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Case Report

Fusion Imaging by Transperineal Sonography/Magnetic Resonance in Patients with Fecal Blockade Syndrome

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Abstract

Aim: To equip a hybrid diagnostic room for fusion imaging of pelvic organ prolapse and fecal blockade syndrome.

Method: A multipurpose portable US scanner equipped with a 2-dimensional curved sector 3.5 MHz transducer is brought into the room adjacent to that of MRI scanner to accomplish Transperineal Sonography (TPS) and subsequent MR-defecography. Images of the two examinations, co-aligned when producing the report, are compared with regard to their overall quality, organ definition and conspicuity of pathology for the final diagnosis.

Results: During a 8-month period (April-November 2017), twenty-four women and eight men (average age 51 ± 4 year, range 21 -80 year) have been enrolled into the TPS/MRI study which lasted 6 and 25 minutes on average, respectively. Indications for imaging included fecal blockade syndrome in all cases and pelvic organ prolapse in 23/32 (71.8%). Overall, TPS proved superior in showing the anatomic details of mucous and full-thickness prolapse (75% and 72.7%, respectively) while MR-defecography did the same for showing the impingement of pelvic organ prolapse down the levator hiatus on straining (up to 100% in case of prostate and seminal vesicles). In addition, only MRI was capable to demonstrate the speed and completeness of rectal emptying.

Conclusions: In less than one hour, a combined TPS/MR dynamic imaging can be considered the best cost-effective approach for routine management of patients with fecal blockade syndrome.

Keywords: *Transperineal Sonography; Obstructed Defecation Syndrome; Magnetic Resonance Defecography; Pelvic Organ Prolapse; Fusion Imaging*

Introduction

Fecal blockade, also known as obstructive defecation syndrome (ODS), is a term used to describe a condition characterized by difficulty in expulsion, straining at stool for more than 25% of the time, prolonged toilet time, hard feces, feeling of unsatisfactory emptying and occasional need for self-digitation [1,2]. It has been found to be the most common digestive complaint in Italy, with over 6 million people suffering from the symptom, a prevalence of about 10%. Fecal blockade is four times more common in women than in men and there is a marked increase in it after the age of 60 years, although the occurrence of the symptom is more and more frequently reported today also in younger people of both genders. Virtually all authors are in agreement that the patient with fecal blockade is at increased risk for the later development of more serious dysfunctions related to it, including pelvic organ prolapse and descending perineum syndrome, pudendal nerve neuropathy, fecal incontinence, lower urinary tract symptoms (LUTS) and sexual complaints, or even inadequate surgery. Once fecal blockade is diagnosed clinically, imaging can often play a critical role in determining not only the etiology but also the therapeutic planning. Long a major challenge for both gastroenterologists and coloproctologists, until recently such patients have been assessed almost exclusively through evacuation proctography [3-7], a radiographic method widely available for the past several years all over the world. Currently, however, its use is declining, with the advent of new modalities such as transperineal ultrasound (TPS) [8-15] and magnetic resonance (MR) defecography [16-18], which are coming into greater use and confronting effectively conventional methods, due to the absence of ionizing radiation, which makes them preferable in young patients during their reproductive age. On the other hand, with the exception of few reports in the literature [19,20] it has been claimed that, despite its ability to display a three-dimensional view of the levator ani hiatus [21], TPS does not document rectal emptying, while at MR defecography the evacuation of contrast is performed with the patient supine, making their diagnostic value questionable. The present report will concern the technical details and unique diagnostic capabilities of a combined US/MRI approach, which can be accomplished in less than one hour for the routine evaluation of patients with fecal blockade syndrome. The new tools are intended to allow the radiologist diagnose complex pelvic floor situations faster and with more confidence.

