3 Anorectal Manometry: Does It Improve the Pathophysiology Knowledge?

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3.1 Introduction

Anorectal physiology is very complex ensuring evacuation of bowel contents that is highly regulated and requires coordinated function of the colon, rectum, and anus [1].

Dysfunction of anorectum can lead to fecal incontinence that implies the inability to completely control defecation and/or symptoms of an evacuation disorder. Both of them can have a devastating effect on quality of life, involving in North America about 12–19% of the population [2–4].

The underlying etiology and pathophysiology of fecal incontinence and evacuation disorders are multifactorial. Although there are data demonstrating a pivotal role of clinical examination alone to treat these patients [5, 6], with the recent advances in diagnostic technologies, a symptom-based assessment seems unsatisfactory to direct therapy [7–9].

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As a consequence, the importance of anorectal physiologic testing is increasing more and more [10, 11]. Moreover, there are some studies which outlined that testing anorectal function influences clinical decision and even more, these tests are able to act as biomarkers predicting the response to treatment [12–15].

Ideally, all understood and measurable components that contribute toward continence or defecation should be assessed (Table 3.1). Nevertheless, no single test is able to fully characterize all components that cause fecal incontinence and/or evacuation disorders. This causes controversies on the usefulness of single test; however, when anorectal function assessment is available its clinical utility increases if it is performed in a structured and systematic manner [16].

Table 3.1 Clinical utility of diagnostic tests of anorectal physiological function [3]

Function	Investigation	Clinical use (utility)
Anus		
Motor	Anorectal manometry (conventional)	++++
	Anorectal manometry (high resolution)	++++
	Anorectal manometry (3D)	+++
	Electromyography	+++
	Pudendal nerve terminal motor latency	+
Structure	Endoanal ultrasonography	++++
	Transperineal ultrasonography	+++
	Endoanal or pelvic MRI	+++
	MRI muscle fiber tracking	+
	Electrostimulation	+
Sensory	Light-touch stimulation	+
	Anal evoked potentials	++
Rectum		
Sensory	Balloon distention	++++
	Rectal barostat	+++
	Rectal motor evoked potentials	++
Motor	Distal colonic manometry	++
	Rectal barostat	+++
	Rectal motor evoked potentials	+
Anorectal unit		
Motor, sensory	Anorectal manometry (conventional, high resolution, or 3D)	++++
	Balloon expulsion	++++
Motor, sensory, and structure	Barium defecography	++++
	Magnetic resonance defecography	+++
	Functional lumen imaging probe	+

+ Limited clinical utility or of research interest only
++ Emerging technology with limited data of clinical utility
+++ Recognized clinical utility but less commonly performer
++++ Good clinical utility and commonly performer

Anorectal manometry is the most established and widely available investigative tool, because it is able to detect functional diseases of anal sphincter and/or recto-anal coordination [17–19].

However, it is not a first level diagnostic technique, but it must be used after other morphological methods (radiological and/or endoscopic) had already excluded lesions of the large intestine and in particular rectum-anus. In clinical practice, in subjects with evacuation disorders (fecal incontinence or constipation with difficult evacuation) with no alarm signs (red flags) and symptoms refractory to first-line therapies such as lifestyle modification and optimization of stool consistency, it is justifiable to proceed with anorectal testing [20].

Therefore, in this chapter, the role of anorectal manometry is examined in relation to factors having effects on anorectal pathophysiology.

3.2 Definition

Anorectal manometry is an instrumental investigation able to evaluate the pressure of the anal canal and the distal rectum, providing motor and sensory information on functional phases of defecation and continence of the anorectal tract and of the pelvic floor muscles [17, 18].

It measures the luminal pressure at 6–8 cm above the anal verge and, in particular, it allows to evaluate:

- the high pressure zone (which refers to the length of the anal sphincter muscles);
- the involuntary function of the anal canal at rest,
- the voluntary anal function on squeezing,
- the rectoanal reflexes,
- the rectal sensitivity and compliance,
- the rectoanal coordination during simulated defecation (“push”),
- the capacity to expel a balloon [21–24].

3.3 Equipment for Conventional Manometry

Conventional anorectal manometry is a water perfusion system able to detect pressure values and stimulators of visceral sensitivity receptors existing in the rectal ampoule and in the anal canal.

It consists of four components: a probe, a pressure recording device (amplifier/recorder, pneumohydraulic pump, pressure transducers), a device for displaying the recording (monitor, printer, or chart recorder), and a data storage facility (computer, chart recorder) (Fig. 3.1) [17].

The manometric probes are represented by catheters with internal channels and perfused lateral openings with continuous flow of bi-distilled water or balloon catheters perfused with water or air (Fig. 3.2).

