Physicians are subjected to an increasing number of medical malpractice claims, and radiology is one of the specialties most liable to claims of medical negligence. The etiology of radiological error is multifactorial, deriving by poor technique, failures of perception, lack of knowledge, and misjudgments. Reducing errors will improve patient care, may reduce costs, and will improve the image of the hospital. The main reason for studying medical errors is to try to prevent them.

This article focuses on the spectrum of diagnostic errors in radiology, including a classification of the errors, and highlights the malpractice issues in methods for functional alimentary tract examination: swallowing act study, 3-dimensional endoanal ultrasound, defecography, and defecography in magnetic resonance.

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Defecography and defecography in magnetic resonance (MR) are indicated in several scenarios to help the clinician fully outline the degree and extent of pelvic floor dysfunction/weakness, causing anorectal dysfunction.\textsuperscript{16,17}

The evolution of these various modalities has facilitated more accurate diagnosis and characterization of many conditions. However, there are pitfalls related to all this procedures, and the main reason for studying medical errors is to try to prevent them.

**Errors in the Swallowing Act Study**

Swallowing is a physiological and complex act that allows the progression and the transport of liquid and solid cud from the mouth to the lower digestive tract. It consists of 3 phases: oral, pharyngeal, and esophageal phase. The first 2 phases, lasting less than a second, need dynamic methods of study, whereas the esophageal phase can be studied with conventional methods. Currently, there is unanimity in considering the VFS as a fundamental examination in the management of the dysphagic patient; this investigation may be associated with manometry (VFMSS) providing anatomical and functional information.\textsuperscript{18,19}

Errors can occur in each of the steps that characterize the radiological medical procedure: justification, execution, interpretation, and communication (Figs. 1 and 2) (Table 1).\textsuperscript{1}

First of all, X-ray examination of swallowing must be justified because it exposes the patient to ionizing radiations that require an appropriate history and diagnostic question even by the radiologist.

Typical symptoms of oropharyngeal dysphagia include nasal regurgitation, impaired speech, cough after aspiration, or recurring sense of bolus hold up localized to the neck (subjective feeling of fullness or neck of a “lump in the throat”).\textsuperscript{20,21} These symptoms should be investigated by the VFS and differentiated from feeling of food that is stuck in the esophagus and retrosternal discomfort. This is suggestive of an esophageal dysphagia, which can be evaluated with double-contrast X-ray esophagus–stomach study.

However, the location of the bolus hold up is subjective, and it is not indicative of the real disease localization; hence, the examination should be monitored by fluoroscopy.

VFS consists of a preliminary phase without contrast medium to study soft palate and vocal cord motility, which is performed by recording videofluoroscopy during phonation. This evaluation is followed by a contrast-enhanced scan to study the entire swallowing act, getting special attention to aspiration. Patient is asked to hold the bolus in his mouth for several seconds and to follow the operator’s instruction.

All phases are recorded with acquisitions of 25 frames/s. The use of equipments recording <8 frames/s does not allow to distinguish the act of swallowing in its videofluoroscopic phases and may not permit distinction between during and after swallowing aspiration.

Misdiagnosis may occur if preliminary phase (without contrast medium) is omitted, as this step helps to identify foreign bodies, fistulas, and abscesses.

Another error can be committed by choosing the contrast medium: water-soluble iodinated contrast medium is not recommended because it is hyperosmolar and can lead to pulmonary edema in case of inhalation. The water-soluble contrast medium is indicated only in the postoperative period, but if the X-ray findings are negative, even in these cases a suspension of barium is suggested, being more sensitive in detecting small leaks. If a massive aspiration into the airways is suspected, it may be a good precaution to use a nonionic (iso-osmolar), iodinated contrast medium, which should not cause complications.

The examination should always be performed in antero-posterior (AP) and laterolateral (LL) projections: the absence of the AP projection does not identify the presence of asymmetries, whereas osteophytes and epiglottis inversion are visible only in LL projection.

Before the patient is discharged, it must be checked whether any residual contrast medium is present on the skin, which can be resulted from lip manipulation or oral incontinence. The contrast on the skin can project onto the examined structures, generating errors in the phase of data interpretation that can be avoided by repeating the doubtful acquisitions.

If contrast medium is aspirated, it should always be suggested and verified the effectiveness of swallowing head compensatory postures and/or suggested combined manometric and videofluoroscopic examination (VFM).

The study of swallowing act should be monitored by fluoroscopy to prevent errors of interpretation: for example, esophageal varices change shape with fluoroscopic observation, but in static images may be seen as linear superficial erosions typical of reflux esophagitis. The gastroesophageal reflux disease (GERD) also should not be interpreted as residual material in the esophagus.

