Chapter 3
Anorectal Imaging

Chapter 3.1(i)
Evacuation Proctography

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Editorial Commentary

Defecography is still the gold standard for the morphological assessment of the rectum and for the objective determination of its emptying efficiency. It would appear that radiological measurements (at rest, during squeeze and following attempted evacuation/strain), provide no real clinical advantage although they may be justified in the validation of newer comparative techniques. Current evidence shows that the vast majority of these patients have complex multicompartmental problems which relate to the middle and anterior pelvic and perineal viscera (and soft tissues). This highlights the need for a multidisciplinary clinical approach by urogynecologists with an interest in evacuatory difficulty assessing these patients in collaboration with the coloproctologist. Urinary difficulties, gynaecological problems and sexual dysfunction need a greater prospective evaluation in many of these cases. Such a view suggests that in some cases where defaecography forms a central diagnostic plank for surgical decision-making that an extended technique of colpocystography and even defecoperitoneography may be required in specialized centres geared for this approach. The consequence is that there will be increased radiation exposure (often in young females) and that some of these investigations will be relatively poorly tolerated despite their clinical utility. Modern approaches will need to test the efficacy of the newer investigation in an algorithm approach comparing these (such as dynamic magnetic resonance imaging and transperineal ultrasonography) with conventional and extended defecography.

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Introduction

Evacuation proctography (EP) is a relatively new technique. The balloon proctogram, a similar fluoroscopic technique that attempts to characterize anorectal dysfunction by using a barium-filled balloon to simulate a soft

stool, has since been superceded (1). Although some rectal evacuation studies had been performed for a number of years (2), the study in 1984 by Mahieu and colleagues popularized the technique, probably because of a burgeoning interest in anorectal surgery for functional evacuatory problems (3). The radiologic criteria for normal evacuation of the rectum was further defined in 1988 by Shorvon et al. and Bartram et al. (4,5), and was variously labeled as defecography, videoproctography, and dynamic rectal examination. Because physiologic defecation is a result of colonic contraction and reflex anorectal accommodatory changes, some of these terms may be relatively misleading since only rectal evacuation is examined; hence, the term evacuation proctography generally is preferred. Several different protocols of EP have been considered, but most are similar to the initial technique described by Mahieu et al. EP—the radiologic visualization of the act of defecation—is, of course, not an exact simulation of defecation since the physical properties of the contrast medium differ from normal fecal content, as does the method of rectal filling and content expulsion.

Initial work in this area concentrated on the evaluation of patients with idiopathic chronic constipation and attempted to separate patients with anorectal dysfunction (so-called "outlet disorders") from those with delayed colonic transit. Despite little scientific data to confirm the inherent diagnostic (and therapeutic) value of EP in primary evacuation difficulty, it has achieved a central place in the investigation algorithm as performed by specialized pelvic floor clinics for patients presenting with these disorders. This is partly a testament to the ease of performing the examination and the fact that no other investigation (up until recently) gave a visual overview of what actually happened during the act of defecation. It should be remembered that EP is an examination of function and not a technique to identify subtle structural or mucosal abnormalities. Of and by itself, defecographic findings are not relied upon solely for operative decision making and should at all times be taken into account with the whole patient picture of history and clinical examination findings (6,7).

During the late 1980s and early 1990s, there were many reported attempts designed to characterize defecographic patterns of rectal and pelvic floor movement during EP that were thought to identify specific structural and physiologic disorders and correlate with specific symptom/examination findings. A complex set of measurements and maneuvers evolved for an extended technique of EP; however, several of these added procedures are now considered unnecessary. More recently, EP has been considered to have a role in the selection of patients presenting with primary evacuatory dysfunction for surgical therapies and approach (such as in rectocele) and for the biofeedback treatment in cases of anismus (8–11).

Indications for EP

Like many investigations, EP is useful only where it is predicted to be helpful in influencing patient management. Many patients with anorectal dysfunction are complicated without clear-cut treatment options and the information obtained by proctography needs to be considered carefully along with clinical and physiological data. Our unit has had extensive experience in its use in the following patient groups.

Constipation

The main indication for EP is in the investigation of refractory constipation. It particularly should be considered in those patients with symptoms suggestive of outlet obstruction (obstipation) or possible prolapse, which is not clinically evident, and it is useful in understanding the mechanisms by which patients manage to enhance defecation where there is reported rectal and/or vaginal digitation or other aiding maneuvers such as perineal pressure, to enhance defecation. Patients presenting with intractable constipation who also fall into this category for defecographic investigation may include patients with suspected rectoanal intussusception, those cases where an enterocele also is suspected in association with a symptomatic rectocele and in those presenting with solitary rectal ulcer syndrome (12–14).

Incontinence

Its value in fecal incontinence is less evident. In patients with major incontinence, it is particularly limited as they are unlikely to be able to retain the barium inserted before getting onto the proctography commode. In patients with soiling, there can be some benefit in performing EP, especially when digital examination, endosonography, or manometry indicate a normal or near-normal sphincter. It also should be remembered that incontinence is a principal symptom in up to one third of patients presenting with evacuatory dysfunction and what is thought to be a clinically significant rectocele (15).

Postoperative Assessments

EP also can be performed in a modified manner to assess dynamic evacuatory function (and capacity) in patients with an ileal pouch (pouchography) and following some other types of reconstructive anorectal surgery—in particular, after some specific reconstructions for anal atresia (16) and in the assessment of post-rectopexy evacuation difficulty (17).

Miscellaneous

EP can be performed in some patients presenting with intractable perianal or rectal discomfort where there is little that is clinically evident to explain their symptomatology, although its yield is low in this group and there is poor correlation with the types of pathology detected and the need for surgical intervention. This patient group may include the constellation of symptoms expressed in the solitary rectal ulcer syndrome, where such defecographic abnormalities as rectoanal intussusception and anismus may be recognized (18).

Contraindications for EP Use

There are no specific contraindications to EP other than its avoidance in pregnancy. Because the radiation dose to the ovaries is considerable (19), EP should be reserved for those women who subsequently are unlikely to have children and only in those for whom it is essential for management. As the testicular dose may be considerable, the technique is also best avoided in young men whenever possible, with a consideration of use of other dynamic tests such as dynamic transperineal ultrasonography (see Chapter 3.2) and dynamic magnetic resonance imaging (MRI) (see Chapter 3.3).

