

## Defecography: a practical approach

Niccoló Faccioli, Alessio Comai, Paride Mainardi, Simone Perandini, Farah Moore, Roberto Pozzi-Mucelli

### ABSTRACT

The purpose of this pictorial essay is to describe the main morpho-functional imaging features, physiological and pathological, of the recto-anal region and pelvic floor as depicted with conventional video defecography.

Defecography has dramatically improved our knowledge of dysfunctions of evacuation. The most frequent indications and related disorders are presented from a database of more than 2500 examinations conducted in two radiology departments over a period of 15 years.

Imaging features of the common recto-anal and pelvic floor disorders are described: rectal prolapse, rectocele, intussusception, descending pelvic floor syndrome, puborectalis muscle syndrome, enterocele, and sigmoidocele. Conventional video defecography still represents the gold standard examination for the identification and staging of morphological and functional disorders of the recto-anal region and pelvic floor in evacuation dysfunctions.

*Key words:* • defecography • rectum • anal canal • pelvic floor

The morphologic and dynamic examination of anorectal region and the pelvic floor was made possible by means of defecography more than 50 years ago, dramatically improving our knowledge of evacuation dysfunctions. This technique was first described by Wallden in 1953 (1). During recent decades, interest in the study of evacuation has grown; today it can also be performed with magnetic resonance imaging (MRI). Nonetheless, this technique still represents a widely available and cost-effective diagnostic tool (2–7).

Evacuation disorders, frequently found in elderly patients, are often caused by morphologic and functional abnormalities that are unlikely to be identified with static imaging techniques. Defecography evaluates in real time the morphology of rectum and anal canal in correlation with pelvic bony components both statically and dynamically by injection of a thick barium paste into the rectum and its subsequent evacuation (2–5). The most common indications are constipation, incomplete evacuation or incontinence (often associated with rectal bleeding), mucous discharge, and perineal pain or discomfort. The technique is also important for follow-up of patients who have undergone surgery of the pelvic region.

Other imaging techniques, such as double contrast barium enema, endocavitary ultrasonography, and computed tomography (CT), are useful for their detailed anatomic resolution, but they are not able to identify the dynamic modifications of the anatomic structures (5, 6). Anal manometry and electromyography provide complementary functional information (5, 6). Recently, MR defecography has been of increasing interest because of its accuracy in morphologic and functional assessment, as well as avoiding radiation exposure for the patient. Open configuration MR systems are required to perform the study with the patient sitting (providing natural conditions) (5, 6). Unfortunately, open configuration MR systems are expensive and scarce. However, defecography can be performed in any hospital with a fluoroscopic room; a relatively short training time is required for the radiologist.

The purposes of this pictorial essay are to explain how to perform defecography and to describe the main physiological and pathological findings of anorectal region and pelvic floor. The most frequent indications and disorders are presented from a database of more than 2,500 examinations conducted in two radiology departments over a 15-year period.

### Technique

#### Preparation

The patient fasts, beginning the evening before the procedure, and performs a rectal cleaning enema at home a few hours before going to the hospital. In the hospital, the patient receives an oral solution of 400 mL of barium solution to obtain opacification of the pelvic loops

From the Department of Radiology (N.F. ✉ [niccolofcc@yahoo.com](mailto:niccolofcc@yahoo.com), A.C., S.P., F.M., R.P.M.), G. B. Rossi University Hospital, Verona, Italy; and the Department of Radiology (P.M.), Sacro Cuore Hospital, Negrar, Italy.

Received 16 January 2009; revision requested 13 March 2009; revision received 31 March 2009; accepted 4 May 2009.

Published online 26 January 2010  
DOI 10.4261/1305-3825.DIR.2584-09.1



**Figure 1.** Rectal probe attached to a 50 mL syringe filled with barium paste. The cup contains barium solution for the preliminary opacification of ileal loops.



**Figure 2.** Fluoroscopic table is tilted vertically and a special commode is attached to the footboard with two fluid-filled ring pillows.

of the small bowel at the time of examination.

It is important to obtain a complete clinical history of the patient with particular attention to abdominal and pelvic surgery; clinical conditions such as diabetes, hypothyroidism, and systemic disorders; and drug consumption. Psychological and behavioral aspects (e.g., hygienic education, diet, sexual habits) are also important to consider

as regards the deep relationship between intestinal functions and the unconscious representation of the body. Defecography can be an embarrassing experience for the patient, and the radiologist must provide a clear explanation of the procedure in order to obtain complete collaboration. A relaxed and cooperative patient is the *sine qua non* condition to perform a correct defecography examination.

