Dynamic MRI of the Pelvic Floor: Its Usefulness at Prolapse

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Resumen
La Resonancia Magnética Dinámica (RMD) del piso pélvico es una excelente herramienta para la evaluación de los trastornos funcionales. La patología es muy variada y frecuente, en especial en el adulto mayor, siendo un motivo de consulta común de distintas especialidades. La RM ha superado a otros métodos complementarios en el estudio de la patología de esta región. La posibilidad de combinar la información morfológica con la evaluación en movimiento durante distintos eventos fisiológicos hace que el resultado diagnóstico sea superior a la simple suma de ambas informaciones, ya que la correlación del defecto estructural responsable de la disfunción dinámica permite una interpretación más precisa de las causas del problema, facilitando una correcta elección del tratamiento. En este artículo nos proponemos establecer las características y la utilidad de la RM dinámica con sus diferentes mediciones para el diagnóstico de la función.

Abstract
Dynamic Magnetic Resonance Imaging (DMRI) of the pelvic floor is an excellent tool for the evaluation of pelvic floor dysfunction. Pelvic floor pathology is varied and frequent, especially in the elderly, and it is a common cause of consultation among various specialties. MRI has gone beyond other complementary methods in the study of the pathology of this region. The combination of morphological and dynamic information during different physiological events results in better diagnostics than simply adding the data, since the correlation of dynamic dysfunction responsible for structural defect permits a more accurate interpretation of the causes of the problem, and that helps in making the correct choice for treatment. In this paper, we intend to establish the features and usefulness of dynamic MRI with its different measurements for the diagnosis of functional...
Introduction

Dynamic Magnetic Resonance Imaging (DMRI) of the pelvic floor is an excellent tool for the evaluation of pelvic floor dysfunction. Pelvic floor pathology is varied and frequent, especially in the elderly, and it is a common cause of consultation among various specialties (urology, gynecology, surgery, among others).

Generally, clinical examination is enough to make a diagnosis of most pelvic floor dysfunctions. However, patients can experience symptoms arising from the involvement of one pelvic floor compartment, but after being evaluated with dynamic radiologic exams, it is possible to determine the involvement of more compartments (1).

Technique description and usefulness

There are three compartments in the female pelvis: anterior compartment (containing the bladder and the urethra), middle compartment (containing the vagina, cervix, and uterus) and posterior compartment (containing the anus and rectum).

Pelvic floor dysfunction is a term that applies to a wide range of clinical conditions, among which there is prolapse of pelvic organs, stress urinary incontinence and fecal incontinence. It is crucial to perform a comprehensive evaluation of the pelvic floor in these patients. Postmenopausal patients, as well as patients with hysterectomies often experience discomfort in the pelvic floor and generally, a physical exam is enough to define the nature and degree of visceral prolapse (1).

MRI is the only imaging technique that can show the supporting structures of the pelvic floor. The exam consists of a static and a dynamic part.

Static MRI is used to describe the components of the supporting system of the pelvic organs (suspension organs involving fascia and ligaments and supporting organs involving muscles and tendons) and to detect asymmetry in those structures, as well as to evaluate intra-pelvic organs such as the position of the bladder, vaginal vaults, uterus, rectum, and anorectal union.

Dynamic MRI with fast sequence permits a functional evaluation to examine the relaxation of the pelvic floor and the descent of pelvic organs. With this method, it is possible to appreciate the relation that organs have with each other and with bone and muscle structures at rest with the Valsalva maneuver,
with urination and/or evacuation, and it can evaluate all compartments simultaneously showing the walls and intrapelvic contents (2, 3).

Two methods are used depending on the configuration of the MRI unit. The patient can be in a supine position in a closed system or sitting in an open system. Acquiring images in this last position has the advantage of maximizing the evidence of pelvic floor weakness due to the gravity and permits physiological anorectal movement when defecating. This correlates with the fact that most women with stress urinary incontinence cannot experience it in a supine position. However, there is no substantial difference in the detection of pelvic floor anomalies that are clinically relevant (1, 5).

There is variation in publications regarding the optimal protocol to perform MRI in patients with pelvic floor dysfunctions. Images must be acquired at rest, in retention and when defecating. It can be performed without contrast agents or with (rectal and/or vaginal) endocavitary substances, using ultrasound gel. It is not necessary to prepare the intestine. It is recommended to ask the patient not to evacuate her bladder one hour prior to being evaluated so it is distended at the moment of the examination. In order to locate the urethra, catheters can be used, but it can also be seen without markers in the sagittal median line, in T2-weighted sequences. However, the diameter of the anatomical structure measures only 1 cm and, therefore, if images are not focused on it, other views may be necessary to visualize them (4, 5). Depending on the resonator, T2-weighted sequences are used (single-shot fast spin echo and single-shot turbo spin echo) for the anatomical evaluation of the pelvic floor, in axial, sagittal and coronal views (the last one is optional) and it is completed with steady-state dynamic sequences (FIESTA, true FISP or balanced FFE). These last images are analyzed in cinema-mode (4, 6).