Technique

Although simple in concept and performance, EP requires a very sensitive approach on the part of the investigator and careful reporting in the context of the patient's symptoms and age. Patients often are embarrassed by the procedure. Time taken to take a history prior to the examination is always helpful in gaining the patient's confidence, as patients often will relay information that hitherto they had kept to themselves because of the difficulty of discussing such personal information in an outpatient clinic.

The Screening Room

The screening room should be kept under subdued lighting during the procedure, with as few staff members present as possible. The examination is performed using a standard fluoroscopic unit, preferably with an overcouch tube. In general, patients do not need any prior preparation, although some units give a glycerin suppository or disposable enema to empty the rectum prior to the procedure. Although there is no evidence that an empty rectum alters broad diagnostic interpretation, it does help to standardize the procedure and perhaps make it more pleasant for patients and staff alike.

Female patients are given 150 to 300 milliliters of oral radiographic contrast media at least half an hour before the examination to outline the pelvic small bowel loops and to aid in the identification of coincident enteroceles. Water-soluble contrast media or a mixture of this with barium passes through the small bowel faster than barium alone.

Rectal Contrast

When the oral contrast has passed sufficiently through the bowel, the patient is asked to lie on their left side. In women, a contrast agent is then inserted into the vagina to be able to identify this structure radiographically. In the past, a contrast-soaked tampon was used, but it was soon realized this would splint the vagina to some extent and prevent the formation of rectoceles. In addition, there is limited interpretation of the rectal wall morphology with a tampon in situ, and some authors have suggested that this may diminish the diagnosis of multiple pelvic floor anomalies by the creation of a "crowded-pelvis" syndrome if the rectum is over distended during the procedure (20,21). Contrast-soaked gauze can be used, but the easiest method is to insert a contrast and gel mixture. Our unit uses about 20 milliliters of 50% Aquagel™ with 50% nonionic intravenous (IV) contrast (300 milligrams iodine per 100 milliliters) mixed in a bladder syringe and injected into the vagina with a soft 10F catheter, as this tends not to leak out of the vagina (without distension) as easily as does liquid contrast. With regard to the nature of the rectal contrast used, several authors have suggested that high-viscosity barium, which mimics the characteristics of feces, should be used—most notably, barium sulphate mixed with potato starch. This may be of advantage in those unlikely to readily retain the rectal contrast either by virtue of age or with a preexisting weak anal sphincter and in those cases where it is preferred to scroll the proctogram in an ortho- and antegrade fashion to assess transiently observable anomalies that are not visualized when the contrast is expelled too quickly.

Originally, stiff pastes were made that were inserted with a caulking gun (22). This is time consuming and unpopular with those who have to prepare it, and most now use a pre-made barium paste that originally was designed as an esophageal paste for chest X-Rays (EZ paste™, EZ-EM). One hundred to 150 milliliters is inserted directly into the anal canal with the nozzle of a standard 50-milliliter bladder syringe. Alternatively, the first 30 milliliters could be standard liquid barium to coat the mucosa and, if possible, opacify the distal sigmoid colon. Ikenberry (23) compared examinations using liquid barium, E-Z paste, and a high-viscosity specially prepared paste and found no significant difference in pelvic floor descent or in the demonstration of rectoceles. Various other mixtures have been tried, including "FECOM," which is said to closely simulate normal stool (24). As the syringe inserting the paste is withdrawn, a small amount of barium is placed

in the anal canal and a dollop of paste is left at the external anal orifice so these structures also are identifiable on the images.

The Commode

Once the rectal contrast has been inserted, a specially designed commode is placed in front of a vertically placed fluoroscopy table. The commode should incorporate additional filtration (equivalent to 4 mCi) (5,25) in order to obtain a uniform radiographic density at the level of the anal canal and to minimize "flare," which can limit defecographic measurements because of its effect on bony landmarks. (26) The commode should be comfortable and permit adequate lateral fluoroscopy with an even visible radiographic density above and below the top of the commode. Radiation filtration is necessary given the different X-ray absorptions of bone, soft tissue, and barium and the high scatter production encountered particularly above the commode.

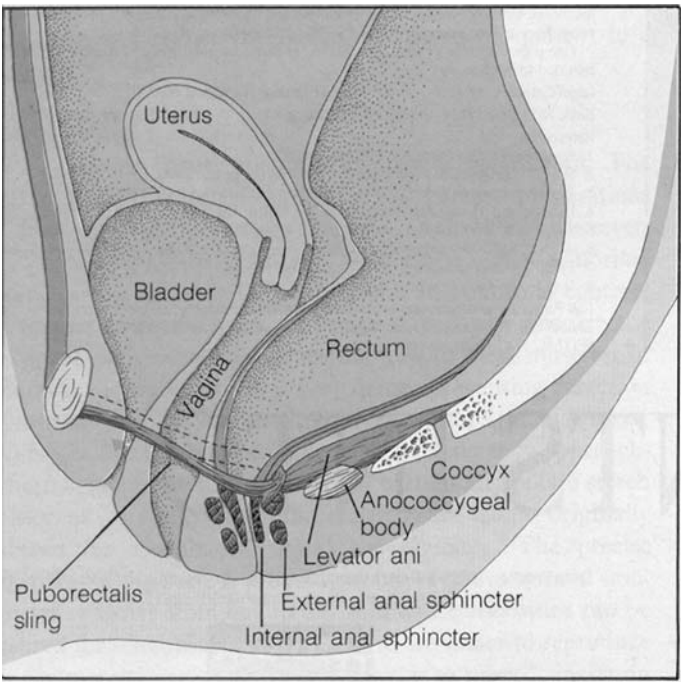
The Procedure

The patient sits on the commode and is imaged fluoroscopically in the lateral position. The patient then is asked to perform a number of simple maneuvers such as "squeeze" (contraction of the pelvic floor muscles and anal canal), "strain" (pushing down without evacuation), "cough," and finally "evacuate." For the latter activity, the patient is asked to empty out the rectum as rapidly as possible; a good incentive is to tell the patient that the quicker they do this, the less radiation they will receive (as many patients may feel particular embarrassment during this time). It often is helpful to ask the patient to strain particularly hard at the end of defecation if prolapse is suspected, as sometimes no intussusception or prolapse will occur until the rectum is empty. The advantage here of the sitting defecogram is that it constitutes a more physiological position for the act of defecation than any of the other more sophisticated dynamic imaging technologies, such as conventional dynamic MRI or dynamic real-time ultrasound (27,28). The whole procedure is videotaped on SVHS format tapes and frame-grab images can be taken at any time. Images at rest, squeeze, and during different phases of evacuation are normally captured. With some equipment and with large patients, the frame-grab images can be of too low a resolution, and in these patients, additional spot films are taken. This is only really possible with good quality digital screening equipment or with conventional equipment with 100-millimeter film capability, as changing cassettes is too slow. An image of a radiopaque ruler in the same sagittal plane as the patient's midline is taken with the patient no longer on the commode to allow direct measurements.