### Procedure

At the beginning of examination the patient is positioned on the left side, and about 300 mL of thick barium paste is injected into the rectum by means of a plastic syringe connected to a catheter (Fig. 1). When the subject reaches the stimulus to evacuate, the anal bulb is completely filled and injection can be interrupted.

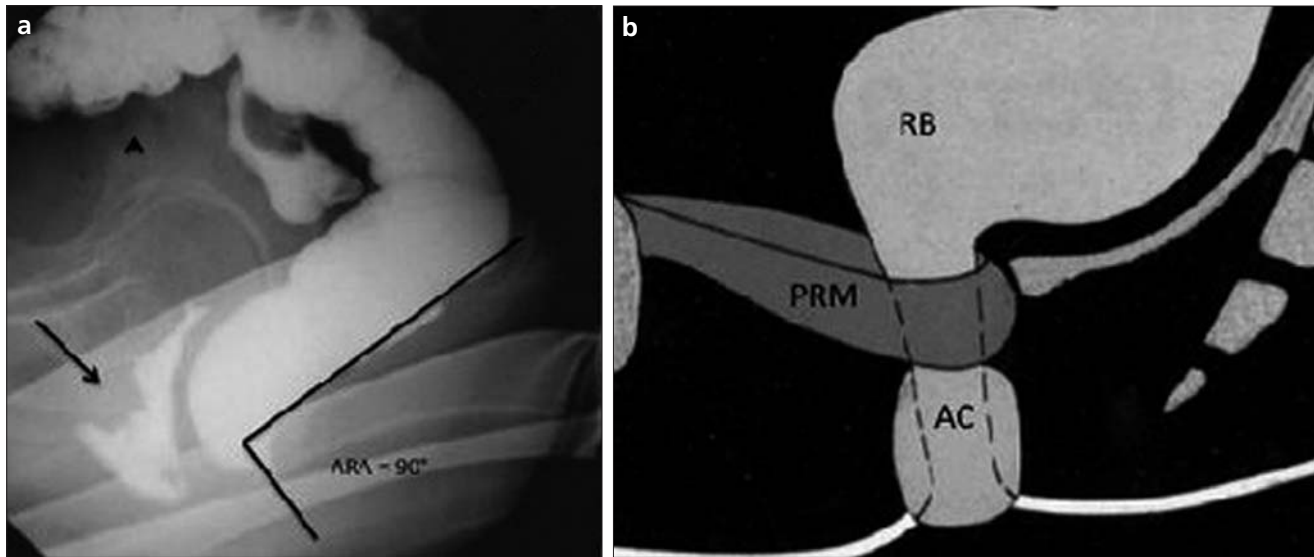
Barium paste is obtained by mixing equal proportions of potato starch and barium solution with water. Barium paste must have the consistency of normal stool or a little more fluid to permit ease of injection into the rectum. According to our experience, we use a galenic preparation with a viscosity of about 800,000 centipoise (cP), compared to physiological fecal viscosity of >1 million cP. These characteristics ease the injection of the barium paste through a rectal probe without alteration of the diagnostic results (8). Finally, in female patients, the vagina is opacified with a commercially available barium sulfate paste for oral use.

The fluoroscopic table is tilted vertically, and a special commode is attached to the footboard with two or three water-filled annular pillows. The patient is then asked to sit on the commode in right lateral projection (Fig. 2). When the radiogenic tube is correctly centered on the pelvis, the first radiograph is acquired. The examination is performed filming the dynamics of defecation step by step with short radioscopic sequences and radiographs. The salient phases of defecography are: (i) during rest with filled anal bulb, (ii) during maximum contraction of anal sphincters and pelvic floor muscles, (iii) during straining without evacuation, (iv) during evacuation, and (v) during rest when evacuation is completed.

The patient must be instructed to empty the rectum completely and without interruption: this process takes less than 30 seconds in physiologic conditions (9).