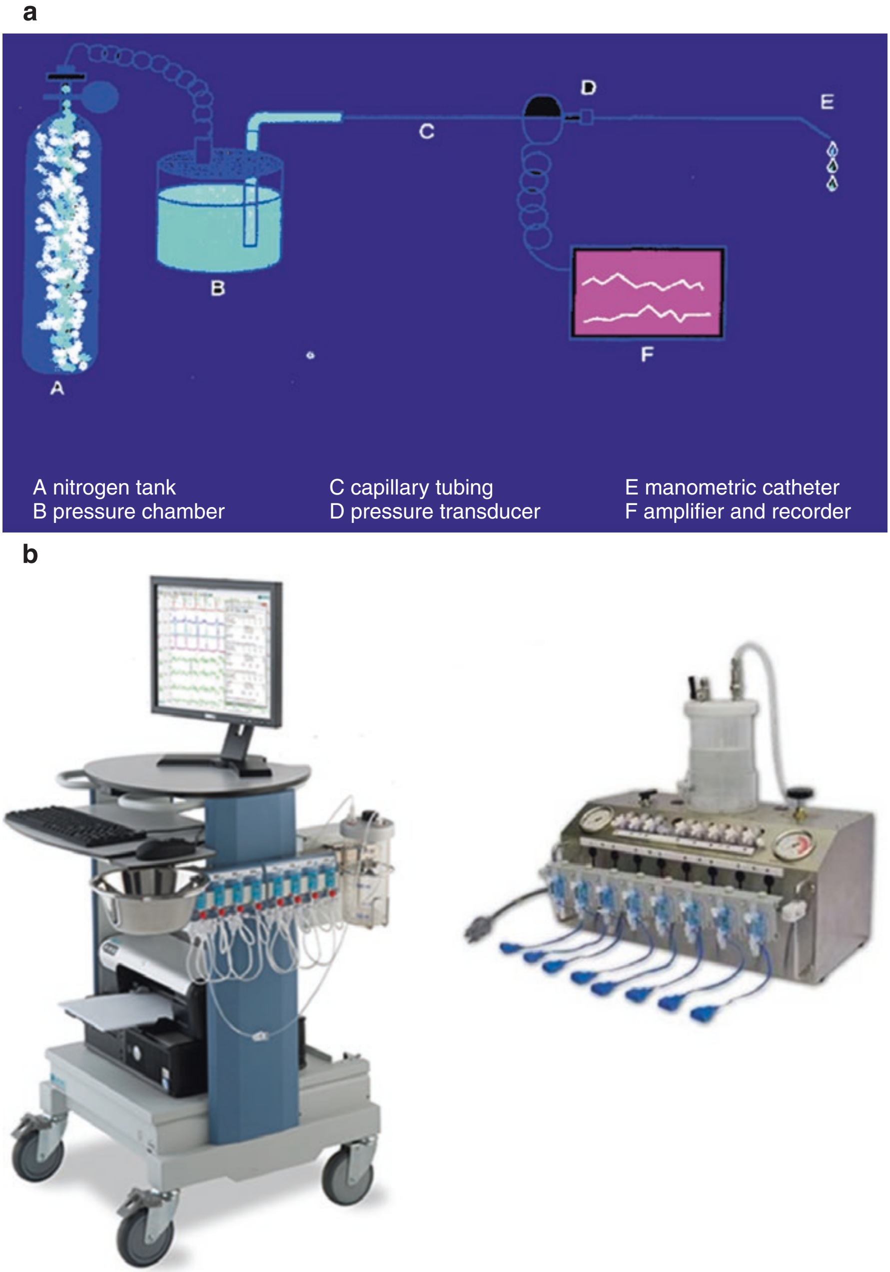


Fig. 3.1 (**a**) Schematic manometric assembly A nitrogen tank B pressure chamber C capillary tubing D pressure transducer E manometric catheter F amplifier and recorder. (**b**) Conventional anorectal manometric equipment

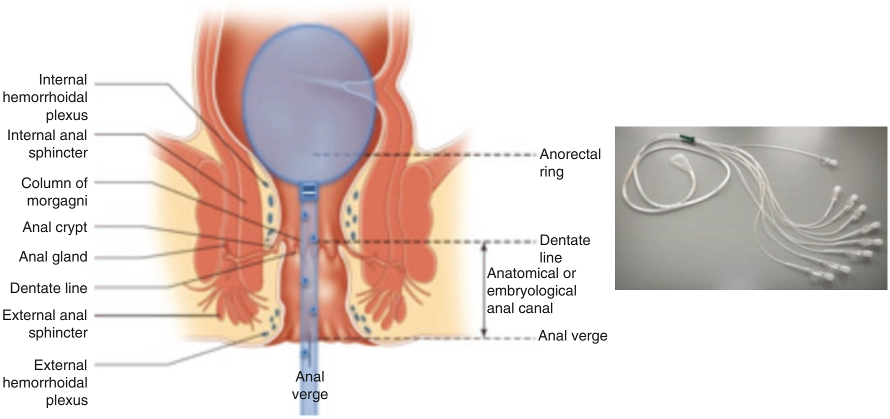


Fig. 3.2 Probe for conventional anorectal manometry

Anorectal manometry can be performed using different types of probes and pressure recording devices. Satisfactory measurements can be obtained also with solid-state microtransducers [25].

3.4 Anorectal Manometry Technique

The patient (who should not be fasting, but must do an evacuation enema a few hours before the examination) is placed in left lateral decubitus with overlapping thighs and bent at 90° on the trunk; the catheter is introduced into the rectum after calibration at the level of the anus.

A run-in period (about 5 min) should be performed to allow the patient relaxing and sphincter tone returning to its physiologic baseline [26].

The integrity of anal sphincter function is assessed by measurement of resting sphincter pressure, the functional length of the anal canal, and squeeze sphincter pressure.

1. Anal resting tone and the functional length of anal canal

   During the first phase of anorectal manometry, the extraction of the probe manually in 1 cm steps (stationary pull-through technique) or at constant speed using an automatic extractor arm (motor pull-through technique) allows to evaluate the functional length of the anal canal and the anal resting tone.

   The functional length of anal canal (high pressure zone, HPZ) is defined as a region (or length) over which resting pressures are ≥30% higher than rectal pressure [27].

We can calculate the mean resting anal pressure since it is the average of all the pressures detected in the HPZ and, the maximal resting anal pressure, defined as the difference between intrarectal pressure and the highest recorded anal sphincter pressure at rest, generally recorded 1–2 cm from the anal verge. Physiologically the anal resting tone is predominantly due to internal anal sphincter (IAS) activity (55–80%, most due to nerve-activity and the remainder purely myogenic) [28], expression of an involuntary function, and to a lesser extent external anal sphincter (30%) and hemorrhoidal pads (15%). Resting sphincter pressure varies according to age, sex, and techniques used. Usually, pressures are higher in men and younger subjects, but with considerable overlap [18, 29, 30].

According to perfused catheter anorectal manometry, the recorded anal canal is often asymmetric. In the proximal anal canal, anterior quadrant pressures are lower than the other quadrants at rest while distally, posterior quadrant pressures are reduced, and in the mid anal canal radial pressures are generally equal in all quadrants [26, 29, 31]. Furthermore, conventional anorectal manometry allows to obtain, through a specific software, the two-dimensional reconstruction of the pressure profile of the anal canal (vector volume) with a detailed evaluation of the pressure asymmetries caused by possible sphincter anatomic pathologies. However, these data are today better obtained through three-dimensional sphincter ultrasound [32].

2. Maximal squeeze pressure and maximal squeeze duration

   During the second phase of anorectal manometry patients were asked to squeeze the anus as hard as possible, avoiding contracting the accessory muscles and, in particular, limiting gluteal muscle involvement. Moreover, the squeeze should be maintained for 30 s, to obtain a measure of fatigability of the external anal sphincter (EAS) [17]; during the squeeze maneuver, the maximal voluntary pressure is recorded at each station to detect appropriate external sphincter activity.