The examination can be considered in three phases; resting, evacuation, and recovery (5). At rest, the rectum is angled posteriorly, parallel to the

presacral space, where its axis forms an angle with the anal canal of approximately 90 degrees (2). With the anal canal closed, the anorectal junction (ARJ) is identified easily [Figure 3.1(i).1 (a,b)]. Its angulation is due to the puborectalis muscle, which forms a sling posteriorly at the junction of the rectal ampulla and anal canal. The inferior aspect of the ischial tuberosity is used to define the level of the pelvic floor (since this lies along the line of the pubococcygeal ligament) and the ARJ should lie at or just above this level at rest. Although the anorectal angle initially was considered important in maintaining continence, subsequent studies have shown a large overlap between normal patients and those with anorectal dysfunction (4,5,29) and it is no longer considered a discriminatory measurement. The pubococcygeal line is difficult to draw because of glare and identifying the bony landmarks, and the plane of the ischial tuberosities is generally preferred (5).

The simple "squeeze" maneuver raises the pelvic floor, decreasing the anorectal angle and lengthening the anal canal, which gives an indication



a

FIGURE 3.1(i).1. (a) Line drawing of the rectal and pelvic floor anatomy. (Printed with permission from Shorvon PJ and Stevenson GW. Defaecography: setting up a service. Br J Hosp Med. 1989;41:460). (b) Normal resting and evacuation phases at EP showing placement of a ruler in the position of the patients mid saggital plane, allowing direct measurements to be calculated.

b

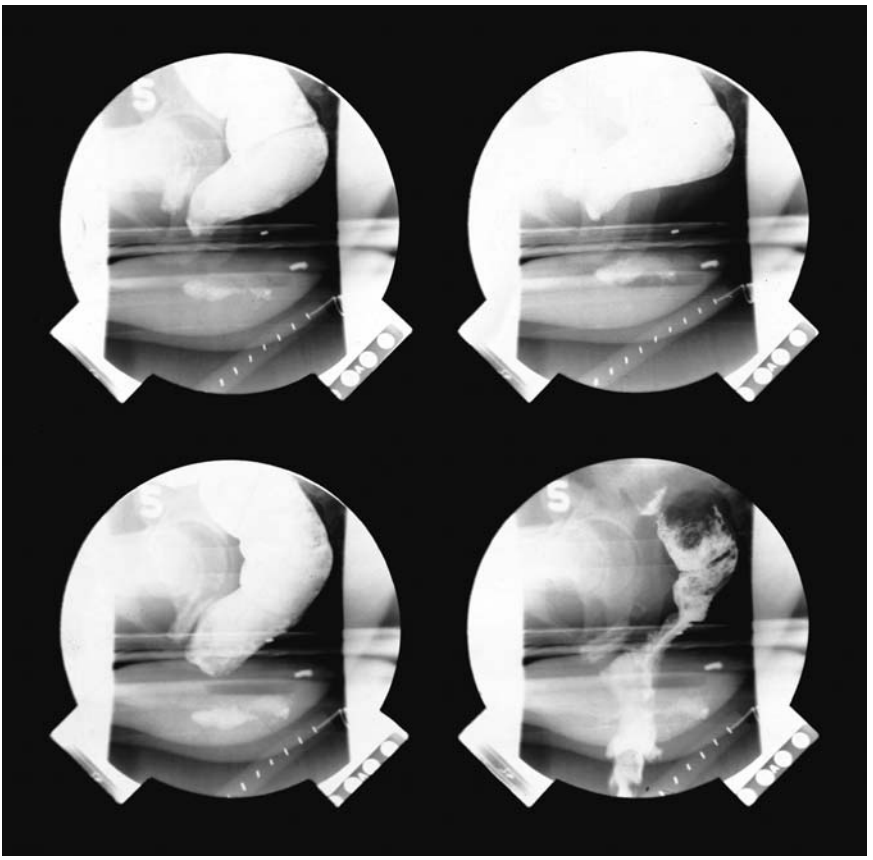


FIGURE 3.1(i).1. *Continued*

of pelvic diaphragmatic and puborectalis contraction, as well as that of the external sphincter.

On coughing, there is a sharp rise in intra-abdominal pressure. In normal subjects, very little movement of the pelvic floor and no involuntary incontinence of barium is seen because of reflex contraction of the pelvic floor and external sphincter.

Evacuation is usually rapid and completed within a few seconds, although it is considered within normal limits if completed within 30 seconds. Because the impersonal environment is anxiety inducing, it is important to use pelvic floor descent as a marker of the onset of evacuation. The puborectalis impression is effaced as the canal opens, with an increase in the anorectal angle of approximately 20 degrees, where the rectum and the anal canal together form a "cone shape." Generally, only the distal rectum beyond the main fold is emptied, with some contrast remaining in the rectosigmoid segment (30).

Once the patient stops straining, the anal canal closes and the puborectalis contracts, elevating the ARJ to its resting position.

Modifications and Variations of Technique

Left Lateral Position

When a suitable commode is unavailable, the entire examination may be performed in the left lateral position. The resting position of the pelvic floor is higher than when seated (31), and the lack of any effects of gravity limit the usefulness of this approach.

Area Postrema (AP) Views

The normal proctographic view is a true lateral view. This is a two-dimensional (2D) representation of a three-dimensional (3D) subject, and abnormalities outside the midline will be projected onto this view. Intra-anal intussusception can be demonstrated more easily on an area postrema (AP) view, with widening of the anal canal during straining after evacuation. An occasional radiographic finding is a posterior rectocele or posterolateral pouch/herniation. This is due to a herniation of the rectal wall through the pelvic diaphragm. It is to one side of the midline, where its precise position is best demonstrated by an AP view (32). Similarly, the "concertina" type of rectal movement during evacuation—although not a true intussusception—may contribute to obstructed defecation and is recognizable in the coronal plane. This can only be suspected on the lateral view, needing an AP view for confirmation. The AP view is often difficult to obtain using conventional undercouch fluoroscopic equipment because of the lack of space between the explorator and the table, and patients may actually have to stand up to demonstrate an abnormality.

