Chapter 2
Diagnostic Procedures

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Anorectal Manometry

Description of Procedure

Anorectal manometry is widely used to diagnose abnormalities of anorectal function. This test employs a pressure-sensitive catheter connected to a transducer. The catheter device is inserted into the anus, and anal pressure is measured throughout the length of the anal canal. The transducer translates the mechanical pressures into an electrical signal, which is converted to a computerized readout and used to interpret the data obtained.

Indications

Chronic constipation, fecal incontinence, documentation of the presence or absence of rectoanal inhibitory reflex (RAIR) for the diagnosis of Hirschsprung's disease (see Fig. 2.1), and preoperative use prior to ileoanal pouch or colorectal anastomosis. Anorectal manometry can also be used as an adjunctive tool for performance of anorectal biofeedback.

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E.D. Ehrenpreis et al. (eds.), *Anal and Rectal Diseases: A Concise Manual*,
DOI 10.1007/978-1-4614-1102-4_2, © Springer Science+Business Media, LLC 2012

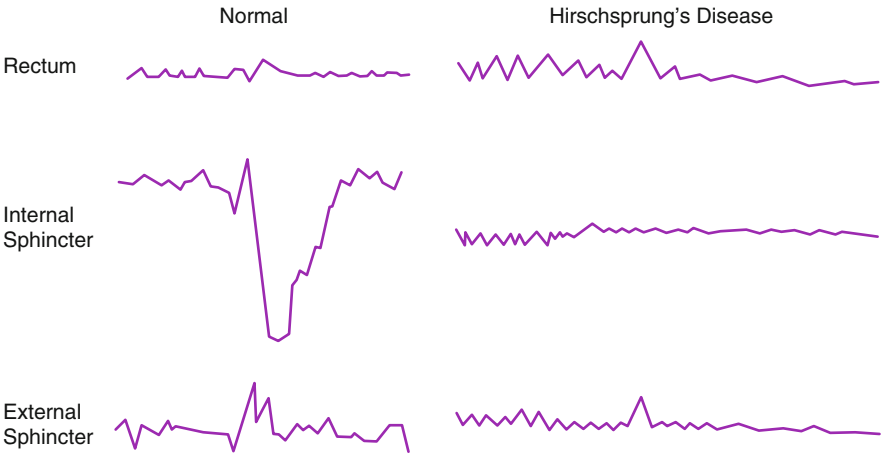

Fig. 2.1 The RAIR demonstrated in a normal subject and absent in a patient with Hirschsprung's disease

Complementary Procedures

Dynamic proctography, anorectal electromyography (EMG) and pudendal nerve terminal motor latency (PNTML) study, flexible sigmoidoscopy, full-thickness biopsy of the rectum (for diagnosis of Hirschsprung's disease), and anorectal ultrasound.

Contraindications

Anal obstruction.

Relative Contraindications

Severe anal pain and anal stricture.

Preparation of Patient

The patient should receive one or two cleansing enemas several hours prior to examination. You should also talk with them prior to the procedure to answer any concerns they may have so that they are relaxed and cooperative when the procedure begins.

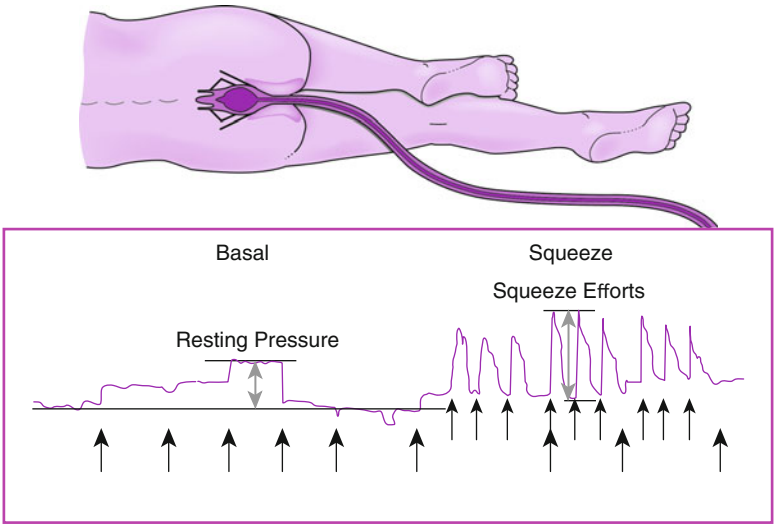

Fig. 2.2 Demonstration of the HPZ and resting and squeeze pressures using a pull-through technique

How the Procedure Is Performed

The patient is placed in a left lateral position with flexion of the knees and hips, and proper draping for adequate modesty. Pressure-sensitive catheters (balloon system, water perfusion system, or solid-state microtransducer system) are gently placed in the anal canal following calibration of the manometer. The pressure is measured through eight channels placed around the catheter, each 1 cm apart and extending 5 cm from the distal portion of the catheter. The pressure in each channel is generally measured with a "pull-through technique" (the probe is placed in the rectum and gradually withdrawn) (see Fig. 2.2). The pressure readings obtained provide a longitudinal pressure profile of the anal sphincter. The parameters measured are discussed in the following sections.

High-Pressure Zone

The high-pressure zone (HPZ) is usually present 1–1.5 cm proximal to the anal verge. This is a portion of the anal canal where pressures are greater than 50% above the average pressures within the remainder of the anal canal.

Resting Pressure

Resting pressure is measured at the HPZ. The average value is 65–85 mmHg.

Squeeze Pressure

The patient performs a squeezing maneuver of the anus following an explanation by the performing technician. These pressures are usually 50–100% higher than the average resting pressure.

Push Pressure

The patient is instructed to perform the push maneuver, mimicking an attempt to defecate. The measured pressure tracings are then viewed to determine whether a normal decrease in anal pressure occurs.

Rectoanal Inhibitory Reflex

Following the above maneuvers, a latex balloon is placed over the manometry catheter, which is then repositioned 2 cm from the anal verge. Small volumes of air are introduced into the balloon (typically beginning with 40 mL). Baseline resting anal pressures are measured to determine whether resting pressures decrease following inflation of the balloon. This decrease in sphincter pressure is called "RAIR." If no reflex is detected, the balloon is deflated and reinflated at a higher volume, such as 60 mL. Volumes of up to 180 mL may be required to document the presence of RAIR.

Detection of Rectal Sensation

The aforementioned balloon inflation using air or water at room temperature is performed and utilized to determine (1) the volume required to elicit an initial sensation, (2) the volume required to produce a sensation of urgency, and (3) the maximum tolerable volume. Volumes of up to 300 mL may be utilized to determine rectal volume sensation.

Pressure measurements may be used to map the symmetry of the anal sphincter. The presence of marked anal asymmetry is seen with sphincter damage or other abnormalities.

Changes in pressure with balloon inflation at different volumes may be used to determine rectal compliance. These studies are generally used for research purposes. Rectal compliance measurements have been used to show, for example, that some patients with irritable bowel syndrome have decreased rectal compliance, enhancing the sense of urgency experienced in the condition.

Typical Abnormal Findings

The most common abnormal findings on anorectal manometry and the possible causes of these abnormalities are shown in Table 2.1.

Table 2.1 Common abnormal findings on anorectal manometry and their possible causes

Finding	Cause
Elevated resting pressure	Anal sphincter spasm (anismus), nonrelaxing puborectalis syndrome, hemorrhoids, anal fissure
Decreased resting and squeeze pressures	Anal injury secondary to trauma, anal surgery or obstetric injury, neurologic diseases, or anorectal prolapse
Absence of the fall in resting anal pressure with push maneuver	Anismus or nonrelaxing puborectalis syndrome
Absence or RAIR	Hirschsprung's disease or megacolon/megarectum
Lowered threshold of rectal sensation	Irritable bowel syndrome or post-gastroenteritis hypersensitivity
Decreased rectal sensation	Altered sensorium, central nervous system disease, neurologic disorders, or megacolon/megarectum
Decrease rectal compliance	Colitis, radiation proctopathy, or irritable bowel syndrome

Complications

None.

Additional Comments

Biofeedback techniques have been successfully utilized in conjunction with anorectal manometry to assist with retraining of the anal sphincter in patients with fecal incontinence and spastic anorectal disorders.

Anoscopy and Proctoscopy

Description of Procedure

Anoscopy (endoscopic examination of anal mucosa and lower rectum) and proctoscopy (endoscopic examination of entire rectum) involve the placement of a rigid plastic or metal instrument (anoscope/proctoscope – see Fig. 2.3) into the anal canal. The proctoscope has either an internal or external light source.

Indications

Anal pain, discharge, rectal bleeding, internal or external hemorrhoids, pruritus ani, palpable mass on digital rectal examination, or anal condyloma.

Fig. 2.3 A Naunton Morgan proctoscope (image courtesy of B and H Surgical Instrument Makers, London, UK)

Complementary Procedures

Flexible sigmoidoscopy and colonoscopy.