Patient

No specific preparation is required except for a partially filled urinary bladder and rectal cleansing two-to-three hours before the examination with a disposable enema. At their arrival in the waiting room of the radiology department, patients are helped by the technical staff (PF, PG, GG) to fill in a form which provides information on history and present symptoms, including details on treatments, either medical or surgical, and prior medical records, if any. During the preliminary interview, all patients are clearly explained the characteristics and finality of the procedure, in order to cooperate actively to its success and are asked to give written consent to both examinations, having been informed on duration (average time, 6 minutes for US and 25 minutes for MRI) and need for insertion of a small catheter inside the anal canal for contrast administration.

Environment and tools

A hybrid diagnostic space is created using the room adjacent to that of Magnetic Resonance Imaging scanner to perform the ultrasound examination. A US/MRI fusion application allows the radiologist (PV) import images from live real-time ultrasound scan, co-aligned with those obtained by MR unit. When producing the final report, the system is based on standard instrumentations and does not need any additional hardware or radiological software to run.

Imaging Technique and Diagnostic Criteria

Transperineal Ultrasonography: The examination is performed by using a curved sector 3.5 MHz transducer connected with a multipurpose, portable model ultrasound scanner (General Electric Healthcare Medical Systems, Logiq V2, Boston, Massachusetts, USA) equipped with advanced software, freeze-frame, postprocessing and recording facilities. The sound waves are emitted forward from the surface of the probe and produce a pear-shaped image on the screen. For the examination, to prevent cross contamination between patients, before positioning in contact with the vaginal labia (woman) or between the anal verge and scrotum (men), the probe is covered with a layer of translucent film which is removed after use (Figure 1 a, b, and c), and the interspace is filled with coupling gel. The examiner wears gloves when preparing the probe and is seated on a low rotating stool near the patient when performing the examination. Therefore, the patient is placed supine with knees bent and feet flat on the table, approximately shoulder-width apart. The documentation of sonograms is standardized, so as to display the transducer at the bottom of the screen. To the purpose, the upside-down facility is activated, so that movements of probe and image correspond. Thus, on sagittal images the caudal side of the patient's body is seen at the lower edge of the scan and the cranial at the top, the posterior on the right side and the anterior on the left. On all other scan planes, the right and left sides are designed following the convention used for abdominal ultrasound, where the left side of the monitor corresponds to the right side of the patient and vice versa. During the initial assessment, for better orientation, a sagittal section of the anterior pelvis on the plane of the symphysis pubis is scanned, so as to obtain direct images of the bladder base. Then, for anorectal imaging, the probe is turned posteriorly. Following acquisition of a basal series at rest, dynamic images of the anatomical relationships are also obtained during cough, squeeze or strain maneuvers. Subsequently, the probe is turned 90° counterclockwise to obtain axial views of the anal canal. The dynamic portion of the examination is documented as follows: once the anorectum is visualized at rest on the monitor screen, the image is frozen and stored on the right half of the screen, while a second image is obtained on the left half during squeezing and maximal Valsalva maneuver. In case of intra-anal or full-thickness external prolapse (Figure 2), the cross-sectional area, calculated by outlining the inner and outer margins of the internal anal sphincter, is seen to increase significantly on straining, if compared to rest (inner-to- outer area ratio > 50%, $p < 0.01$). In particular, specific observations are made concerning the Douglas pouch (woman) and the anal canal (both genders), as follows: (a) the posterior cul-de-sac of the most dependent region of the peritoneal cavity is seen on sagittal scans as an echogenic "V-shaped" stripe just posterior to the cervix, reflecting the interface between the posterior vaginal fornix, peritoneum, and the anterior rectal wall. In case of vaginal vault prolapse and enterocele, free fluid, omentum or even bowel loops can be seen to impinge onto the potential space when the patient is asked to strain (Figure 3); (b) the internal anal sphincter is consistently seen on axial scans as a 3 mm-thick hypoechoic ring encircling completely two-to-three triangular–shaped images of intermediate echogenicity, which represent the submucosa. The virtual lumen of the anal canal is seen as a central X-like hypoechoic image mimicking the shape of a clover that reproduces the mucosa (see Figure 1c). Directly outside the internal sphincter, the mixed echogenic external anal sphincter is found.

