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Some Provocative Concepts On Constipation

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Abstract

Constipation is a collective term with different definitions and manifestations. In the present communication, I hope to shed light on the pathogenesis, investigation, and treatment of these manifestations. The levator ani is the principal muscle of defecation; together with anorectal reflex actions, it conducts the act of defecation. Strainodynia is the term I give to excessive and exhaustive straining at defecation. Band strainodynia has normal stool character but elevated rectal neck pressure due to the presence of a fibrous band in the rectal neck. Diet strainodynia presents with lower stool weight and frequency than normal; the internal anal sphincter is fibrous. The stools in levator strainodynia have been repeatedly obstructed at defecation due to levator dysfunction. Idiopathic oligofecorrhea or infrequent defecation was studied in 146 patients. Three stages could be identified: the deep and the everted intersphincteric groove and the cone anus. Fecoflowmetry is introduced as a method for investigating anorectal disorders. It measures the defecated volume per time unit, and provides quantitative as well as qualitative data concerning the act of defecation. Changes in the fecal flow parameters or curve configuration from normal point to a defecation disorder.

Keywords: Constipation - Strainodynia – Oligofecorrhea – Defecation – Continence – Fecoflowmetry - Reflexes.

Constipation is a collective term used by the patient to imply that stools are either too hard, too small, or infrequent, or that straining at defecation is excessive (1).The literature, too, has a variety of definitions of constipation. Devroede (2) considers a patient if the daily stool weight remains below 35 g, or if despite a high residue diet (14.4 g crude fiber) the weekly stools are fewer than three for women and five for men, or if more than 3 days pass without a bowel movement. Moore-Gillon (3) defines constipation as difficult defecation, infrequent defecation, or both. According to Drossman et al. (4) a patient who strains for more than 25% of the time at stool and / or passes two or fewer stools per week is constipated. Painter (5) classifies as constipated any patient who strains to defecate and does not pass minimally one soft stool daily without effort. Recently, the Rome III criteria for definition of constipation is widely accepted by the scientific world. Thus, the definitions of constipation in the literature differ from each other just as much as the various rectal manifestations: e.g., excessive straining or too hard, too small and infrequent stools. All these manifestations are noted by patients as constipation regardless of their possibly unrelated and different pathogenese and methods of treatment. These discrepancies challenged me to study each of the manifestations separately.

Stool Character

For a comprehensive understanding of constipation we must look first at stool character. Stool consistency is difficult to measure except in qualitative terms, although a device not generally used, a penetrometer, can give a figure (6). Water content in a normal stool is said to be about 70%; in a hard stool, from 40 to 60%; and in a liquid stool, more than 95%(7). Stool weight varies widely in an individual from day to day (8), and from person to person and country to country. Mean daily weight among healthy people in the United Kingdom and the United State lie between 100 and 200 g daily, with frequent values below 100 g. In rural Uganda, the mean observed was 470 g (9) and in healthy Indian adults it was 311 g(10). Larger stools tend to contain more water and are therefore softer (10). Surveys have shown that most people in Western countries pass a stool every day. Fewer than 1% of a healthy British population said they passed 2 or fewer stools a week, and all these subjects were women (11). In a sample of American population, up to 5% have this bowel frequency (4). Bowel histories are fallible, but they have to be accepted unless a diary card is used (12,13).

Mechanism of Defecation

Muscles of Defecation

The muscles that act on the rectal neck are the external and internal anal sphincters, puborectalis, levator ani, and longitudinal muscle. The external and internal sphincters, as well as the puborectalis, are muscles of continence. Their role at stool is to contract in order to interrupt or terminate the act of defecation (14, 15). However, the principal muscles of defecation are the levator ani and the longitudinal muscles (16,17,18). They act jointly to open the rectal neck at defecation. The two muscles are interrelated due to the fact that the suspensory sling, a part of the levator, constitutes the middle layer of the longitudinal muscle (16,18) (Fig.1).