Contraindications

Acute myocardial infarction (due to the potential of inducing a vagal response) and a patient who is unable/unwilling to cooperate with the procedure.

Relative Contraindications

Suspected acute abdomen, debilitated patient, or anal stenosis.

Preparation of Patient

Patient reassurance is mandatory. Generally, no preparation is required for the procedure, although an enema may be used if necessary.

How the Procedure Is Performed

The patient is placed in a left lateral position. A local anesthetic may be applied to the anal region. A digital examination is performed after lubrication of the gloved finger. The anoscope or proctoscope is lubricated and placed gently into the anus. This is advanced slowly following relaxation of the anal sphincter. Sometimes, gentle rotation of the device eases insertion. After full advancement of the scope, the inner obturator is removed. Suctioning may be performed to clear the view, and a light source is utilized to obtain good visualization. The scope is gently withdrawn for evaluation, and the walls of the anus and rectum are viewed. Biopsies and suctioning of fecal material for culture and microscopy may be performed.

Typical Abnormal Findings

Anal or rectal lesions such as hemorrhoids or neoplasms. Biopsies of lesions may be obtained, and suctioned material collected for culture and microscopic evaluation. The collected material is useful for diagnosing sexually transmitted diseases of the anus and rectum.

Complications

Patient discomfort and/or embarrassment are common. Uncommon complications include tearing of the anoderm or postbiopsy bleeding.

Additional Comments

Anoscopy and proctoscopy have been replaced by flexible sigmoidoscopy in many clinical practices.

Barium Enema

Description of Procedure

A barium enema is a radiographic examination of the colon (see Fig. 2.4a, b). It is performed using either a single column of barium sulfate instilled into the colon or a barium instillation combined with air to perform an air-contrast study.

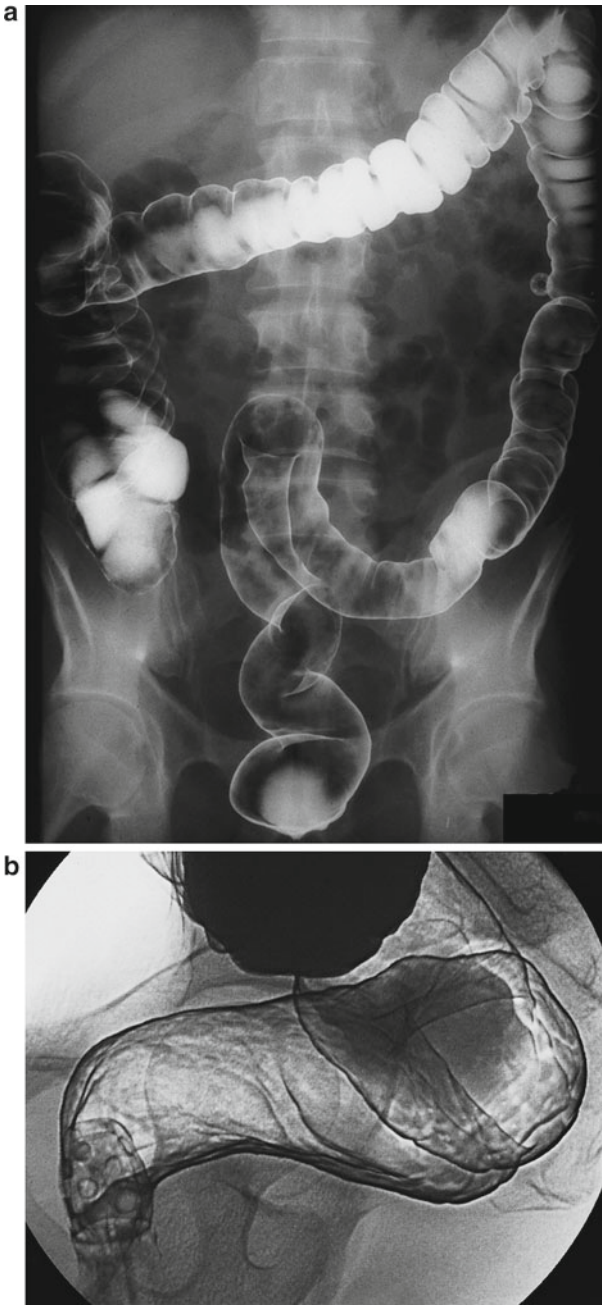

Fig. 2.4 (**a**) Normal view of the colon on barium enema examination. A single diverticulum is noted in the descending colon (*arrow*). (**b**) Normal view of the rectum on barium enema. Enema tip is present

Indications

Evaluation of symptoms suggestive of colonic disease, such as constipation, rectal bleeding, irritable bowel syndrome, and unexplained diarrhea. Complete evaluation of the colon for colorectal cancer screening or surveillance when colonoscopy is contraindicated or cannot be safely or adequately performed.

Complementary Procedures

Colonoscopy, anorectal manometry, EMG, defecography, abdominal and pelvic computed tomography (CT) scan, stool culture, stool microscopy, stool for *Clostridium difficile* toxin testing, fecal fat testing, and electrolyte examination.

Contraindications

Prior allergic reaction to barium, imperforate anus, bowel obstruction, or tight stricture of the colon.

Relative Contraindications

Inability to prepare a patient, a patient who is unwilling or unable to cooperate with the procedure, or a colonic stricture.

Preparation of Patient

This usually takes place over 2 days. On day 1, patients begin a low residue diet with encouragement of liquid intake. On day 2, patients initiate a clear liquid diet. This is complemented by administration of laxatives, enemas, and/or suppositories. In our practice, patients are encouraged to drink one 8 oz bottle of magnesium citrate at 12:00 (midday) on day 2. This is followed by two bisacodyl tablets at 16:00 and 20:00. Clear liquids are encouraged until 22:00, after which no further intake of food or liquids is allowed. At 06:00 on the day of the study, the patient self-administers one bisacodyl suppository.

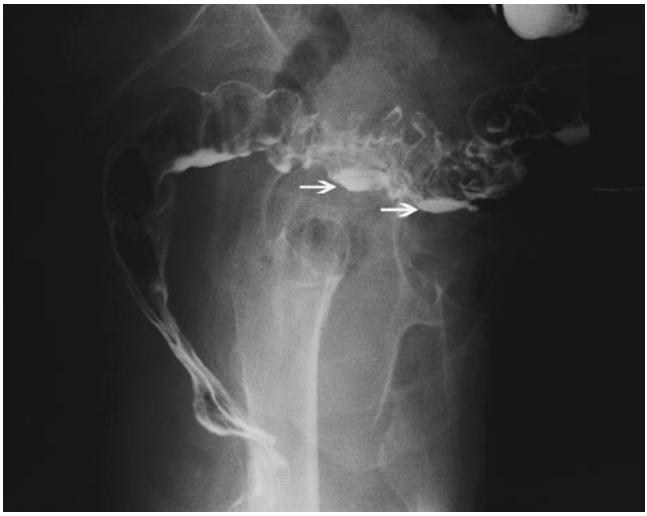

Fig. 2.5 Marked sigmoid diverticulosis (*arrows*) demonstrated on barium enema. The colon is poorly distensible

How the Procedure Is Performed

The technician places a catheter into the rectum and barium is injected to fill the colon. Intravenous glucagon is often administered to assist with distribution of the barium. Barium placed into the colon provides contrast material to outline colonic lesions and makes them visible on X-ray films. Fluoroscopy is used (with the patient in a supine position) to visualize the posterior portions of the colon, and with the patient in a prone position to evaluate the anterior colonic walls. Patients are turned periodically to coat the entire colon with barium. Subsequently, air is instilled to provide air contrast by spreading the barium into a thin layer along the colonic wall. A balloon is placed and inflated in the rectum to prevent discharge of the barium. During the procedure, fluoroscopy and static X-rays are obtained at various angles to visualize all regions of the colon. After evacuation of the barium, the images of the colon are examined for mucosal abnormalities and anatomic disruptions.

Typical Abnormal Findings

Alterations of colonic anatomy such as tortuosity and increased length of the sigmoid colon in chronic constipation or loss of haustration in cases of laxative abuse may be identified. The barium enema may reveal causes of constipation, abdominal or pelvic pain, and diarrhea, such as obstructing colonic lesions, severe diverticular disease (see Fig. 2.5), ulcerative colitis, and Crohn's disease.

Complications

Barium enemas are usually very well tolerated, although discomfort and embarrassment are common during the procedure. Perforation, dehydration, barium concretion, severe constipation, and obstipation are relatively rare.

Additional Comments

Barium enema examination will miss up to 10% of colorectal cancers and colonic polyps and is therefore not recommended as a first-line procedure for colorectal cancer screening or surveillance. The inflated rectal balloon that is present during the performance of the barium enema limits visualization of the rectum; therefore, a proctoscopy or sigmoidoscopy is required for complete colonic evaluation. Barium enemas may be combined with defecography in a single test for constipation. This combined test is used in patients with chronic constipation to rule out anatomic abnormalities and to evaluate for the presence of pelvic floor disorders.