Failure to Evacuate

Occasionally, patients will be unable to evacuate, and although this may be due to their outlet obstruction, it often is due to embarrassment. To avoid excessive radiographic screening, the investigation staff can place themselves "out of sight" and the patient can be given the fluoroscopy pedal to press when evacuation begins. Additionally, encouragement by explaining that the quicker the examination is performed, the less radiation is received often shortens the procedure. It should be remembered that the average skin dose of radiation during conventional defecography is about 0.02 to 0.66 cGy (centigray) when compared with a barium enema (0.22–0.64 cGy), where the ovarian dose is about 0.036 to 0.053 cGy compared with that of a barium enema of 0.32 to 0.42 cGy (5,7). Patients who "aid" evacuation (e.g., by transvaginal or perineal pressure on a rectocele, or anal digitation

to overcome a spastic puborectalis) are encouraged, wherever possible, to demonstrate these actions while screening in order to understand their mechanism.

EP with Concurrent Peritoneography

Peritoneography is a diagnostic technique occasionally used for identifying hernias. It involves injection of non-ionic water-soluble contrast media into the peritoneum. The technique can be used as an addition in defecography in order to visualize the peritoneal cavity, particularly the Pouch of Douglas (33–35). This is useful for demonstrating deep recesses that have the potential for hosting enteroceles, even if these are not evident on the study—in effect, a classification of peritoneoceles (36,37).

Digital Subtraction EP and Computer Analysis

Subtraction techniques in radiology are a well-established means of illustrating the differences between two images; in conventional subtraction radiography, an image is taken prior to contrast administration, then a reversed image (or mask) is superimposed on the radiograph containing contrast so that all non-contrast detail is subtracted and a final image of only the contrast-enhanced structures is seen. This is a slow process, but digital subtraction has since speeded the process to almost real time and allowed a variety of postprocessing computerized enhancements. Similarly, digital subtraction defecography can show just the changes occurring in the rectum and anal canal during defecation, the subtracted images allowing easy analysis for area measurement via planimetry (and therefore assumptions on volume changes) in assessing the rapidity and completeness of rectal emptying (38,39). Although this creates numeric data that is invaluable in further analysis and correlation, it is not considered to add significantly to patient management, and furthermore, such data is probably more accurately achieved with isotope techniques. Moreover, subtracted images actually hindered the visualization of morphological abnormalities in five of 18 patients in one study (40), and hence, digital subtraction is currently little used.

Dynamic Cystoproctography

There is increasing recognition that the different compartments in the pelvic floor (posterior or rectal, middle or vaginal and uterine, and anterior or bladder and urethra in females) are interrelated and that disease processes in one can affect others. Pelvic floor prolapse can affect all compartments at once or be largely confined to one or two compartments only. Many patients undergoing defecography also will have micturating cystography in their diagnostic work-up. For these reasons, there is more interest in the development of multidisciplinary pelvic floor teams and manage-

ment. It is possible to perform cystography at the same time as EP rather than at a separate investigation. While this has the advantage of seeing the interrelations of the two compartments, the difficulty for both the patient and the investigator is increased. Furthermore, cystography traditionally has been performed by careful pressure measurements taken in the bladder using a rectal catheter to obtain subtracted detrusor pressures from the bladder, and this is difficult to do when defecation is also being assessed. The combined technique is good for showing anatomical abnormalities such as bladder neck problems, cystocele, and prolapse. The concept of "competition for space" within the pelvis has been elaborated by this technique. It has been shown that either a cystocele or an enterocele may be demonstrated, but not both at the same time. Similarly, a rectocele and enterocele may inhibit one another. As a consequence of this, a sequential approach often is used, opacifying the bladder first to demonstrate the degree of cystocele, emptying the bladder, and then opacifying the rectum to perform a standard EP (41).

MRI EP

A number of groups have investigated the use of MRI defecography (42,43) (see Chapter 3.3). The advantage of this technique is the avoidance of ionizing radiation and the visualization of all the organs of the pelvis at the same time. Patient preparation is easier, multiplanar views can be obtained, and perhaps surprisingly, bony landmarks are easier to identify using MRI. The technique also has been shown to be extremely accurate in the delineation of attendant enteroceles, which can be missed in conventional defecography in up to 20% of cases. These are vital for diagnosis where a rectocele may be repaired for evacuatory difficulty and where the preoperative definition of an enterocele prevents residual evacuatory problems (36,44). Studies have been performed with the patients lying supine in a conventional scanner, but others have used open magnets with the patients sitting on specially constructed commodes similar to conventional radiographic defecography. With the former method, both non-evacuation (straining only) and evacuation studies have been performed (27,42,45,46).

There are inherent problems with this approach when compared with defecography. Most MRI studies tend to image only in the midline sagittal plane and are at risk of missing changes outside this plane. Studies without evacuation will miss many morphological abnormalities that only progress as the rectum empties (such as rectoanal intussusception and rectal prolapse), and any such study generally is considered incomplete (47). Supine studies with evacuation are likely to under-represent the true degree of descent and prolapse, although this may be less than initially thought. In many ways, proctograms with the patient sitting in open magnets are the ideal, as not only do they mirror normal evacuation, but all the pelvic organs can be visualized at one time. However, to date, relatively low field magnets

(0.5 Tesla) have been used, and only T1-weighted sequences with a maximum of two images per second have been achieved. It also has required gadolinium rectal paste to be inserted in order for the rectal contents to be visualized. The examination is expensive and the bladder views appear to be sub-optimal on T1-weighted images. Moreover, some proctographic changes can be missed when images are only taken at two-second intervals.

Magnetic resonance imaging studies clearly have many advantages and considerable potential; however, the difficulties with performing these studies, particularly in conventional magnets, are significant. Furthermore, MRI is relatively expensive and currently has somewhat limited availability in most hospitals, particularly for allocation for pelvic floor functional disorder evaluation.