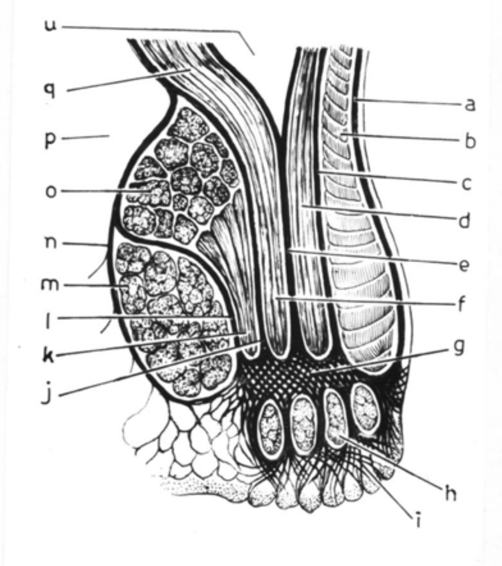

***Fig.1** - Diagram illustrating the rectal neck musculature: a, submucosus space; b, internal sphincter; c, e, j, and l, four interspincteic space; d, f, and k, medial, intermediate, and lateral longitudinal muscle; g, central tendon; h, m, and o, base, intermediate, and top loops of external anal sphincter; l, corrugator ani cutis; n, external fascial septum; p, ischiorectal space; q, levator plate; f, suspensory sling of levator muscle (intermediate longitudinal muscle); u, pelvirectal space.*

Anatomical Mechanism of Defecation

With knowledge of the physioanatomical aspects of the pelvic floor muscles and assisted by manometric EMG and barium enema studies, the precise mechanism of defecation could be explored (19, 20). As stools enter the rectum, reflex detrusor contraction and internal sphincter relaxation occur. Continuation of defecation depends on two factors: (a) external sphincter relaxation, and (b) straining. If defecation is acceded to, the external sphincter is voluntarily relaxed. Straining is necessary to maintain defecation, as it raises the intra-abdominal pressure. This serves a double purpose: it compresses the detrusor, which helps evacuation, and it stimulates levator contraction through the straining-levator reflex (21). Although the intra-abdominal pressure compresses the detrusor, the rectal neck is spared owing to its protected location below the levator plate. When the levator plate contracts, it moves from the cone to the flat position and is elevated and laterally retracted (17) (Fig. 2). This results in pulling on the hiatal ligament, which in turn pulls open the anorectal junction and partially opens the rectal angle. Simultaneously, the suspensory sling contracts and not only pulls up the base loop to unseal the anal orifice, but it also partially opens the rectal neck (Fig. 2). The longitudinal muscle joins the detrusor in contraction, which results in shortening and opening of the rectal neck as well as in complete straightening of the rectal angle (16). This brings the rectal neck into alignment with the detrusor so that efficient fecal pumping occurs. The final result of the joint contraction of the detrusor, longitudinal muscle, and levator is the opening of the rectal neck for the rectum to evacuate its contents.

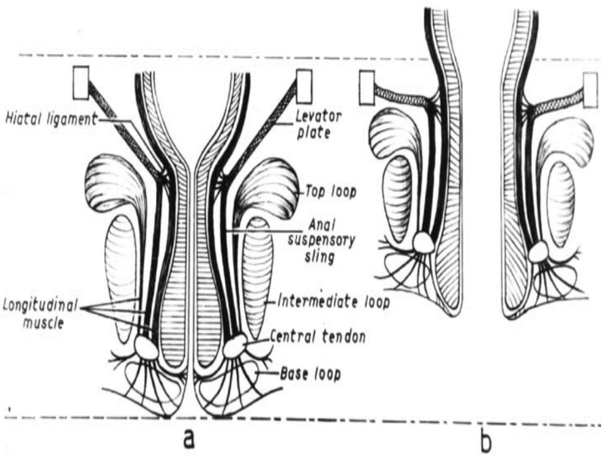

Fig.2 *- Mechanism of defecation: a, at rest; b, at defecation. Flattening of levator cone as well as suspensory sling contraction results in opening of rectal neck.*