Biofeedback Therapy

Description of Procedure

Biofeedback therapy is a form of pelvic muscular retraining.

Indications

Chronic constipation and fecal incontinence.

Complementary Procedures

Kegel exercises, defecography, balloon expulsion testing, testing of rectal sensation, and intrasphincteric botulinum toxin (Botox) injections.

Contraindications

Imperforate anus.

Relative Contraindications

Inability of the patient to understand or cooperate with the procedure.

Preparation of Patient

Some centers recommend that patients use two Cleansing enemas on the morning of the procedure: others perform the procedure without preparation with Fleet's enemas.

How the Procedure Is Performed

Anal EMG or anorectal manometry is used to provide biofeedback during pelvic retraining. Exercises are generally performed for 1 h/week. Initially, patients are educated on the function of the pelvic floor muscles, often with the use of a video demonstration. This increases patient understanding and compliance, and encourages patient participation in the procedure. Patients are then taught to appreciate the difference in sensation between anal resting, squeezing, and pushing. Measurements of anal pressures and activity during these maneuvers are obtained using anorectal manometry or EMG. Patients perform Kegel exercises and relaxation techniques at home and chart home bowel activities. Follow-up sessions with manometry or EMG measurements are performed. Biofeedback therapists use reinforcement techniques and set specific objective goals (based on manometric or EMG measurements) for resting, pushing, and squeezing maneuvers. Biofeedback therapists may utilize additional techniques during the sessions to assist patients in stress management, proper bathroom goals, and lifestyle modification.

Results Obtained

A number of studies have demonstrated that biofeedback therapy is highly successful for the treatment of pelvic floor-related defecation disorders (84% of patients undergoing the procedure report improvement in their symptoms). This technique is also relatively successful in patients with fecal incontinence.

Complications

There are no complications per se; the technique is usually well tolerated, although mild discomfort may occur.

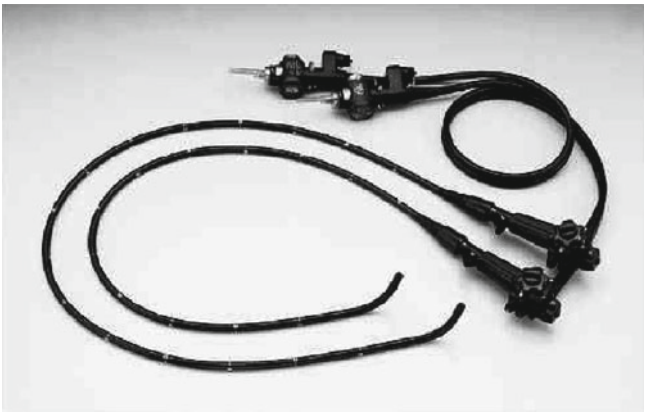

Fig. 2.6 A colonoscopy (CF240-DLI, courtesy of KeyMed Ltd)

Additional Comments

Biofeedback therapy has also been utilized for the treatment of other forms of chronic constipation and for irritable bowel syndrome.

Colonoscopy

Description of Procedure

A colonoscopy is an endoscopic investigation of the colon using a colonoscope; a flexible device that is 8–12 mm in diameter and 120–230 cm in length (see Fig. 2.6). It is inserted into the anal canal and advanced proximally to the cecum (and at times to the terminal ileum) (see Fig. 2.7). The colonoscope provides a well-lit, magnified view of the colonic mucosa. It has a suction channel to remove fecal material for analysis and a biopsy port to obtain mucosal specimens for histologic evaluation. Hemostasis of bleeding lesions can be performed through this channel using injection therapy with epinephrine and thermal coagulation therapy.

Indications

Evaluation of an abnormality seen on barium enema, gastrointestinal bleeding, unexplained iron deficiency anemia, surveillance of patients with a history of colon cancer or colonic polyps, screening of high-risk individuals for colon cancer or

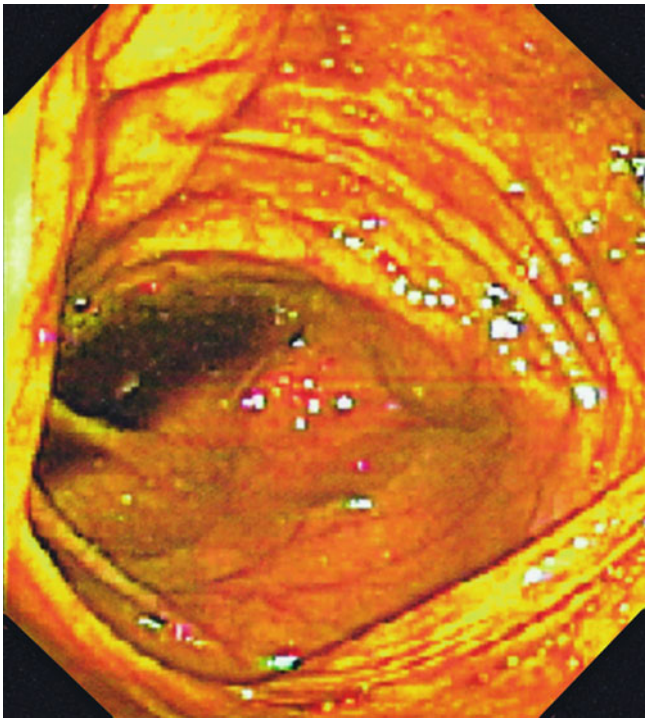

Fig. 2.7 The base of the cecum and ileocecal valve demonstrated on colonoscopy

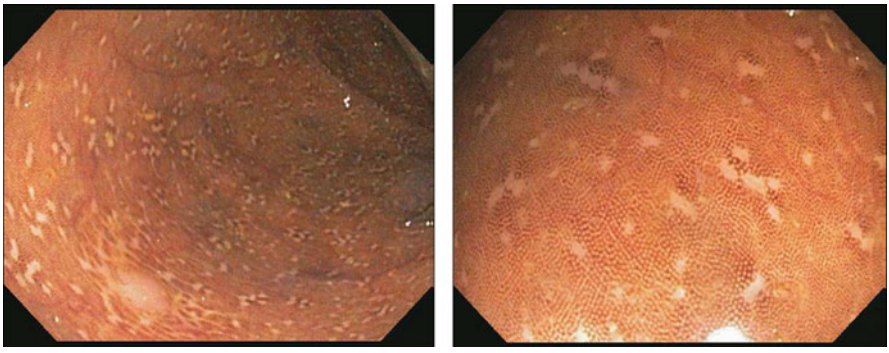

Fig. 2.8 Melanosis coli of the colonic mucosa seen during colonoscopy. The mucosa has a speckled or snake skin appearance. Pale areas represent sparing of lymphoid aggregates. Lipfuscin accumulation in histiocytes causes the characteristic darkening of the mucosa

colonic polyps, screening of normal individuals for colon cancer or colonic polyps, evaluation of patients with chronic inflammatory bowel disease or unexplained diarrhea, other mucosal abnormalities (see Fig. 2.8), and intraoperative evaluation of colonic lesions.

Complementary Procedures

Small intestine radiography, upper endoscopy, and CT scan of the abdomen and pelvis.

Contraindications

Fulminant colitis, acute severe diverticulitis, and suspected gastrointestinal perforation.

Relative Contraindications

Inability to prepare for the procedure (since the colon must be purged for a complete evaluation), inability to obtain consent for the procedure, lack of intravenous access, inability to provide adequate sedation to complete examination, and coagulopathy.

Preparation of Patient

This generally begins the day prior to the procedure. A clear liquid diet is started in the afternoon before the colonoscopy. On the evening before and then morning of the procedure, the patient should consume 1–2 liters of polyethylene glycol in a balanced electrolyte solution over 2–5 h. An oral sodium phosphate preparation in tablet form has been introduced. Lower volume preparations are available.

How the Procedure Is Performed

The patient is usually placed in a left lateral position. Intravenous sedation (usually combining an opioid such as meperidine and a benzodiazepine such as midazolam or diazepam) is administered. A digital rectal examination is performed. The colonoscope

is introduced and advanced to the cecum. External pressure and position changes are often required to allow a safe, full evaluation of the colon. If Crohn's disease is suspected, or a more proximal source of gastrointestinal bleeding is considered, the ileocecal valve is traversed and the colonoscope is introduced into the terminal ileum. After confirmation of the location of the tip of the colonoscope in the cecum, the scope is gradually withdrawn.

