Chapter 2
Overview of Testing of Motility and of the Anorectum

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Chapter Objectives

At the conclusion of reading this chapter, the reader will be able to:

1. Recognize that routine testing is not indicated in the absence of alarm signs and symptoms.
2. Describe options for testing for the symptom of constipation.
3. Define what parameters are evaluated in each type of testing option.
4. Evaluate a patient presenting with constipation.

Key Points

Diagnostic testing is not routinely recommended in the initial evaluation of constipation in the absence of alarm signs. Testing should be targeted at symptoms or signs elicited in the history or physical that suggest an organic process.

1. Colonoscopy is indicated in all patients over 50 years of age (consider 45 years of age in African Americans and the obese) who have never had colorectal cancer screening and in those with alarm symptoms.
2. Anorectal manometry, along with the rectal balloon expulsion test, should be performed in patients who fail to respond to laxatives or empiric medical therapy for constipation.
3. Anorectal manometry systems quantify internal and external anal sphincter function at rest and during defecatory maneuvers, rectal sensation, and compliance.

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4. The balloon expulsion test can help identify, but does not exclude, a functional defecation disorder.
5. Colonic manometry may help identify colonic neuropathy, myopathy, or normal colonic function before consideration of colectomy in patients with severe constipation.
6. Standard defecography provides dynamic evaluation of the pelvic floor and can indicate the presence of rectal prolapse, enterocele, rectocele, intussusception, cystocele, and perineal descent.
7. Dynamic pelvic MRI is the only imaging modality that can evaluate global pelvic floor anatomy as well as the anal sphincter without radiation exposure.
8. Colonic transit studies are recommended if anorectal testing results do not show a defecatory disorder or if symptoms persist despite treatment of a defecatory disorder.

Introduction

Chronic constipation can be divided into two main categories: primary and secondary. Primary constipation is further divided into the following main types: normal transit constipation, slow transit constipation, and pelvic floor dysfunction. There can be overlap of primary types of constipation, as with slow transit and pelvic floor dysfunction, or pelvic floor dysfunction and normal transit [1]. Secondary constipation may be due to diet, medications, and underlying medical conditions (see Chap. 7).

Evaluation of constipation begins with a detailed history and physical examination, including an adequate visual and digital anal examination. This initial assessment will aid in determining primary and secondary causes of constipation, as well as the presence of alarm symptoms (Table 2.1). Diagnostic testing for constipation is not routinely recommended early on in the absence of alarm signs. Rather, a treat and test approach is practical and cost-effective, where testing can be pursued in

Table 2.1 Alarm symptoms in chronic constipation

Hematochezia
Heme-positive stools
Iron deficiency anemia
Rectal prolapse
Obstructive symptoms
Acute onset of constipation
Unintended weight loss
Family history of colon cancer
Change in stool caliber

From Gallegos-Orozco, J.F., Foxx-Orenstein AE, Sterler M, et al., *Chronic constipation in the elderly*. Am J Gastroenterol, 2012. 107(1): p. 18–25; quiz 26, with permission patients refractory to conservative treatment. Diagnostic testing is often targeted at symptoms or signs elicited in the history or physical that suggest an organic process and should be employed if the information gained is apt to alter treatment. Not all patients require the same diagnostic approach. The objective of this chapter is to review diagnostic modalities key to assessing the anorectum, and their utility in the management of chronic constipation.

Colonoscopy

When alarm symptoms are present (Table 2.1), a dedicated evaluation of the colon with colonoscopy, or in selected cases, computed tomographic colonography or flexible sigmoidoscopy should be performed [1]. Colonoscopy is indicated in all patients over 50 years of age who have never had colorectal cancer screening and many experts recommend screening begin at age 45 for African Americans and for obese individuals due to the detection of pathology at a younger age in these populations. Endoscopic inspection of the colon, and the anorectum viewed in direct plus retroflex position, will identify lesions including inflammation, hemorrhoids, solitary rectal ulcer, or obstructing masses that may explain the etiology of the constipation. Flexible sigmoidoscopy with barium enema or CT colonography may replace colonoscopy in the identification of structural disease [2].

Anorectal Manometry

Anorectal manometry systems quantify internal and external anal sphincter function at rest and during defecatory maneuvers, rectal sensation, and compliance [3]. Anorectal manometry, along with the rectal balloon expulsion test, should be performed in patients who fail to respond to laxatives or empiric medical therapy for constipation [4]. Anorectal manometry can be used to diagnose and differentiate between the four patterns of dyssynergic defecation (Table 2.2). It may also aid in

Table 2.2 Patterns of dyssynergic defecation using anorectal manometry

Type I	Paradoxical increase in residual anal pressure in the presence of adequate propulsive pressure (increase in intrarectal pressure of ≥45 mmHg)
Type II	Inability to generate adequate expulsive forces (no increase in intrarectal pressure) together with a paradoxical increase in residual intraanal pressure
Type III	Generation of adequate expulsive forces, but absent or incomplete (<20%) reduction in intraanal pressure
Type IV	Inability to generate adequate expulsive forces (no increase in intrarectal pressure) and absence or incomplete reduction in residual intraanal pressure

assessing an objective response to biofeedback therapy or neuromuscular training in patients with dyssynergic defecation. Anorectal manometry also assesses for the presence of the rectoanal inhibitory reflex (RAIR). The RAIR is a decrease in anal resting pressure elicited by rectal distention and is mediated by the myenteric plexus.