   The maximal squeeze pressure is measured by evaluating the difference between the pressure increments during a maximal voluntary contraction and the basal resting tone at the same level of the anal canal [8, 17, 27].

   The sphincter endurance is the time interval at which the patient is able to maintain a squeeze pressure above the resting pressure, in particular greater than or equal to 50% of the maximum squeeze recorded pressure [17, 27, 33].

   Both of these measurements primarily reflect the strength and fatigability of the EAS [11, 19, 33, 34].

3. The integrity of neural reflex pathway is assessed by measurement of anocutaneous reflex, cough reflex, and rectoanal inhibitory reflex (RAIR)

   (a) Anocutaneous reflex and cough reflex

      The anocutaneous reflex is detected by crawling a needle on the perianal skin; Valsalva reflex evaluation is obtained by inviting the patient to cough. Specifically, cough increases abdominal pressure and, rectal pressure trigger a reflex contraction of the external anal sphincter. The integrity of Valsava reflex acts to maintain anal continence in urgency. This contraction is recorded with an increase in the pressure obtained by the manometer, and cough pressure is calculated as the difference between the maximum pressure recorded during cough and the resting pressure at the same level in the anal canal. Physiologically, it must be higher than the anal canal.

(b) Rectoanal inhibitory reflex (RAIR)

Rectoanal inhibitory reflex (RAIR) is measured by recording the resting anal pressures during rapid and intermittent inflation of a distal rectal balloon, positioned at the apex of the manometric catheter: the balloon is inflating with air, (10 or 20 mL aliquots, up to about 50–60 cc or higher volumes in some cases with chronic constipation and megarectum); in this way is recorded the threshold volume needed to elicit the reflex.

The rapid distention of the rectum leads to a transient increase in rectal pressure (due to secondary rectal contraction—the rectoanal contractile reflex), followed by a transient increase in anal pressure (due to EAS contraction) and finally a prolonged reduction in anal pressure, due to relaxation of IAS (the rectoanal inhibitory reflex); this last is thought to allow sampling rectal contents by sensory area present in the anal canal, allowing discrimination between flatus and fecal matter (solid, liquid, and gas); conversely, the rectoanal contractile reflex is a compensatory mechanism that allows the maintenance of a positive anal pressure during increase of intraabdominal or intrarectal pressure (e.g., coughing) which is essential for continence [8, 34].

4. The assessment of rectal sensibility and rectal compliance

Testing rectal sensitivity is generally performed with a balloon distention, positioned in the rectum, filled (manually using a hand-held syringe or pump-assisted) with air or water. It is able to record intraballoon pressure expression of rectal pressure and distending volumes by means of incorporating water-perfused catheters or microtransducers. During the test, patient is instructed to report the first sensation that is the minimum rectal volume perceived by the patient, desire to defecate, urgency that is the volume associated with the initial urge to defecate, maximum tolerated volume that is the volume at which the patient experiences discomfort and an intense desire to defecate, and pain. These sensory thresholds are recorded (through the distending volume or less frequently the pressure) [3, 8, 35].

This assessment allows also to calculate rectal compliance from the derived pressure–volume curve: it is defined as the “volume response to an imposed pressure,” and represents the change in rectal pressure in response to changes in rectal volume (change in volume divided by change in pressure = $\Delta V/\Delta P$). In response to distention, the rectal wall is able to have an “adaptive relaxation” at the beginning due to its viscoelastic properties and this allows accommodation of significant increases in volume despite low intraluminal pressures, so that continence is guaranteed; continuing distention the rectum becomes more resistant to stretch until the elastic limit is reached and regular contractions start, causing an increase of intrarectal pressure [36, 37].

Despite large variation, in literature there is a high degree of reproducibility about recording sensory thresholds [38, 39], and many consensus statements and technical reviews have attested that this test is useful in the assessment of functional intestinal disorders [16, 18, 34].

Another test to get rectal sensitivity makes use of an electronic barostat. Briefly, the barostat maintains a constant pressure on the inside of a bag containing air by means of feedback. The feedback mechanism consists of a strain gauge connected to an injection/aspiration system by means of a relay. Both the strain gauge and the injection/aspiration system are independently connected by a double-lumen polyvinyl tube, one lumen is used for inflation, the other for monitoring pressure, to a non-elastic, oversized, polyethylene ultrathin bag and so very compliant to avoid any influence on internal pressure. A dial allows the selection of the desired pressure level. Pressure and volume within the bag are continuously recorded [40–42]. Measurement of rectal compliance and capacity using the barostat are more specific than those using balloon, considering that this last needs correction because of its intrinsic elasticity. Although barostat is less available, it is advisable to consider it in patients with alterations of rectal sensation already assessed by balloon distention and/or with a strong suspicion of abnormal rectal compliance or capacity [17, 33].

5. The assessment of attempted defecation.

   In patients with symptoms of disordered evacuation, the manometric assessment of rectoanal coordination during defecatory maneuvers can help in the diagnosis.

   During this part of anorectal testing, the patient is asked to strain or bear down, as during defecation, while pressures of anus and rectum are detected simultaneously; normally an increase in intrarectal pressure is detected, due to the Valsava maneuver, associated with a decrease in intraanal pressure, due to coordinated relaxation of the EAS; these mechanisms facilitate the process of defecation, allowing propulsive forces to drive stool easier through the anal canal with learned response under voluntary control [20, 21].

   When defecation is impaired during ARM is possible to observe inadequate rectal propulsive force and/or inadequate relaxation or paradoxical anal contraction [20, 43–45].

   Specifically, four patterns of pressure changes seen in the rectum and anus during attempting defecation have been described [33, 44, 46].

   Type 1: increase of rectal propulsive pressure (rise in intraabdominal pressure with generation of an adequate pushing force) with paradoxical increase of anal pressure as well.

   Type 2: inadequate rectal propulsive pressure (no increase in intrarectal pressure) with paradoxical anal contraction.

   Type 3: adequate rectal propulsive pressure (increase in intrarectal pressure) with absent or incomplete anal relaxation (≤20%) (i.e., no decrease in anal sphincter pressure).

   Type 4: inadequate rectal propulsive pressure and absent or incomplete anal sphincter relaxation (≤20%) (Fig. 3.3) [44, 46].