In patients presenting dilated esophagus and a standing column of contrast medium, achalasia can be distinguished from pseudoachalasia by fluoroscopy. In case of achalasia, the esophagogastric junction distends, transiently opening, when the hydrostatic barium column in the esophagus exceeds lower esophageal sphincter muscle tone; in pseudoachalasia (carcinoma of the gastroesophageal junction), a fixed, nonrelaxing obstruction is present.\textsuperscript{22}

**Three-Dimensional Endoanal Ultrasound: Common Pitfalls**

EUS of the anal sphincters, achieved by using a mechanically rotated endoprobe, obtains a 360° axial view of the anal canal and depicts anal canal anatomy correctly, visualizing anal sphincters and the puborectalis muscle.\textsuperscript{23-25}

This examination allows the radiologist to detect structural abnormalities that may support functional defects of posterior pelvic floor compartment, and at present, it has become important part of diagnostic workup of patients with fecal
incontinence and perianal fistulas, providing sufficient information for clinical decision-making in many cases.3,26-28

Three-dimensional software has enhanced the usefulness and diagnostic accuracy of EUS above all for the anatomy of the fistulous tract in complex perianal sepsis that may be imaged in greater detail.7,26 Interpretation errors can derive from execution of bidimensional US alone that cannot exactly describe a fistulous tract and classify it correctly (Fig. 3).

In addition, the major problems in investigating primary tracts with EUS occur because of the structural alterations of the anal canal and perianal muscles and tissues (which can overstage the fistula) or poor definition of the tract when filled with inflammatory tissue (which can downstage the fistula). The administration of hydrogen peroxide injection through the external opening of the fistula appears to improve the diagnostic accuracy of standard EUS. With this technique, the external opening of the fistula is cannulated,

Figure 1 (A) Oropharyngeal phase. Normal swallowing act during ingestion of barium visualized in anteroposterior (AP) projection. (B) Esophageal phase. Barium examination shows ectopic way from esophagus to tracheobronchial tree (arrows) overcalled as fistula.
and hydrogen peroxide is injected, allowing delineation of the fistula track with hyperechoic gas bubbles. Thus, hydrogen peroxide-enhanced EUS can be helpful in identifying tracts that had not been observed at the standard EUS examination or the presence of which had not been definitively established. It can be also particularly useful when an active fistulous tract needs to be distinguished from postsurgical or post-trauma scar tissue, causing tissue alterations that are difficult to analyze.

Nevertheless, the operator should be aware of several common pitfalls that may result in overestimation of the fistulous tract extension.

<table>
<thead>
<tr>
<th>Table 1 Errors Occurring During Execution of Swallowing Act Study</th>
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<tr>
<td><strong>Use of equipments that allow acquisitions with &lt;8 frames/s</strong></td>
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<tr>
<td><strong>To omit study without contrast medium (foreign bodies, fistulas, abscesses)</strong></td>
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<td><strong>Do not check if there is any residual contrast medium on the patient’s skin</strong></td>
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<tr>
<td><strong>Failures in the choice of contrast medium</strong></td>
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<td><strong>To carry out examination only in 1 projection</strong></td>
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<td><strong>Do not suggest and verify head compensatory postures</strong></td>
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<td><strong>Do not perform or suggest manometric evaluation after or synchronized with VFSS</strong></td>
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<tr>
<td><strong>Missed monitoring of swallowing act by fluoroscopy</strong></td>
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When external openings are immediately adjacent to the anal opening, peroxide may leak from the external opening across the skin and reflux into the anal canal. Air trapped in the anal canal has an appearance similar to that of peroxide. This phenomenon will result in bright echogenic shadowing that seems to arise from the lumen of the anal canal, suggesting a patent track communicating with the anal lumen (Fig. 4). In these patients, the course of the fistula must be carefully documented during injection, since this hardware is frequently associated with the fistula track. Clips, setons, surgical drains, and hemorrhoidal bands in the anal wall are echogenic and may simulate a small intramural abscess (Fig. 5). Therefore, it is important to identify and document any

Figure 2 Double-contrast barium examination in the same case of Figure 1. An appropriate method in association with a proper clinical history of caustic ingestion allowed correctly diagnosing aspiration (arrowhead) in airways (A) and typical esophageal stenosis (dashed arrows) (B).

Figure 3 Anal canal. EUS scan shows trapped air in anal canal simulating a fistulous tract. (Color version of figure is available online.)

Figure 4 Lower anal canal. EUS scan shows submucosal hemorrhoids that may falsely suggest a posterior anal sepsis.
abnormalities in the anal wall on the scans obtained before peroxide is administered.31

Pitfalls of Defecography and Defecography in MR in the Evaluation of Pelvic Floor Diseases

The radiologic techniques defecography and defecography in MR, defined as cine colpocystodefecography, involve dynamic detection of rectal voiding, associated with a cystographic examination and opacification of vaginal canal, to visualize simultaneously the bladder, urethra, vagina, rectal ampulla, and anal canal at rest and during evacuation.23,33

MR imaging provides a level of detail otherwise unobtainable. MR defecography contributes to effective patient care by accurately evaluating dynamic anatomy of a patient presenting with obstructed defecation and the sequelae of pelvic floor weakness. It is important to keep in mind that many normal patients have mild defecography abnormalities that have no associated clinical symptoms. Therefore, it is the severity of the findings correlated with the symptoms that is required for a final diagnosis. However, whether as part of preoperative planning for a pelvic floor repair or in the clinically complex patient, MR defecography helps delineate all pathology that is present, allowing optimization of treatment plans.