The anorectal, manometry assembly consists of a probe, pressure recording device, device for displaying the recording, and a data storage facility [5]. Two types of probes are commonly available. The water-perfused probe is least expensive and traditionally used. Solid-state probes with closely spaced pressure sensors are becoming more common. High-resolution 3-D manometry with up to 256 sensors are now available to evaluate pressure profiles and topographic changes [6].

Anorectal manometry should be performed in experienced labs with experienced interpretive personnel. No fasting or discontinuation of medications is required prior to testing. Patients should evacuate their bowels prior to the testing if possible. If digital rectal examination reveals stool, a tap water enema may be administered. The lubricated manometry probe is inserted into the rectum while the patient lies in the left lateral position with knees flexed. A resting period of about 5 min is allowed for the patient to relax and for the sphincter tone to return to basal levels.

Anal pressures at rest and with squeeze are measured first. Patients are then instructed to squeeze as tight as possible for as long as possible. Next patients are asked to cough or blow up a balloon as hard as possible for as long as possible to increase intra-abdominal pressure, as would be done when bearing down. Each of these is repeated three times with a 1 min resting period between each attempt [3]. Figure 2.1 illustrates resting and squeeze pressures using high-resolution manometry. Patients are then instructed to attempt defecation of a liquid-filled balloon or fecal simulator while lying on the bed followed by simulated defecation on the commode. High-resolution anal manometry correlates well with traditional manometry and can more precisely define anal pressure profiles which might increase diagnostic yield [7].

Interpretation of anorectal manometry involves qualitative and quantitative analysis. Anal sphincter pressures, including maximum at rest, during squeeze, and sustained squeeze pressures with their duration, are compared to validated healthy adult results. Anorectal pressures during bearing down and defecatory maneuvers are also compared to healthy adults. Table 2.3 outlines the typical data collected and interpreted [3]. When evaluating patients with fecal incontinence, the functional anal canal length, maximum resting sphincter pressure and the duration of sustained squeeze pressures are helpful in determining the function of the internal and external anal sphincters.

Patients are assessed for patterns of dyssynergia when straining while lying down and while sitting on the commode. Dyssynergic defecation occurs when a patient is unable to coordinate an increase in the intrarectal pressure when bearing down and a volitional decrease in intraanal pressure (see Chap. 6) [8]. Paradoxical contraction or failure to relax the anal sphincters and puborectalis muscle occurs. Figure 2.2 compares a normal patient to one with dyssynergia using high-resolution anorectal manometry.

The RAIR reflex is tested by rapidly infusing the rectal balloon with 50 mL of air. Patients who lack a RAIR may have Chagas or Hirschsprung's disease (see Chap. 7) [3]. Figure 2.3 demonstrates a normal RAIR.

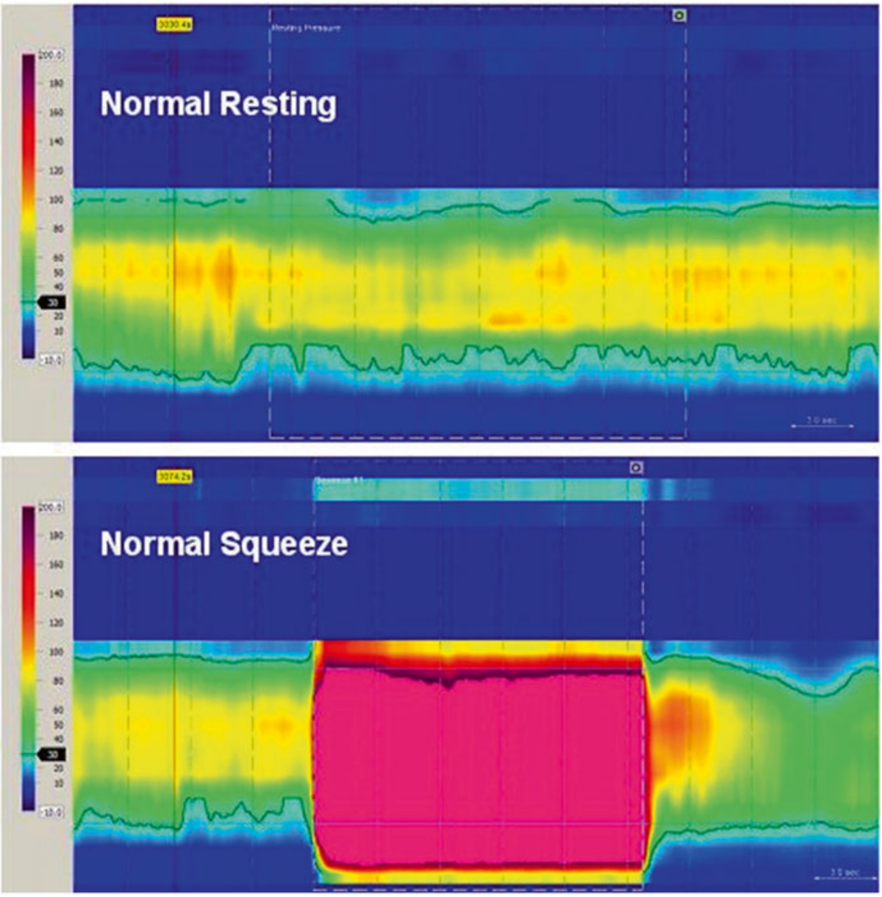

Fig. 2.1 High-resolution anorectal manometry: normal resting and squeeze. High-resolution topographic contour plot of resting anorectal motor function in a healthy control with normal resting internal anal sphincter tone (*top*). High-resolution topographic contour plot showing maximal squeeze pressures in a healthy control with normal external anal sphincter squeeze pressure and endurance (*bottom*). The resting and squeeze event windows are shown within the *dashed white lines*. Pressures in mmHg are calibrated to the color contour chart on the *left*. A *solid black contour line* delineates all pressures at 30 mmHg or above