   Unfortunately, some of that abnormal manometric patterns (for example an abnormal reduced rectoanal pressure gradient) during simulated evacuation are found in more than 50% of the asymptomatic subjects and, therefore, the diagnosis of functional defecation disorders cannot rely only on anorectal manometry [2, 8, 33, 44].

   According to Rome III criteria, diagnosis of functional defecation disorders is possible in presence of (1) constipation symptoms, (2) the presence of inadequate rectal propulsive force and/or inadequate relaxation or paradoxical anal contraction at ARM (or electromyography), and (3) at least another positive test among balloon expulsion test or impaired rectal evacuation by imaging [47].

   The new Rome IV diagnostic criteria for functional defecation disorders (Table 3.2) incorporates also IBS with constipation patients [48]. In addition, the diagnosis of dyssynergic defecation has been limited to the finding of paradoxical anal contraction at either ARM or pelvic floor electromyography.

3.4.1 Balloon Expulsion Test (BET)

This is the simplest procedure for evaluating a patient's ability to evacuate a stool surrogate. It can be performed alone or to implement ARM results. A 16 F Foley that acts as water-filled balloon is placed in the rectum and filled up with 50 mL of warm water to simulate stool; it is possible to use air in place of water; however, the last is better for a more accurate simulation of a fecal bolus. The patient is invited to push for the expulsion of the device on a commode chair or in a private toilet. Recording the time needed to evacuate the balloon is critical to define normal values.

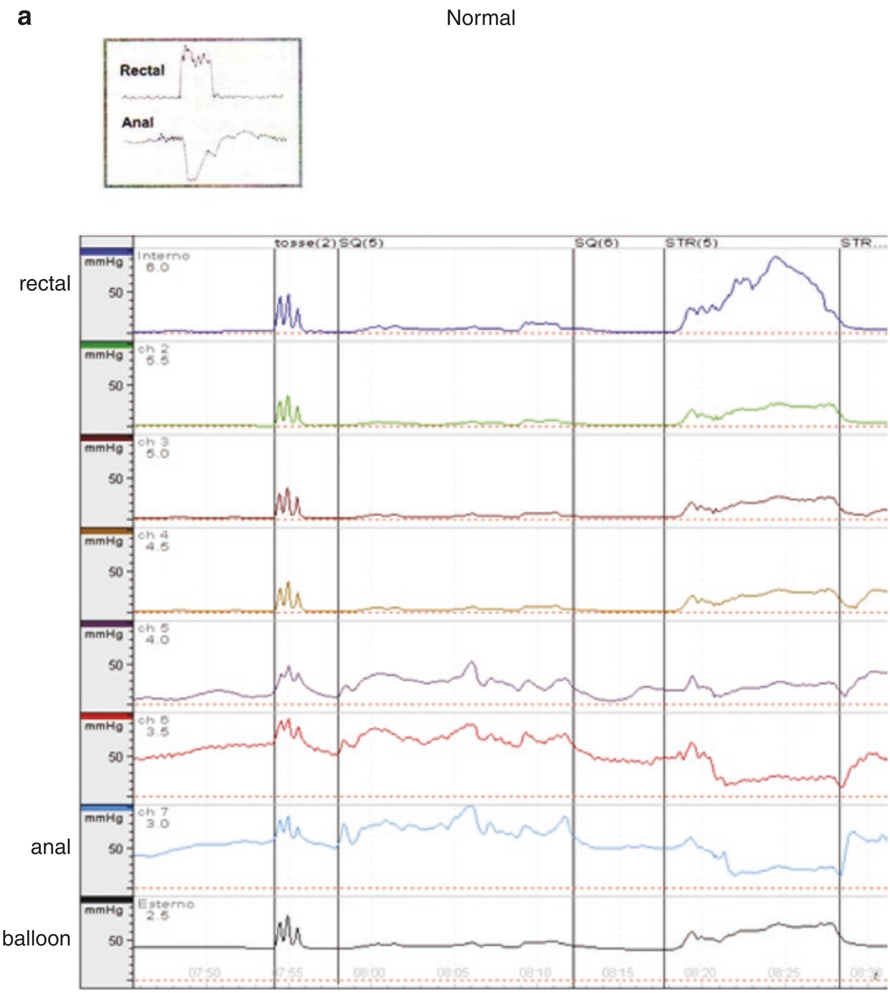
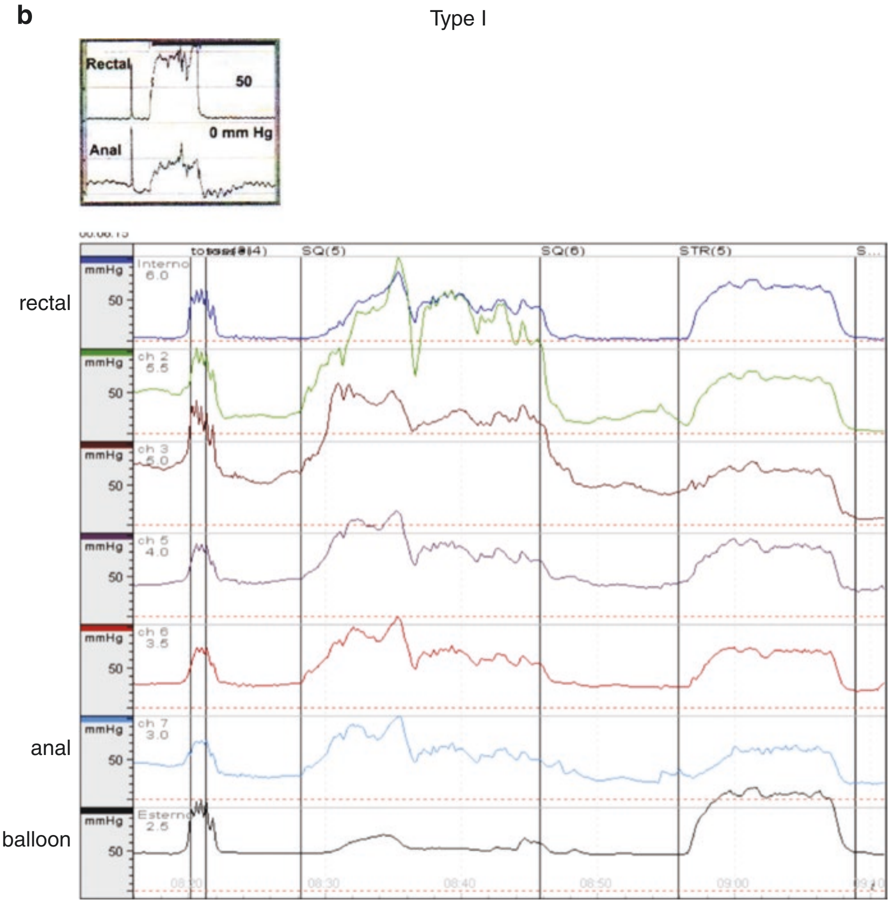