Any polyps that are seen on colonoscope withdrawal are removed. Techniques for polyp removal include snaring the polyp with or without electrocautery and performance of a biopsy with associated electrocautery. Multiple biopsies are performed on suspected cancers or lesions that are too large to remove with the colonoscope. If patients are evaluated for unexplained diarrhea, biopsies of the colon (and sometimes the ileum) are obtained in abnormal as well as apparently normal mucosa. In patients with ulcerative colitis or Crohn's disease who are receiving colonoscopic surveillance, biopsies are obtained from each of the four quadrants every 10 cm for histologic evaluation to rule out dysplasia. Retroflexion of the colonoscope in the distal rectum allows visualization of the proximal anal canal and the dentate line. This is particularly useful when looking for internal hemorrhoids and distal rectal or high anal canal lesions. The retroflexed view is also useful for finding and removing polyps in the distal rectum.

Typical Abnormal Findings

Full evaluation of the colonic mucosa is obtained with colonoscopy. Identification and removal of colonic polyps is performed (see Figs. 2.9–2.11). Identification of sources of colonic bleeding (see Figs. 2.12 and 2.13), evaluation of the distal rectum and anal canal for bleeding sources, diagnosis of inflammatory bowel disease, determination of endoscopic and histologic severity of inflammatory bowel disease, surveillance of those carrying the diagnosis of ulcerative colitis or Crohn's disease, and diagnosis of microscopic colitis.

Complications

The perforation rate for colonoscopy is estimated to be between 0.2 and 1.0% (depending on whether a polypectomy has been performed). Postpolypectomy bleeding ranges from 0.4 to 2%. Dehydration and electrolyte abnormalities – including hypernatremia, hyponatremia, hypokalemia, and hypomagnesemia – may occur with sodium phosphate-based colonoscopy preparations. Several cases of severe hyponatremia have been described after polyethylene glycol preparation. Respiratory depression, hypotension, and bradycardia associated with excessive sedation are infrequent. Patients may generally experience some discomfort during the procedure.

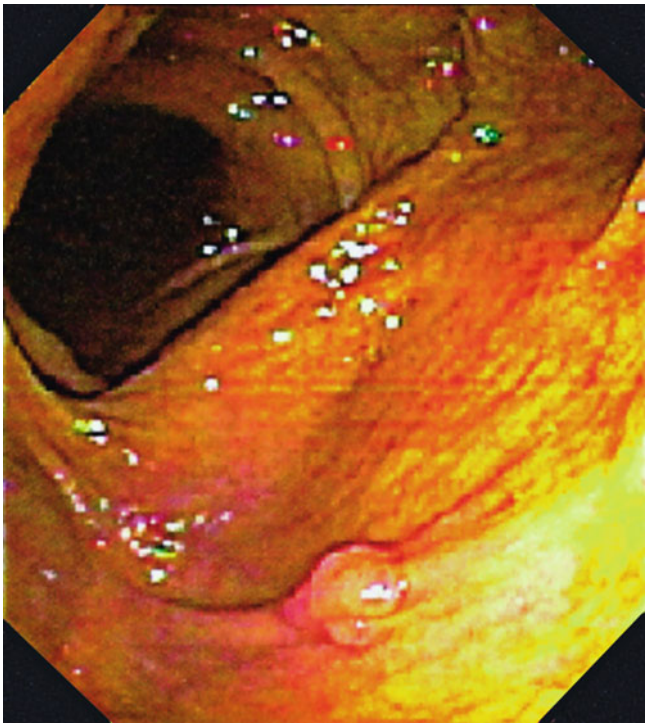

Fig. 2.9 A sessile polyp of the ascending colon

Fig. 2.10 A pedunculated polyp in the descending colon

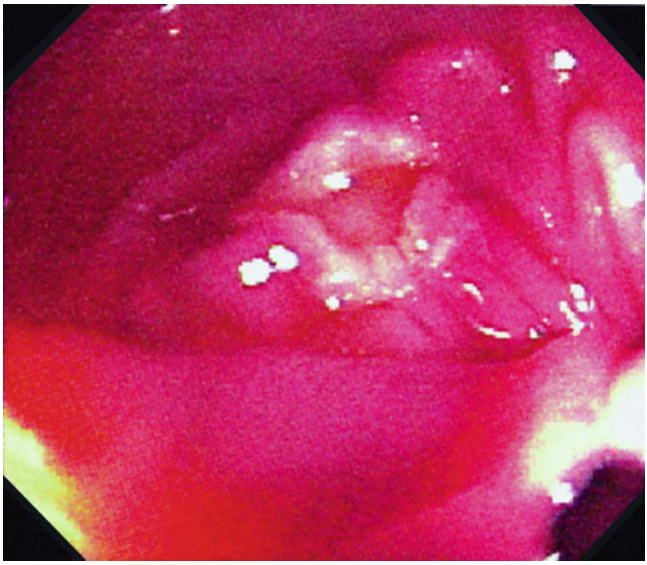

Fig. 2.11 Polypectomy site after snare and electrocautery of a polyp

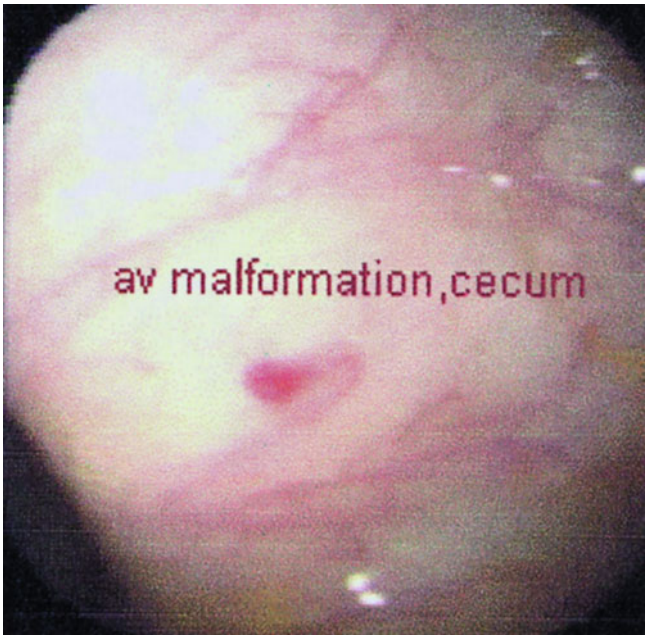

Fig. 2.12 Cecal arteriovenous malformations

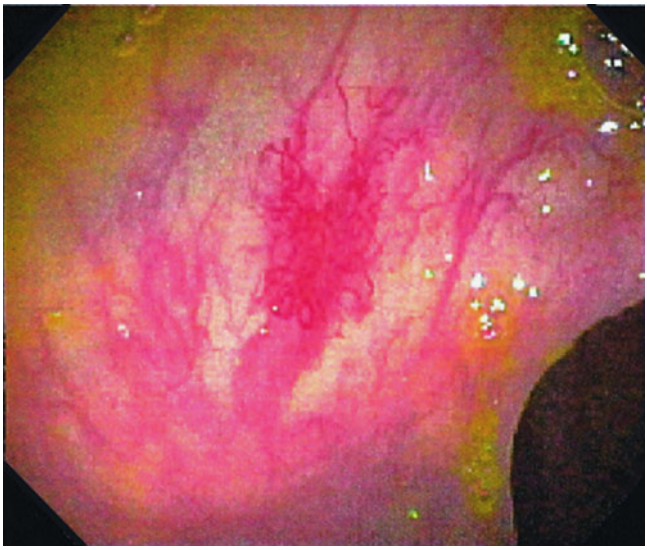

Fig. 2.13 Arteriovenous malformation of ascending colon

Additional Comments

New techniques for colon cancer screening, including CT of the colon (virtual colonoscopy) and molecular biology-based stool testing, are under investigation.

Dynamic Proctography

Description of Procedure

A small quantity (about 250 mL) of high viscosity barium is placed in the rectum. Subjects are then seated on a radiolucent commode. Lateral fluoroscopy is performed following identification of the anal canal. The radiologist instructs the patient to hold the barium to allow films to be taken at rest, and to squeeze the anus shut to hold in the barium to obtain "squeeze" films. Finally, the patient is asked to strain and attempt to evacuate the barium. Continuous video fluoroscopy is the preferred method of obtaining data. Static views are also obtained, and the anatomic position of the pubococcygeal line is determined. Lateral films are utilized to measure the anorectal angle between the anal canal and the horizontal axis of the rectum (located approximately 2 cm above the ischial tuberosity). This technique can identify

changes in the anorectal angle, alteration of anorectal anatomy, and abnormal mobility of the pelvic floor with the aforementioned maneuvers.

Indications

Constipation, fecal incontinence, identification of rectovaginal fistulas, and evaluation of ileoanal pouch anastomoses.

Complementary Procedures

Barium enema, EMG, anorectal ultrasound, and colonoscopy.

Contraindications

Allergy to barium, imperforate anus, or tight rectal stricture.

Relative Contraindications

Inability of the patient to cooperate with the procedure.