The rectal balloon distention test measures rectal sensation and compliance by assessing sensory-motor responses to incremental volumes of air or water. The rectal balloon is inflated with air at a rate of 10 mL per second in 10 mL increments until the patient reports a first sensation. The balloon is then inflated with 30 mL of air incrementally to a maximum volume of 250 mL. The volume at which the patient feels the urge to defecate and the maximum tolerable volume are also recorded. There are no consensus thresholds for making the diagnosis of rectal hypo- or hypersensitivity. Thresholds for rectal hyposensitivity are center dependent, but typically 20 mL for first sensation, 100 mL for constant first urge to defecate,

Table 2.3 Anorectal manometry testing

Anal sphincter measurements	• Maximum resting pressure (mmHg) • Maximum squeeze pressure • Sustained squeeze pressure • Duration of sustained squeeze
Anorectal measurements while simulating defecation	• Maximal intrarectal pressure • Anal residual pressure • Presence/absence of dyssynergia while sitting or supine
Rectoanal inhibitory reflex (RAIR)	• Present or absent
Rectal sensation thresholds (mL)	• First sensation • Desire to defecate • Moderate desire to defecate • Maximum tolerable volume
Balloon expulsion test	• Able or unable to expel • Time to expel

150 mL for constant moderate urge, and greater than 200 mL for maximal tolerable volume are considered upper limits of normal.

The balloon expulsion test can help identify, but does not exclude, a functional defecation disorder [9]. A balloon is inflated with water to a fixed volume, usually 50 mL, inside the rectum. The patient is then seated on a commode and asked to expel the balloon. The test is normal if the patient expels it within 60 s. This test is often used in screening for dyssynergic defecation as it has an 88% sensitivity, 89% specificity for identifying dyssynergic defecation or pelvic floor dysfunction, and a negative predictive value of 97% for excluding pelvic floor dysfunction [10].

Colonic Manometry

Colonic manometry can be considered in adults with refractory constipation unresponsive to conventional treatment, although this test is generally available only in specialized motility centers [11]. Assessment of colonic transit using radio-opaque markers, scintigraphy, or wireless motility capsule does not provide the underlying pathophysiological basis of constipation and therefore cannot guide treatment. Colonic manometry measures the intraluminal pressure of the colon and rectum, providing information on the pattern of colonic motor activity, and if combined with barostat assembly will assess colonic tone, compliance, and sensation [3]. Colonic manometry may help identify colonic neuropathy, myopathy, or normal colonic function before consideration of colectomy in patients with severe constipation [3].

The colonic manometry assembly consists of four components: probe, pressure recording device, device for displaying the recording, and data storage facility [12]. Two types of probes are commonly available, solid-state and water-perfused. Probes have a variable number of measurement ports and can only measure pressure at 6–8 sites with the usual spacing between sensors ranging from 10 to 20 cm [3].

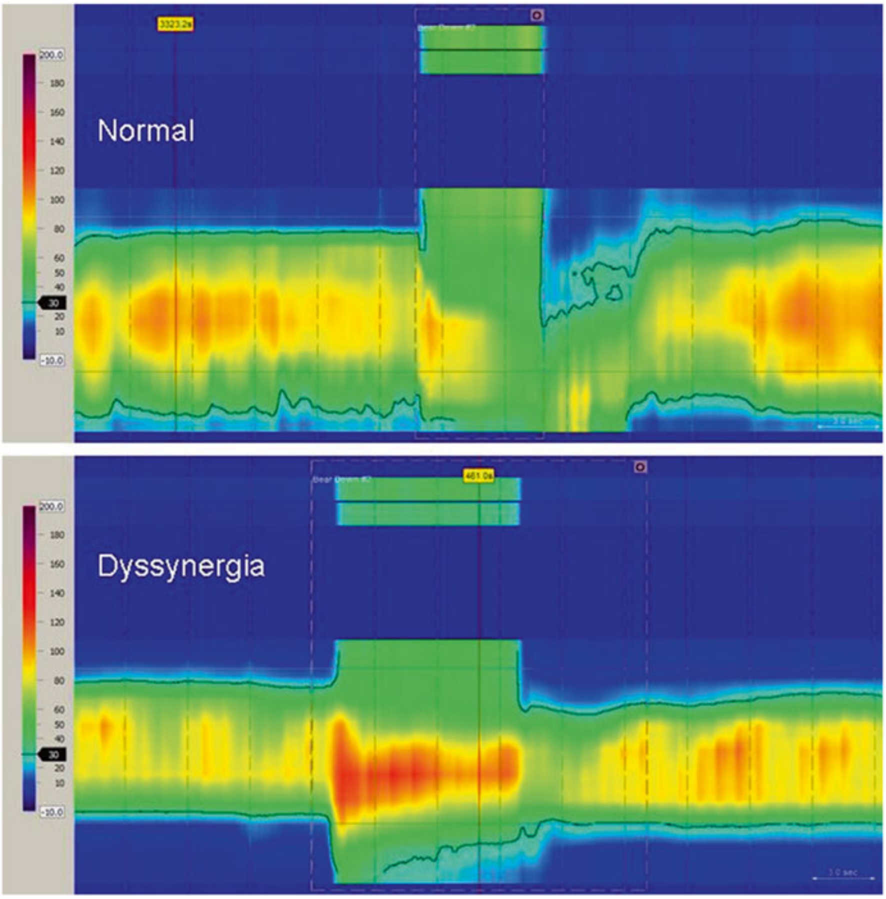

Fig. 2.2 High-resolution anorectal manometry: normal and dyssynergia. High-resolution topographic contour plot in a patient with a normal decrease in intraanal pressure when bearing down or attempted defecation (*top*). High-resolution topographic contour plot in a patient with dyssynergia (*bottom*). Note the paradoxical increase in intraanal pressure when bearing down or attempted defecation

High-resolution manometry with solid-state catheters is now available with a limited number of sensors as increasing sensors decrease flexibility of the device.