Physiologic Mechanism of Defecation

The concerted functions of the anorectal musculature at defecation are initiated and harmonized by voluntary impulses and reflex actions (22–26). When the rectal detrusor is distended with fecal mass and the stretch receptors are stimulated, the rectoanal inhibitory reflex (22) is initiated by which the rectal detrusor contracts and the internal sphincter relaxes. Detrusor contraction triggers two reflexes: the rectopuborectalis reflex (23) and the rectolevator reflex (24). These two reflexes act simultaneously yet have opposite functions; on detrusor contraction, the rectolevator reflex effects a reflex levator contraction, which opens the rectal neck. At the same time, the reflex puborectalis contraction, actuated by the rectopuborectalis reflex, functions to close or keep closed the rectal neck as impulses reach the conscious level to probe the circumstances for defecation. If inopportune, the puborectalis continues voluntary contraction. Voluntary puborectalis contraction evokes two reflex actions: (a) reflex levator relaxation through the levator-puborectalis reflex (25), and (b) reflex detrusor relaxation by means of the voluntary inhibition reflex (26). Meanwhile, it aborts the rectoanal inhibitory reflex, which relaxes the internal sphincter. Hence, voluntary puborectalis contraction, through the voluntary inhibition reflex, prevents internal sphincter relaxation, which results in reflex detrusor relaxation and waning of the urge to defecate (26) (Fig. 3). However, as soon as circumstances would allow defecation and the sensation of desire is felt, the puborectalis muscle relaxes voluntarily, and the detrusor evacuates its contents. This demonstrates that the act of defecation is under voluntary control despite the presence of reflex actions sharing in the mechanism of defecation. Thus, although the rectoanal inhibitory and rectolevator reflexes function to open the rectal neck, the rectopuborectalis and the levator-puborectalis reflexes keep the rectal neck closed until the decision for defecation has been made. Straining at the start of defecation is a normal physiological process and as such is part of the mechanism of defecation. By elevating the intra-abdominal pressure, it triggers the straining-levator reflex (21), which effects levator contraction and the opening of the rectal neck for spontaneous evacuation of stools.

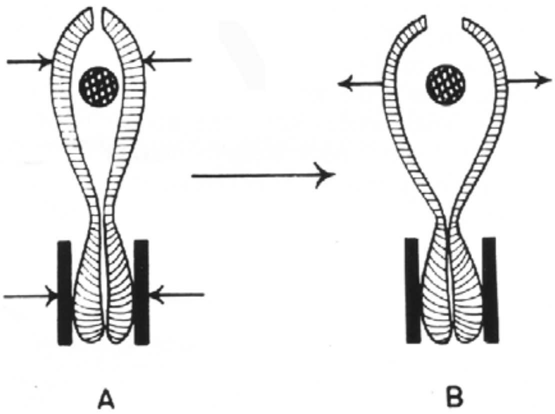

Fig.3 *- Mechanism of voluntary inhibition action: A, detrusor contraction with failture of internal sphincter relaxation due to voluntary external sphincter contraction; B, reflex detrusor relaxation due to failure of internal sphincter relaxation (volunmtary inhibition action).*

Strainodynia

Excessive and exhaustive straining that may accompany defecation is a pathological manifestation I call strainodynia (27). Eighty-six patients with this complaint were examined by investigations of stool character, proctoscopy, colonoscopy, barium enema, intestinal transit rate, electromyogram, manometry, and rectal biopsy. According to results they were classified into three groups: band, diet, and levator strainodynia. Band strainodynia (46 patients) was more common in men, presented with a normal stool character, had elevated rectal neck pressure, and by rectal neck biopsy revealed a fibrous band. Bandotomy relieved strainodynia. Diet strainodynia (31 patients) had a higher incidence in women, and presented with lower stool weight and frequency than normal. Rectal neck pressure was normal in 19 and elevated in 12 patients. The rectoinhibitory reflex was diminished. There was internal sphincter fibrosis. Improvement occurred after dietary management in 16 patients and after internal sphjincterotomy in 15.

Levator strainodynia (9 patients) was due to levator dysfunction syndrome (28), and was more common in women. Stools had been repeatedly obstructed at defecation despite normal stool character. Rectal neck pressure was elevated only on straining. There was reduced levator myoelectric activity. Levatorplasty cured the condition.