Radioisotope EP

Some centers have performed EP using radioisotopes and a gamma camera (48,49). A potato starch "paste" mixed with Technetium 99^{m} is utilized. The use of isotopes facilitates quantification. By drawing areas of interest around the rectum, rates of emptying, completeness of emptying, and pelvic floor descent are measured. Rectoceles can be diagnosed and the percentage trapping of isotope can be calculated. The technique is useful for the quantification of the effectiveness of surgery for rectal emptying problems. However, the anatomical detail that can be assessed using this method is very limited and morphological abnormalities of the rectum are easily overlooked. The technique has not achieved wide acceptance.

EP in Evacuation Disorders

The significance of structural abnormalities demonstrated by EP is greatly debated because they are found in many normal subjects undergoing this investigation (4). Because there is always a tendency to attribute symptoms to a radiographically demonstrated abnormality, it is important to both consider the incidence of that abnormality in asymptomatic patients and also to try to correlate the finding (as mentioned above) with the patient's symptoms.

Rectocele

This term is used to describe the anterior bulge of the rectal wall that occurs in females during evacuation (4,11). In normal individuals, including nulliparous females, this may be up to two centimeters in depth (3), as measured

from the anterior anal canal to the most anterior part of the rectocele. When large (Figure 3.1(i).2), the rectocele acts as a pressure, as well as a volume, reservoir where anal canal opening may be delayed, a phenomenon particularly evident on real-time MRI scanning. Some patients will support the rectovaginal septum during straining in order to counteract this effect, either by digital pressure on the anterior perineum or trans-vaginally. This information, however, is uncommonly volunteered and is best obtained by direct inquiry. Asking the patient to demonstrate this often will confirm the mechanism by which their "aiding" of defecation is effective.

Posterior rectoceles occur fairly rarely, but they are better termed posterior perineal hernias resulting from a defect in the levator ani. The orientation of this will be shown on an AP view during defecography (50). These are often transitory during straining early on, but will become permanent "pouches" with time.

FIGURE 3.1(i).2. Large anterior rectocele. A black arrow delineates the vaginal marker and a white arrow a small enterocoele.

Neither the size of the rectocele or trapping of contrast within it following evacuation has been shown to correlate with symptoms (51,52), and on postoperative EP after rectocele repair, there is no correlation between the radiological appearances and the symptomatic response. A study comparing constipated, incontinent, and asymptomatic patients found a similar prevalence and size of rectoceles in all groups (52). Barium trapping within a rectocele is a not uncommon finding, which could account for symptoms if stool becomes sequestrated or if elevation of intrarectal pressures is inadequate for complete evacuation. In order to examine this postulate, Halligan and Bartram (52) looked for differences in intrarectal pressure during evacuation and the ability to expel a non-deformable balloon between patients with documented barium trapping and those without contrast retention. The presence or absence of a rectocele, its size, or barium trapping had no effect on the patients' ability to expel the balloon, but a marked fall in intra-rectal pressure was seen when the manometer entered the rectocele in seven of 12 patients with barium trapping. This finding suggests that trapping is due to sequestration in the anterior wall of the rectum in an extraperitoneal position, isolating part of the rectocele from differential changes in intra-rectal pressure (53).

The presence of a rectocele or trapping within it should not be taken as a primary sign of impaired evacuation. However, if patients aid evacuation by compressing or splinting the rectocele, it is more likely to be of functional importance. Rectoceles often are found in association with anismus, which may account for poor symptomatic relief if rectocele repair is performed, although this remains controversial (54,55).

Pelvic Floor Descent

Pelvic floor descent of up to three centimeters can be seen during normal evacuation (19). Excessive pelvic floor descent is a common finding (Figure 3.1(i).3), although its significance is still uncertain. While some studies have demonstrated differences between controls and constipated patients, others have failed to show significant differences between constipated or incontinent patients (56,57). Chronic straining has been implicated in the etiology of pudendal neuropathy, but there is no correlation between neuropathy and pelvic floor descent on EP (58). Reduced descent implies a poor increase in intra-rectal pressure (59), but in the elderly or incontinent patient, the position of the pelvic floor may be low at rest, with little further descent during evacuation (56,60). The descending perineum syndrome was a term applied to those patients, often elderly, who had excessive pelvic floor descent and difficultly with evacuation (61). On straining, the perineum balloons and the abdominal pressure appears to "spread" the rectum in a globular fashion with only poor evacuation; in effect, the raised abdominal pressure appears to be "wasted" in creating this rectal configuration rather than directing intra-rectal contents in a cone shape towards the anal canal.

FIGURE 3.1(i).3. Excessive pelvic floor descent. The upper arrow indicates the position of the ischial tuberosities and the lower arrow the anorectal junction in this patient with marked descent.

Enterocele, Sigmoidocele, and Peritoneocele

Herniation of bowel, bladder, or uterus into a deep rectogenital space may occur during evacuation. When the small bowel herniates, this is called an enterocele, whereas a sigmoidocele contains sigmoid colon. This is common following hysterectomy and cystopexy, where enteroceles can be present in up to two-thirds of patients following hysterectomy and a quarter following cystopexy. Enteroceles usually descend between the vagina and rectum, but can invaginate into the vagina itself (Figure 3.1(i).4). While this may be inferred during EP from widening of the rectovaginal distance or compression of the anterior rectal wall, it is best demonstrated when the vagina and small bowel contain contrast. A sigmoidocele, although much less

FIGURE 3.1(i).4. Enterocele. Marked widening of the Pouch of Douglas with evacuation. No oral contrast was given in this study, but a barium study later confirms the large enterocele filling this space. (Printed with permission from Shorvon PJ and Stevenson GW. Defaecography: setting up a service. Br J Hosp Med. 1989;41:464).

common, is often easily demonstrated as a herniating soft tissue mass containing fecal residue if no rectal contrast has entered the sigmoid (Figure 3.1(i).5). Enteroceles most commonly are seen on straining at the end of evacuation, and indeed, some units advocate a "post-toilet" image, as patients can sometimes complete evacuation in private when unable to do so on the EP commode.

An enterocele or sigmoidocele requires a deep peritoneal pouch or cul-de-sac, and these may be present without any bowel within. In this situation, they will only be shown on EP if peritoneography is performed at the same time, but recognition is felt to be important as, if overlooked, it may compromise the success of other pelvic floor operations (62).