Colonic manometry can be done in the ambulatory setting with minimal sedation. An overnight fast is required and medications that affect gastrointestinal motility should be discontinued at least 48–96 h prior. Bowel cleansing is done through administration of polyethylene glycol colonic lavage or tap water enemas [12].

The colonic manometry catheter can be placed using one of the following methods: nasal intubation with migration of probe into the colon, guide wire-assisted probe placement, or retrograde direct probe placement [13]. Catheter placement should be verified with either fluoroscopy or abdominal X-ray.

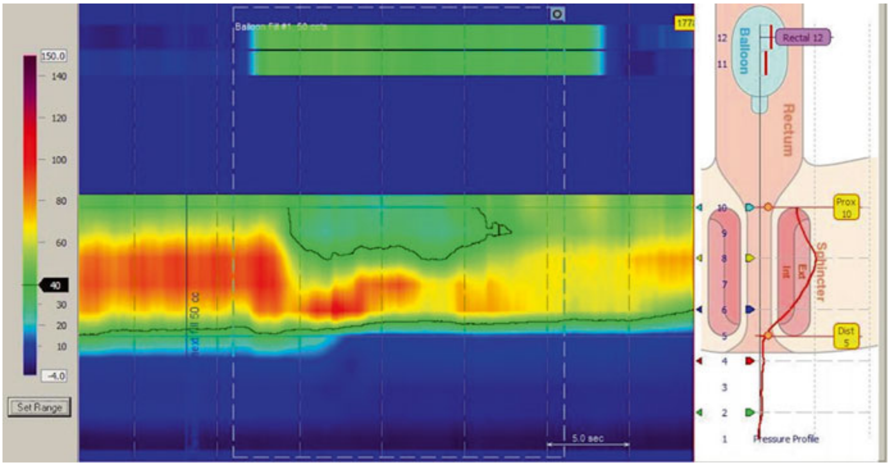

Fig. 2.3 High-resolution anorectal manometry: normal rectoanal inhibitory reflex (RAIR). High-resolution topographic contour plot in a patient with a normal RAIR. Note the decrease in resting anal pressure elicited by rectal distention

The duration of the study can be short or prolonged. Prolonged or physiological studies are typically 24 h in duration. During this period, patients are allowed to leave the lab, but are instructed to consume standardized meals, sleep and wake at specific times [13]. They also should keep an event diary for stool and symptoms. Short or provocation studies typically last less than 8 h and assess the effect of given stimuli, such as Bisacodyl or pyridostigmine, balloon distention, and a standardized meal [12] on motor activity. Colonic sensation and tone are also assessed during this time. Once the test is complete, the colonic probe is removed.

Analysis of the test has both qualitative and quantitative components. Qualitative analysis includes reviewing contractile patterns and the type of contractile activity [3]. Colonic motor activity is not rhythmic, but rather is composed of phasic or brief contractions and tonic or sustained contractions. Colonic motor activity is also divided into segmental and propagated activity. Segmental activity accounts for most of the colonic activity and consists of single contractions or bursts of rhythmic or arrhythmic contractions which are represented by waves ranging from 5 to 50 mmHg [3]. Segmental activity serves to slow colonic transit, allowing optimal absorption of contents and facilitating the propulsion of fecal contents over short distances. Propagated activity can be divided into low- or high-amplitude propagated contractions (LAPCs/HAPCs). LAPC are less than 50 mmHg and occur relatively frequently [14]. HAPCs are usually >50–100 mmHg and account for transport of contents over larger portions of the colon and play an important role in the defecatory process [13]. HAPCs occur about 4–6 times per day, usually upon awakening, after a large meal, or after a stimulant such as hot fluid or caffeine. The rectosigmoid colon experiences periodic rectal motor activity which includes discrete bursts of phasic and tonic pressure waves with a frequency and duration of greater than 3 min.

Table 2.4 Colonic neuropathy and myopathy using colonic manometry

Colonic neuropathy	Absence of two of the following three physiological responses • High-amplitude propagated contractions (HAPCs) • Meal-induced gastrocolonic response • Waking response
Colonic myopathy	Magnitude of response is less than two standard deviations of the normal range in two of the following three physiological responses • HAPCs • Meal-induced gastrocolonic response • Waking response

Quantitative analysis includes determining the number of contractions and the mean amplitude, duration, direction, and length of propagation and velocity of each contraction [3]. The number of HAPCs is reviewed and assessed for premature abortion. Patient event diaries are reviewed for waking-induced colonic motility response, meal-induced gastrocolonic response, and variations in motor activity secondary to stimuli. Symptoms from the diary are also compared to events and pressure waveforms.