Oligofecorrhea

There are many known causes for oligofecorrhea, the term I gave to infrequent defecation of two or less weekly bowel movements (29), but 'idiopathic oligofecorrhea' is the category without a traceable cause.

Patients (n=146) with idiopathic oligofecorrhea were subjected to the same investigation as performed for strainodynia. According to clinical and investigative results, the patients were classified into three stages (Table 1).

Table 1 *- Clinical and investigative results of the 3 stages of oligofecorrhea*

Stage	No. Patient	Age (mean)	Duration (mean) year	Stools per week (mean)	Response to laxatives	Rectal neck pressure (mean) cm H2O	Rectoinhibitory reflex	EMG internal sphincter	Internal Sphincter biopsy
1	46	28	6.8	1.8	+	118	Weak	Brisk	Hypertrophied muscle and degenerated nerve plexus.
2	92	42	13	1.1	±	126	Absent or weak	Brisk	Hypertrophied muscle and degenerated nerve plexus
3	8	58	23	0.7	-	148	Absent	Brisk	Hypertrophied muscle and degenerated nerve plexus

Deep Intersphincteric Groove

In the deep interspnincter groove category (stage 1, 46 patients), the lower end of the internal anal sphincter was thick and the intersphincteric groove deeper than normal. The clinical and investigative results are showen in Table1. In this group, oligofecorrhea is attributable to a disordered internal sphincter due to abnormal innervation as evidenced by degenerated intramusclcular nerve plexus, brisk myoelectric activity of the internal sphincter, reduced rectoinhibitory reflex, increased rectal neck resting pressure, and internal sphincter hypertrophy. Sphincter dilatation resulted in temporary improvement. Subsequent internal sphincterotomy had satisfactory results (Table 2).

Everted Intersphincteric Groove

In this category (stage 2, 29 patients), the intersphincteric groove lay outside the rectal neck orifice and was deeper than normal. The lower edge of the internal sphincter was thick and prominent and lay at the level of the external anal sphincter. It descended on straining to project as a cone outside the rectal neck outlet, a sign I call the "cone sign". Internal sphincterotomy resulted in improvement in 84.7%; the cause of failure in 14 patients could not be identified and remained uncorrected (Table 2).

Cone-Anus

Here (stage 3, eight patients), the internal sphimcter protruded as a cone outside the rectal neck orifice and below the external sphincter lower edge. On palpation, it was thicker and firmer than normal. The internal sphincter cone

elongated on straining. Internal sphincter myotomy resulted in improvement of all patients in the group (Table 2).
The three groups of oligofecorrhea share major abnormal findings which comprise high rectal neck resting pressure, reduced or absent recto-anal inhibitory reflex, internal sphincter hypertrophy, and degeneration of the nerve plexus of the internal sphincter. It is belived that abnormal internal sphincter innervation interferes with the recto-anal inhibitory reflex action, and so the internal sphincter fails to relax on rectal distention. The degenerative changes of the nerve plexus seem to affect mainly the parasympathetic supply, thereby producing sympathetic overactivity that leads to abnormal internal sphincter contraction and eventually results in muscle hypertrophy. Of the 146 patients with idiopathic oligofecorrhea operated on, 132 showed improvement. They were followed for a period varying from 1 1/2 to 5 years with no recurrence of constipation; no patients have used laxative or enema medication since. However, after myotomy, four patients have loss of flatus control and two are experiencing fecal soiling.