### Parameters

The anorectal angle (ARA) is measured between the anal canal longitudinal axis and the posterior rectal line, parallel to the longitudinal axis of the rectum. In resting conditions, its average value is 95°–96° (physiological range, 65°–100°), without noticeable differences between men and women (Fig. 3) (9–11). ARA is



**Figure 3. a, b.** Normal defecography at rest in lateral projection (a). Anorectal angle (ARA) is measured between the anal canal longitudinal axis and the posterior rectum line parallel to the rectum longitudinal axis (a). Vaginal lumen is opacified by means of barium paste (arrow, a). Note the ileal loops previously opacified with barium solution *per os* (arrowhead, a). Schematic representation (b) of the puborectal sling, rectal bulb (RB), pubo-rectal muscle (PRM), and anal canal (AC).

an indirect indicator of the puborectal muscle activity. Fibers of the puborectal muscle insert into the symphysis pubis and form a V-shaped sling around the posterior wall of the anorectal junction (levator ani). At rest, the anal canal is almost completely closed, and the anorectal angle is about 90°; during muscle contraction, the angle becomes more acute, while during relaxing phase it becomes obtuse.

The second important parameter to evaluate is movement of the anorectal junction (ARJ) during straining. The line drawn between the ischial tuberosities is called the bis-ischial line and can be used as a fixed bony landmark. Another fixed reference point is represented by the tip of the coccyx. The craniocaudal migration of anorectal junction indirectly represents the elevation and descent of pelvic floor. The reproducibility and reliability of these two parameters as usually measured have been confirmed, but their clinical significance is still controversial (9).

### Normal findings

In the resting phase, the anal canal is almost completely closed and the impression of puborectal sling is visible on the posterior wall of caudal rectum. In this condition, the angle between the anal canal and rectum is 95°–96° (Fig. 4a).

During voluntary contraction of the pelvic floor, the anorectal angle

decreases to about 75°, and the ARJ migrates cranially. The puborectal impression becomes more evident because of the contraction of levator ani, pulling the ARJ toward its insertion at the symphysis pubis (Fig. 4b).

When the patient is asked to strain, the converse is seen: the anorectal angle increases with partial to complete loss of puborectal impression, and the pelvic floor descends (Fig. 4c). The degree of caudal migration as measured in relation to the bony landmarks (bis-ischial line and tip of the coccyx) is considered normal when less than 3.5 cm relative to the resting position (12).

During evacuation, the anal canal and the rectum migrate caudally. The anal canal opens and the anorectal angle increases in relation to the relaxation of external and internal sphincters and puborectal muscle, respectively. Puborectalis sling impression on the rectum posterior wall disappears almost completely, and the anal canal reaches the widest diameter (Fig. 4d). During the late phases of evacuation, the rectal bulb funnels and its walls progressively collapse. The entire process lasts less than 30 s in physiologic conditions (13). At the end of evacuation, the resting condition is reached when the anal sphincters close and levator ani restores its tone, pulling the anorectal junction cranially. The rectum is completely

empty, and only minimal barium dye can be found.

