The study of the correlation between MRI staging and clinical POP-Q staging in pelvic floor dysfunction

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Purpose

Pelvic floor dysfunction (PFD) is a term applied to a wide variety of clinical conditions including urinary incontinence, pelvic organ prolapse (POP), defecatory dysfunction, sensory and emptying abnormalities of the lower urinary tract, sexual dysfunction and several chronic pain syndromes \cite{1}. It is estimated that more than 15% of multiparous women are affected by some sort of pelvic disorder and that 10%-20% of patients seek medical care in gastrointestinal clinics for evacuation dysfunction. The most common symptoms related to PFD are the sensation or visualization of a vaginal lump or bulge, which often significantly affect the quality of life \cite{2}. The pelvic floor in women is usually divided into three compartments: the anterior compartment including bladder and urethra, the middle compartment including vagina and uterus, and the posterior compartment including rectum and anal canal. Since the introduction of the Pelvic Organ Prolapse Quantification (POP-Q) \cite{3} by the International Continence Society in 1996, it has been widely used as a clinical staging system of PFD. But the degree and present of pelvic organ prolapse may not be always apparent in clinical examination. It either underestimate or result in misdiagnosis in the site of prolapse in 45% - 90% patients, especially in the patients with multi-compartments problem \cite{4}. It is difficult to make a correct and complete diagnose of PFD by clinical examination only, which may be one of the reason for the high rate of recurrence after prolapse surgery.

Preoperative imaging is become a promising complementary tool in assessment of PFD. Compared with some more conventional fluoroscopic and sonographic imaging methods, MRI has several advantages of its multiplanar imaging capability, high intrinsic soft tissue contrast and temporal resolution with no radiation. It can evaluate the condition of the main support structures of pelvic simultaneously including endopelvic fascia, ligament and muscle \cite{5}. A variety of reference points and lines for staging pelvic organ prolapse with imaging have been proposed. Currently, a standardized system for staging pelvic floor prolapse on MRI dose not exist. The publication by Suzan R. Broekhuis et al \cite{6,7} and Novellas S \cite{8} have shown that pubococcygeal line is a more reliable and widely used one than others for evaluation of PFD. It is the landmark for measuring organ prolapse drawn from the inferior border of the pubic symphysis to the last coccygeal joint \cite{9}, and represents the level of the pelvic floor.

The purpose of our study was to determine whether magnetic resonance imaging (MRI) reference line for staging pelvic organ by using the pubococcygeal line (PCL) has a high agreement with clinical staging. Pelvic floor structural abnormalities were also analyzed. These included the abnormalities of ileococcygeus, pubococcygeus, puborectalis muscles and the anorectal angle.
Methods and Materials

Patients

The observation study was performed at Obstetrics and Gynecology Hospital of Fudan University from April 2011 through May 2012. 15 patients with symptoms of PFD (i.e. pelvic floor prolapse, urinary or defecatory disorders) were included. The clinical POP-Q staging was measured with the patients at 45° supine position during Valsava, using the vaginal hymen as a reference point. All examinations were performed by one experienced gynecologist.

MR imaging protocol

Patients were detected by a 1.5 T magnet (Siemens, Avanto, German) with a pelvic phased array coil within 3 days. They were requested not to void for 1-2 hours before examination. The vagina and rectum were filled with 60-120 ml sonography gel immediately prior to the exam. During the examination, patients covering with a plastic sheet were firstly asked to relax their pelvic floor muscles in a supine position. The following sequences were examined at rest: sagittal T2WI_Blade sequence (TR/TE=4490/83 ms#FOV=250×250#Nex=1#Matrix=320×320#slice thickness=5 mm), axial T2WI_Blade sequence (TR/TE=8000/83 ms#FOV=350×350#Nex=1#Matrix=256×256#slice thickness=5 mm), coronal T2WI_Blade sequence (TR/TE=4000/83 ms#FOV=350×350#Nex=1#Matrix=320×320#slice thickness=5 mm). Then patients were requested to contract the pelvic muscles slowly, relax again, and to increase the intraabdominal pressure in order to defecate. A Midline sagittal section T2WI half-fourier-acquired single short turbo spine echo (HASTE) sequence (TR/TE=1350/92 ms#FOV=420×420#Nex=1#Matrix=448×448#slice thickness=5 mm) were examined during contraction and defecation. To insure adequate straining, patients were asked to perform Valsava maneuver for two times. If there was no more change in prolapse size on dynamic MR, the second Valsava would be selected.

Measurement

The images were analyzed by an experienced radiologist who was blinded to the clinical POP-Q staging. PCL line was selected as the landmark of pelvic. The pelvic was divided into three compartments: anterior, apical and posterior. The reference points of these three compartments are as follows: the most posterior and inferior aspect of bladder base for anterior compartment, the most anterior inferior aspect of cervical lip or the posterior superior vaginal apex (post hysterectomy) for apical compartment, the anterior aspect of the anorectal junction for the posterior compartment. The perpendicular distance from these reference points to PCL line were measured during the rest, contraction and defecation. The degree of prolapse is graded as mild (grade I) if the reference point
descends less than 3cm below PCL, moderate (grade II) if it descends between 3cm and 6 cm, and severe (grade III) if it descends 6cm or more.