It can be used to assess pelvic floor mobility with more precision and the involvement of anterior and middle compartments.17,23,34,35 It has been applied to pelvic floor dynamics to evaluate the complex anatomy and topography of pelvic structures, and simultaneously to assess their variations during physiological dynamic acts. This examination shows the excursion of bladder, rectum, uterus, and vagina, and it analyzes the efficacy of puborectalis muscle contraction and the pelvic floor descent during evacuation.23

Diagnostic errors can derive, for both methodics, from an incomplete opacification of investigated anatomical cavities or, for defecography, by an imprecise execution of radiographic projections consisting in an AP projection of pelvis at rest and an LL projection of pelvis at rest and during contraction, straining, and defecatory phases. At rest, the position of the bladder base with urethra, rectum, anal canal, and vaginal vault is determined by the basal tone of the pelvic floor muscles. In the contraction phase, the strength of voluntary pelvic floor musculature can be evaluated; if the contraction is valid, the vesicourethral angle and anorectal angle decrease significantly. In the straining phase, the impact on the pelvic viscera of the pelvic muscle relaxation can be demonstrated to assess pelvic floor descent.

During evacuation, it is possible to observe bladder excursion and the loss of the puborectal impression, with the anorectal angle becoming more obtuse; it is also possible to identify any alterations of rectum profile and any change in the contact between the anterior rectal wall and the posterior portion of vagina.23

Figure 5 External anal sphincter. A fistulous tract studied by preliminary two-dimensional EUS (A) and more detailed depiction with 3D-EUS after peroxide administration (B). Yellow arrows show the double way of fistulous tract (C). (Color version of figure is available online.)
Pelvic floor abnormalities as anterior rectocele, multiple mucosal prolapses, and rectal intussusceptions may be not visualized if the examination is not completed with evacuation and postevacuation phases. At dynamic imaging, the phase of evacuation is necessary to be conclusive in all most rectoceles that are not evident at rest phase. A protrusion of the rectum may be also posterior, known as a “posterior rectocele” or, more correctly, as “posterior perineal hernia.” Both anterior and posterior rectoceles are well detected with defecography.

In addiction, it should be kept in mind that iatrogenic diverticula of the lateral rectal walls, arising after hemorrhoidectomy according to Longo, has been reported in the literature; they may be missed on defecographic examinations performed in LL projections, whereas an AP view should always be obtained to complete the examination. Recognizing rectal diverticulum as a possible consequence of Longo or stapled transanal rectal resection procedures is important for correct identification and interpretation of defecography findings and possible treatment planning (Fig. 6).

An important parameter to evaluate pelvic floor mobility in defecography is the movement of the anorectal junction during straining. Misinterpretations can arise from an incorrect position of the bony landmark line drawn between the ischial tuberosities, called the bisischiatic line or another fixed reference point 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 2 parameters as usually measured have been confirmed, but their clinical significance is still controversial, in fact, if measured in relation to the bony landmarks (bisischiatic line and tip of the coccyx), it may result in under and/or overestimated pelvic prolapses.

In MR defecography, analogue errors can be made if the landmark plane, represented by pubococcygeal line, important to define the excursion of pelvic viscera, is incorrectly put.

Intrinsic limits deriving from either methods can lead to interpretation failure: dynamic MR imaging has better accuracy in detecting and characterizing pelvic organ prolapse but has lower sensitivity than cine colposcystodfecography in detecting parietal and mucosal alterations as rectal prolapse and intussusception. Evacuation proctography remains, in fact, the examination of choice for studying intussusception and mucosal prolapse because it documents the entire process of intussusception, the segment involved, its location, and any amount of contrast medium not expelled. It also visualizes mucosal prolapse, defines its extent into the anal canal, and reveals any involvement of small intestinal loops.

MR defecography is the best way to assess rectal ampulla and pelvic floor descent, and it is able to determine whether the descent involves only the posterior compartment or whether it extends to the anterior and middle compartments. In fact, perineal hernias are identified easily with traditional defecography, but it is necessary to integrate the study with pelvic AP projections. Dynamic MR imaging allows a panoramic view of the entire perineal region, and multiplanar acquisitions can outline the hernial route precisely.

Enterocoele is easily documented with traditional evacuation proctography, but it is necessary to opacify small bowel loops with barium contrast (4-contrast defecography). On the contrary, dynamic MR imaging has the advantage of visualizing intestinal descent without the need to opacify bowel loops, and it better assesses pelvic floor excursion and the real
dimensions of the hernial orifice (Fig. 7). Furthermore, it easily detects omentocele, which is peritoneal fat herniation and sigmoidocele, which is a descent of sigmoid colon.

Moreover, evaluation errors, as downstage of pelvic prolapse, can be attributed to performing the examination using a magnet with a phased array coil, with the patient in gynecologic position or in the supine position, which compared with the same examination being performed with the patient in an orthostatic position, which is less accurate for the evaluation of pelvic floor disorders.

References