Fig. 3.3 Manometric pattern: attempted defecation (modified by Rao [46]). (**a**) Normal. (**b**) Type I. (**c**) Type II. (**d**) Type III. (**e**) Type IV



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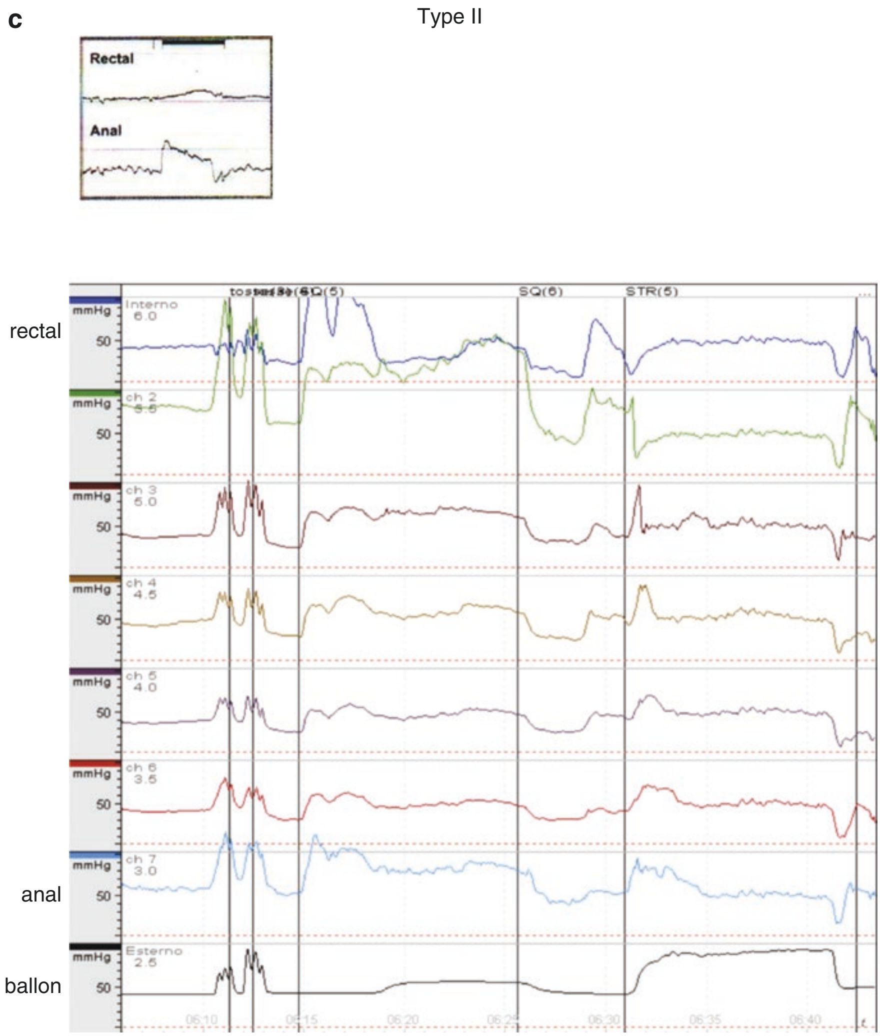
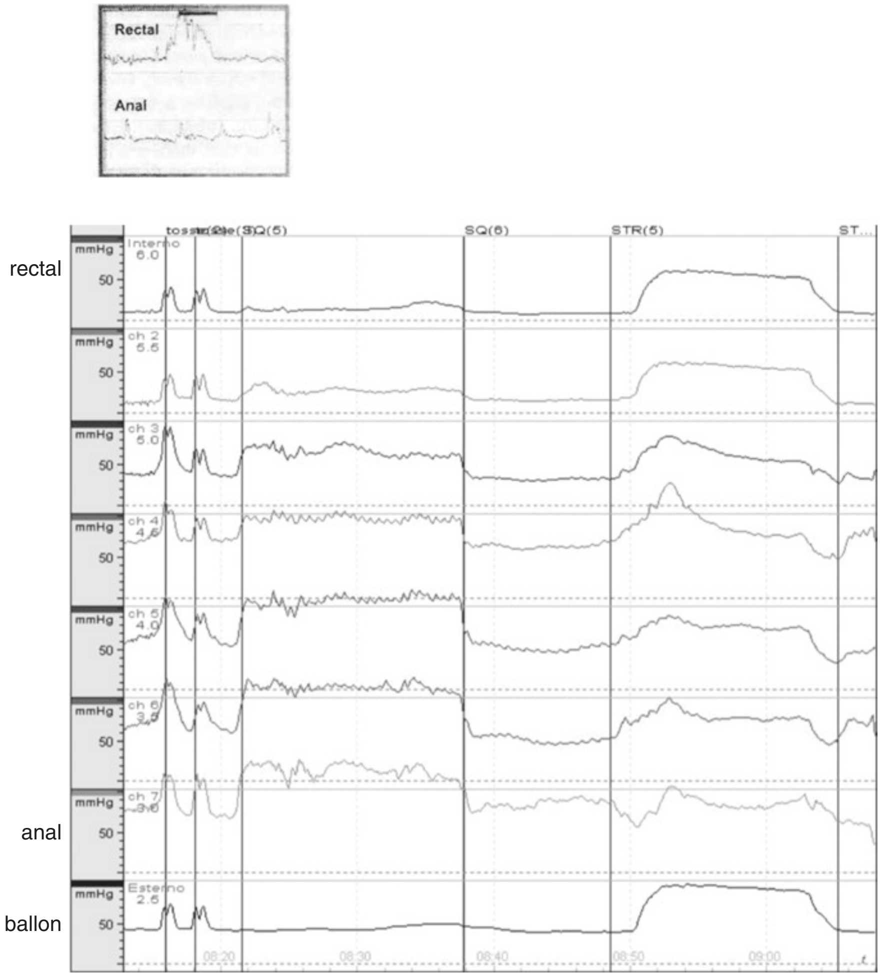