Table 2 *- Results of internal sphincter myotomy in 146 patients with oligofecorrhea.*

Stage	No. patients	Patient improved		Stools / week (mean)		Rectal neck pressure (mean, cm H2O)	
		No.	%	Before treatment	After treatment	Before treatment	After treatment
1	46	46	100	1.8	5.5	118	50
2	92	78	84.7	1.1	5.0	126	82
3	8	8	100	0.7	6.0	148	72

Anorectal Band and Constipation
The anorectal band, a fibroepithelial tube located in the rectal neck submucosa below the pectinate line (30), is a remnant of the anorectal sinus which results from hindgut invagination by the proctodeum. It is commonly accompanied by failure of remodeling and stenosis of the lower rectal neck. The anorectal band or its remnants, the epithelial debris, share in the genesis of hemorrhoids (31) and chronic anal fissures (32). The fibrous band and associated rectal neck stenosis elevate the rectal neck pressure and hinder full rectal neck expansion at defecation with a resulting partial obstruction to the descending fecal mass. Although the stools are soft and bulky in such patients, extra straining is necessary to effect rectal neck dilatation sufficient for evacuation. This would explain the cause of strainodynia, apprehended by the patient as constipation, even with soft and bulky stools. The presence of this constricting anorectal band may also explain the high rectal neck pressure recorded in hemorrhoid patients by some investigators (33-35). However, Hancock and Smith related this high pressure to excessive internal sphincter activity, and found that performing Lord's procedure (36) (maximal anal dilatation) as treatment, the resting rectal neck pressure was significantly reduced (33). We believe that Lord's technique induces this effect by disrupting the anorectal band. The operative techniques introduced in the treatment of hemorrhoids (37) and fissures (32) deal with the anorectal band as their major pathogenic agent and make its operative division (bandotomy) an imperative measure to relieve its constricting effect. The results are good, with disappearance of strainodynia and normalization of rectal neck pressure (32,37).

Investigations
As regards the studies needed in investigations of constipation valuable information can be obtained from a physical workup, including neurologic and proctologic examination. Investigations comprise barium enema, colonoscopy and biopsy studies, defecography (38,39), intestinal transit, anorectal manometry, balloon expulsion test (40), and defecometry (41), as well as electromyogram (EMG) of anal sphincters and levator ani muscle. This is in addition to endoanal ultrasonography (EAU) and magnetic resonance imaging (MRI). However, conventional examinations of the anorectum commonly reveal little correlation between subjective symptoms and investigative results. Although they offer valuable information regarding anorectal function, they are not representative of the act of defecation, and the range of normality is quite broad. Herein, we present new methods that can add to the diagnostic tools investigating the anorectum.

Fecoflowmetry

Since the introduction of the fecoflowmeter, which we developed to obtain an authentic and detailed recording of the act of defecation (42–44), fecal flow rate can be studied from curves that represent the changes occurring in rate versus time. Fecal flow rate is the product of rectal detrusor action against outlet resistance. A 1-l enema is given, and the subject sits on the commode of the fecoflowmeter when he/she feels the desire to defecate. Fecoflowmetry provides quantitative and qualitative data regarding the act of defecation (Figs. 4 - 6). It is simple, easy, noninvasive, and nonradiological.

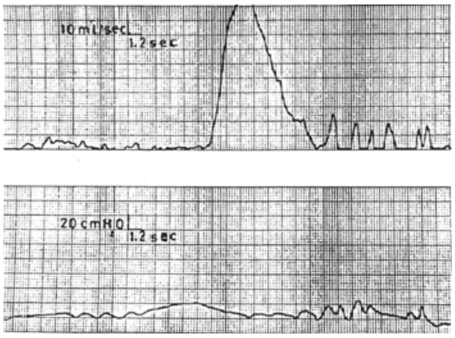

Fig.4 - *A normal defecation flow curve (top). The lower tracing is the intraabdominal pressure curve.*

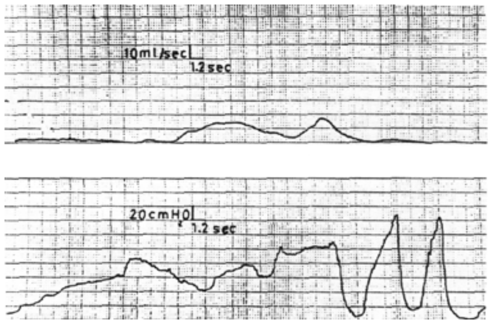

Fig. 5 *– Defecation flow curve of the obstructive type constipation (top). The lower curve is the intraabdominal in pressure.*