Patients with slow transit constipation (see Chap. 5), also called colonoparesis, have abnormal phasic colonic motor activity with significantly decreased HAPCs which terminate prematurely and have decreased amplitude [14]. Patients with dyssynergic defecation lack pre-defecatory augmentation of frequency and amplitude of propagating pressure waves that would allow expulsion of stool [15]. Colonic neuropathy is diagnosed when two of the following three physiological responses are absent: (1) HAPCs, (2) meal-induced gastrocolonic response, and (3) waking response (Table 2.4) [16]. Colonic myopathy is diagnosed when two of the three previous responses are present, but with a magnitude of response that is less than two standard deviations of the normal range [16]. Distinguishing colonic neuropathy from myopathy is crucial in guiding treatment as those with neuropathy do not respond to aggressive medical management [16].

Colonic tone is essential for normal colonic motor activity. Lack of adequate increase in tone (<15%) following a meal indicates a colonic motility disorder [3]. However, alterations in tone can be found in all types of constipation and does not help differentiate the subtype of constipation [17].

Standard Defecography

Standard defecography provides dynamic evaluation of the pelvic floor and can indicate the presence of rectal prolapse, enterocele, rectocele, cystocele, pelvic floor descent, and effective evacuation. Defecography should be considered when results of anorectal manometry and rectal balloon expulsion are inconclusive for defecatory disorders [4].

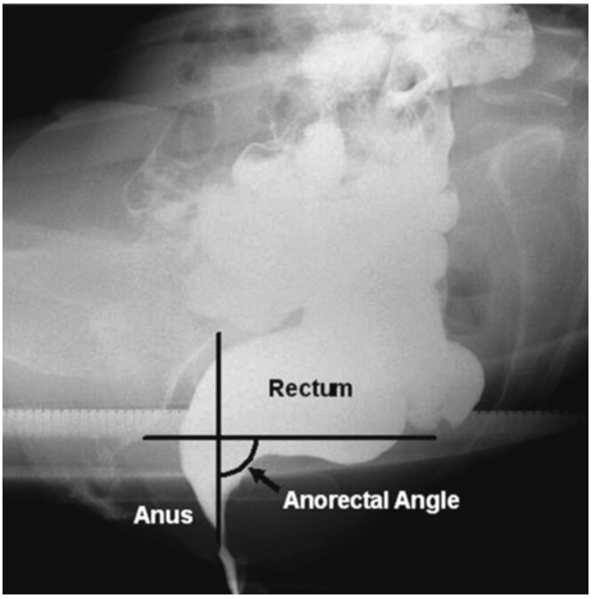

Fig. 2.4 Anorectal angle. The anorectal angle is measured between the anal canal longitudinal axis and the posterior rectum line that is parallel to the rectum longitudinal axis

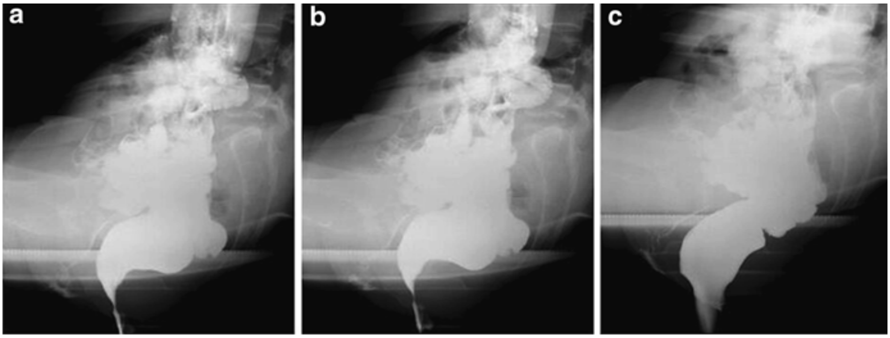

Fig. 2.5 Standard defecography. Standard defecography anorectal images at rest (**a**), squeeze (**b**), and evacuation (**c**). Note: a small amount of fecal leakage at present at rest and with squeeze

Oral liquid barium delineates the small intestine. Thick barium paste is inserted into the rectosigmoid, then dynamic anatomy and pelvic floor motion images are recorded with the patient at rest, coughing, squeezing, and straining to expel the barium [9]. Various parameters are measured to evaluate anorectal motion, including the anorectal angle, perineal descent, anal diameter, puborectalis indentation, and rectal contents [18].

Defecography is not standardized across institutions and is not widely available. There is significant variability in the measurements of the anorectal angle, which is considered vital in the interpretation of results. The anorectal angle is measured between the anal canal longitudinal axis and the posterior rectum line that is parallel to the rectum longitudinal axis (Fig. 2.4). An example of normal defecography study is shown in Fig. 2.5. Small rectocele, internal intussusception, and enterocele can occur

Fig. 2.6 Standard defecography: large anterior rectocele. Standard defecography anorectal image demonstrating a large anterior rectocele (*white arrows*) during defecation. Note excessive perineal descent

