-3

ORIGINAL ARTICLE

Effect of hemorrhoidectomy on anorectal physiology

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Accepted: 11 September 2009 / Published online: 21 October 2009

Abstract
Purpose The aim of this study was to determine whether overactivity of the anal sphincter in patients with hemorhhoids is primary or secondary and thus assess indication of lateral internal sphincterotomy to surgical treatment of hemorrhoids. Tonic contraction of the sphincter muscle in patients with advanced stages of hemorrhoids is considered by many authors as a primary cause, and therefore, they complete hemorrhoid surgery with lateral internal sphincteroomy. If hypertension of anal sphincter is secondary during hemorrhoid disease, lateral internal sphincterotomy is not indicated. Although examinations made immediately after sphincterotomy proved no changes of anal continence, certain sequelae of lateral internal sphincterotomy cannot be excluded and may later negatively affect patient's anal continence.
Patients and methods The prospective study comprised 385 patients treated in 2002–2006 by Hemoron or surgery according to Milligan-Morgan or Longo. Patients with history of another disease of the anal canal, radiotherapy of pelvis, Crohn's disease or ulcerous colitis were excluded. Manometry was performed before and after surgery at intervals of 1, 3, 6 and 12 months after operation using a perfusion flow method, six-channels catheter with radial arrangement of channel tips.
Results In all three groups (Hemoron, sec. Milligan-Morgan, sec. Longo), there were 60–65% of patients with third degree hemorrhoids. Normal resting anal pressure before surgery was recorded in only 25% of men and 30% of women. Patients with advanced hemorrhoid degrees were found to have significant hypertension of the anal sphincter. The most significantly improved state of sphincter overactivity was observed after surgery according to Longo and application of Hemoron. After surgery, according to Milligan-Morgan, recovery of anal sphincter tension was the longest; even 6 months after operation, a mean increased resting anal pressure persisted (91–110 mmHg) in 25% of men and 19% of women. After 12 months, recovery of anal tension occurred in this group also—mean increased anal pressure was recorded in only three patients (1.67%).
Conclusion Overactivity of the anal sphincter in patients with hemorrhoids is secondary and according to our results. Hypertension of the sphincter muscle in patients with hemorrhoids is significantly increased in patients with advanced degrees of hemorrhoids. Therefore, it is not recommended to postpone surgery and indicate patients with advanced degrees of hemorrhoids to hemorrhoidectomy.

Keywords Hemorrhoids · Anorectal manometry · Sphincter muscle

Introduction

Problems with hemorrhoidal nodes occur in the third decennium with equal prevalence in men and women. The etiology of hemorrhoids is primarily congenital and associated with physical constitution. The triggering mechanism of hemorrhoidal disease is defecation, namely constipation as well as severe diarrhea. In women, hemorrhoids are related to premenstrual period, pregnancy and delivery, also to the use of hormonal contraceptives. Patients with hemorrhoids are often found to have similar

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The project has been supported by the grant IGA NR 7804-5/2004

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lifestyles; they have a higher consumption of spicy meals, strong coffee or alcohol, sedentary habits or enjoy biking and horse-back riding. On the other hand, frequent coexistence of hemorrhoids and lower extremity varices is accidental because etiology of these diseases is quite different [1–4].

The submucosa in the anal canal does not form a continuous ring of thickened tissue but a discontinuous series of cushions, the three main ones being found constantly in the left lateral, right anterior, and right posterior positions [14].