Otherwise, we evaluated another two reference lines. 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. M line which is drawn perpendicular from the most posterior aspect of the H line to the PCL. H line represents for the anteroposterior width of the levator hiatus, while M line represents for the descent of it. They should not exceed 5cm and 2cm in length respectively. All MRI studies were reviewed with electronic calipers (Fig 1 a, b).

Pelvic floor structural abnormalities were also analyzed. These included puborectalis muscle which forms a "U" rising from the pubic bones anteriorly and forming a sling around the rectum, ileococcygeus and pubococcygeus muscles which are horizontal sheetlike structures. These configurations are nicely assessed in the transverse and coronal plane respectively. MRI is help for demonstrating the normal signal intensity, thickness and symmetry of the fibers.

**Statistical analysis**

Agreement between MRI staging and clinical POP-Q staging was estimated by using weighted #coefficient. Kappa of less than 0.4 denote poor agreement, between 0.4 and 0.75 moderate agreement, more than 0.75 excellent agreement. Statistical evaluation were done by using SPSS 13.0 for windows.

**Images for this section:**
**Fig. 1:** Fig1-a b A 73-year-old female patient with PFD. A T2WI sagittal image at rest Fig 1-a demonstrates the PCL (black line) extends from the inferior symphysis pubis to the last coccygeal joint. Compartment measurements made from the bladder base (point B) in the anterior compartment, anterior cervical lip in the middle compartment (point C), and the anterior inferior anorectal junction (point R) in the posterior compartment. In Fig-1 b we can see the H line drawn from the inferior border of the pubic symphysis to the posterior wall of the rectum at the level of the anorectal junction, and the M line drawn perpendicularly from the most posterior aspect of the H line to the PCL.
Results

Fifteen PFD patients (mean age 64.07±6.98) underwent dynamic MR imaging. Most of them had the symptoms of pelvic organ prolapse. 7 of them had urinary disorders and 1 of them had defecatory disorders. 4 patients had a previous history of gynecological or abdominal operations. Elongated H lines (mean value 5.34±0.88cm) and M lines (1.89±1.49cm) were detected in 9 and 7 patients at rest respectively. And they (mean value 6.21±1.27cm of elongated H line, mean value 2.09±1.77cm of elongated M line) were detected in 14 and 6 patients during defecation respectively (Table 1). The injury of puborectalis muscles could be seen at rest in all patients, which demonstrated as intact puborectalis muscle forming sling around the rectum on one side or both sides. The injury of ileococcygeus, pubococcygeus muscles demonstrated as losing their horizontal orientation or/and muscles of one side thinner than the other side, which could be seen in 13 patients (Fig 2-a#b#c).

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<th>relaxation</th>
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<td>H line</td>
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<td>6.21±1.27cm</td>
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<tr>
<td>M line</td>
<td>1.89±1.49cm</td>
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<td>2.09±1.77cm</td>
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Table 1 H line and M line measured during relaxation and defecation

In the anterior, apical and posterior compartment, the MR staging with PCL reference line compared to clinical staging were similar of 23, overestimating of 3, underestimating of 17. Weighted coefficient showed a moderate agreement between MR staging and clinical staging in the anterior and apical compartment ( anterior#=0.438#standard error=0.16#apical#=0.423#standard error=0.16 ), while the agreement was poor in the posterior compartment##=0.057#standard error=0.17#(Table 2, Fig 3).

<table>
<thead>
<tr>
<th>MR staging and pelvic compartment</th>
<th>Clinical POP-Q staging</th>
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<tbody>
<tr>
<td>anterior</td>
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### Images for this section:

- **Fig. 2:** Fig2-a shows a 60-year-old patient with PFD at rest. In the T2WI transverse image we can see the puborectalis muscle forms a "U" arising from the pubic bones anteriorly and forming a sling around the rectum. The intact puborectalis muscle (black arrows) forming sling around rectum on the left side. Fig2-b#c show a T2WI coronal image of a normal female and this patient. Fig2-b shows normal iliococcygeus, pubococcygeus muscles (long black arrows) with horizontal orientation. In Fig3-c we can see iliococcygeus, pubococcygeus muscles lose their horizontal orientation. Note right side of the muscle (white arrow) is thinner than left.
**Fig. 3:** Fig3 shows T2WI sagittal image of a 60-year-old post hysterectomy female patient with PFD at rest (Fig3-a) and during strain (Fig3-b). At rest, positions of the bladder neck and the posterior superior vaginal apex are normal. The anterior inferior anorectal junction is under the PCL. The evacuation phase shows a large cystocele and severe descending vaginal apex, with elongation of the distance from anorectal junction to PCL. The descending bladder bulges into the vagina and is responsible for complete eversion of the anterior vaginal wall. Black arrow demonstrates the abnormal thickening and redundant infolding of both the mucosal and muscle layer in the posterior and anterior rectal wall.
Conclusion

Our study revealed that agreement between clinical and PCL staging was moderate in the anterior and middle part, this may show that clinical assessment and MR imaging are interchangeable. The agreement between MRI staging and clinical is poor in the posterior part. It seems reasonable to assume that dynamic MR imaging may have advantages over clinical staging in the assessment of posterior compartment prolapse. It is crucial when choosing a conservative or a surgical treatment for patients.

References