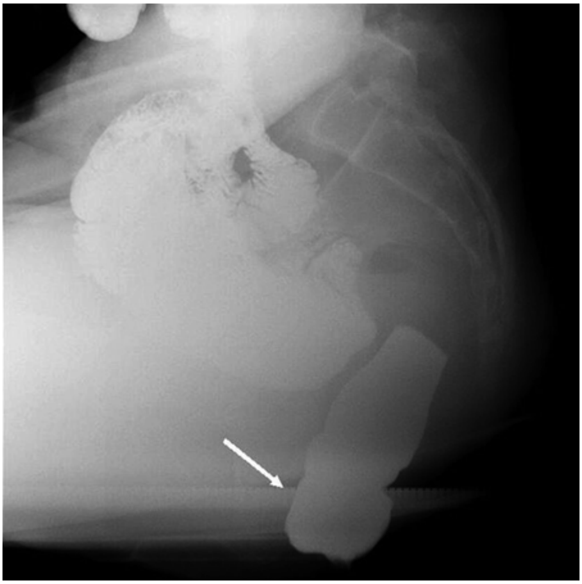

Fig. 2.7 Standard defecography: rectal prolapse. Standard defecography anorectal image demonstrating severe rectal prolapse (*white arrow*)

in asymptomatic patients and may not correlate with symptoms of infrequent or incomplete evacuation [19, 20]. Defecography can provide more detailed information about the anatomy of the pelvic floor and serve to reinforce the validity of prior testing, including anorectal manometry. Figure 2.6 demonstrates a large anterior rectocele, as well as excessive perineal descent. Figure 2.7 demonstrates severe rectal prolapse.

Dynamic Pelvic Magnetic Resonance Imaging

Dynamic pelvic magnetic resonance imaging (MRI) is the only imaging modality that can evaluate global pelvic floor anatomy as well as the anal sphincter without radiation exposure [21]. It allows visualization of the bladder, genital organs, and relationship of the colon to surrounding organs, thus providing a comprehensive view of pelvic floor structures and motion. Like standard defecography, it can indicate the presence of rectal prolapse, enterocele, rectocele, and cystocele. This modality has played a key role in identifying mechanisms of difficult or complex bowel function.

MRI of the anal sphincter provides superior spatial resolution of the internal and external sphincter compared to standard endoanal ultrasonography [21, 22]. The external sphincter can be distinguished from surrounding perirectal fat, allowing better diagnosis of external sphincter atrophy [21]. This is particularly useful in evaluation of patients with fecal incontinence.

Dynamic pelvic MRI can be performed with conventional, closed-configuration MR systems as there appears to be minimal difference in the detection of clinically relevant findings between supine MR and seated MR with open-configuration magnets [23]. Before the examination, patients are usually asked to empty their bladder but others prefer full bladder [24]. During the testing, patients will perform a variety of maneuvers, including straining and squeezing of the pelvic floor muscles, bearing down, and ultimately relaxation and rectal evacuation. Images are acquired in the axial, sagittal, and coronal planes angled to the pelvic floor muscles using a surface coil; however, an endoanal coil provides a detailed view of the sphincter [25]. Figure 2.8 demonstrates evacuation with dynamic pelvic MRI.

Dynamic pelvic MRI showed equivalent diagnostic performance compared to endoanal ultrasonography in the evaluation of patients with dyschezia in the identification of rectoceles, enteroceles, and perineal descent [26]. However, dynamic pelvic MRI was able to identify rectal intussusceptions when endoanal ultrasonography did not [26]. Figure 2.9 demonstrates multiple abnormalities, including a large anterior rectocele, rectal prolapse, and retention of contents. In a recent study, dynamic pelvic MRI and standard defecography showed no significant difference in the identification of rectocele, but did show differences in identification of a descending perineum [27].

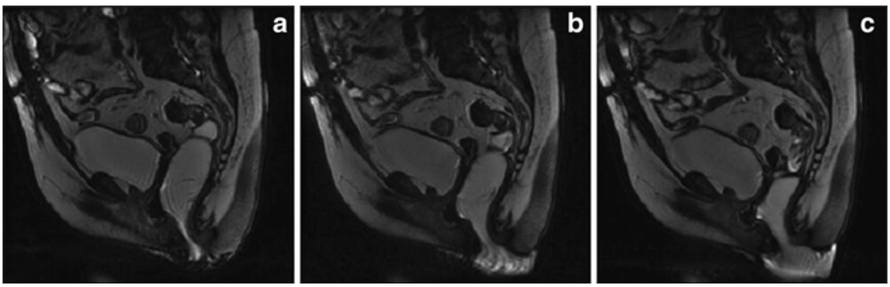

Fig. 2.8 Dynamic pelvic MRI: normal evacuation. Dynamic pelvic MRI demonstrating evacuation (**a–c**)

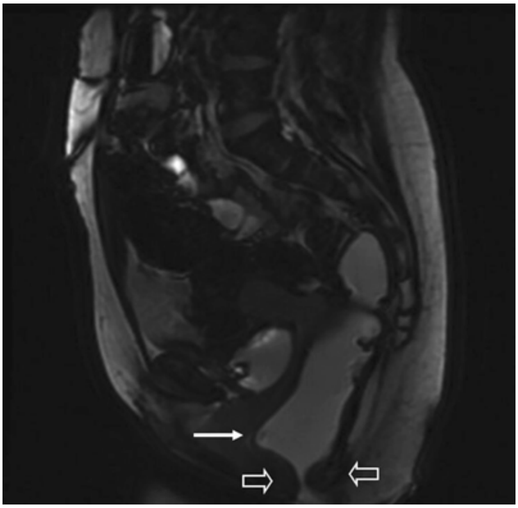

Fig. 2.9 Dynamic pelvic MRI. Dynamic pelvic MRI demonstrating anterior rectocele (*solid white arrow*), rectal prolapse (*hollow arrows*), and retention of rectal contents

Dynamic MRI has some advantages over conventional defecography, including avoidance of radiation exposure by the patient, better soft tissue resolution of all pelvic structures, and thus a more comprehensive picture that allows for better surgical planning [24, 28]. It is the preferred test for diagnosing rectal intussusception. However, MRI is costlier and not widely available.