Hemorrhoidal nodes are caused by venous hypertension in submucous tissue of the anal canal and probably also changes in anal sphincter tension [5, 6]. Pathological changes in the venous system of the anal canal result in bleeding. Venous downflow in the anal canal submucosa forms two types of arterial-venous shunts. Surface arterial-venous shunts at the level of the capillary network may open due to increased arterial flow. This may be caused by pressure changes during difficult defecation in patients with constipation, but also by consumption of alcohol, spicy meals, i.e., all factors modifying vasomotor activity of the pelvis and its organs. The blood flows directly to hemorrhoidal veins that are acutely dilated by the pressure of arterial blood [14]. This explains bright red bleeding in the absence of swollen hemorrhoids. In these shunts, when veins are full, blood circulation may be hampered, for instance by defecation, so that there are now conditions for thrombosis development in the hemorrhoidal node. Deep arterial-venous shunts of the anal canal submucosa may form a very extensive, even cavernous, blood bed with numerous shunts. In their proximity are many nervous vasomotor plexuses regulating pressure and blood flow [7–9]. The second factor involved in the etiology of hemorrhoids comprises changes in muscular and fibrous tissues of the submucosa. They play a crucial role in the slipping and protrusion of mucosa together with hemorrhoids, thus inducing pressures in the anal canal at defecation, especially during constipation. This results in atonia of muscular and fibrous tissues of submucosa. The submucosa of the anal canal usually has three strengthened points called cushions containing rich venous plexuses localized dextro-antero-laterally and postero-laterally and sinistro-laterally [14]. They are located in sites where a hemorrhoid usually forms. Cushions are able to change their volume, adapt to changed size of the anal canal, and thus completely close the lumen of the anal canal. They are thus important for full continence of the anal canal. Muscular fibers of the submucosa normally fix the mucosa to the internal anal sphincter and allow mobility of mucosa and submucosa during defecation. Protrusion of the anal mucosa with hemorrhoidal nodes results in atonia of muscular and connective structures of the submucosa [10–14].

The third important factor involved in protruding hemorrhoids and also in bleeding from hemorrhoidal nodes is tonic contraction of the sphincter muscle. Bleeding of hemorrhoidal nodes is provoked by protruding hemorrhoids. Tonic contraction of the sphincter muscle impairs return of slipping anal canal mucosa into the original position after defecation is finished and thus paradoxically impairs anal continence [15–18].

In our prospective study, we focused on changed tonic contractions of the anal canal sphincter in patients with hemorrhoids during their therapy. Changes in tension of the internal sphincter muscle were followed preoperatively and after treatment of hemorrhoids by Hemoron or surgery according to Milligan-Morgan or Longo. The aim of our study was to determine whether tonic contraction of the internal sphincter muscle is a primary cause of hemorrhoids or originates secondarily during initial stages of this disease; we also studied whether less extensive therapeutic procedures applied to hemorrhoidal nodes reduce hypertension of the sphincter muscle.

Materials and methods

This prospective study included 385 patients treated for hemorrhoidal disease from 1/2002 to 12/2006 (Table 1). Mean age of men was 45.4 years, of women 50.2 years. Eighty-two patients (48 men, 34 women) underwent surgery according to Longo (group A). In-patient treatment by Hemoron was applied to 123 patients (72 men, 51 women; group B). Hemoron is an outpatient procedure for treating hemorrhoids, which utilizes high frequency electrical current. Contact of the electrode with the hemorrhoidal tissue causes coagulation, retraction of the node, and gradual closure of the afferent artery. This has a significant influence on future reccurence of hemorrhoids.

One hundred eighty patients (82 men, 98 women) were subjected to surgery according to Milligan-Morgan (group C). Those patients had hemorrhoids of II–IV degree (Tables 2, 3, 4). All three groups comprised mostly patients with third degree hemorrhoids (60–65%). Second-degree hemorrhoids were most frequent in the group of patients treated by Hemoron (28%) compared to 4% and 7% in groups treated by Longo and Milligan-Morgan, respectively.

Table 1 Patients

Groups of patients	Men	Women	Total
Longo (A)	48	34	82
Hemoron (B)	72	51	123
M-M (C)	82	98	180
Total	202	183	385

Table 2 Hemorrhoid degrees in patients treated by Longo's method

Longo	Number	I	II	III	IV	Total
Men	48	0	2	30	16	48
Women	34	0	1	21	12	34
Total	82	0	3 (4%)	51 (62%)	28 (34%)	82

Converse was the proportion of patients in individual groups in the fourth degree. Hemoron was administered to only 12% of patients with fourth degree; surgery according to Longo and Milligan-Morgan was performed on 34% and 28% of patients, respectively (Tables 2, 3, 4).

Initially, 405 patients were included in the study. During the 1-year follow-up, 20 patients were removed from the study for failure to cooperate. At the end of the study, 385 patients remained. Patients who had history of another disease of anal canal (anal fissures, perianal fistulae, polyps or tumors), radiotherapy of pelvis, Crohn's disease, and ulcerous colitis were rejected. None of our patients was previously treated for hemorrhoids by another invasive procedure.