Intussusception

Various degrees of infolding of the rectal mucosa ranging from anterior mucosal prolapse to full-thickness rectal prolapse or "procidentia" may

occur during evacuation. Intussusception has been graded on a seven-point scale (3), although recently there has been a trend towards more simple stratification based on the likely contribution to symptoms. Classification into high- or low-grade intussusception is possible with assessment based on the rectal appearance at the end of evacuation. It is termed intra-rectal when confined to the rectum and intra-anal if the apex enters the anal canal. Generally, low-grade intussusception is defined as circumferential infolding of rectal mucosa, which is less than three millimeters thick and confined to the rectum (3). Full-thickness prolapse defines high-grade intussusception where the prolapsing fold is greater than three millimeters thick and impacts on the anal canal [Figure 3.1(i).6 (a,b)]. It may stop at the internal anal orifice or progress down the anal canal level [Figure 3.1(i).7 (a,b)].

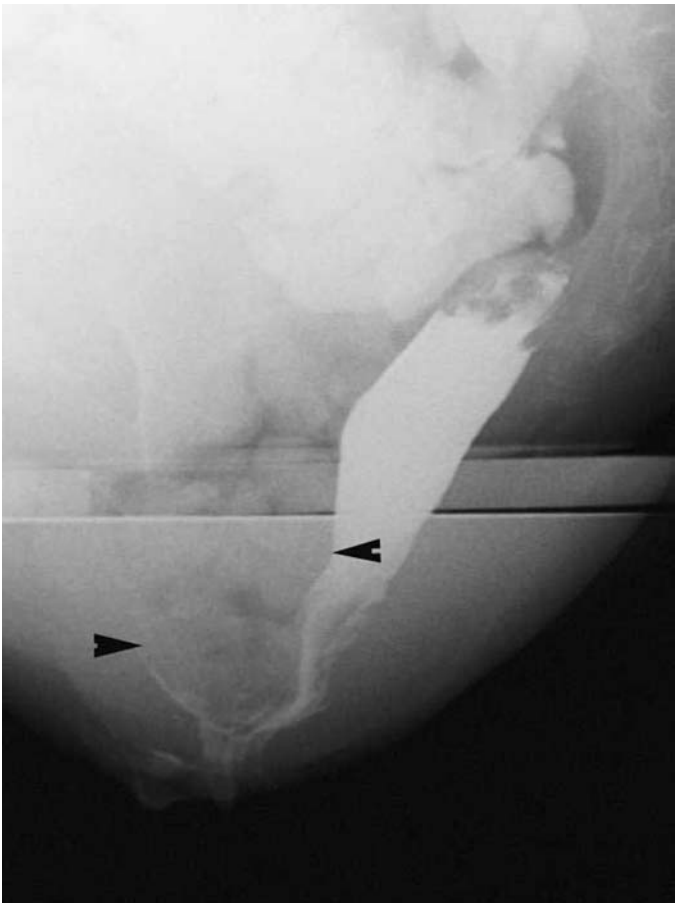


FIGURE 3.1(i).5. Sigmoidocele. Arrowheads indicate the posterior vaginal wall and the anterior rectal wall with a sigmoidocoele projecting between them.

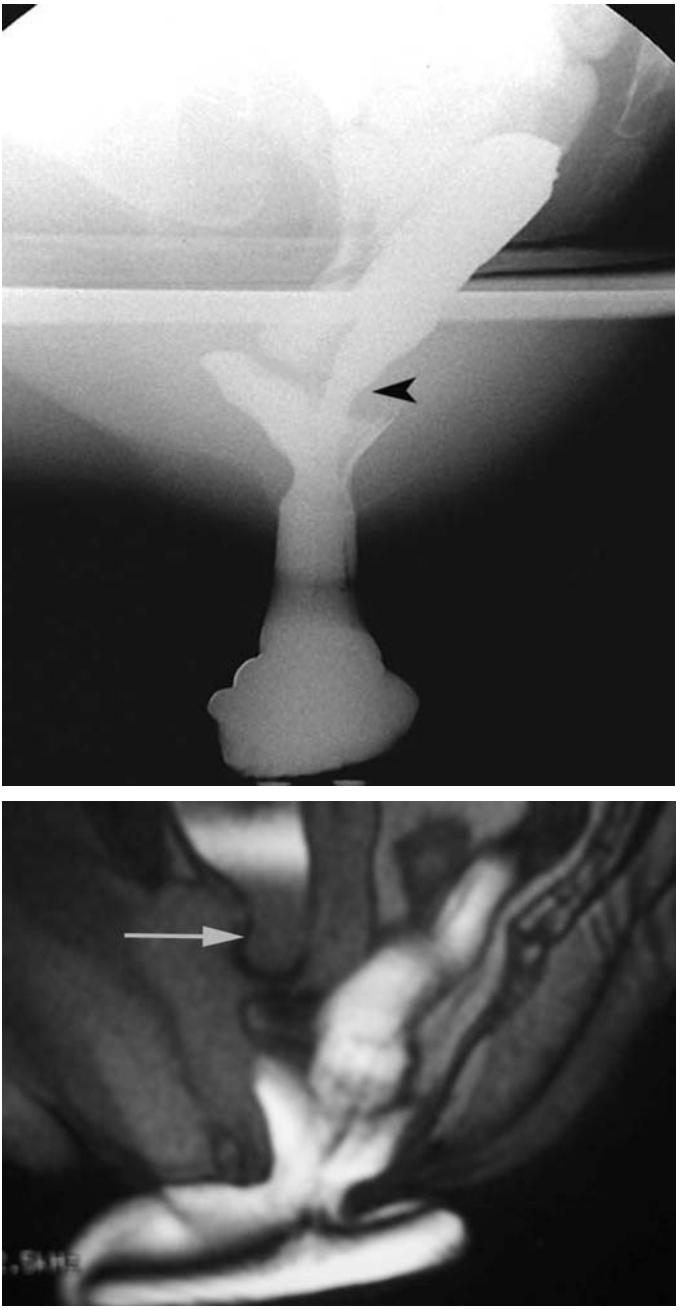


FIGURE 3.1(i).6. Intussusception demonstrated on (a) EP and (b) at dynamic MR proctography in an open magnet. Magnetic resonance also demonstrates a small cystocele (arrow).