Fig. 3.3 (continued)

d Type III



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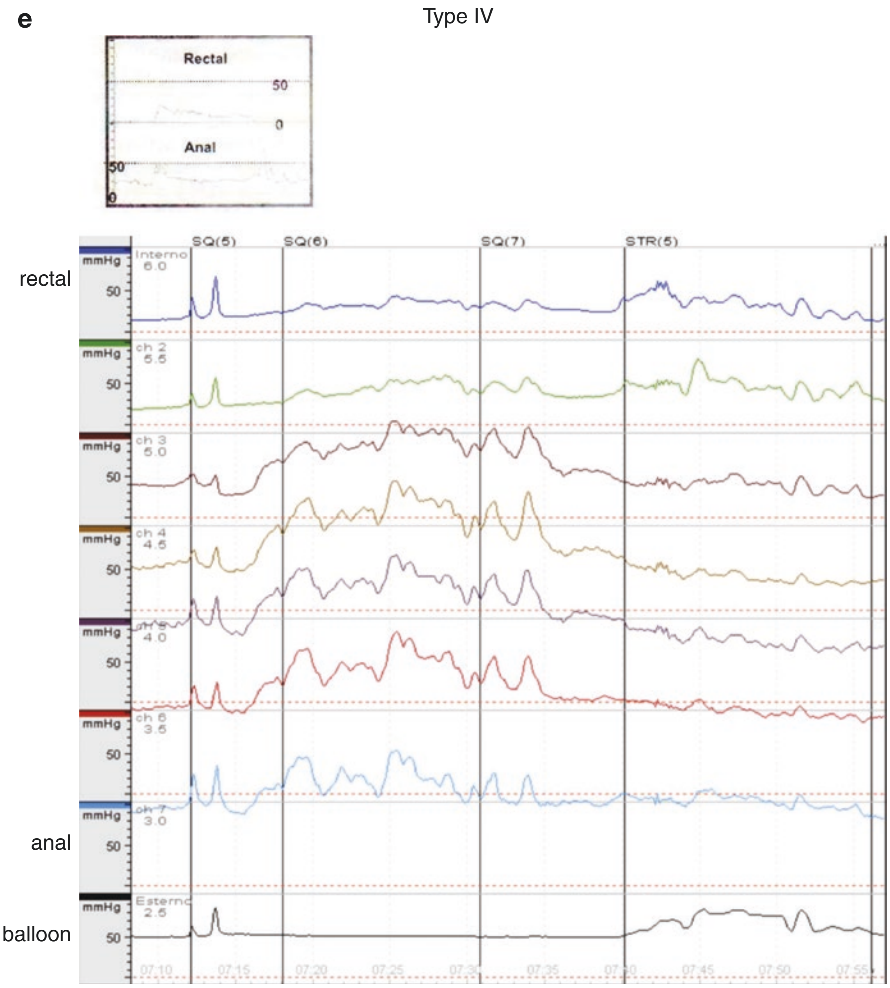

Fig. 3.3 (continued)

Most normal subjects can expel a stool surrogate device within 1 min [8, 20, 49], but although reported cut-off for normality is variable, the generally accepted limit for expulsion is between 1 and 2 min; expulsion times longer than this can suggest defecation disorders or dyssynergic defecation (DD) [8, 33, 49, 50].

ARM should be performed in conjunction with a BET. A recent large cohort study found BET to have a high level of agreement with both ARM and pelvic floor surface electromyography in CC [51].

BET might be performed using the same manometric catheter, at the end of ARM.

Table 3.2 Diagnostic criteria for functional defecation disorders according to Rome IV criteria (modified from [48])

1. The patient must satisfy the diagnostic criteria for functional constipation and or/irritable bowel syndrome-predominant constipation.
2. During repeated attempts to defecate, there must be reduced evacuation characteristics coming from two of the following three tests:
• Anomalous balloon ejection test
• Anomalous model of anorectal evacuation with manometry or EMG of anal surface
• Impairment of evacuation through image acquisition
Criteria should be satisfied for the last 3 months with onset of symptoms at least 6 months before diagnosis
Sub-categories F3a and F3b apply to patients who satisfy the FDD criteria
F3a diagnostic criteria for inadequate defecatory propulsion
Anomalous energy of contraction evaluated with manometry with or without insufficient contraction of the anal sphincter and / or pelvic floor muscles
F3b diagnostic criteria for dyssynergic defecation
Inadequate contraction of the pelvic floor evaluated with EMG of anal surface or manometry with adequate propulsive forces during the defecation
These criteria are described in relation to normal values for the technique appropriate for age and sex

3.4.2 ARM and Pathophysiology

The role of manometric examination allows to recognize multiple mechanisms underlying the most frequent anorectal disease (Table 3.3).

In this part of the chapter, we revise several anorectal disorders enhancing the multiple pathophysiological mechanisms that can be assessed by ARM.

1. Fecal Incontinence (FI)

   FI or involuntary rectal outflow represents the instability to control discharge of gas and stools, with involuntary discharge of them, and occurs when multiple mechanisms of continence (from visceral sensitivity to sphincter tone, to the contractile capacity of striated muscles) are compromised at the same time, even in various ways, so patient reports symptoms like increased frequency or extreme urgency of evacuation, tenesmus, difficulty in holding the stool in case of urgency [56–58].