Preparation of Patient

Most radiologists recommend colonic cleansing using a saline-based cathartic laxative such as magnesium citrate and/or enemas. A few perform the procedure without prior preparation.

How the Procedure Is Performed

As described earlier, analysis of static and dynamic data is required. In normal patients, the anorectal angle is approximately 90° at rest, increasing to >135° with straining and defecation, and decreasing to about 75° with squeeze maneuvers (see Figs. 2.14 and 2.15). The presence of a widened resting anorectal angle can be seen in patients with neurogenic incontinence. Abnormalities such as rectoceles and anorectal intussusception can also be determined during maneuvers.

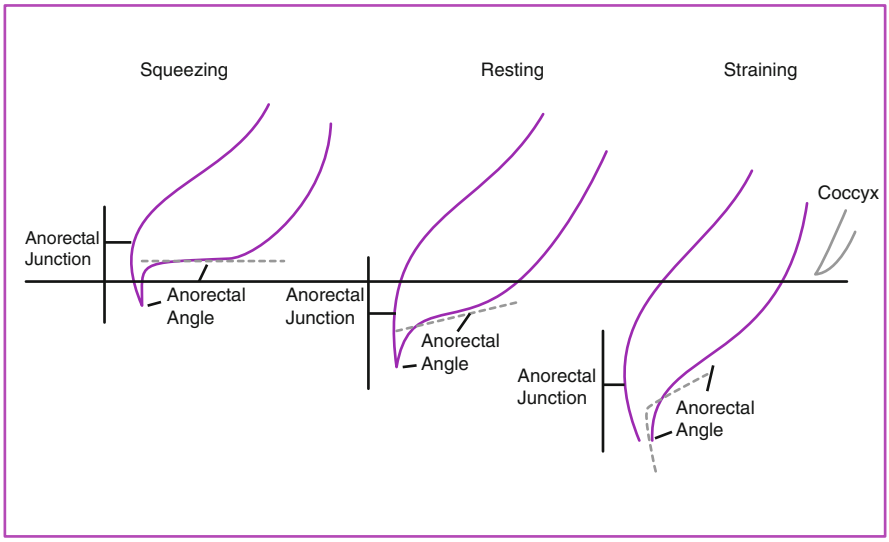

Fig. 2.14 Normal changes of the anorectal angle and anal canal seen with maneuvers during dynamic proctography

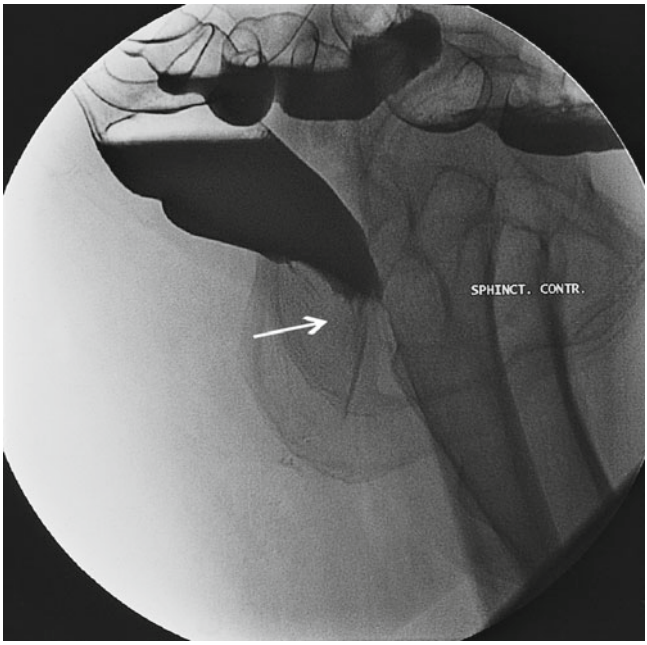

Fig. 2.15 Squeeze maneuver on dynamic proctography. Barium does not move into the anal canal due to comtraction of the puborectalis muscle (*arrow*)

Fig. 2.16 Lateral rectoceles demonstrated on dynamic proctography

Typical Abnormal Findings

Dynamic proctography may reveal abnormalities as described earlier. Alterations in the anorectal angle can be seen, and nonrelaxing puborectalis syndrome or anismus can be diagnosed. Rectocele (see Fig. 2.16), abnormal pelvic descent, anorectal intussusception, anovaginal fistula (see Fig. 2.17), pubococcygeal tear (see Fig. 2.18), ileoanal pouch leakage, and rectal prolapse may all be diagnosed.

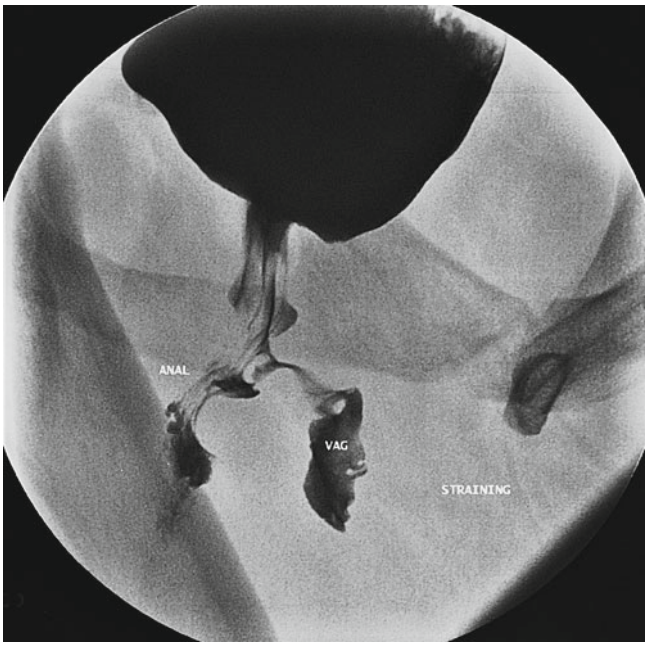

Fig. 2.17 Oblique view of an anovaginal fistula seen on dynamic proctography

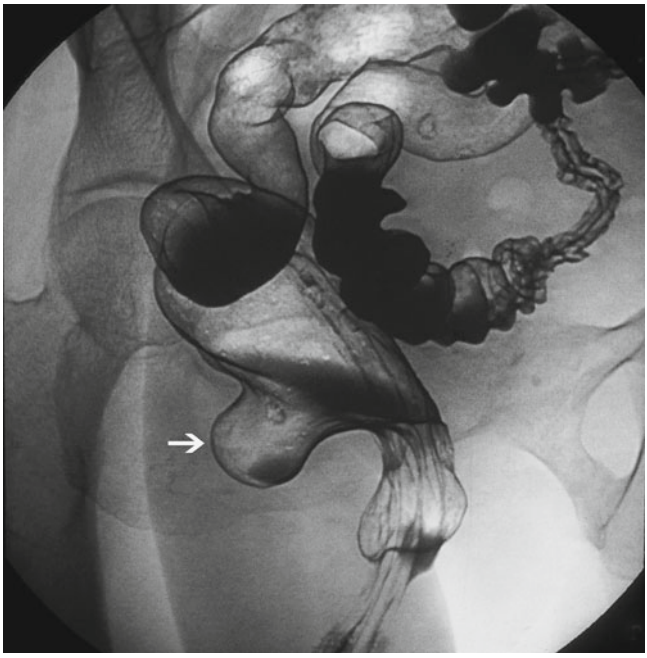

Fig. 2.18 Pubococcygeal tear with herniation of rectal tissue (*arrow*) demonstrated on dynamic proctography. Hernia was only seen when the patient bore down with contrast in place during dynamic study

Complications

Patient discomfort and barium impaction.

Additional Comments

Dynamic proctography should be performed in a center where the staff have experience with the procedure. It is a time-consuming technique and the patient must be reassured and given clear instructions during the procedure to allow for optimal cooperation. Patient embarrassment during the procedure can produce radiographic changes mimicking nonrelaxing puborectalis syndrome.

Electromyography

Description of Procedure

Anal EMG is the measurement of electrical activity in the anal muscle. The procedure involves placement of an electrode (using a needle, wire, or surface plug) onto the anal muscle. The electrical activity of the internal anal sphincter (IAS) and external anal sphincter (EAS) and the puborectalis muscles is then measured. Electrical action is measured at rest and during various maneuvers, including squeezing, pushing, and coughing (see Fig. 2.19). The signal is transferred from the record electrode to an amplifier and oscilloscope. Data are converted via a computerized formula.

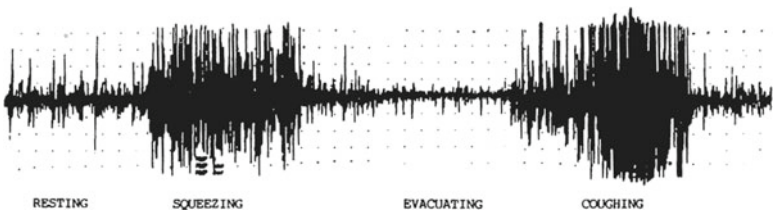

Fig. 2.19 Normal EMG patterns with maneuvers

Indications

Chronic constipation with suspected obstructive defecation disorders, chronic straining, suspected pelvic neuromuscular disorders, identification of anal sphincter injury, and fecal incontinence.