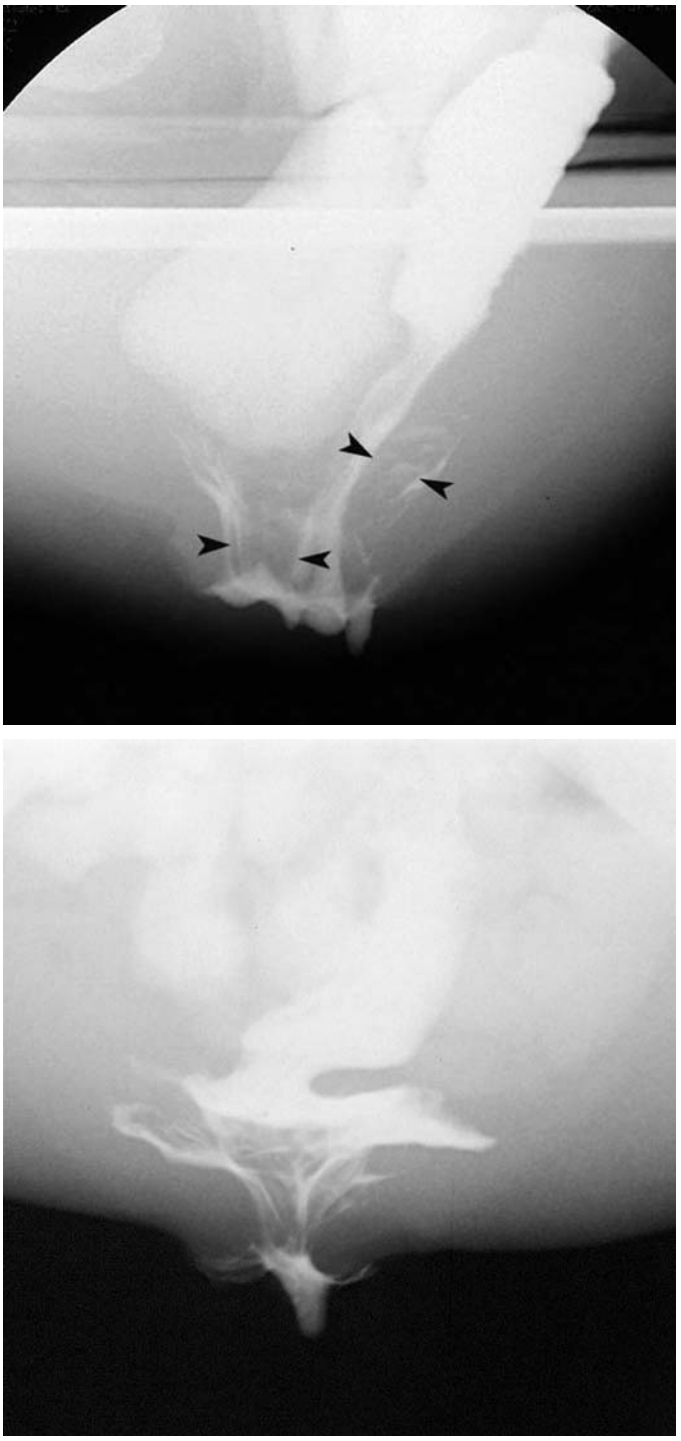


FIGURE 3.1(i).7. Intra-anal intussusception—lateral (a) and AP (b) views. Note enterocele on lateral view.

High-grade intussusceptions are associated with feelings of difficult or incomplete evacuation (4). While the intussusception may impede rectal emptying, it often occurs only at the end of evacuation when the rectum is empty. In this situation, the intussusceptum may be inducing a feeling of incomplete evacuation as, in effect, the patient tries to pass it per anum. It is not uncommon to see full-thickness prolapse and complete rectal prolapse (procidentia) with spontaneous reduction in patients who are unaware that this is actually occurring. These are examples of what has been labeled as "occult" intussusceptions, which are assisted in diagnosis by defecography in suspicious cases (63).

Anterior mucosal prolapse is seen commonly in association with a rectocele, where that part of the rectal wall above the rectocele descends towards the anal canal as the rectum collapses, often associated with barium trapping within the rectocele. There is no established relationship with rectal intussusception (64); however, EP is indicated if anterior wall mucosal prolapse is detected clinically but more significant intussusception is suspected (65).

Asymmetric collapse of the rectal tube during evacuation is often over-interpreted as intussusception. When screening in the AP projection, the valves of Houston, which in part govern the process of rectal collapse, are seen clearly. Intra-anal intussusception is evidenced by the advance of the folded rectum into the anal canal, which becomes widened during straining.

EP and Functional Abnormalities

Anismus

Although functional assessments traditionally are performed in the physiology department, accurate quantification of contrast evacuation is possible using EP (66). Anismus describes impaired rectal evacuation secondary to a functional disturbance of defecation and may be demonstrated in isolation or in association with a structural abnormality. Many alternative terms have been used (some of which reflect postulated etiologies), including spastic pelvic floor syndrome, rectal dyschezia, non-relaxing puborectalis syndrome, and paradoxical sphincter contraction. Failure of the anorectal angle to efface and a prominent puborectalis impression during attempted evacuation are cited frequently in the literature as signs of anismus (Figure 3.1(i).8).

Considerable inter-observer error has been documented in measuring the anorectal angle (ARA) (67), but more importantly, no correlation has been produced between the ARA and the anorectal physiologic criteria for anismus (68). In a study of 24 patients with a diagnosis of anismus based on multiple criteria, only measurements indicating delayed rectal emptying were able to differentiate patients from controls (69). Confounding results

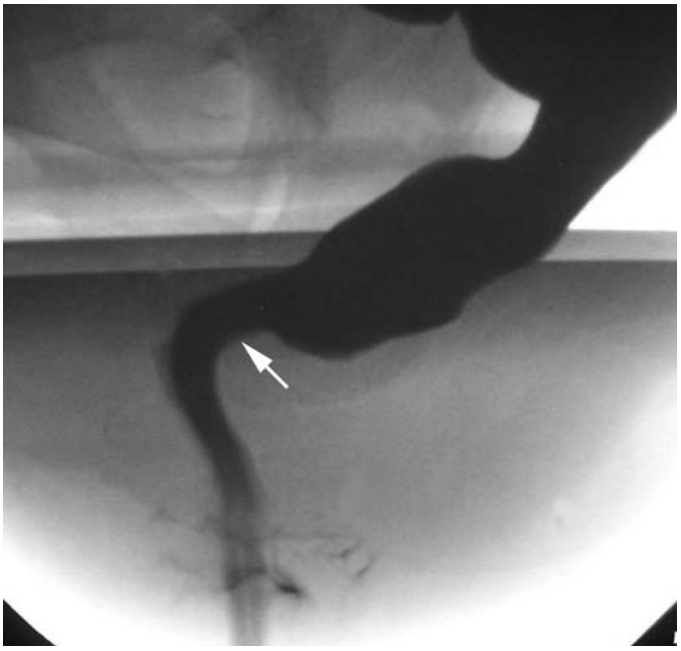


FIGURE 3.1(i).8. Non-relaxing puborectalis muscle.

exist, however, where patients with electromyographic criteria for anismus can demonstrate normal evacuation on EP (70,71). Further confusion has arisen from the results of ambulatory physiology studies, suggesting that some of the signs of anismus may even be a laboratory-observed phenomenon (71–73). In general, patients who evacuate rapidly and completely are unlikely to have anismus; those who cannot do so *may* have anismus, but the finding may be artifactual due to psychological inhibition.