(a) (b) (c)

Figure 1: *Probe preparation for TPS : the surface of the probe is draped on a layer of translucent film (a) with interposition of acoustic transmission gel; on the sagittal plane (b) the internal anal sphincter (arrow) is seen as a hypoechoic 3-mm thick line directly outside the intermediate echogenicity of the submucosa; on the axial plane (c), the virtual lumen of the anal canal appears as a hypoechoic X-shaped image located in the center representing the mucosa (m) while the internal anal sphincter (ias) is seen as a hypoechoic ring encircling completely the submucosa. Ias: Internal Anal Sphincter; m: Mucosa.*

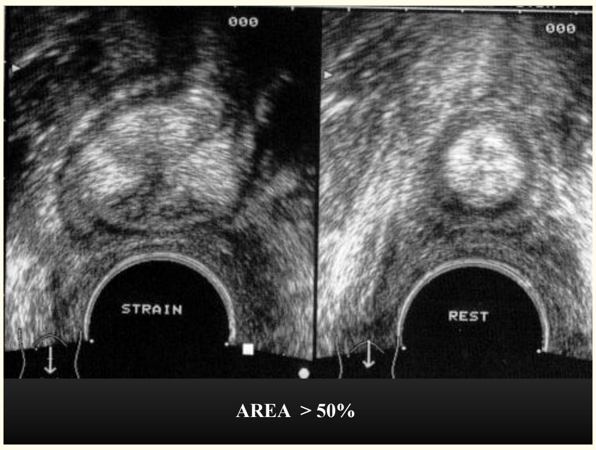


Figure 2: *PThe cross-sectional area of the anal canal calculated in the axial plane on straining (left half) with respect to rest (right half) by outlining the inner and outer margin of the internal anal sphincter is a sensitive parameter which provides evidence of full thickness prolapse when the ratio is greater than 50%.*

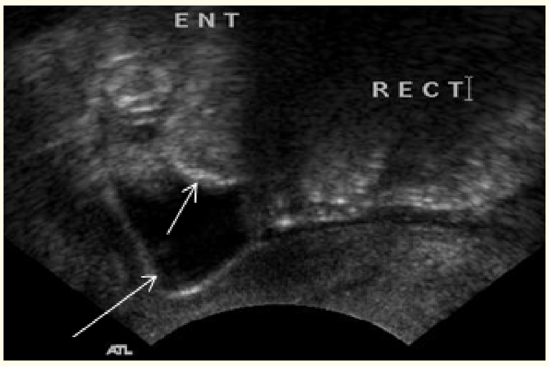


Figure 3: *PS, sagittal scan: A Fluid collection at the bottom of the rectovaginal pouch clearly outlines the peritoneal reflection (long arrow) as well as the bowel loops impingement (short arrow) during the Valsalva maneuver. Ent: Enterocele; Rect: Rectum.*