The initial data were processed statistically using chi-square test that showed no statistically significant differences among individual groups that could misrepresent next follow-up ($p = 0.039$). With regard to many tables and figures obtained at initial processing, only a summarizing table with statistical comparison of groups under study is presented (Table 5). Each patient was duly informed about his/her disease and therapeutic modalities; indication for a given therapy was always consented by doctor and patient.

Anorectal manometry of the sphincter muscle was performed before and after surgery in 1, 3, 6, and 12 months consecutively.

For anal manometry, we use a perfusion flow system (Polygraph, Syntectics Medical, Sweden). Manometric evaluation was carried out using a six-channel catheter with radial arrangement of channel aperture. This allows us to follow pressures in individual sectors and set the vector of volume imaging. After calibration, a continuously perfused catheter is introduced into the rectal ampulla and after pressure setting by step-to-step method at a constant speed of 5 mm pulled through the sphincter. Intraluminal pressure deviations at water/anorectal mucosa border are transmitted by water column into transmitters and then transformed into electric signal and monitored in mmHg. At examination, we obtain six pressure waves corresponding to individual channels of the catheter.

Table 3 Hemorrhoid degrees in patients treated by Hemoron

Hemoron	Number	I	II	III	IV	Total
Men	72	0	23	42	7	72
Women	51	0	11	32	8	51
Total	123	0	34 (28%)	74 (60%)	15 (12%)	123

Table 4 Hemorrhoid degrees in patients treated according to Milligan-Morgan

	Number	I	II	III	IV	Total
Men	82	0	5	58	19	82
Women	98	0	8	59	31	98
Total	180	0	13 (7%)	117(65%)	50 (28%)	180

In the first stage of examination, anorectal profilometry is performed. Resting anal canal pressures and length of high-pressure zone (HPZ) are followed. Resting pressure reflects tonic activity of both internal and external sphincter muscles; internal sphincter muscle accounts for 85% of resting pressure. Normal length of HPZ in men is 25–35 mm, in women 20–30 mm. Resting pressure ranges from 40 to 70 mmHg.

In the second phase, we evaluate the function of sphincter muscles and anorectal reflexes. Squeeze pressure is measured at three to four levels of the anal canal in order to determine the maximal possible contraction of the external sphincter muscle. Squeeze pressure lasts for 10 sec; besides maximal pressure, fatigue quotient is also determined. The value of normal resting contraction is 120–180 mmHg. Pressure within 181–200 mmHg was evaluated as slightly increased, 201–220 as mean and 221–240 as significantly increased resting pressure.

Other maneuvers followed at anal manometry are: cough maneuver, relax maneuver, push maneuver, and reflex anal sphincter response.

Rectum filling under physiologic conditions leads automatically to decreased pressure of the internal sphincter muscle and subsequent defecation. At manometry, this physiologic process is simulated by anorectal distension using the introduced balloon filled with various volumes. Pressure of internal anal sphincter is affected not only by volume, but also by distension speed. This balloon reflex remains intact in patients with denervation but disappears in

Table 5 Statistical comparison of groups under study

Therapeutic intervention/hemorrhoid degrees	I	II	III	IV
Longo (group A)	0	3	51	28
Hemoron (group B)	0	34	74	15
M-M (group C)	0	13	117	50

Chi-square test, $p = 0.0001$

Longo vs. Hemoron, $p = 0.0001$

Longo vs. M-M, $p = 0.3660$

Hemoron vs. M-M, $p = 0.0001$

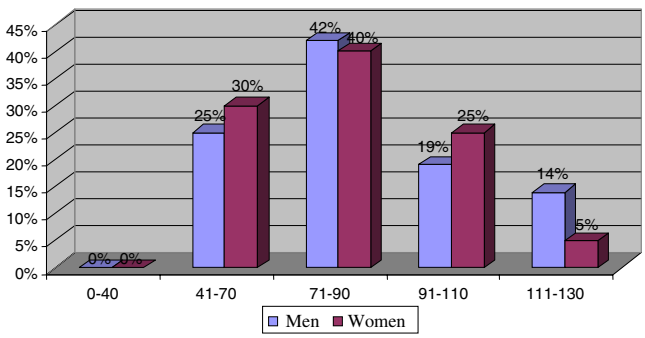
neuropathy and ganglion loss in myenteric plexus or in patients with atrophy and fibrosis of internal anal sphincter.

All data were statistically evaluated using the chi-quadrate test with a 5% significance level.