   The manometric examination is very important in these patients:

   - sphincter hypotonia (low anal resting pressure) that is associated with passive fecal incontinence, often due to degeneration or rupture of smooth muscle ring (IAS activity is the primary component contributing to anal resting tone) [52, 59]. However, ARM may detect very low basal pressures also in continent patients, and in other way incontinent patients may present normal resting tone [22, 60]. As a consequence, measurement of resting tone must be considered in combination with other functional tests [34].
   - symptoms of urge or stress fecal incontinence (urgent need to defecate with inability to arrive to the toilet in time) are often associated with low anal squeeze pressures and suggest strength and fatigue of EAS due to a sphincter

Table 3.3 Pathophysiological mechanism causing fecal incontinence

Function	Investigation	Finding	Examples of disorders
Anus			
Motor	Anorectal manometry	Anal hypotonia	Passive fecal incontinence due to muscular damage (IAS weakness for smooth muscle ring rupture or degeneration): • Obstetric injury • Cauda equina • Myelomeningoceles • Multiple sclerosis • Pudendal neuropathies • Demyelination injury • Diabetes • Spinal cord injury • Stroke • Aging • Dementia/disability • Psychosis • Drugs (laxatives, antidepressants, anticholinergics, caffeine, muscle relaxants) [8, 18, 19]
		Anal hypertonia	Fissures or hemorrhoidal plexuses Chronic constipation [3]
		Anal hypocontractility	Urge or stress fecal incontinence due to EAS weakness for muscular damage: • Obstetric injury (major causative factor) • Neuropathy • Diabetes • Spinal cord injury • Stroke [8, 18, 19, 52]
Rectum			
Sensory	Balloon distension	Rectal hypersensitivity	Urge fecal incontinence Inflammatory bowel diseases Actinic proctitis Rectal neoformation Surgery of the rectum IBS-D [39, 42, 53, 54]
		Rectal hyposensitivity	Fecal impaction (fecal seepage) Chronic constipation Defecation disorders IBS-C Spinal cord injury [8, 35, 50]
Motor sensory and structure	Rectal balloon or barostat	Rectal hypercompliance	Megarectum (lax-floppy rectum) Chronic constipation [50]
		Rectal hypocompliance	Rectal fibrosis (stiff rectum) for chronic ischemia, inflammatory bowel disease (IBD), or pelvic irradiation IBS-D Urge fecal incontinence [8, 34]
Anorectal unit			
Motor	Balloon expulsion	Prolonged expulsion time	Fecal incontinence Chronic constipation
	Anorectal manometry	Anorectal areflexia	Fecal incontinence Hirschsprung's disease Chronic constipation [8, 52, 55]

Irritable bowel disease predominant diarrhea (IBS-D), Irritable bowel syndrome-predominant constipation (IBS-C) damage (with the major causative factor being obstetric injury) or associated neuropathy [22, 52, 58]. Moreover, also squeeze duration (endurance) is significantly reduced in incontinent patients versus controls [61]; among all measurements of anorectal function, anal squeeze has been shown to have the greatest sensitivity and specificity for discriminating patients with fecal incontinence from continent subjects [8, 60, 62].

- a difference in rectoanal inhibitory reflex compared with controls: the amplitude and duration of this intramural reflex correlate with distending volumes and in clinical practice an abnormal reflex may correlate with clinical or subclinical neuropathy. In particular, in patients with urge incontinence is possible to record an abnormal reflex response, associated with attenuated voluntary squeeze pressure, which could indicate a neural damage of the sacral arc (spinal sacral segments or pudendal nerves); these patients may have a lesion of the cauda equina or sacral plexus, a pudendal neuropathy or a peripheral neuropathy (e.g., diabetes) [19, 34, 63].
- rectal hypersensitivity that can be frequently found in certain patients with urge fecal incontinence [8], as well as in patients with diarrhea-predominant bowel disease (IBS) (the more severe the IBS, the more hypersensitive the patient is) [39, 42, 53, 64]. Rectal hypersensitivity can also be associated with a reduction in the distensibility of the rectum ("stiff" rectum), with symptoms like urgency and frequent defecation, for example in rectum with fibrosis (i.e., inflammatory bowel diseases (IBD), chronic ischemia, actinic proctitis, rectal neoformation, and in patients undergoing resection surgery of the rectum [32, 34, 54]. In this situation the calculated compliance is reduced.
- impaired evacuation and impaired rectal force during attempted defecation (push) in most patients with fecal incontinence, especially those with fecal seepage. They might be unable to expel the balloon from rectum in 2 min suggesting the presence of an underlying disorder of defecation, often associated with hyposensitivity [34, 65–67].

2. Chronic Constipation (CC)

There are three underlying pathophysiological mechanism of chronic constipation (CC) recognized from transit studies: CC with normal transit (NTC) where the subject has symptoms of constipation but colorectal transit time is normal, CC with slow-transit constipation (STC) with abnormally slow transit throughout the whole colorectum, and CC with outlet obstruction where transit is mainly delayed in the distal colorectum.

Using ARM 27–59% of patients with chronic constipation can be classified with functional defecation disorders or dyssynergic defecation (DD), which refers to the paradoxical contraction or inadequate relaxation of the pelvic floor attempted defecation; an overlap of dyssynergic defecation and irritable bowel syndrome-predominant constipation (IBS-C) is commonly present [44, 68, 69].

However, the ARM diagnosis of a functional defecation disorder has to be supported by the evidence of impaired evacuation by either BET or imaging, according to the Rome IV criteria.

Moreover, a diagnosis of a functional defecation disorder is a predictor of successful biofeedback outcome in constipated patients [5, 21, 70].

The manometric examination allows recognizing in CC patients:

- Impaired rectal sensation. Threshold for first sensation and desire to defecate can be higher in 60% of patients with DD and are associated with an impaired rectal sensation, generally an increased rectal compliance, with rectal hyposensitivity, indicative of an excessively lax (floppy) rectum; higher volumes of rectal distention are required to elicit perception also in patients with important dilatation of the rectum (megarectum) [8, 46, 64, 71]. Rectal hyposensitivity can predict a poor response to treatments such as biofeedback or surgery because it indicates a severe clinical phenotype [72]; however, it has been described an improvement of symptom [66, 73], especially during treatment with neuromodulation [13].
- A subgroup of patients with DD can have structural disorders found on evacuation proctography or magnetic resonance imaging [69].
- An absent rectoanal inhibitory reflex in adult is more often due to chronic constipation with megacolon [33]; however, a failure of reflexive IAS relaxation in ARM allows the diagnosis of congenital ganglia of the myenteric plexus, Hirschsprung's disease; most cases of Hirschsprung's disease are detected in childhood, while short segment Hirschsprung's disease can be present in adulthood [32, 52].
- Very often more than one abnormality can be found in the same patient and abnormal tests are common among healthy subjects without symptoms of CC. Thus, no test can stand alone in the evaluation of individual patients.

3. Chronic Proctalgia

Chronic or recurrent pain in the anal canal, rectum, and pelvis can be detected in 7–24% of the population and is associated with impaired quality of life and high health care costs [74]. After the exclusion of organic causes, ARM allows to evaluate the presence of functional anorectal pain disorders or sphincter hypertonicity.