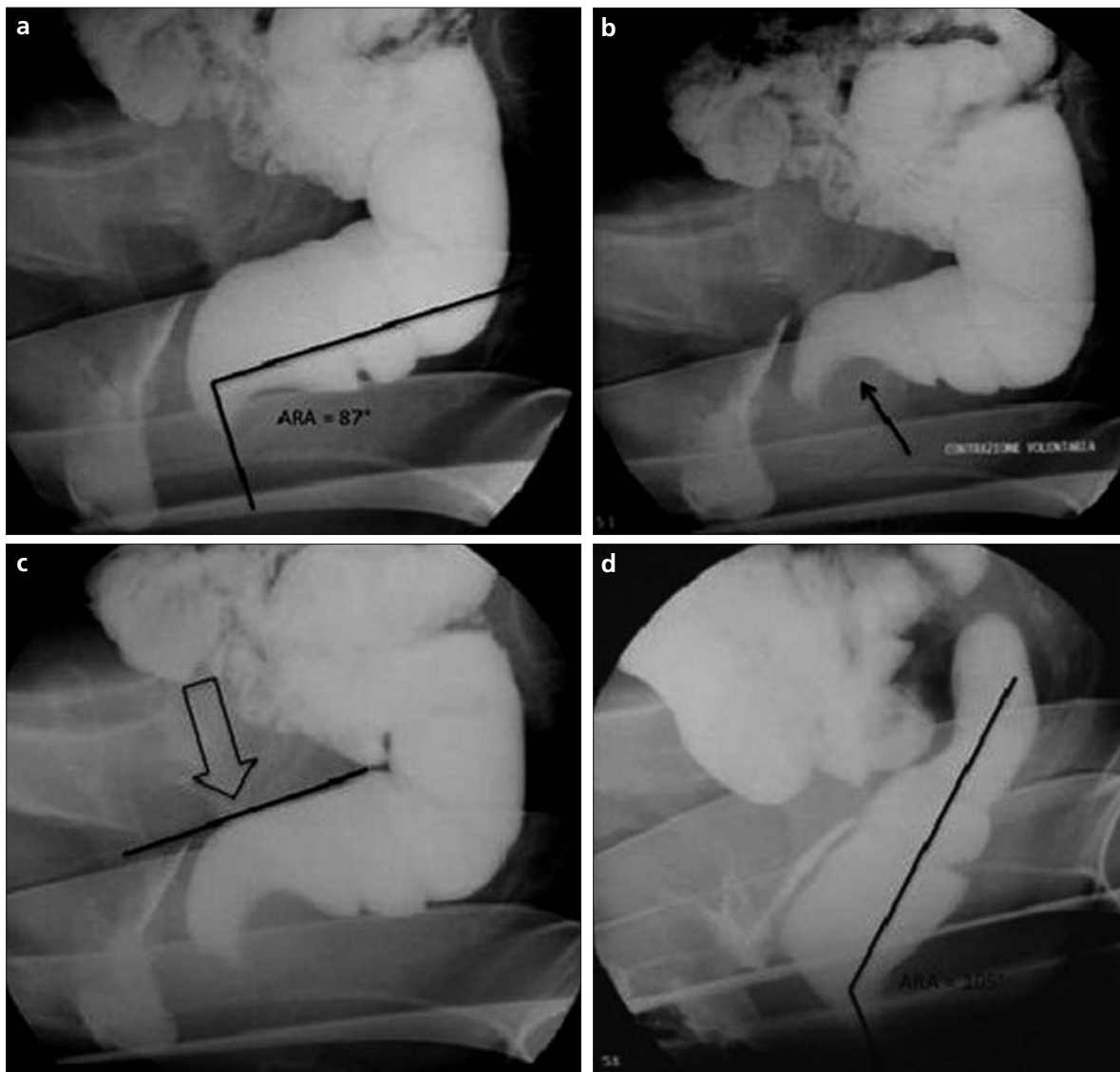
### Pathological findings

#### *Intussusception and rectal prolapse*

Rectal prolapse can be categorized as intrarectal, rectoanal, or external, depending on extension inside the viscus; and as simple or complete, depending on the involved wall layers. The pathological condition called simple prolapse or procidentia occurs when the mucosal layer protrudes into the lumen. Complete prolapse or intussusception can be observed when all layers of the wall are involved (13). Clinical manifestations frequently associated with rectal prolapse are chronic stypsis, rectal blockage, tenesmus, hematochezia, and incontinence. Symptoms are caused by the obstructive effect of the prolapsed wall on the propulsion of rectal contents. This condition is frequently found in association with solitary ulcer syndrome (14).

At the end of defecation, small infoldings thinner than 3 mm can be frequently observed without any clinical significance. Larger protrusions have been also observed in asymptomatic patients (10, 12). Intussusception usually originates 6–8 cm above the anal canal at the level of the main rectal fold (12).

Simple intrarectal prolapse is identified with defecography as a wall protrusion inside the rectal lumen more evident during straining and evacua-



**Figure 4.** a–d. Normal defecography phases. At rest (a). During forced contraction (b). Note the deeper impression exerted by the puborectal sling and the cranial migration of the distal rectum, (arrow, b). During straining with closed sphincters (c), the first tract of the anal canal widens but sphincters are contracted. Caudal migration of the anorectal junction is accompanied by initial rectilinearization of the ventral profile of the rectum (open arrow, c). During evacuation, the anal canal opens and the angle increases (d).

tion (Fig. 5a). Mucosal protrusions are almost exclusively found on the anterior rectal wall with a thickness less than 1 cm because of their simple mucosal composition.

In complete prolapse, all layers of the wall are involved. At defecography, dilation of the anal canal is evident during evacuation, and a circular infolding of the rectal wall invaginates into the lumen (Fig. 5b, c). Descent can be so dramatic as to pass through the anus and prolapse externally (Fig. 5d). Evacuation can be blocked by the intrarectal prolapsed wall which creates a plug obstructing the stool transit, causing barium paste to stagnate inside the viscus. During intussuscep-

tion, the rectum pulls the anterior peritoneum caudally, covering the rectum and resulting in a deep pouch that can contain small bowel (i.e., enterocele). Defecographic evidence of intussusception in a clinical setting of blocked defecation is an indication for surgical treatment (7).