Results

On the basis of our experience with patients with hemorrhoids, we focused on resting anal pressure measuring the high-pressure zone and on the squeeze maneuver. At anorectal manometry, we also followed cough maneuver, relax maneuver, and reflex anal sphincter response. These maneuvers were not affected by hemorrhoid therapy.

While the change in resting anal pressure resulted in the statistically significant differences among individual groups, length of the high-pressure zone was not significantly changed. At the beginning, we performed a statistical comparison of resting anal pressure in all men and women and because a statistically significant difference was discovered (p= 0.01), men and women were processed separately (Graph 1.). Statistical evaluation of the effect of individual therapeutic modalities of hemorrhoids on contraction of anal sphincter (groups A, B, C) was performed, men and women were evaluated together within a given group. We were aware of a certain distortion, which, however, remained statistically insignificant; favorable was better orientation in final data and tables. Normal resting anal pressure is 40–70 mmHg. Pressure within 71–90 mmHg was evaluated as slightly increased, 91–110 mmHg as mean and 111–130 mmHg as significantly increased. Normal resting anal pressure before surgery was recorded in only 25% of men and 30% of women. We recorded a significantly increased tonic contraction of sphincters, particularly in patients



Sphincter hypotonia:	0-40 mmHg
Norm:	41-70 mmHg
Slightly increased sphincter tone:	71-90 mmHg
Moderately increased sphincter tone:	91-110 mmHg
Significantly increased sphincter tone:	111-130 mmHg

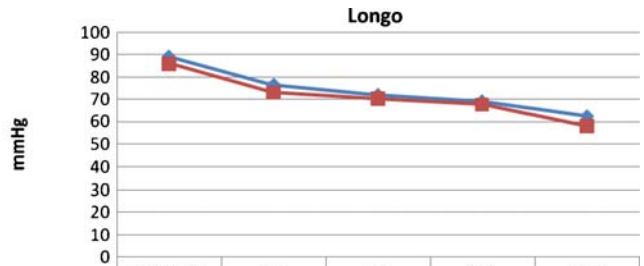
Graph 1 Preoperative anorectal manometry

with advanced hemorrhoidal nodes. After the operation, the most significant recovery of resting anal pressure was found with surgery after Longo; not only 1 month after operation, but also during the next 12-month follow-up. Therapy of hemorrhoids by Hemoron also showed a gradual recovery of resting anal pressure. Contrarily, classical surgery after Milligan-Morgan was found to have the least recovery of resting anal pressure and even 6 months after operation mean increased resting anal pressure persisted in 25% of men and 19% of women. In the course of 1-year-follow-up, gradual improvement of anorectal function was observed as well as recovery of resting anal pressure and subsequent partial comparability of findings in individual groups. It is concluded that therapy of hemorrhoids using Longo's method and Hemoron is significantly better for recovery of resting anal pressure. Manometric values obtained 6 months after surgery showed that differences between group A (therapy after Long) and group B (therapy by Hemoron) are insignificant (p= 0.674), while comparison of these two methods with group C (surgery according to Milligan-Morgan) is highly different (A vs C, p= 0.016, B vs C, p= 0.005; Figs. 1, 2, 3).

The progression of sphincter tone at rest during the course of the 1-year follow-up is shown in the statistical report 1.

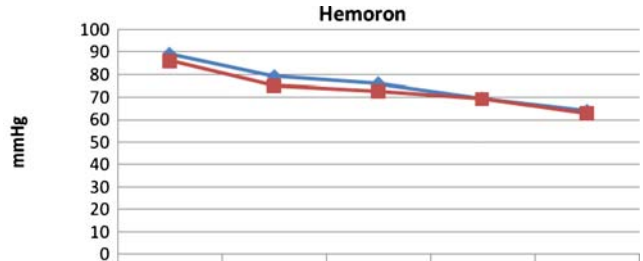
Another parameter studied during anorectal manometry was squeeze maneuver. This maneuver also showed postoperative changes compared with preoperative examination, but differences among individual groups were statistically insignificant. For better survey, men and women were evaluated statistically together, but figures give gender results. Statistical analysis was again performed using chi-square test.

Measurements were made before surgery and 1, 3, 6, and 12 months after surgery. The value of normal squeeze maneuver is 120–180 mmHg. Squeeze maneuver within 181–200 mmHg was evaluated as slightly increased, 201–220 mmHg as mean increased, and 221–240 indicated a significantly increased squeeze maneuver.