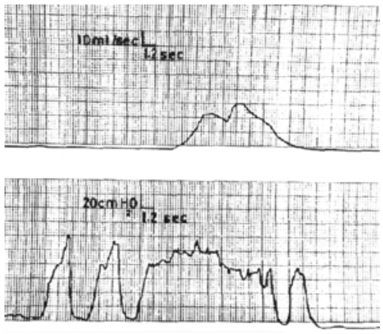

Fig.6 - *Defecation flow curve of the inertia type constipation (top). The lower curve is the intraabdominal pressure.*

Table 3 - *Fecoflowmetric parameters in 82 normal subject and 154 chronically constipated patients.*

Parameter	Normal subject		Constipated	
	Range	Mean	Range	Mean
Volume (ml)	233 – 720	406 ± 72.3	135-240	157±32
Flow time (sec.)	10-32	22±7.8	11-22	15±6.8
Mean flow rate (ml/sec.)	15-31	19±8.2	8-13	10±3.2
Maximum flow rate (ml/sec.)	61-112	84±22.6	19-46	33±11.6
Time to maximum flow (sec.)	1-3	1.8±0.5	4.5-15	10±2.3
Time to urge (minutes)	3-8	5.2±1.2	20 – 30	26±5.8

Determination of Residual Stools

Twenty healthy volunteers, mean age 35.7 years, and 25 patients with chronic idiopathic constipation (CIC), mean age 31.2 years, were evaluated for residual stools in the rectum after defecation (45). The act of defecation was studied by fecoflowmetry. A 1-l water enema was administered, and fecoflowmetric studies were done while the subject was evacuating the enema. After evacuation, a rectal tube was introduced to evacuate the residual fluid for quantitative assessment. Six of the 20 healthy volunteers had a mean volume of residual fluid of 32.3 ml; the remaining subjects had no residual fluid. All constipated patients had a mean residual fluid of 370.6 ml.

Rectometry

Rectal volume, pressure, and compliance at first rectal and urge sensation are assessed in one test by a simple and noninvasive new parameter: rectometry (46). The shape of the rectometrogram is also informative. Rectometry was performed on 36 subjects: 20 healthy volunteers and 16 patients with constipation. Carbon dioxide was infused into a balloon introduced into the rectum and connected to a pressure transducer. The rectal neck and intra-abdominal pressures were measured simultaneously. A rectometrogram was obtained (Fig. 7).

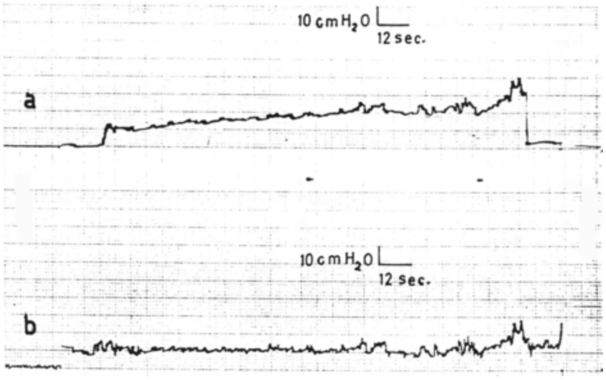

***Fig.7 -** Rectometrogram of spontaneous evacuation (a) and intra-abdominal pressure curve (b) showing slight increase or pressure at evacuation. First dash below tone limb denotes first rectal sensation, second dash denotes urge sensation. This is shown in all the illustrations.*

It reads the volume of carbon dioxide infused and the intrarectal and detrusor pressure at both the first rectal and urge sensation. In addition to quantitative values, the curve configuration could differentiate between not only normal and constipated subjects but also obstructive and inertia-type constipation (Fig. 8, 9). Apart from its diagnostic value, rectometry can be used to monitor the effectiveness of pharmacotherapy on detrusor function.