Complementary Procedures

Dynamic proctography, sigmoidoscopy, colonoscopy, Sitz™ marker study, anorectal ultrasound, barium enema, and PNTML.

Contraindications

Bleeding disorders or anal carcinoma.

Relative Contraindications

Inability to cooperate with testing, anal stenosis, anal abscess, or bleeding hemorrhoids.

Preparation of Patient

Some centers recommend a preparation of one or two cleansing enemas just prior to the procedure; others do not recommend any enemas as preparation for the procedure.

How the Procedure Is Performed

Catheters may consist of a needle, a small single-fiber electrode, or a small anal plug made from a plastic or sponge material upon which surface electrodes have been mounted. After application of topical anesthesia, with the patient lying in a left lateral position, EMG catheters are inserted into the IAS and EAS and puborectalis muscles. The catheters are connected to the amplifier and electrical transducer. Patients are instructed to perform various activities including squeezing, pushing (defecatory simulation), and coughing. Recordings are taken during these activities.

Typical Abnormal Findings

EMG is highly effective for diagnosing nonrelaxing puborectalis syndrome and anismus. With these abnormalities, continued or increased muscle contraction occurs during a push maneuver. In anal sphincter injuries and neuromuscular damage, decreased or erratic motor function is documented.

Complications

Patients often complain of discomfort; bleeding and/or infection are rare complications.

Additional Comments

Surface electrode techniques reduce patient discomfort and decrease the risk of infection; however, needle EMG is more accurate for documenting anal trauma and sphincter injuries. A 24-h ambulatory EMG has been proposed as a sensitive means of correlating symptoms with disorders of the anal sphincter and puborectalis muscles. Surface electrode EMG has been used in biofeedback treatment of pelvic floor disorders.

Flexible Sigmoidoscopy

Description of Procedure

Flexible sigmoidoscopes are 8–12 mm in diameter and 60 cm in length. The sigmoidoscope is inserted into the anal canal and advanced proximally as far as patient tolerance permits. The flexible sigmoidoscope provides a well-lit, magnified view of the colonic mucosa. It has a suction channel to remove fecal material for analysis and a biopsy channel to obtain mucosal specimens for histologic analysis.

Indications

Rectal bleeding, rectal mass, colitis, diarrhea, screening for colon cancer (in combination with stool Hemoccult® fecal blood testing), surveillance of patients with an ileoanal pouch, fecal incontinence (in combination with other studies), constipation (in combination with other studies), or screening of patients with a family history of familial polyposis syndromes.

Complementary Procedures

Barium enema, stool collection, Hemoccult® fecal blood test, anorectal ultrasound, anorectal manometry, and defecography.

Contraindications

Imperforate anus.

Relative Contraindications

Severe anal or rectal pain (such as that caused by an anal fissure), anal or rectal stricture, or severe coagulopathy (in which biopsies should not be performed).

Preparation of Patient

The patient should only receive clear liquids after their dinner the night or 16 h before the procedure and should be given two sodium phosphate enemas on the morning of the procedure. More aggressive preparations, such as 24 h of clear liquids and oral laxatives, have been recommended by some to improve mucosal visualization. Some clinicians recommend flexible sigmoidoscopy without preparation in patients undergoing evaluation for colitis because a preparation may alter the appearance of the mucosa.

How the Procedure Is Performed

The patient is placed in a left lateral position and a gentle digital rectal examination is performed. It is possible to perform a prostate examination on male patients at this time to screen for prostate cancer. The flexible sigmoidoscope is inserted and advanced to 60 cm, or as far as is tolerated by the patient. It is not uncommon for patient discomfort (due to sigmoid angulation and redundancy) to limit advancement of the flexible sigmoidoscope beyond 30 cm. If a large polyp is seen, the patient will undergo a colonoscopy for complete evaluation of the colon and removal of the polyp (see Fig. 2.20). If smaller polyps are seen (see Figs. 2.21 and 2.22), biopsies of these lesions are recommended. Colonoscopy is subsequently performed if adenomatous polyps are identified.

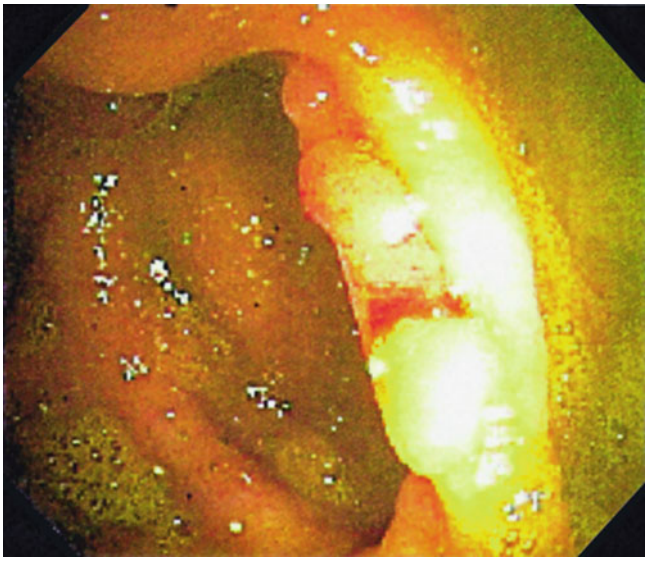

Fig. 2.20 A large sessile sigmoid polyp.

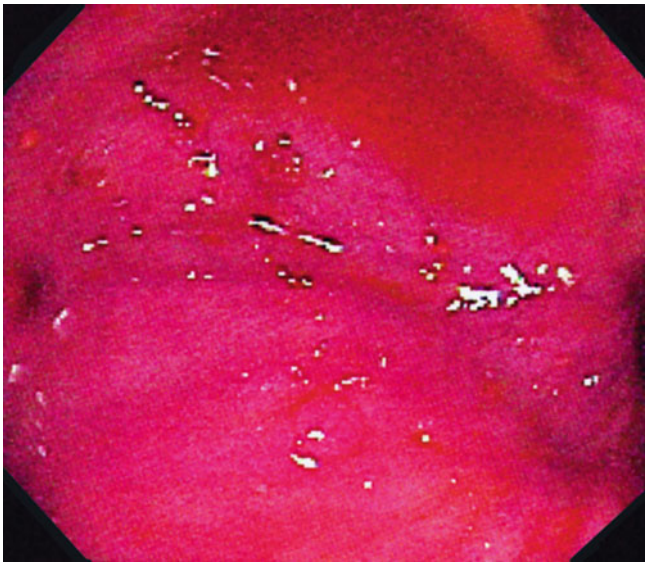

Fig. 2.21 Small sessile rectal polyp, a common finding on flexible sigmoidoscopy

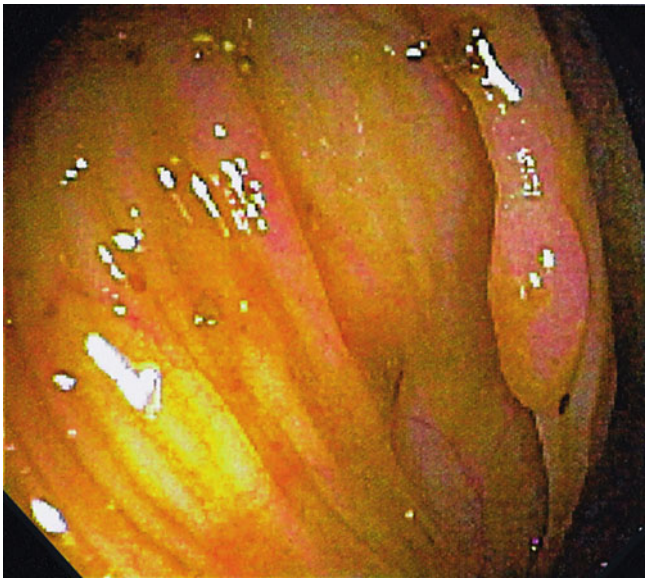

Fig. 2.22 Sigmoid colonic polyp demonstrated on flexible sigmoidoscopy

In patients with diarrhea caused by a suspected infection, fecal material may be suctioned and collected for culture, and ova, parasite, and *C. difficile* toxin PCR evaluation. Retroflexion of the sigmoidoscope in the distal rectum allows visualization of the proximal anal canal and the dentate line. This is particularly useful for looking at internal hemorrhoids and high anal canal lesions. The retroflexed view is also useful for finding polyps in the distal rectum (see Fig. 2.23). If colitis is suspected based on visualization of the mucosa and/or clinical history, biopsies are obtained and sent for histologic evaluation.