Colonic Transit Studies

A colonic transit study objectively measures the speed of stool movement through the colon. Three methods to measure the speed of stool through the colon are available: radiopaque markers (Sitzmarks), colonic scintigraphy, and wireless motility capsule. These tests are useful for objectively confirming a patient's subjective complaint of constipation or decreased bowel frequency, confirming slow transit, and for documentation of regional delays in transit [19]. Colonic transit studies are recommended if anorectal testing results do not show a defecatory disorder or if symptoms persist despite treatment of a defecatory disorder [4].

Radiopaque Marker Test

The radiopaque marker or Sitzmarks technique is the most commonly used test for measuring colonic transit time [29]. It is not necessary to perform bowel cleansing prior to the study. The radiopaque marker test is performed by ingesting a single capsule containing 24 plastic markers on day 0 and obtaining a plain abdominal radiograph on day 5 or 120 h later. Retention of more than 20% or ≥6 markers on

Fig. 2.10 Sitzmarks test. Multiple radiopaque markers are retained throughout the colon, suggesting abnormal colon transit time

day 5 is indicative of slow transit constipation [11, 30]. Alternatively, the multiple marker test involves ingestion of one capsule daily for 3 days. Plain abdominal radiographs are obtained on days 4 and 7. Retention of more than 20% of the makers on day 7 is indicative of slow transit constipation [31, 32]. Figure 2.10 demonstrates multiple retained radiopaque markers.

Patients with dyssynergic defecation may also retain excess markers, and therefore, dyssynergia should be excluded prior to diagnosing slow transit constipation. If colonic transit time is normal on two consecutive studies despite a patient's continued complaint of infrequent defecation, colonic function is likely normal and no further testing is required [19]. The radiopaque marker test has multiple drawbacks, including radiation exposure, multiple visits which may affect compliance, inability to assess regional gut transit, and lack of standardization protocols for the test and interpretation [33, 34].

Colonic Scintigraphy

Colonic scintigraphy involves the oral administration of radioisotopes such as 111Indium bound to diethylene triamine pentaacetic acid (DTPA) or 111Indium/activated charcoal slurry contained within a methacrylate-coated capsule which is designed to break down in the distal ileum [35–38]. Depending on the isotope ingested, gamma camera scans are taken at various intervals, until hour 48 or 96. A constructed time-activity curve can demonstrate the progression of the isotope through various regions of the colon. Diagnosis of slow or delayed transit is dependent on the percentage of isotope retention, but these values differ among centers and depend on the method used [37, 38].

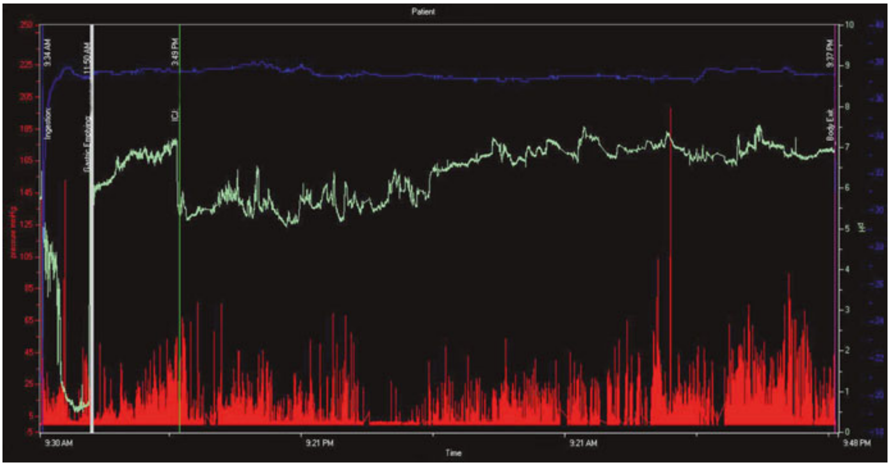

Fig. 2.11 Wireless capsule. The SmartPill system provides a noninvasive monitoring technique for characterizing disorders of GI motility. Segmental transit times can be assessed based on standardized changes in intraluminal pH (*green line*) from the stomach through the small intestine and the colon. The segmental motility index can be quantified using the intraluminal pressure sensor (*red line*). Temperature (*blue line*) should remain relatively constant under normal conditions

Wireless Motility Capsule

The wireless motility capsule or SmartPill™ is a data recording device that provides real-time measurements of temperature, pH, and pressure of its immediate surroundings [39] (see Fig. 2.11). It is a nonradioactive alternative for evaluating chronic constipation and can provide a quantitative assessment of colonic transit time [39]. In addition, it provides information on transit times of the stomach and small bowel and can help exclude a more global gastrointestinal transit disorder. It was approved for evaluation of colonic transit in patients with chronic idiopathic constipation by the Food and Drug Administration in 2009 [40].

The study may be done in a physician's office after an overnight fast and discontinuation of medications that could alter gastric pH and gastrointestinal motility. Proton pump inhibitors should be stopped 7 days prior to testing, histamine receptor antagonists 3 days prior to ingestion, and antacids 1 day prior to ingestion. Narcotics, antidiarrheal agents, prokinetics, laxatives, and anticholinergics should be stopped between at least 3 days prior to testing [39].