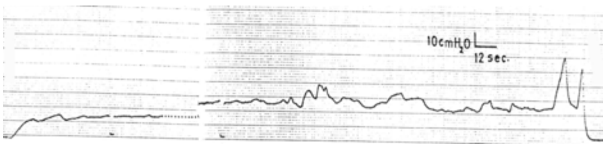

***Fig.8 -** Rectometrogram of inertia type of constipation. The patient has succeeded in expelling the balloon. As the tone limb was too long, a big segment of it was deleted from the illustration and is represented by the dotted line.*

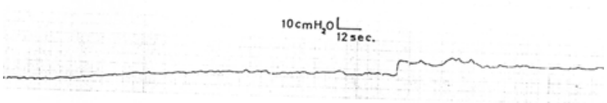

***Fig.9 -** Rectometrogram of obstructive constipation. The patient has failed to expel the balloon. The evacuation curve has a long plateau and no descending limb.*

Rectal-neck Pressure Profilometry

Rectal-neck pressure profile was measured by means of a catheter with a ring of side holes at its distal end (47). After the catheter was inserted into the rectum, carbon dioxide was infused. Pressure in the rectal neck was recorded while the catheter was being withdrawn automatically by a device. Important parameters that could be studied from the rectal-neck pressure profile include: maximum rectal-neck pressure, maximal closing rectal-neck pressure, as well as functional and anatomical rectal-neck lengths. Mean rectal-neck pressure and the pressure index could also be calculated. Normal profilogram was bell shaped (Fig. 10).

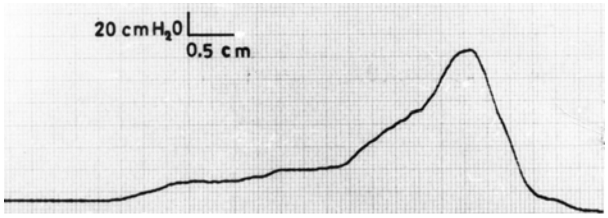

***Fig.10** - Rectal neck pressure profile in normal subjects.*

The ascending limb showed a two-step rise, the first rise of which was gradual and affected by internal anal sphincter tone while the second was steep and evoked by external and internal anal sphincter tone. A formula was introduced to calculate separately the pressure induced by each of the external and internal sphincters. In constipated subjects, two patterns of rectal-neck pressure profile could be recognized: inertia and obstructed (Figs. 11, 12).

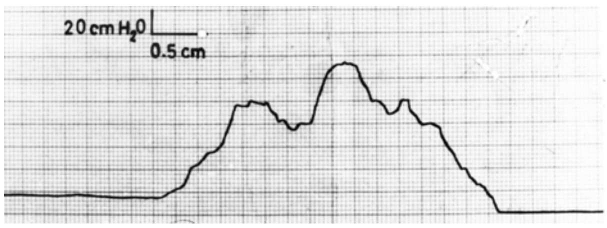

***Fig.11 -** Rectal neck pressure profile in constipated subjects with internal anal sphincterspasm. a) internal sphincter spasm, b) internal sphincter fibrosis.*

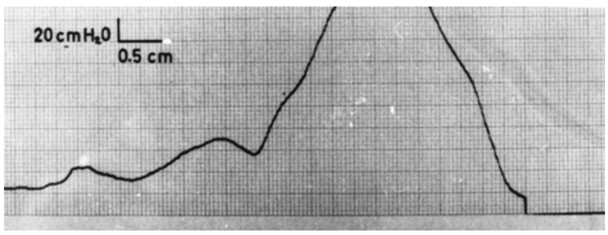

Fig.12 *- Rectal neck pressure profile in constipated subject with external anal sphincter spasm. It exceeded the limits of the chat.*

Each pattern had its characteristic parameters and curve configuration. In addition, the rectal-neck pressure profile was able to define whether obstructive constipation was caused by external or internal sphincter spasm and whether fecal incontinence was partial or complete. The rectal-neck pressure profile is useful in evaluating sphincter activity at various levels along the rectal-neck length. It also measures the individual sphincter activity. Furthermore, it can help to identify some types of constipation and fecal incontinence.