MR-defecography: Immediately after completion of the ultrasonic evaluation, patients are asked to empty their bladder in the toilet, located inside the diagnostic room. Then, static and dynamic MRI of the pelvis is performed, using a 1.5 T superconducting horizontal magnet system (Siemens Magnetom AERA, Erlangen, Germany) equipped with high-speed gradients and surface phased-array coils wrapped around the patient's pelvis. With the patient lying on his/her left side, a soft rubber tube is placed into the rectum for contrast administration (acoustic coupling gel), until obtaining a characteristic desire to evacuate. Then, after withdrawing the catheter and a proof pad placed beneath the exposed buttocks to collect any material, dynamic images are obtained at the very beginning during rest, squeezing and straining in the midsagittal plane, using a T2 weighted TRUE FISP pulse sequence. After this, the patient is instructed to start the movement at will and just make notice of it by intercom, to allow contemporary acquisition of images during rectal emptying. Using real-time image reconstruction, the examiner can constantly monitor, instruct or encourage the patient and ensure performance of desired maneuvers. On the basis of the sagittal images obtained during evacuation, the same sequence is then repeated on the coronal plane, centered over the anorectal junction. Subsequently, to image the levator hiatus during maximal Valsalva maneuver, three to five parallel, contiguous 1-cm-thick sections, using a FSE pulse sequence, are obtained on the axial plane, starting at the mid of the pubic symphysis, down to the level of the anal margin. Finally, static T2-weighted images are acquired at rest to provide complete evaluation of the pelvic anatomy on the axial, coronal and sagittal planes, using fast recovery spin echo pulse sequence. A complete summary of the imaging protocol is presented in table 1. Quantification of pelvic floor relaxation and visceral prolapse on sagittal images is calculated by measuring the vertical distance in mm above (-) or below (+) the hymen plane (woman) or the horizontal line tangent the inferior border of the symphysis pubis (man) taken as reference. This was preferred to the pubo-coccygeal line (PCL) of the traditional "hiatus, muscle, organ" (HMO) system described by Comiter., *et al.* [22] because of better comparison with the classification system and terminology in use by clinicians [23]. In addition, the axial images are used to calculate the pelvic floor hiatal area and the perimeter at rest and during maximum strain. The anterior–posterior diameter corresponds to the distance from the pubic symphysis to the ventral margin of the puborectalis muscle sling; the transverse diameter is the distance between the medial borders of the levator ani muscle. Cystocele, genital prolapse, peritoneocele, enterocele or sigmoidocele, are defined as descent of the bladder base, vaginal vault prolapse or any part of the remaining cervix, herniation of the peritoneal cul-de-sac with or without small bowel or sigmoid colon below the reference line, respectively. Rectocele is defined as an abnormal outpouching of the rectum, involving most frequently the anterior wall, and extending more than 2 cm anterior to a line drawn through the anterior part of the anorectal junction. Lateral or posterior bulging of the rectum (Figure 4), occurring in areas where there is weakness of the levator ani muscle, is defined as perineal hernia. Intussusception is described as a circumferential infolding of the rectal wall that descends toward the anal canal and differs in thickness, depending on the presence of wall components (mucosal or mural) and position of the head of intussuscipiens, with respect to the level of the anal canal (upper, middle, lower third). Paradoxical contraction of the puborectalis muscle is defined as a persistent impression at the posterior aspect of the anorectal junction (Figure 5) and thickening of the muscle during defecation of rectal contrast. Taking into account the overall image quality, anatomic definition, and conspicuity of pathology, the frequency with which TPS was judged as same, better or worse than MRI in displaying various abnormalities was calculated so as to establish the relative contribution to the final diagnosis.

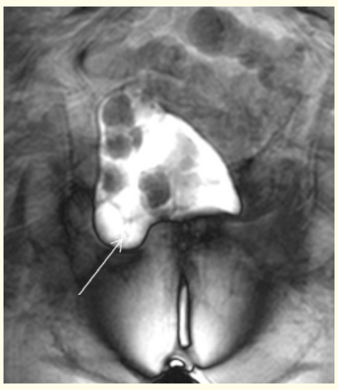


Figure 4: *MR defecography, Coronal view: bulging of the right lateral wall (arrow) of the rectal ampulla consistent with translevator hernia.*

Parameter	Series 1	Series 2	Series 3	Series 4	Series 5	Series 6
Type	Dynamic	Dynamic	Dynamic	Static	Static	Static
Pulse Sequence	TRUE FISP	TRUE FISP	TRUE FISP	T2 TSE	TSE TSE	TSE TSE
Plane	Sagittal	Coronal	Axial	Sagittal	Coronal	Axial
TR (ms)	3.80	3.77	3.77	3880	4400	4810
TE (ms)	1.58	1.53	1.53	91	57	58
ETL	17			17	15	15
NEX	60	60	60	1	1	1
FOV	260	380	380	260	340	350
Matrix	475	475	475	371	378	437
Slice thick/gap (mm)	10.0	8.0	8.0	4.0	3.0	4.0
Flip angle (°)	45	45	70	150	150	150
Scan time (min) total im/sec	1.10 1.2	1.03 1.1	1.03 1.1	4.33	2.58	3.24
Slices (n°)	1	1	1	36	46	45