#### *Descending perineum syndrome*

This syndrome represents a condition of pelvic floor muscle hypotonia and presents with difficult evacuation, incomplete emptying of the rectum, and/or incontinence. This condition is usually found in elderly women; risk factors are chronic stypsis, neurologic dysfunction, perineal

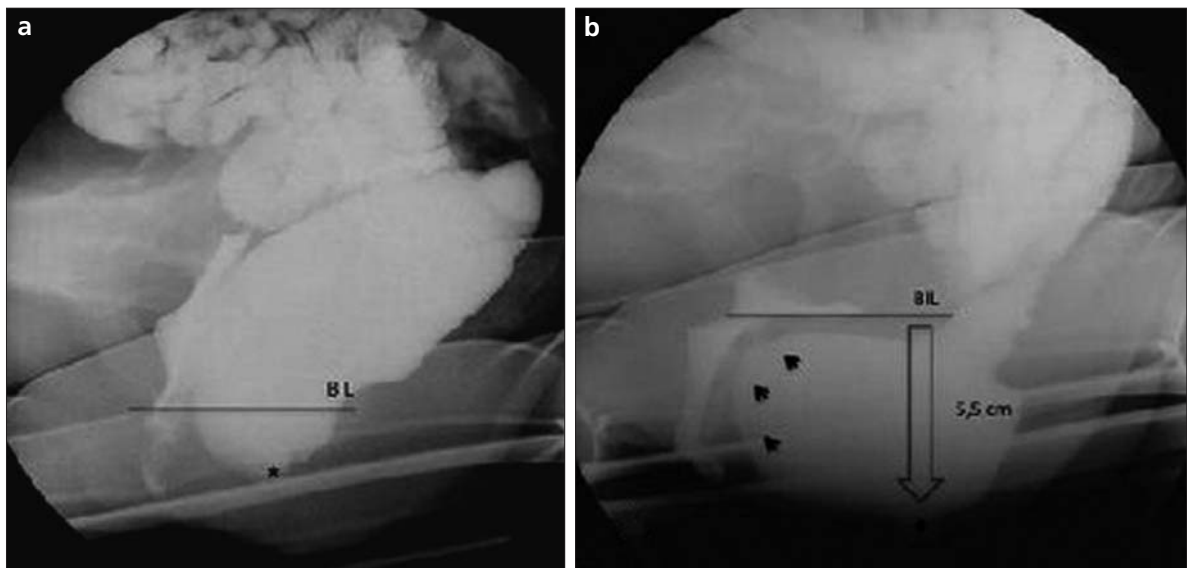
trauma, multiparity, and surgical procedures (13).

The main radiographic feature is the caudal migration of the anorectal junction more than 3.5 cm during straining (Fig. 6) (9). The degree of descent is calculated from the resting position to the most caudal position during straining or evacuation in relation to the bony landmark (bis-ischiatic line or coccygeal tip). Similarly, the anorectal angle is more than 130° at rest and increases to more than 155° during straining (14–16).

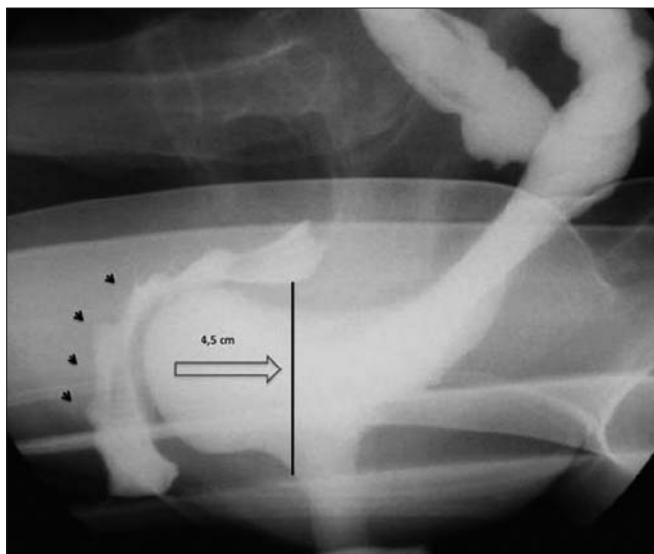
Caudal migration of the anorectal junction indirectly represents the perineal descent caused by increased intra-abdominal pressure during strain-