The wireless motility capsule is ingested immediately after consuming a standardized SmartBar™ and 50 mL of water. The patient wears a small external data recorder, which must be within 5 ft of the patients throughout the testing period. The patient records meals, sleep, and bowel movements by entering them into the data receiver. Exercise may alter the transit measurements so it should be avoided during the testing period. The data receiver is returned to the physician's office at the end of the study after 3 days. Passage of the capsule from the body can be confirmed by an abrupt drop in temperature or loss of recording signal [39].

Colonic transit time is defined from the time the wireless motility capsule enters the cecum to its passage from the body. The wireless motility capsule correlated well with radiopaque marker testing [29]. Delayed colonic transit using the wireless motility capsule is defined as a colonic transit time of greater than 59 h [39, 40]. Contraindications to wireless motility capsule include patients with a history of a gastric bezoar, swallowing disorders, dysphagia, suspected strictures or fistulae along the gastrointestinal tract, physiologic gastrointestinal obstruction, gastrointestinal surgery within the previous 3 months, Crohn's disease, diverticulitis or implanted or portal electromechanical medical device (e.g., cardiac pacemaker). The incidence of equipment failure was reported to be 0.8–0.9% [39]. Serious adverse events include inability to confirm passage of the capsule outside the body, capsule retention, and obstruction. Post-marketing, the retention rate was 0.33% [39].

Electromyography

Electromyography (EMG) can help identify myopathic, neurogenic, or a mixed injury through measurement of small or large polyphasic motor unit potentials [9]. Small polyphasic motor unit potentials are associated with myopathic damage, whereas large polyphasic motor unit potentials are associated with neurogenic damage. EMG of the pelvic floor may be done for the following reasons: (1) to identify areas of sphincter injury by mapping the sphincter, (2) to determine if the muscle contracts or relaxes, and (3) to identify denervation-reinnervation potentials indicative of nerve injury [19]. The 2013 American Gastroenterological Association (AGA) Technical review and position statement on constipation did not discuss the use of EMG in evaluating patients with chronic constipation, suggesting its role is limited in this population.

Both needle and surface electrodes are available. Though needle EMG allows mapping of the sphincter to identify defects, surface electrodes provide information about muscle behavior and can determine the presence of appropriate sphincter relaxation during defecation. Surface EMG also may be used during biofeedback pelvic floor retraining.

Pudendal Nerve Terminal Motor Latency Testing

Pudendal nerve terminal motor latency (PNTML) testing can help determine whether anal sphincter weakness is due to pudendal nerve injury, sphincter injury, or both. Patients with pudendal neuropathy do not fare as well as those without pudendal injury following surgical repair of sphincter defects. Patients previously underwent PNTML prior to undergoing surgical intervention to determine if surgical repair should be considered. However, subsequent studies questioned the utility of this test as 50% of patients with prolonged PNTML had normal anal canal squeeze pressures, and 27% of patients with chronic constipation had prolonged PNTMLs. In 1999 the AGA recommended that PNTML not be used in the evaluation of patients with fecal incontinence [19]. The role of PNTML testing has not been defined in patients with chronic constipation.

Summary

The evaluation of constipation with testing is not necessary in patients without alarm signs and symptoms and in those who have had a successful response to treatment. The most important first step is to obtain a detailed history and to do a thorough physical examination including an abdominal examination and rectal examination. Without alarm signs and symptoms (see Table 2.1), one can proceed with empiric treatment. The algorithms for testing have been changed recently [4]. The assessment of colonic transit is recommended to be done at a later stage and not initially but rather for patients who do not have a defecatory disorder or for those with defecatory dysfunction that has not responded to biofeedback. The algorithm presented as Fig. 5.3 shows one accepted approach to the patient with constipation. This shows the initial study as anorectal manometry with balloon expulsion. Other more detailed algorithms do include defecography if manometry and balloon expulsion are inconclusive.

There is great variability for what might be considered based on individual presentation and also the availability of testing. In unique tertiary and quaternary motility centers, there are often distinctive approaches. This author suggests that manometry and nuclear transit studies may be done at the same time in our center which serves as a quaternary referral center where refractory patients (many of whom have already undergone much testing) are seen and where combination constipation is a common presentation. This author begins the evaluation with a complete history and rectal exam including visual inspection and digital exam. The patient is then treated with high fiber, adequate hydration, and "bowel management techniques" (hot caffeinated beverage, breakfast, within 45 min of awakening). If there is no improvement, and if there are more than two bowel movements weekly, anorectal manometry and defecography are considered (Fig. 2.12). In situations where the patient notes symptoms of prolonged time between stools (<2 bowel movements weekly), the colon transit study with anorectal manometry may be performed. These strategies point out both the importance of an evidence-based

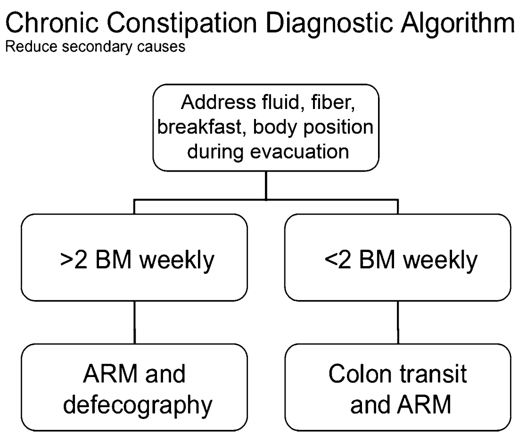

Fig. 2.12 Chronic constipation diagnostic algorithm

approach and also tailoring the evaluation to the patient's presentation and to the types of patients that may be seen in specialized centers. The chapters that follow further discuss the evaluation and management of constipation.

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