Table 1: *Imaging Protocol for MR- defecography by SIEMENS MAGNETOM AERA (1.5 T) scanner and BODY 18 A 1.5 T Tim Coil. Note: FISP: Fast Imaging Spoiled; T2 weighted TSE: Turbo Spin Echo*

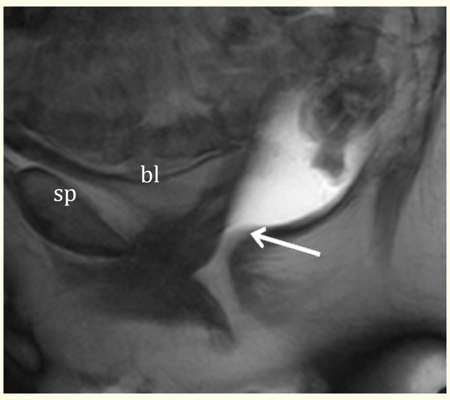
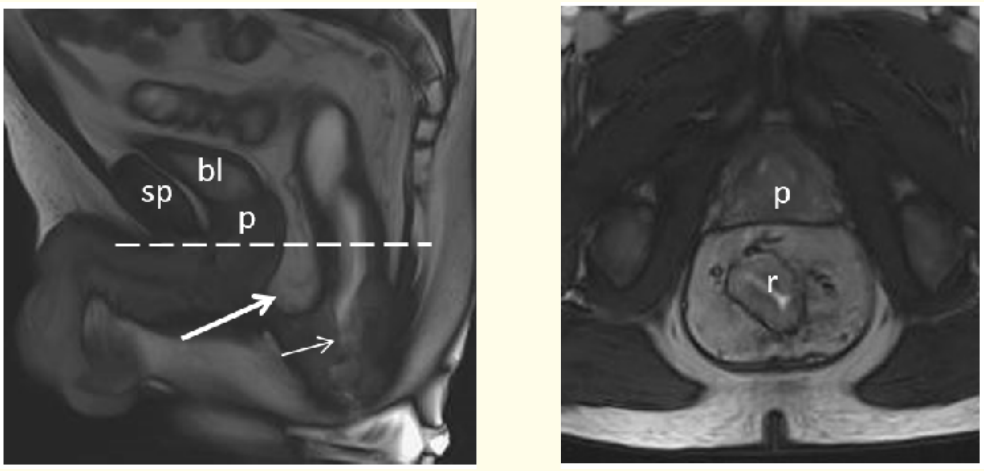


Figure 5: *MR defecography, Sagittal view: outlet obstruction from persistent impression of the dyskinetic puborectalis muscle (arrow). sp: Symphisis Pubis; bl: Urinary Bladder.*

Case Report

A sixty-five year-old man with a ten year history of unsatisfactory evacuation, split defecation, digitation and rectal bleeding of recent onset, was referred to imaging investigation by his coloproctologist. At colonoscopy, besides presence of diverticular disease in the sigmoid colon, a flat ulcerative lesion was found at 10 cm from the anal verge covered with fibrinoid material, consistent with a diagnosis of solitary rectal ulcer (SRU) syndrome. According to the protocol described above, the patient was submitted to TPS and subsequent MR-defecography examination, which showed evidence of intermittent full thickness prolapse and recto-anal intussusception, respectively. Unexpectedly, however, a significant enlargement of the levator ani hiatus was also noted on dynamic axial MRI (Figure 6a and 6b), combined with impingement of pelvic organs, peritoneocele and detachment of the Denonvilliers fascia, closely resembling the pelvic prolapse syndrome commonly seen in female patients. All the above lead the referring coloproctologist to consider the surgical option to cure the disease.