Solitary Rectal Ulcer Syndrome (SRUS)

This condition is normally associated with either overt rectal prolapse or lesser degrees, including rectal intussusception and pronounced anterior rectal wall mucosal prolapse. EP usually identifies one of these abnormalities in patients with solitary rectal ulcer syndrome (SRUS). These patients often strain excessively, and first-line treatment for those without marked prolapse is behavioral, as surgical correction of these various types of prolapse only has moderate success. Endoanal ultrasound can identify thickening of internal sphincter, although the reason for this is unknown (74–76).

Congenital Anomalies

Imperforate anus is part of the spectrum of rectal agenesis. There may be an almost normal distribution of striated muscle from which the external anal sphincter should have formed. In many cases, a colonic "pull through" operation is performed, with reconstruction of the anal canal and perineum. As young adults, varying degrees of incontinence are a common sequel. Resting anal tone is usually reduced due to the absence of any properly developed internal sphincter. Additionally, there may be an ineffective external sphincter (or levator plate) due to either an incomplete muscle ring or misplacement of the anorectum in an eccentric position alongside the malformed sphincter mechanism (77,78). However, because chronic intussusception may cause or exacerbate incontinence, EP is indicated to exclude its presence. There may be varying degrees of sacrococcygeal agenesis associated with high rectal agenesis. Here, the rectum is usually vertical in configuration and the normal puborectalis impression is partially effaced. Evacuation may be prolonged and puborectalis relaxation can be intermittent, producing a "milking" effect on the rectum. Anismus may coexist, and in such cases, disordered evacuation may be a result of a mixed neuropathy.

Post Surgical Appearances

Many surgical procedures have been described for the treatment of rectal prolapse and patients may present postoperatively with recurrent symptoms of evacuatory difficulty or incontinence after these surgeries (79). While recurrent intussusception is not uncommon (reported at between 3 and 17% following perineal procedures and closer to 10% following rectopexy), proctography is indicated to exclude other causes of obstructed evacuation such as a sigmoidocele, anismus, or proximal rectal stenosis.

Abdominal Rectopexy

Here, the rectum is mobilized and the posterior wall elevated and fixed to the presacral fascia with nonabsorbable sutures or mesh. Several modifications to the technique have been described, ranging from alternative fixation techniques to resection rectopexy where the prolapsing rectum and any redundant sigmoid colon are excised (80). Theoretically, this protects against recurrence and sigmoidocele, but because chronic constipation is common in patients with intussusception, the colon alters its configuration over time and new redundant loops may develop.

At EP, there may be widening of the presacral space and a vertical configuration to the rectum, the apex of which is normally angulated and closely approximated to the sacral promontory.

Delorme's Procedure

Rectal prolapse is common in elderly women, many of whom may be unfit for major abdominal surgery. Delorme's procedure (using a perineal approach to excise the prolapsing mucosa and reef the muscularis propria) can be carried out under local or regional anesthetic where necessary. The muscle layers in this segment of bowel are stitched together in a concertina fashion, forming a ring of plicated redundant muscle at the anorectal junction. Resultant decreased rectal capacity and compliance are thought to be important factors implicated in the low incidence of evacuation problems following this procedure, although the post-Delorme's physiology is complex (81). The EP features can reflect the decreased rectal capacity and the plicated muscle at the anorectal junction, which may become stenosed.

Colo Anal Anastomosis

Rectal excision with a colo-anal anastomosis may be performed as part of anterior resection for a low rectal carcinoma. Although remodeling of the neorectum will occur with time, a J-pouch is sometimes created to act as a reservoir and avoid problems of frequency postoperatively. Again, findings at EP will reflect the surgery, with widening of the presacral space and a somewhat vertical configuration to the pouch (82). The most common structural abnormality that may present with evacuatory difficulty is stricture formation, which may result from pouch ischemia or an isolated anastomotic leak.

Pouchography

Panproctocolectomy for ulcerative colitis usually involves formation of an ileal reservoir in an attempt to reduce stool frequency. Several pouch configurations are described, and it is not uncommon to encounter patients with pouch dysfunction, although presentation may be late. Dynamic evaluation of evacuation is similar in principle to EP, although it is sensible to use less-viscous barium. Evacuatory difficulty may be functional or structural. Structural abnormalities include stenosis at the anal anastomosis or of the afferent limb. Dilatation of the distal small bowel is a normal finding after a few months, as it adapts to provide additional reservoir function. Where a long distal segment is present, this may be effaced by the distended pouch as intra-abdominal pressure is raised and the pouch descends inferiorly with the pelvic floor, creating a true outlet obstruction that lies away from the anastomosis (83).

An unsuspected anastomotic leak and chronic presacral sepsis are other causes for long-standing pouch dysfunction. Presacral widening is usually present and a leak or cavity may be demonstrated at EP. If no cavity is seen at EP, it may be worth considering further imaging of the presacral space to exclude sepsis. Obstructive problems with long-standing pouches may be

due to adhesions or stricture formation, especially related to the covering ileostomy; here a formal small bowel study often is helpful (84).

Conclusions

EP has been shown to assist our clinical understanding and management in a setting where symptoms and clinical signs often may be confounding (4,5). EP studies are best reported in multidisciplinary meetings alongside clinical and laboratory data. Care must be taken to not always attach clinical significance to morphological radiologic findings, as the range of normality in EP is wide, particularly in females. Correlation of symptoms to visualized abnormalities and the demonstration of the action of patient "aiding maneuvers" often will help in the correct interpretation of studies.

Acknowledgments. We are grateful to Professor C.I. Bartram and Professor W. Gedroyc for their contributions to the figures.

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