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MAGNETIC RESONANCE IMAGING OF PELVIC FLOOR DYSFUNCTION, REVIEW

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SUMMARY

Pelvic floor dysfunction is an important medical and social problem in the female population. The impact of pelvic floor disorders (PFD) is likely to grow as the prevalence of these disorders increases with an aging population. Pregnancy and delivery are considered major risk factors in the development of POP and stress urinary incontinence. Pelvic floor dysfunction may involve pelvic organ prolapse and/or pelvic floor relaxation. Organ prolapse can include any combination of the following: urethra (urethrocele), bladder (cystocele), or both (cystourethrocele), vaginal vault and cervix (vaginal vault prolapse), uterus (uterineprolapse), rectum (rectocele), sigmoid colon (sigmoidocele),and small bowel (enterocele).Given the paucity of understanding of PFD pathophysiology ,multicompartmental pathology, the high rate of recurrence and repeat surgery imaging plays a major role in its clinical management.The magnetic resonance imaging (MRI) allows noninvasive, radiation-free, rapid, high-resolution evaluation the multicompartment defects in one examination.Findings reported at MR imaging of the pelvic floor are valuable for selecting candidates for surgical treatment and for indicating the most appropriate surgical approach.

Key Words: *magnetic resonance imaging, pelvic organ prolapse, pelvic floor dysfunction.*

Pelvic organ prolapse (POP) is a common condition, affecting 25–41% of middle-aged and elderly women [1, 2]. Pelvic floor disorders (PFD) are associated with a negative impact on quality of life (QoL) and health-care expenditures. The impact of POP is likely to grow as the prevalence of these disorders increases with an aging population [3-7].

The etiology is multifactorial including advanced age, multiparity, obesity, connective tissue diseases, pelvic surgery, and disorders resulting in increased intra-abdominal pressure [8].

Physical exam (PE) remains the primary modality to evaluate POP [9,10], but clinical examination alone is not enough diagnosing pelvic floor dysfunction. Physical examination can lead to underestimate or misdiagnose the site, degree, and nature of visceral prolapse of pelvic organ prolapse in 45–90% of patients and caused result in incorrect treatment and recurrence of symptoms in 10–30% of patients after surgery [11-13].

Magnetic resonance imaging (MRI) is a noninvasive diagnostic study with its multiplanar capability, lack of ionizing radiation and excellent soft tissue resolution. Static MRI demonstrates pelvic floor anatomy and defects of the supporting structures, while dynamic MRI (dMRI) visualizes pelvic organ mobility, pelvic floor laxity, (POP) and associated compartment defects [14,15].

Urinary incontinence (UI), (POP), and anal/fecal incontinence (AI/FI) symptoms commonly occur after pregnancy and delivery [16-18]. Hans Van Geelen at al. studied the impact of pregnancy and childbirth on pelvic floor function as assessed by objective measurement techniques with quantitative data carried out during pregnancy and after childbirth. They were performed a literature search in journals from 1960 until 2017 for articles dealing with the impact of pregnancy and childbirth on pelvic floor function as assessed by objective measurement methods. The authors concluded that a pregnancy, especially first pregnancy, is associated with pelvic organ descent, decreased levator ani strength, and decreased urethral resistance. These changes were accentuated after vaginal delivery. Cesarean delivery was not completely protective. In most women, pelvic floor muscle function was recovered in the year after delivery. So, objective measurement techniques during pregnancy may allow identification of women susceptible to pelvic floor dysfunction later in life. It will offer the opportunity to initiate preventive treatment strategies, such as supervised pelvic pelvic floor muscle training and/or pessary placement [19].

To help standardize interpretation and grading of pelvic floor dysfunction with MRI, the HMO (H line, M line, organ prolapse) system was developed, which allows grading of various forms of PFD at dynamic MR images, by the use of

reference lines. The most commonly used reference line is the pubococcygeal line (PCL), which is drawn from the inferior border of the symphysis pubis to the last visible coccygeal joint. The PCL is not influenced by pelvic tilt, and includes the 2 important bony attachments of the pelvic floor (symphysis and coccyx). An alternative reference line is the midpubic line (MPL), which extends across the long axis of the pubic symphysis and denotes the level of the vaginal hymen, a landmark for clinical staging. The PCL is graded by the "rule of three" (see Table 1) [20,21] and the MPL is quantitated 5 stages (see Table 2). The anteroposterior diameter of the urogenital or levator hiatus is demarcated by the H line, which is drawn from the inferior border of the pubic symphysis to the posterior wall of the rectum at the level of the anorectal junction. A vertical line drawn at a right angle from the PCL to the most posterior aspect of the H line is called an M Line and signifies the vertical descent of the levator hiatus [22]. The HMO (H line, M line, and organ prolapse) system clearly defines and differentiates between the two main components of PFD: pelvic floor relaxation (assessed by the H and M lines) and pelvic organ prolapse which measure by using the PCL or MPL (see Table1,2) [23].