6(a) 6(b)

Figure 6: *MR defecography in a 65-year-old man with rectal prolapse, unsatisfactory evacuation and lower urinary tract symptoms : Sagittal view (a) note the increased descent of anorectal junction (short arrow), and prostate base relative to the reference line (dotted line) together with development of peritoneocele (long arrow). Axial view (b) ballooning of the levator ani hiatus with impingement of the prostate base. sp: Symphysis Pubis; bl: Urinary Bladder; p: Prostate; r: Rectum.*

Results

All patients referred consecutively to our Diagnostic Imaging Department for MR-defecography between April and November 2017 were offered the chance to undergo a combined TPS/MRI examination free of additional charge.

Twenty-four women and eight men (mean age 51 ± 4 year, range 21-80 year) accepted the proposal and reported at the end not receiving any particular discomfort from both imaging procedures, which lasted 6 and 25 minutes in average, respectively. Clues for the examination included obstructive defecation syndrome (ODS) for all patients and pelvic organ prolapse (POP) in 23 out of 32 (71.8%) of them. When compared to MR-defecography (Table 2), TPS resulted in better evidence of mucous and full-thickness prolapse (6/8, 75%, and 8/11, 72.1%, respectively) since it depicted soft tissues details of the anal canal not seen at MR-defecography, due to its superior spatial resolution. On the other hand, TPS underestimated pelvic organ descent mainly because of the obstacle determined by the probe held in place by the hand of the examiner, and by the loss of certain anatomic landmarks during Valsalva maneuvers. Conversely, MR-defecography proved definitely superior for documentation of the kinematic aspects of rectal emptying, including the assessment of the speed and completeness of contrast evacuation and calculation of time to anal opening, as well as the impingement of pelvic organs and ballooning of the levator ani hiatus on straining. Occasionally, an enterocele not shown at MR-defecography after repeated Valsalva maneuvers was easily demonstrated at TPS. The case report mentioned above highlights the advantage of performing fusion TPS/MR imaging in ODS, allowing the referring physician to be more confident in decision making.

Pathology	Total rate&&		Partial score					
		Same		Better		Worse		
	n°	%	n°	%	n°	%	n°	%
Pelvic Organ Descent	23	71.8						
Rectal floor	18	78.2	5	27.7	/	/	13	72.2
Bladder base	15	65.2	11	73.3	1	6.6	3	20.0
Cervix	7	30.4	2	28.5	/	/	5	71.4
Prostate	4	17.3	/	/	/	/	4	100.0
Rectocele	12	37.5	4	33.3	3	25.0	5	41.6
Full-thickness prolapse/ intussusception	11	34.3	3	27.2	8	72.7	/	/
Mucous prolapse	8	25.0	2	25.0	6	75.0	/	/
Peritoneocele	6	18.7	1	16.6	/	/	5	83.3
Enterocele	4	12.5	2	50.0	1	25.0	1	25.0

Table 2: *Detection rate and visibility score of various abnormalities & at 2-D TPS compared to MR-defecography in 32 consecutive patients with fecal blockade syndrome.*

Notes - &: Other than poor rectal emptying and ballooning of levator ani hiatus; &&: Multiple findings for each patient.

Discussion and Conclusion

Few areas of medical practice have undergone such dramatic change over the past decades as diagnostic imaging of pelvic floor disorders. In particular, imaging of evacuation has become an integral part of the initial evaluation and subsequent follow-up of patients with fecal blockade syndrome. TPS can be considered a valuable study to start with, due to its non-invasiveness, rapidity and capability to depict soft tissues details of the anal canal not seen even at MRI, the only limitation being its inability to assess rectal voiding. Therefore, in order to limit unnecessary procedures, attendant expense or additional patient inconvenience, a cost-effective approach is the combination of TPS with MR-defecography within the same session, as described in the present report. In less than one-hour, fusion TPS/MR imaging seems to serve ideally as a first-order, problem-solving technique in patients with fecal blockade syndrome. Future studies will tell us if the modality can help clinicians with treatment planning.

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