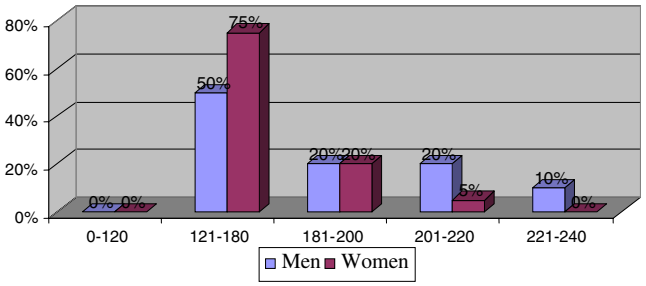
	Before op.	1M	3M	6M	12M
Men	89,4	76,8	72,3	69,4	62,7
Women	86,2	73,2	70,4	67,8	58,1

Fig. 1 One-year progression of anal sphincter tone at rest in patients operated by Longo method



	Before op.	1M	3M	6M	12M
Men	89,4	79,4	76,3	69,8	64,3
Women	86,2	75,2	72,8	69,6	63,1

Fig. 2 One-year progression of anal sphincter tone at rest in patients treated with Hemoron



Pathological voluntary contraction:	0-120 mmHg
Normal squeeze:	121-180 mmHg
Ligh hypertonus:	181-200 mmHg
Moderate hypertonus:	201-220 mmHg
Significant hypertonus:	221-240 mmHg

Graph 2 Squeeze maneuver preoperatively (force of voluntary contraction)

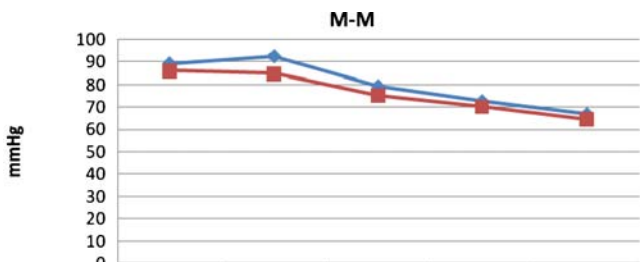
Normal values of squeeze maneuver before surgery were observed in 50% of men and 75% of women. In 10% of men, we recorded a highly significant increase of squeeze maneuver values (Graph 2). One month after surgery, normal squeeze maneuver was found in 65% of men and 78% of women; 12 months after surgery in 79% of men and 92% of women. After surgery, all groups showed a significant improvement of squeeze maneuver in terms of return to normal (Fig. 4). None of the patients had impaired sphincters or impaired squeeze maneuver leading to anal incontinence.

Progress of voluntary contraction during the 1-year follow-up is shown in statistical report 2.

During anorectal manometry, the cough reflex, relaxation maneuver and rectoanal inhibitory reflex were also standardly monitored. None of these maneuvers were pathologically affected in association with the hemorrhoid therapy.

Discussion

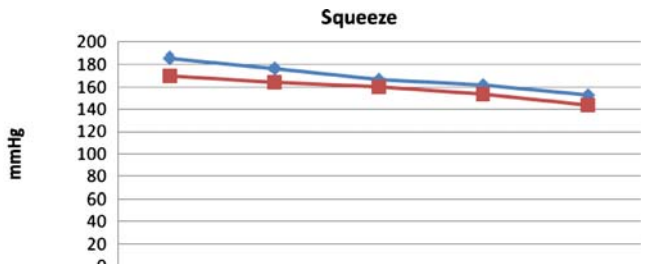
Most papers dealing with hemorrhoids confirm hypertension of the anal sphincter during hemorrhoidal disease [19–21]. Some authors consider the increased pressure of the anal sphincter as a cause of advanced stages of this disease.