Water Enema Test

Anorectal investigations can also be performed by a recently introduced, simple office test – the water enema test (48). Water (1.5 l) contained in a graduated vessel and incubated at 37°C is instilled under gravity into the rectum through a 16F Nelaton catheter at a rate of 150 ml/min. The subject is asked to report on the first rectal sensation as well as on the desire and urge to evacuate. The volume of water infused at the time of these occurrences is determined and compared with standard levels in controls. Defecation disorders may be identified with this easy and noninvasive test.

Fecal-leak Test

To assess results of repair and the degree of fecal incontinence, another simple office test was performed in 24 patients with complete incontinence who had undergone direct suture operation (49). Rectal pressure and infusion volume were recorded during rectal filling with saline at a rate of 50 cc/min. Two rectal-leak pressures were determined: resting and coughing. Before incontinence repair, coughing rectal-leak pressure was significantly higher than the resting one whereas the infused saline volume at the two pressure levels showed an insignificant difference. After operative repair, 16 patients who became totally continent had no leakage. Six patients who improved following partial incontinence exhibited a significant increase in resting and coughing rectal-leak pressures compared with preoperative values. Infused saline volume at the two leak pressures also increased significantly. The two patients who remained incontinent after repair showed an insignificant difference in resting and coughing rectal-leak pressure or infused saline volume against prerepair levels. The degree of continence increased with the increase in resting and coughing rectal pressure. Resting rectal-leak pressure determines outlet resistance under normal conditions while coughing rectal-leak pressure determines outlet resistance under stress conditions. The rectal-leak pressure test is a simple, reproducible, and cost-effective test to assess incontinence and the results of treatment.

Transcutaneous Electrorectography

A transcutaneous recording of rectal electric activity, or an electrorectography, was obtained from 24 healthy volunteers with a mean age of 39.6 years (50). A silver-silver chloride electrode was applied laterally to each of the two sacroiliac joints, and a third one was placed midway between the left greater trochanter and ischial tuberosity. The reference electrode was applied to the right lower limb. At least two 20-min recording sessions were performed for each of the 24 subjects. In addition, an intrarectal electrorectographic recording was done in ten of the 24 subjects using silver-silver chloride electrodes attached to the rectal mucosa by suction. Pacesetter potentials (PPs) were recorded transcutaneously. The wave was triphasic, with a small positive, a large negative, and another small positive deflection (Fig. 13). PPs had a regular rhythm and were reproducible. The mean frequency was 3.1 cycles/min. Transcutaneously recorded PPs could be confirmed by the intrarectal route. Both routes had similar electrorectographic recordings except for the action potentials, which did not show in the transcutaneous electrogram.

Fig.13 *- Transcutaneous electrorectogram showing PPs. APs are not shown.*

Reflexometry

Additional investigative tools to obtain reliable, objective, and substantial information on the physiologic state of pelvic floor muscles and the nerves supplying them are the reflexes described above (21, 23-26, 51). Evaluation of reflex actions of the pertinent musculature contributes to establishing the diagnosis in anorectal disorders with even greater accuracy, in a more comprehensive manner, and in less time because the approach is direct. The technique follows an easy principle: A balloon-tipped catheter is introduced into the rectum and a needle electrode, inserted into the muscle to be tested, records the response of the muscle to distension of the rectal balloon. Detectable changes in latency or amplitude of motor unit action potentials or the evoked response may indicate a defect in the reflex pathway that could be due to muscle or nerve damage.

Management

When no organic pathology is present, the initial approach for the treatment of the uncomplicated constipation is dietary measures , physical activity and the use of laxatives, enemas or suppositories (52-56). Surgical treatment is not justified unless conservative therapy has been fully explored. There should be no psychological contraindication to operation and a primary metabolic or neurological disorder has been excluded (57-60).

Oultet obstruction is difficult to treat. A variety of therapeutic options have been explored but so far few have achieved long-term benefit. Biofeedback retraining the sphincter and pelvic floor to relax in response to rectal distension has been used (61). In children with internal anal sphincter hypertonia, response to treatment by anal dilatation or anorectal myectomy is promising (62,63). Other therapeutic modalities used in the treatment of constipation comprised of botulinum A toxin injection of the puborectalis muscle and sacral nerve stimulation (64).

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