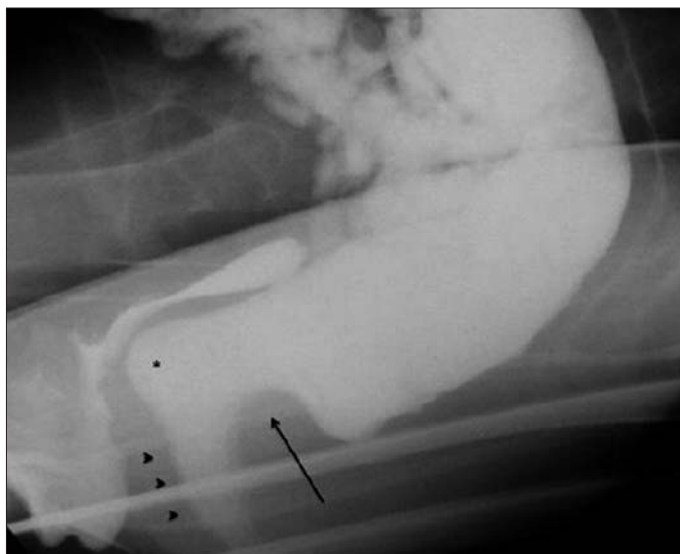
**Figure 5. a–d.** Rectal prolapse. The anterior rectal wall (*left arrow*) protrudes into the bulb during evacuation (**a**). An annular groove (*arrowheads*) deepens into the rectal lumen causing intussusception (**b**). Complete rectal intussusception with the prolapsed rectal wall passing through the anal canal (*arrowheads*) and anus (*open arrows*) during evacuation (**c, d**).



**Figure 6. a, b.** Descending perineum syndrome. Note the descent of the anorectal junction (*asterisk*) between resting position (**a**) and during evacuation (**b**). Bis-ischial line (BIL) is considered as the reference level. A large rectocele is also evident (*arrowheads*).



**Figure 7.** Rectocele bulging on the opacified vaginal lumen during evacuation. The anterior rectal wall protrudes over the expected position (*open arrow*) and the vaginal lumen is dislocated anteriorly (*arrowheads*).



**Figure 8.** Dyskinetic puborectalis muscle syndrome. The arrow indicates an abnormally deep puborectal impression at the beginning of the evacuation phase. The anal canal is opening (*arrowheads*) and a little rectocele is appearing (*asterisk*).

ing associated with relaxation of the puborectalis and pelvic muscles. In this pathological condition, muscles of the perineum are hypotonic and overwhelmed by the caudal migration of abdominal organs, so that the descent of ARJ is abnormally pronounced (12).

This repeated stretching of pelvic floor chronically causes damage to the nervous structures, most notably the pudendal nerve, and determines dysfunction of continence and pain. Incontinence is frequently associated with this syndrome (12). If this process is chronic, a vicious cycle is established in which intense and prolonged strain is necessary to evacuate, leading to further stretching and weakening of the pelvic muscles. Descending perineum syndrome can be conservatively treated by means of suppositories to reduce straining during evacuation (7).

#### *Rectocele*

Rectocele is the most common cause of obstructed evacuation treated by surgery. It consists of an anterior bulge of the rectal wall wider than 2 cm in the anteroposterior diameter (7). This condition is most commonly found in females because of laxity of the rectovaginal septum (congenital or caused by obstetrical traumas or surgical procedures). Outpouchings smaller than 2 cm are frequently found in asymptomatic females; these outpouchings are without clinical significance and

are not considered pathological (10). Outpouchings larger than 2 cm are significantly associated with evacuation disorders (17).

On defecography, an anterior outpouching of the anterior rectal wall bulges and dislocates the opacified vaginal lumen during straining and evacuation (Fig. 7). A certain degree of radiopaque paste can be retained inside the pouch and persists at the end of defecation.

There are three degrees of rectocele: first degree is <2 cm in anteroposterior diameter (not clinically significant); second degree is between 2 and 4 cm; and third degree is >4 cm. Excessive straining may also cause posterior bulges of the rectum because of hernias of the levator ani on posterolateral pelvic floor (16). Clinical manifestations are caused by incomplete emptying of the rectum; some patients apply digital rectal or vaginal maneuvers to complete evacuation.