Functional anorectal pain disorders include both proctalgia fugax and levator ani syndrome (LAS), characterized by recurrent pain localized to the anus or lower rectum without evidence of anorectal disease; the first is defined by Rome IV criteria [48] as recurrent episodes of midline anal pain, lasting from seconds to minutes, <20 min, unrelated to defecation, for at least 3 months, with absence of anorectal pain between episodes; in a small group of patients with severe proctalgia, there may be a myopathy of the IAS [18, 65]. The second is characterized by recurrent anorectal pain occurring in episodes lasting >20 min, worse when sitting than standing; the symptoms may also include a chronic sensation of rectal fullness, urge to defecate, and tenderness during traction on the puborectalis [18].

Etiology is poorly defined, but a chronic spasm in the striated muscles of pelvic floor is often thought to be the pathophysiological mechanism for most of them. However, DD has been recently reported to be relevant etiology, even for patients without constipation symptoms [74].

In a large randomized controlled trial biofeedback, electrogalvanic stimulation and massage were compared for the treatment of chronic proctalgia. Biofeedback showed a success rate of 85% in patients with evidence of tenderness in response to traction on levator ani muscle. This is a physical sign suggestive of striated muscle tension [74].

In patients with chronic proctalgia and a normal structural evaluation, DD may play a role beyond constipation; hence, in these patients ARM with BET should be employed early to diagnose DD. In fact, impaired pelvic floor muscle relaxation and abnormal BET have been shown to be related to anorectal pain and have a favorable response to biofeedback therapy [66].

4. Preoperative and postoperative evaluations of patients with anorectal disease

   Candidates to ARM are patients with anorectal pathologies (prolapse, fissures, hemorrhoids, tumors) or with RCU in view of recanalization after Hartmann's intervention or to evaluate the feasibility of an ileo-anus-anastomosis. The comparison between the data detected by pre- and post-surgery manometry can provide useful information to interpret the causes of any disturbances or problems that have arisen or otherwise remained unchanged.
5. Finally, the role of manometry for *Legal Medical Purposes* should not be underestimated: the possibility of documenting what the intervention performed has modified in terms of rectal-anal functionality, might be supporting a negative diagnosis of procedure related symptoms.
6. Biofeedback Therapy (BFT)

   The anorectal manometry contributes significantly to the recognition of defecation disorders or dyssynergic defecation (DD) and it provides the main indication for rehabilitation programs through the implementation of a biofeedback training for the recovery of anorectal and pelvic floor function [75].

   This therapy is an "operant conditioning" technique, in which information about a physiological process (recorded by electromyographic sensors or manometry) is converted into a specific signal able to teach the patient to control a function. This allows to restore a normal pattern of defecation, correcting dyssynergia or incoordination of abdominal and pelvic floor muscles and anal sphincter, to obtain a normal and complete evacuation, and to improve perception in patients with impaired rectal sensation [20, 46, 55].

   Moreover, patients can learn to expel an air filled balloon, and if reduced rectal sensation is present, they can learn to recognized weaker sensations of rectal filling, through sensory retraining [20]. Rehabilitation therapy may also include measures to improve pelvic floor contraction (i.e., Kegel exercises) [66].

   BFT has 70–80% of efficacy in randomized controlled trials, more effective than diet or pharmacological therapy (polyethylene glycol or diazepam or placebo) [33, 66, 76–79].

   Long-term studies have shown that its beneficial effect is maintained for more than 2 years after treatment [66, 80, 81], although important alteration of sensitivity and compliance have an unfavorable prognosis on BFT results.

   BFT has been shown efficacy in about 76% of patients with FI [82] and is recommended when conservative management failed [83–85]. However, metaanalyses suggest that the efficacy of BFT in FI is still controversial [86]. It is widely accepted that a reduction in FI episodes/week by ≥50% can be considered a valid and clinical outcomes measure, and it correlates well with bowel symptoms and its severity [85–87].

3.5 Contraindications to Arm

Relative contraindications are the presence of bloody fissures and active proctitis of different etiology; in these cases the manometric procedure can exacerbate the pain and produce an important anorectal bleeding.

Absolute contraindications are represented by recent surgical interventions on the anorectal region, poor patient compliance to procedure, and severe anal stenosis.

3.6 Limitations of ARM

The interpretative difficulties of the results, due to wide variability and overlap of manometric measurements in health and disease, the discussed impact on the outcomes of patients, the high costs of dedicated equipment, strongly limit the use of anorectal manometry in clinical practice, as well as its widespread diffusion [3].

Moreover, the anorectal manometry is characterized by a certain intra- and inter-operator variability, both in the execution of the examination (given the considerable heterogeneity of the available instruments) and in the interpretation of the results.

The recent use of the new computerized technologies, the elaboration of standard execution protocols [17], and the publication of the normality limits of the manometric parametric principles [25, 26, 33, 88–90] have partly reduced intraoperator variability, contributing to the standardization of the anorectal manometry both in the executive and interpretative aspects.

3.6.1 High-Resolution Anorectal Manometry

Recently, an advanced high-resolution anorectal manometry (HRAM) (or high definition manometry—HDAM) has been introduced, providing a dedicated software and specific solid-state probe with sensors able to provide a detailed topographic and colorimetric mapping of the anorectal and a more intuitive evaluation of the anorectal function without the need for pull-through of the catheter [91, 92].

This new technique would be able to show in detail the various subgroups of patients with dyssynergic defecation and detect the defects of the anal sphincter at rest and during squeeze in great detail [44, 93].

HRAM is significantly more expensive and is more likely to be found at high-volume academic centers but allows interpretation of topographical plots of anorectal function. Conventional ARM allows an inexpensive screening test for community practitioners often requiring less space and staff support. Because of the significant differences in testing equipment available and interoperator differences in performance and interpretation of test, there is a large amount of heterogeneity in the results of ARM. Furthermore, the high costs of the technology still strongly limit its diffusion and therefore its use in clinical practice [33].

Use of HRAM seems to be more intuitive, showing a large amount of data into a detailed color topography. HRAM is very clever to stratify patients with DD into subgroups, and this could allow to incorporate the multiple parameters derived from HRAM into a classification scheme similar to the Chicago classification that has revolutionized the diagnosis of esophageal motility disorders [93, 94].

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