	Before op.	1M	3M	6M	12M
Men	89,4	92,5	79,5	72,9	67,2
Women	86,2	84,9	75,4	70,3	64,6

Fig. 3 One-year progression of anal sphincter tone at rest in patients operated by Milligan-Morgan method

Hannock suggested that overactivity of the internal anal sphincter might be important in the pathogenesis of high anal pressure and hemorrhoids [6]. Shafik stated that the higher pressure in hemorrhoids was caused by a fibrous anorectal band, which induced a high shearing force during straining, thus causing protruding and bleeding of the hemorrhoids[22]. Teramoto suggested that the increased basal pressure in hemorrhoids was caused by a state of tonic contraction of the external sphincter muscle, and was the result of the presence of a hemorrhoidal mass rather than the cause of hemorrhoids [23]. Our study proved that patients with hemorrhoids have increased pressure of sphincters compared to healthy population. Prior to therapy of hemorrhoids, normal pressure was found in only 25% of men and 30% of women. It is still disputable whether increased pressure of sphincters precedes the origin of hemorrhoids or occurs as a secondary event at initial stages of the disease and participates in a protrusion of hemorrhoids or larger bleeding of hemorrhoidal varices. If hypertension of the anal sphincter was primary in patients with hemorrhoids thus being causal for the origin of hemorrhoids, the hypertension of the anal sphincter would



	Before op.	1M	3M	6M	12M
Men	186	177	167	162	153
Women	170	164	160	154	144

Fig. 4 One-year development of voluntary contraction in the groups studied. No significant difference between the individual groups (therefore only one graph)

persist after surgery of hemorrhoids. In such case, hemorrhoidectomy should be completed with lateral internal sphincterotomy. But if hypertension of the anal sphincter is not the primary cause of hemorrhoids, there is no indication for lateral internal sphincterotomy (LIS). Although many authors report that after lateral internal sphincterotomy, no anal incontinence was observed and advocate LIS for acceleration of postoperative healing and elimination of postoperative pain, we consider a partial sectioning of anal sphincter as a non-indicated method [24–28]. We are certain that long-term follow-up of patients after LIS would show an increased incidence of anal incontinence in old age compared to the normal population.

Patients with hemorrhoidal nodes often have coincidence of hemorrhoids with painful ragades of anal mucosa and inflammation of anal canal mucosa, which may affect hypertension of the anal sphincter. It should be proved whether these complications are caused by hemorrhoidal disease or are an accidental finding. But we suppose that during the increase of hemorrhoidal nodes above certain limit the anal canal is insufficiently cleaned, and feces irritate the anal mucosa. This results in anitis development, inflammatory infiltration, and mechanical impairment of anal mucosa with subsequent occurrence of ragades. Only painful affections in the anal canal lead to sphincter spasms that are gradually fixed and the anus is relaxed with difficulties at defecation. This is a pathogenetic circle broken only by therapy of hemorrhoids [29].

The theory of primary hypertension of the anal sphincter in patients with hemorrhoidal nodes is contested by manometric measurement of our patients during 1-year follow-up after surgery. The most significant recovery of resting anal pressure was observed after surgery, according to Longo, not only 1 month after operation, but also during 12-month follow-up. The application of Hemoron also showed a gradual recovery of resting anal pressure. Finally, classical surgery according Milligan-Morgan was the least significant (6 months after surgery, mean increased resting anal pressure persisted in 25% of men and 19% of women); the resting anal pressure significantly decreased 12 month after surgery. Persisting hypertension of the anal sphincter after surgery according to Milligan-Morgan is highly probably associated with healing of extensive defects of anorectal mucosa lasting for 3–5 weeks. At the same time, higher tension of anal sphincter present in this method impairs epithelialization of mucosa defects thus prolonging the time of postoperative healing.

Important for the healing process after surgery according to Milligan-Morgan is the intensity of postoperative pain. Pain always leads to increased tension of the anal sphincter and subsequently to prolongation of operative wound healing. In the course of 1-year follow-up, gradual improvement of anorectal function and recovery of resting anal pressure were observed, so that findings of individual groups could be partly comparable. However, therapy of hemorrhoids using Longo's method and Hemoron significantly improves the value of resting anal pressure. Moreover, anorectal function was improved more rapidly and in a higher percentage of patients compared to the group subjected to surgery according to Milligan-Morgan. This confirms the theory stating that reduction of hemorrhoids leads to normal anorectal function, especially its self-cleaning ability and subsequently normalized pressure of the anal sphincter.

Our results indicate that hemorrhoidal disease is a triggering event for hypertension of anal sphincters. Postponed surgery of hemorrhoidal disease in initial stages probably leads to hypertension of anal sphincter and protrusion of anal mucosa with hemorrhoidal nodes as well as other impairments of the anal canal. The therapy then requires not only a more extensive surgery, but also longer postoperative healing markedly limiting patient's comfort. In some patients, hypertension may persist for a long time.

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