Table 1 - HMO classification: diagnostic criteria.

	Small/Mild	Moderate	Large/Severe
H line(cm)	6-8	8-10	>10
M line(cm)	2-4	4-6	>6
Organ descent			
(rule of 3) (cm)	<3	3-6	>6

Table 2 - Grading of pelvic organ prolapse using MPL.

Stage	Distance from the MPL
0	> 3 cm above the MPL
1	>1- 3 cm above the MPL
2	Within 1 cm above or below the MPL
3	> 1 cm below the MPL
4	Complete organ eversion

Frank C. Lin at al. compared dMRI defecography phase findings with physical examination (PE) grading in the evaluation of pelvic organ prolapse (POP). They retrospectively reviewed 274 consecutive patients who underwent Baden-Walker (B-W) grading and dMRI with defecography. Anatomically significant POP on PE was defined as B-W Grade ≥ 3 and on dMRI by dMRI Grade ≥2. The dMRI defecography demonstrated good correlation for anatomically significant prolapse in anterior and posterior compartments. dMRI was superior to PE for enterocele detection and was better able to distinguish an enterocele from a rectocele. The authors recommend that patients with difficult or ambiguous physical examinations, multicompartment prolapse, or prior failed repairs may have dMRI performed for additional evaluation [24].

The pelvic floor is divided anatomically into the anterior, middle, and posterior compartments [25]. Pelvic floor dysfunction can involve any of these compartments and lead to respective symptoms, such as urinary or fecal incontinence or chronic constipation, pelvic pain, and organ prolapse. As abnormalities of the three pelvic compartments are frequently associated, the treatment of pelvic floor dysfunction is becoming increasingly dependent on preoperative imaging [26].

Urethral hypermobility can be frequently associated with cystocele. In these severe cases, the posterior wall of the bladder descends disproportionately more than the anterior wall, resulting in a downward and clockwise bladder rotation as well as urethral prolapse. In the postoperative period, in such patients will occur stress urinary incontinence after the elimination of cystocele. In order to avoid such cases, Boyajyan at al. propose to conduct a separate preoperative assessment of the location of the urethra and bladder using d MRI [27].

The structures supporting the uterus and vagina include the pubocervical fascia, cardinal, and uterosacral ligaments. At rest, the normal position of the uterus is well above the PCL. Prolapse can be graded as mild (<3 cm), moderate (3–6 cm), or large (>6 cm) [22]. The laxity of the uterosacral ligaments allows the cervix to move anteriorly, resulting in progressive uterine retroversion and subsequent prolapse [28]. The vagina pathologically displaces inferiorly on dynamic MRI, and distal portion moves anteriorly. Due to the shared fascial supports, uterine prolapse often associates with cystocele and anterior vaginal wall eversion. [26] In some patients often develop concurrent enteroceles as the small bowel descends in the potential space of the dead end. So, vaginal vault prolapse can be associated with multicompartmental defects, therefore comprehensive assessment of the entire pelvis with MRI is particularly important [29].

The diagnosis of prolapse of the posterior vaginal compartment, which is common in women with symptoms of prolapse and obstructed defecation: gynecologists call posterior vaginal wall descent a 'rectocele', but this appearance may be caused different anatomical conditions, which are difficult to identify without imaging. These include true radiological rectocele, perineal hypermobility, enterocele, rectoenterocele, sigmoidocele, mesenterocele and rectal intussusception [30,31]. These herniation defects present the diagnostic challenge at physical examination, especially when multiple organs are involved. DMRI is ideally suited to preoperative characterization of these bulges. For example, MRI differentiates enteroceles and high rectoceles, enabling more efficient surgical planning with safer planes for intraoperative dissection [32-34].

Working Group of the European Society of Urogenital Radiology (ESUR) and the European Society of Gastrointestinal and Abdominal Radiology (ESGAR) gathered expert consensus for develop recommendations that can be used as guidance for standardized approach regarding indications, patient preparation, sequences acquisition, interpretation and reporting of MRI for diagnosis and grading of PFD. They created reporting template which include two main sections for measurements and grading. The experts commend to use the PCL as the reference line to measure pelvic organ prolapse, «the rule of three» for the grading system in the anterior and

middle compartments starting at 1 cm below the PCL and «the rule of two" - for grading the anterior rectal wall bulge in rectoceles [35].

PFD is an important medical and social problem in the female population. As abnormalities of the three pelvic compartments are frequently associated, a complete survey of the entire pelvis is necessary before surgical repair. Because of its inherent soft tissue contrast and multiplanar capabilities, functional MRI can provide comprehensive details of pertinent disorders without radiation exposure. MRI plays an integral part in both the diagnosis and management of pelvic floor dysfunction [36-38]. In addition, it has tremendous potential to be used as a research tool in trying to understand the pathophysiology of POP.

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