#### *Dyskinetic puborectalis muscle syndrome*

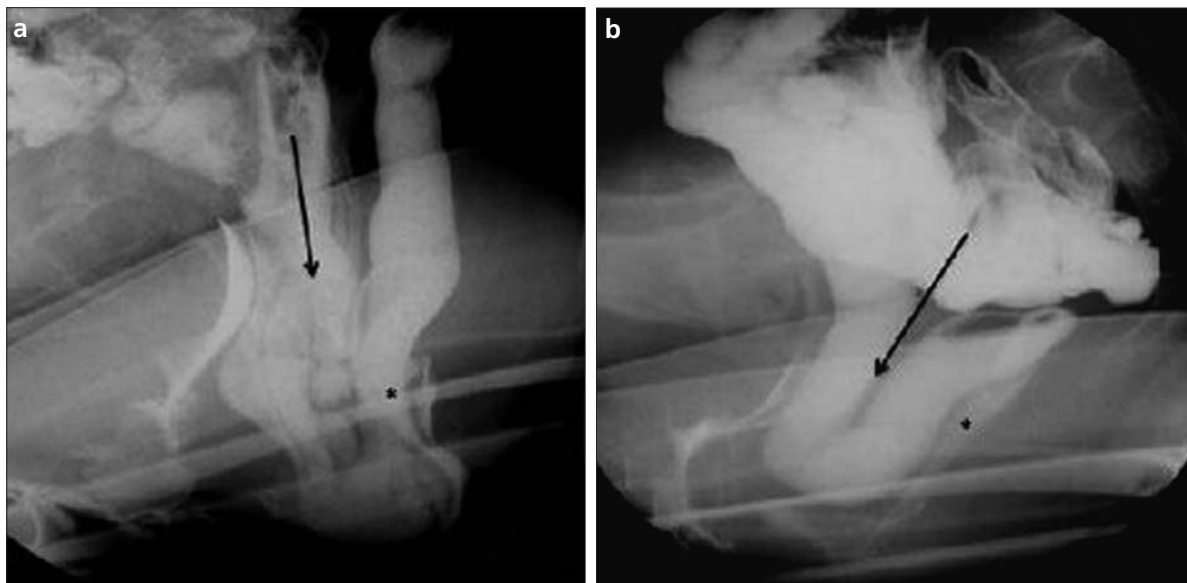
Also known as spastic pelvic floor syndrome, this condition is due to an inappropriate contraction of the puborectalis muscle during evacuation instead of physiologic relaxation. Most cases are idiopathic, although focal pathological alterations such as fistulas, solitary ulcers, and thrombotic hemorrhoids can be associated with this syndrome (14).

At defecography this syndrome is characterized by a lack of pelvic floor descent during straining and evacuation and paradoxical contraction of the levator ani (Fig. 8). Another less specific feature is an aberrantly deep impression of the puborectalis sling on the posterior rectal wall at rest; this is even more evident during squeezing. This sign is caused by the presence of a hypertrophic levator ani muscle, but its specificity is low; it can be also observed in asymptomatic subjects (18). Measurement of the anorectal angle changes showed no significant difference between symptomatic subjects and asymptomatic controls and is not a reliable parameter of this syndrome (19).

Clinical manifestations are prolongation of evacuation time and incomplete emptying. Evacuation time longer than 30 s is highly predictive of dyskinetic puborectalis muscle syndrome (20).

#### *Enterocèles and sigmoidocèles*

Herniation of a peritoneal sac into the pouch of Douglas containing ileal loops or part of the sigmoid are respectively called enterocele and sigmoidocele. They are almost exclusively found in female subjects; pelvic surgical procedures are risk factors for this condition, especially gynecological procedures such as hysterectomy or urethropexy (12). Patients describe a



**Figure 9. a, b.** Enteroceles in different patients. The recto-vaginal space is widened because of the descent of opacified intestines (**a, b**). Herniated ileal loops (*arrow*) are opacified due to the previous oral administration of barium solution (about 2 hours before) (**a**). In another case, a larger sigmoid loop (*arrow*) is being demonstrated after a longer period of time (**b**). In both cases, the anal canal and rectal bulb are compressed (*asterisks* in **a, b**) by the herniated loops causing obstruction during defecation.

sensation of pelvic oppression during evacuation and incomplete emptying of the rectum. These symptoms are usually not associated with obstructed defecation, and rectum emptying is complete at defecography (7).

Good opacification of ileal loops is essential for identification of intestinal herniation into the rectovaginal space. Descent of barium-filled ileal loops is evident during evacuation in the space between the rectum and vagina that is widened (Fig. 9). Widening of this space is also an indirect sign of enterocele when opacification of ileal loops is not achieved. The presence of air between the rectum and opacified vaginal lumen can confirm this suspicion (13). These signs are evident during straining or evacuation (increased abdominal pressure). Occasionally enteroceles become evident only when the rectum has been completely emptied and sufficient space is left for the small bowel loops to herniate. Protrusion of herniated viscera on the anterior rectal wall frequently causes an associated rectal prolapse (12).