Typical Abnormal Findings

Screening of the distal 60 cm of the colon may reveal polyps or colon cancer; evaluation of the distal 60 cm of the colon allows for identification of sources of rectal bleeding, including hemorrhoids and proctocolitis. Biopsies may be obtained for suspected colitis if the mucosal appearance is abnormal. Diverticulosis of the colon may also be identified (see Fig. 2.24).

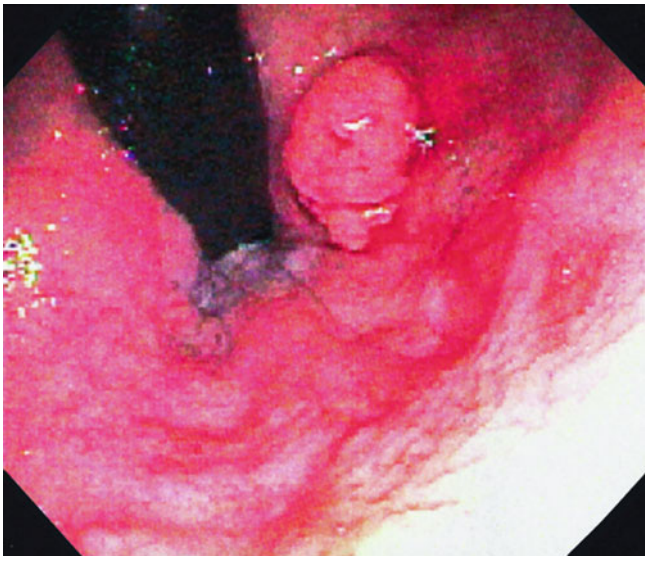

Fig. 2.23 A sessile polyp near the dentate line seen on retroflexion of the sigmoidoscope

Fig. 2.24 Sigmoid diverticulosis, a common endoscopic finding

Complications

Patient discomfort is common. Bleeding may occur subsequent to biopsies. Perforation is a very rare complication of flexible sigmoidoscopy.

Additional Comments

In the United States, colonoscopy with visualization of the entire colon is replacing flexible sigmoidoscopy as the preferred method for screening for colon polyps and cancers.

Pudendal Nerve Terminal Motor Latency

Description of Procedure

The pudendal nerve innervates the anal sphincters; therefore, pudendal nerve injury may result in sphincter dysfunction. Pudendal nerve terminal motor latency (PNTML) measures pudendal nerve function. With this procedure, a stimulating and recording electrode are utilized to measure the conduction of an impulse across the pudendal nerve.

Indications

Fecal incontinence and chronic constipation.

Complementary Procedures

Anorectal ultrasound, anorectal manometry, defecography, and flexible sigmoidoscopy.

Contraindications

Imperforate anus.

Relative Contraindications

A patient who is unable/unwilling to cooperate with the procedure.

Preparation of Patient

Some centers recommend a preparation of one or two Cleansing enemas prior to the procedure; others do not recommend any enemas as preparation for the procedure.

How the Procedure Is Performed

A physician places the electrode device over a gloved finger (a disposable model is available). This device has two stimulating electrodes at the tip of the gloved finger and two surface recording electrodes at the base of the finger. A grounding pad is applied to the patient's thigh. The finger is gently placed in the rectum with the tip of the finger pushing against the ischial spine. An electrical signal is given at the point of induction of contraction of the EAS, which may be felt by the examiner. The recording electrode then measures the latency separating the stimulating impulse and the contraction of the sphincter. This is termed the PNTML. Three readings are obtained at least three times on either side of the rectum. PNTML duration that is longer than 2.2 ± 0.2 ms is considered prolonged and is suggestive of pudendal nerve damage.

Typical Abnormal Findings

Prolonged PNTML is seen in patients with unexplained fecal incontinence. Unfortunately, it also appears to occur as a natural consequence of aging. Prolonged PNTML has been associated with pudendal nerve damage due to pelvic floor laxity and rectal prolapse. Recent studies have failed to demonstrate a relationship between descent of the perineum (a potential cause of obstructive constipation) and prolongation of PNTML.

Complications

None.

Additional Comments

This procedure is not recommended as a routine test in patients with chronic constipation or fecal incontinence due to a high rate of false-positive results in these patients.

Quantitative Stool Collection

Description of Procedure

In some patients with unexplained diarrhea, quantitative measurement of fecal volume, electrolytes, pH, and fat content over 24–72 h will assist in determining the cause of diarrhea. Stools may be spot tested for occult blood, white blood cells, parasites, pathogenic bacteria, and *C. difficile* toxin.

Indications

Chronic diarrhea with or without weight loss and nutritional deficiencies.

Complementary Procedures

Colonoscopy with biopsy of the mucosa, upper endoscopy with small intestinal biopsy, complete blood count, serum chemistry, thyroid-stimulating hormone levels, stool culture, D-xylose serum test, 24-h urine 5-hydroxyindole acetic acid (5-HIAA), small intestinal radiography, CT scan of the abdomen and pelvis, and serum hormone levels (vasoactive intestinal peptide, gastrin, somatostatin, and calcitonin).

Contraindications

None.

Relative Contraindications

Inability to collect stool specimens properly and to store over several days.

Preparation of Patient

For patients undergoing fecal fat testing, it is helpful to have a patient on a diet of 100 g fat/day. Patients should be given instructions regarding this diet. Patients should otherwise continue their usual activities.

How the Procedure Is Performed

All stools are collected over the designated time period using a special collection device that is placed over the toilet. Stools obtained during the collection period are stored in a sealed can containing a preservative. In between stool passages, the can with the collected stool is placed in a refrigerator. Patients keep a diary of all foods consumed during the collection period.

Typical Abnormal Findings

The collected stool is measured for volume and weight. Diarrhea is considered to be present if the volume is >200 mL/day or the weight is >200 g/day (see Table 2.2). The following electrolytes are commonly measured: sodium (Na), potassium (K), chloride (Cl), magnesium (Mg), and bicarbonate (HCO_3). The fecal osmotic gap is calculated with the following formula:

Fecal osmotic gap = 290 − 2(Na + K).

A fecal osmotic gap of <50 suggests secretory diarrhea, while a fecal osmotic gap of >100 is characteristic of osmotic diarrhea. A fecal pH of <6 is suggestive of a malabsorptive disorder. In normal individuals, the total amount of fat in the stool should be <6% of the amount consumed. Thus, the presence of >6 g fat in the stool after consuming a 100 g fat diet suggests fat malabsorption. Very high fecal fat excretion (>20 g/day) is suggestive of pancreatic insufficiency. Elevated Mg in the stool can be found in laxative abusers. Additionally, the stool can be tested with a laxative screen using chromatography.

Table 2.2 Stool features in chronic diarrhea

Stools	Secretory	Osmotic	Inflammatory
Weight (g/day)	>1,000	500–1,000	<500
Osmolality	Normal	+	Normal
Osmotic gap	Normal	+	Normal
Na, CI	+	Normal	+
K; HCO_3	Low	Normal	Normal
Ph	High	Low	Normal

Complications

None.

Additional Comments

Although this procedure may be beneficial in diagnosing difficult cases of unexplained diarrhea, quantitative stool collection is cumbersome and is strongly disliked by patients and laboratory personnel.

Transanal Ultrasound

Description of Procedure

This is a transanal procedure involving placement of an ultrasonographic probe into the anus and rectum. The device rotates 360° for full evaluation of the IAS and EAS, as well as the rectum (compared to proctoscopy or sigmoidoscopy, which are used to view the mucosa only). Anorectal ultrasound has the advantage of evaluating all the tissue layers of the examined organs.

Indications

Evaluation of the anal sphincters in patients with fecal incontinence, staging of rectal cancers, evaluation of rectal lesions for evidence of invasion beyond the mucosa, and characterization of submucosal rectal lesions.

Complementary Procedures

Anorectal manometry, anorectal EMG, defecography, flexible sigmoidoscopy, colonoscopy, and barium enema.

Contraindications

Imperforate anus.

Relative Contraindications

Patient inability to cooperate with the procedure or severe anal stricture.

Preparation of Patient

The patient should receive two cleansing enemas 1–3 h before the procedure.

How the Procedure Is Performed

The patient is placed in a left lateral position. The ultrasonographic device is placed inside a hard plastic cover for evaluation of the anal canal, or inside a water-filled balloon for visualization of the rectum, and these are introduced into the anus. Ultrasound frequencies are transferred from the probe to a computer where they are reconstructed into a visual image. A resulting cross-sectional image of the anus and rectum is obtained. The IAS appears as a dark ring surrounded by a whitish ring representing the EAS. The mucosa, submucosa, lamina propria, muscularis mucosa, and serosa of the rectum can all be visualized as separate layers.