Therefore, DMRI includes morphological classic images that show the anatomical structures and their alterations, and moving images of organs and supporting structures, which constitute the dynamic element of the study; each provides complementary information. On the other hand, measurements can be obtained at any time of the dynamic phase, which help in the analysis of the magnitude of defects and the degree of involvement of compartments, through the measuring of distances known as Comiter-Fielding criteria (Figure 1), which are explained next (3).

The radiologist has to start the interpretation of sagittal MR images by drawing the Pubococcygeal line (PCL) from the inferior edge of the pubic symphysis up to the last sacrococcygeal articulation. PCL represents the level of the pelvic floor and it is the point of reference to measure the prolapse of organs (Figure 2). Measurements should be made in images obtained of perineal descent at rest and during maximum pelvic distention (4). In healthy patients, there is a minimum movement of pelvic organs in relation to PCL, even during maximum straining, reaching up to 1 cm. (4, 6). In patients who experience symptoms, organs descent is greater than 1 cm below PCL and indicates pelvic floor laxity. An organ descent greater than 2 cm indicates surgical intervention (6).

Then, H and M lines should be measured. H line corresponds to the anteroposterior diameter of the hiatus of the anus levator muscle and it is drawn from the inferior edge of the pubic symphysis to the posterior wall of the rectum at the level of the ano-rectal union. M line is a vertical line drawn perpendicular from PCL to the posterior extreme of H line and it represents the vertical descent of the levator hiatus. Normally, H and M lines do not exceed 5 and 2 cm in length, respectively (Figures 3 and 4). Lesions of the pelvic supporting muscle-fascia determine the extension of the hiatus and the descent of the levator plate (4, 7). Therefore, lines H and M tend to enlarge with pelvic floor laxity, representing the extension of the levator hiatus and the descent of the levator plate, respectively (4, 8). The levator plate (LP) corresponds to the level of the ischio-coccygeal fibers (anococcygeal ligament) and it is an indicator of weakness of the posterior compartment supporting muscles, when it forms an angle greater than 20 degrees with PCL (Figures 5 and 6). In young women, the anococcygeal ligament is parallel to the pubococcygeal line at rest, as well as when straining. An increase in the caudal inclination would indicate loss of the posterior supporting muscles (3, 7, 9).

The position of the bladder, vaginal vault and ano-rectar union are measures in an angle of 90° from PCL. PCL is used as a reference line to determine the
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Figure 1. T2-weighted MRI of a normal pelvis. Sagittal view: Static evaluation.
A) Puboccygeal line (PCL) in the same plane as the pelvic floor. H line less than 5 cm and M line less than 2 cm.
B) Levator plate (LP) practically parallel to PCL. C) Anorectal angle (ARA) of 100° (normal from 90°-110°).

extension of a cystocele or of an enterocele and the descent of the rectum and the vaginal vault. Prolapse is classified as minor (< 3 cm below PCL), moderate (3-6 cm) or severe (> 6 cm) (7, 10).

The anorectal angle (ARA) is drawn from the longitudinal axis of the anal canal and the posterior wall of the rectum (Figure 7). Normally, it measures from 90 to 110° and it opens during defecation (with the contraction of anal sphincter, it decreases to approximately 85° and with Valsalva maneuver and defecation it increases to 135°) (7, 11).

Figure 2. T2-weighted MRI of a patient at rest and when straining with hysterectomy. Sagittal view.
At rest, pelvic viscera are above PCL. When straining, there is an important descent of the rectum and small intestine loops below PCL, due to rectocele and enterocele respectively.
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Figure 3. T2-weighted sequence MRI. Sagittal view.
At rest, the image shows clinically evident rectocele, where H and M lines are pathologically elongated. The maximum normal value of the H line is 5 cm and of the M line is 2 cm. When straining, the image shows the descent of the rectum, bladder and uterus with the possibility to measure such descent. These alterations are compatible with pelvic floor weakness syndrome.

Figure 4. T2-weighted sequence MRI at rest and when straining. Sagittal view.
Intra-pelvic organs at rest sequence in normal position at the level of PCL. The values of M and H lines are normal. When straining there is descent of the rectum below PCL and increase in the diameter of the M line, compatible with rectocele.

Figure 5. T2-weighted sequence MRI. Sagittal view.
This patient shows the levator plate (LP) in normal position at rest (practically parallel to PCL) and it becomes pathological when straining (increase in the angle from PCL). There is also descent of the bladder and rectum below PCL.
Conclusion
The pathology of the pelvic floor can involve multiple compartments, which are not always clinically evident. The combination of morphological (static) and dynamic information obtained through Magnetic Resonance Imaging during different physiological events results in better diagnostics than simply adding the data, since the correlation of dynamic dysfunction responsible for structural defect permits a more accurate interpretation of the causes of the problem, and that helps in making the correct choice for treatment.

Figure 6. T2-weighted sequence MRI at rest and when straining. Sagittal view.
Normal angle of the levator plate (LP) at rest, which increases slightly when straining. The levator plate should be practically parallel to PCL and, therefore, an angle greater than 20° is considered pathological and it represents weakness of the supporting muscles of the posterior compartment.

Figure 7. T2-weighted sequence MRI. Sagittal view.
At rest and when straining, the images show a pathological increase of the anorectal angle, where the normal ranges from 90° to 110°. When straining, there is also descent of the bladder and uterus.
Bibliography