The main limitations of defecography are related to the conventional technique: low-contrast resolution and bidimensional imaging. Failed visualization of soft tissues is partially overcome with opacification of viscera near the anal canal and rectum such as the vagina and ileal loops. Another limita-

tion is patient exposure to ionizing radiation, although the age of subjects is high in most cases.

During the last 15 years, MR defecography has been described and proposed as an alternative technique to study the pelvic region dynamically with high-contrast resolution and multiplanarity and without radiation exposure of the patient. However, MR defecography is far less available and more expensive than conventional defecography. Normal MRI devices require supine position of the patient, and unfortunately open MRI systems are far less available (7).

### Conclusion

Defecography is a cost-effective procedure, simple to perform and widely available in every hospital equipped with a fluoroscopy room. This method has the highest accuracy in diagnosing rectal intussusception, prolapse, and enteroceles. The main limitation of this technique is patient exposure to ionizing radiation in comparison with MR defecography, but MR defecography has limited availability. Defecography still represents a unique diagnostic technique for the examination of defecation dysfunctions.

### Acknowledgement

We thank Yves Doessant for helping us in preparing our manuscript.

### References

1. Wallden L. Roentgen examination of the deep rectogenital pouch. *Acta Radiol* 1953; 39:105-116.
2. Brodén B, Snellman B. Procidencia of the rectum studied with cineradiography: a contribution to the discussion of causative mechanism. *Dis Colon Rectum* 1968; 11:330-347.
3. Mahieu PH, Pringot J, Bodart P. Defecography. 1. Description of a new procedure and results in normal patients. *Gastrointest Radiol* 1984; 9:247-251.
4. Mahieu PH, Pringot J, Bodart P. Defecography. 2. Contribution to the diagnosis of defecation disorders. *Gastrointest Radiol* 1984; 9:253-261.
5. Ganesan A, Anderson EM, Upponi S, et al. Imaging of obstructed defecation. *Clin Radiol* 2008; 63:18-26.
6. Roos JE, Weishaupt D, Wildermuth S, et al. Experience of 4 years with open MR defecography: pictorial review of anorectal anatomy and diseases. *Radiographics* 2002; 22:817-832.
7. Mezwa DG, Feczko PJ, Bosanko C. Radiologic evaluation of constipation and anorectal disorders. *Radiol Clin North Am* 1993; 31:1375-1393.
8. Ikenberry S, Lappas JC, Hana MP, et al. Defecography in healthy subjects: comparison of three contrast media. *Radiology* 1996; 201:233-238.
9. Choi JS, Wexner SD, Nam YS, et al. Intraobserver and interobserver measurements of the anorectal angle and perineal descent in defecography. *Dis Colon Rectum* 2000; 43:1121-1126.
10. Shorvon PJ, McHugh S, Diamant NE, et al. Defecography in normal volunteers: results and implications. *Gut* 1989; 30:1737-1749.

11. Pieri L, Perri G, Napoli V, et al. La videoradiografia digitale applicata allo studio della regione retto-ale durante defecografia. *Radiol Med* 1991; 81:90–96.
12. Karasick S, Karasick D, Karasick SR. Functional disorders of the anus and rectum: findings on defecography. *AJR Am J Roentgenol* 1993; 160:777–782.
13. Maglente DDT, Bartram C. Dynamic imaging of posterior compartment pelvic floor dysfunction by evacuation proctography: techniques, indications, results and limitations. *Eur J Radiol* 2007; 61:454–461.
14. Kuijpers H, Schreve R, Hoedemakers H. Diagnosis of functional disorders of defecation causing the solitary rectal ulcer syndrome. *Dis Colon Rectum* 1986; 29:126.
15. Ekberg O, Nylander G, Fork FT. Defecography. *Radiology* 1985; 155:45–48.
16. Yang XM, Partanen K, Farin P, Soimakallio S. Defecography. *Acta Radiol* 1995; 36:460–468.
17. Matikainen M. Does defecography help in diagnosis and clinical decision-making in defecation disorders? *Abdom Imaging* 1994; 19:355–358.
18. Halligan S, Bartram CI, Park HJ, et al. Proctographic features of anismus. *Radiology* 1995; 197:679–682.
19. Ott DJ, Donati DL, Kerr RM, et al. Defecography: results in 55 patients and impact on clinical management. *Abdom Imaging* 1994; 19:349–354.
20. Halligan S, Malouf A, Bartram CI, et al. Predictive value of impaired evacuation at proctography in diagnosing anismus. *AJR Am J Roentgenol* 2001; 177:633–636.