Typical Abnormal Findings

Transanal ultrasound can be used to evaluate the anatomy of the IAS and EAS. Sphincter injuries (due to obstetric damage, trauma, and prior surgeries) can be visualized (see Fig. 2.25). Thinning and degeneration of the anal sphincters may also be seen. The test may be used to evaluate patients who are being considered for sphincter repair for fecal incontinence. Transanal ultrasonography may be used to stage rectal carcinomas. Specifically, the test is accurate in determining whether the tumor is invading beyond the mucosa and the extent of this invasion. Enlargement of lymph nodes adjacent to the tumor may also be visualized. Therefore, this technique is useful in staging rectal tumors and for determining optimal medical and surgical management of the disease. Suspicious lymph nodes may also be sampled.

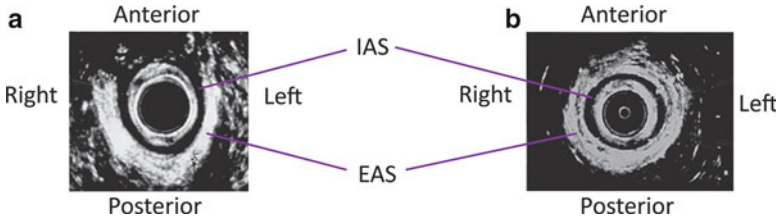

Fig. 2.25 (**a**) Anterior defect of IAS and EAS; (**b**) Normal IAS and EAS

Complications

Mild discomfort.

Additional Comments

This is an evolving technology. As with other forms of ultrasonography, the quality of information obtained from transanal ultrasonography is highly operator dependent.

CT Colonography

Procedure Overview

CT colonography (CTC), also known as virtual colonoscopy, is a minimally invasive, ultra-low radiation CT scan (typically done on a patient who underwent a saline cathartic preparation with oral contrast to tag residual fluid). It is performed to detect polyps and masses in the colon. Two- and three-dimensional images are reconstructed to search for polyps and to distinguish polyps from stool and other pitfalls of interpretation. Specialized training is critical in learning to recognize polyps and differentiating them from other structures (stool, folds, and other nonneoplastic findings). Colonic cleansing and gaseous distention (usually using carbon dioxide and a mechanical pump) is used to enhance the quality of the procedure (Fig. 2.26).

Indications

Screening or surveillance for colorectal polyps and masses, incomplete optical colonoscopy for any reason, searching for synchronous lesions in patients with known masses. Patients with relative contraindications for colonoscopy, for example,

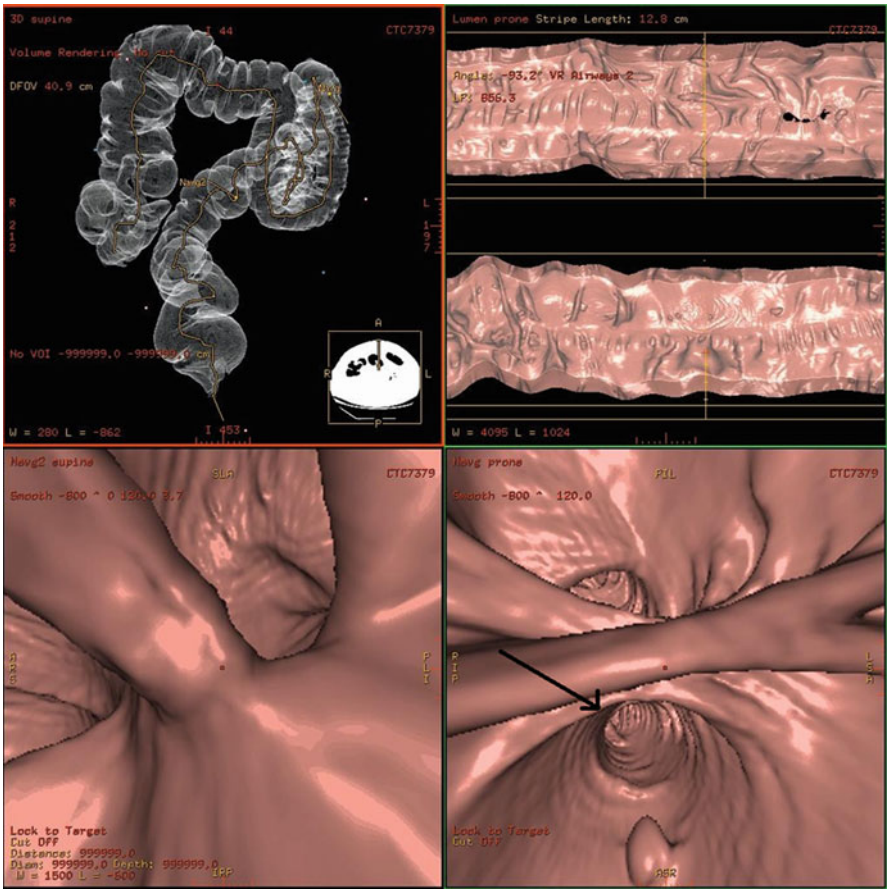

Fig. 2.26 Virtual colonoscopy. Example of a CTC display. Easy comparison of 2D and 3D images and of supine and prone images are critical to any CTC workstation. In this display: Upper left: 3D transparency overview of the colon shows the degree of tortuosity and can be used to mark polyp location to aid localization during follow-up endoscopy for patients with polyps. Lower: Supine and prone 3D endoluminal views. A polyp is seen on the prone view. Upper right: "Virtual dissection" view is one of several "novel display" options, which morph the colon to a flat surface for quick search for polyps. However, the polyps are therefore distorted (*arrow*)

on anticoagulation may prefer CTC. Uncommonly, to characterize indeterminate lesions found on optical colonoscopy, CTC can be done with intravenous contrast.

Complementary Procedures

Colonoscopy, flexible sigmoidoscopy, fecal occult blood testing, and fecal DNA testing.

Contraindications

Any reason to avoid raising intra-colonic pressure, for example, peritoneal signs, severe rectal bleeding, recent colon snare polypectomy, or electrocautery.

Relative Contraindications

Patients that would benefit from full colonoscopy including those with a high index of suspicion of colon cancer or polyps, known inflammatory bowel disease requiring surveillance or strong family history of colon cancer.

Preparation of Patient

Low-volume residue cathartic, for example, magnesium citrate, often with oral positive contrast tagging agents (low-density barium and or water soluble contrast). Polyethylene glycol-based colonic preparations can be used, although some deem this less desirable.

How the Procedure Is Performed

A thin catheter is placed in the rectum. The colon is insufflated with carbon dioxide using a pressure-sensitive mechanical pump for safety and comfort. Alternately, manual insufflation of room air can be used. The CT technologist must be trained to perform insufflation and recognize proper insufflation on the scout views. After insufflation, a scout view is performed to confirm adequate colonic distension. An ultra-low radiation dose CT is performed in a single short breathhold (16 slice scanner or better). This is repeated in the prone position. The technologist confirms that all segments of the colon are distended and that intraluminal fluid is properly tagged. If not, additional views can be obtained. The exam is interpreted on a dedicated 3D workstation by a trained radiologist.

Typical Abnormal Findings

Colon polyps and colon cancer. There are issues regarding the utility of this procedure as an alternative screening test compared to colonoscopy. Using multidetector scanners, meta-analysis suggests that the sensitivity of CTC for polyps greater than

10 mm is 82–100% and specificity of 90–98% for polyps greater or equal to 10 mm in diameter. Sensitivity and specificity are markedly decreased for smaller polyps. For example, it has been estimated that for polyps that are 6 mm or greater, CTC has a sensitivity of 86% and a specificity of 86%. The cost-effectiveness of reporting extracolonic findings is controversial, but significant actionable extracolonic findings are found in 5–9% of patients and up to 15% of medicare-aged patients undergoing CTC.

Complications

Pain, generally described as mild, from colonic distention or rare vasovagal reactions. Perforation is extremely rare. Pneumatosis intestinalis is also rare.

Additional Comments

Testing options for early detection of colorectal cancer and adenomatous polyps in asymptomatic adults 50 years of age and older have recently been published as a joint guideline from the American Cancer Society, the US Multi-Society Task Force on Colorectal Cancer, and the American College of Radiology. Options include fecal occult blood testing, flexible sigmoidoscopy, barium enema, CTC, and fecal DNA testing. Guidelines suggest that the sensitivity and specificity as well as ease of use of these tests vary, and the decision of which to use depends on a number of factors including availability, cost, and degree of invasive testing that patients wish to undergo for screening purposes. See American College of Radiology and American Gastroenterological Association white papers dealing with the subject and with training requirements. This chapter was written with the assistance of Dr Abraham Dachman, Department of Radiology, University of Chicago.

http://www.springer.com/978-1-4614-1101-7

Anal and Rectal Diseases
A Concise Manual
Ehrenpreis, E.D.; Avital, S.; Singer, M. (Eds.)
2012, XIII, 277 p. 120 illus., 90 illus. in color., Softcover
ISBN: 978-1-4614-1101-7