Correlation between Magnetic Resonance imaging and female pelvic anatomy

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Learning objectives

The use of Magnetic Resonance (MR) technique in the female pelvis imaging has expanded considerably over the past decade. We here evaluated the contribution of MR findings to describe the most important anatomical structures involved in cases of pelvis pathology or malignancy. An in-depth knowledge of the anatomy of the female pelvis is necessary for gynaecologists especially in the pre-operative planning in order to improve the Patient's quality of life (1,2).

The purpose is to illustrate the correspondence between MR images and the female pelvic anatomy for a better clinical and surgical management of the Patient.
Background

Pelvic floor imaging is particularly important to gynecologists in the pre-surgical planning for a better management of the Patient. The development of new surgical techniques, like the nerve-sparing radical hysterectomy, necessitates the translation of surgical anatomy into anatomic imaging in order to improve Patient’s quality of life after the operation (3,4). The pelvic floor is a complex structure with passive components like fasciae and ligaments, and active components like muscles (1). This multilayer system provides pelvic support, maintains continence, and coordinates relaxation during urination and defecation. In recent years, nerve sparing radical hysterectomy has proven successful in reducing postoperative bladder, colorectal and sexual dysfunction. To improve this kind of surgery, it is fundamental to understand the pelvic floor anatomy, especially the pelvic fasciae, because most of the damage of the nerves occurred during the incision of the vescico-uterine ligament (4). Therefore, in the vision of improving both cure and quality of life of the Patient, the MR study of the anatomy of the pelvic floor deserves consideration for the surgical preservation of the pelvic autonomic nerves, in the treatment of the female genital tract pathologies.
Between January 2011 and December 2011 we prospectively studied 26 consecutive patients (mean age 45 years old; range 29–74 years old) referred for MR imaging of the inferior abdomen by gynecologists. Among these 7/26 presented endometriosis, 12/26 uterus cancer, 4/26 adnexal pathology and 3/26 resulted with no pathology.

MR imaging was performed on a 1.5T scanner (Magnetom Symphony, Siemens, Erlangen, Germany), using a pelvic phased array coil.

To reduce bowel peristalsis, the patients were asked to fast 4–6 hours before the examination and 1 mg of butylscopolamine (Buscopan, Schering, Germany) was administered intramuscularly in all patients, 10 minutes before the beginning of the examination.

Axial T1-weighted Spin Echo (SE) images were obtained with the following imaging parameters: TR/TE 520/9.3 msec, 1 Average, FOV read 320 mm, 4 mm section thickness and 1 mm interslice gap.

Sagittal T2-weighted Turbo Spin Echo (TSE) images were obtained with TR/TE 6040/90 msec, 4 Averages, FOV read 330 mm, 3 mm slice thickness, 1 mm interslice gap.

Subsequently axial T2-weighted TSE images, with TR/TE 5520/106 msec, 2 Averages. FOV read 320 mm, 4 mm slice thickness, 1 mm interslice gap, and coronal T2-weighted TSE images, with TR/TE 3870/101 msec, 2 Averages, FOV read 320 mm, 3 mm slice thickness, 1 mm interslice gap, were obtained respectively perpendicular to and parallel to the endocervical canal.

Furthermore axial T2-weighted TSE images, with use of body coil, were obtained from the level of the thin-section axial images to the level of the renal hila, with 7 mm slice thickness and 1 mm interslice gap, for evaluation of paraaortic lymphadenopathy (Table 1 on page 6).

Two radiologists analyzed all the MR images in order to investigate the topographical anatomy of the pelvic fasciae.

The pelvic visceral peritoneum was divided into three groups of fasciae, partially fused together: the parietal pelvic fascia, the visceral pelvic fascia and the extraserosal pelvic fascia (5).

The parietal pelvic fascia covers the anterior surfaces of the sacrum and the coccyx and the structures contiguous to the pelvic walls. Its muscular component includes the elevator ani, the internal obturator, the coccygeo and the piriform muscles, that usually appears hypointense on T2-weighted images (Fig. 1 on page 6). In this connective tissue we can identify two important bilateral surgical landmarks: the tendinous arch of pelvis fascia (1,6), a whitish line stretching from the pubic bone and symphysis to the ischial spine, (Fig. 2 on page 7; Fig. 3 on page 7) and the pubo-vescical ligament (5), tauted between the pubic symphysis and the bladder neck (Fig. 4 on page 8; Fig. 5 on page 9), that appear hypointense on T2-weighted images.

The visceral pelvic fascia envelopes all the visceral organs, binding them to the pelvic walls. It is normally divided into fasciae of individual organs (vescical, vaginal and rectal...
fascia), pubo-cervical fascia, recto-vaginal fascia and recto-sacral fascia. Furthermore two bilateral important ligaments can be appreciated: the utero-sacral and the recto-vaginal ligaments (Fig. 6 on page 10). These two ligaments with the rectal stalks and the recto-sacral fascia constitute a single connective fascial block that prevents the prolapse of the pelvic organs during movements (Fig. 7 on page 10).

The extraserosal pelvic fascia is formed by the parametrio, the paracervix, the superior vesical ligament, the lateral ligament of rectum and the presacral fascia (5). It is considered like a support to the neuro-vascular structures of the pelvis and permits the physiological movements of each organs (Fig. 8 on page 11). All these connective structures are in effect useful anatomical landmarks in the gynecologic pelvic surgery for both benign and malignant conditions.
Images for this section:

<table>
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<th>Pulse sequence</th>
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**Table 1:** protocol for MR image acquisition.

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**Fig. 1:** a-d: coronal T2-weighted image: a) internal obturator muscle, b) pubo-coccygeo muscle, c) pubo-rectal muscle, d) pubo-vaginal muscle. All these muscular components of the parietal pelvic fascia present low-signal intensity in the T2-w.

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**Fig. 2:** IS, ischial spine; P, pubis; B, bladder.

Fig. 3: coronal T2-weighted image: the yellow arrows identify the tendinous arch of pelvic fascia, hypointense in the T2-w.

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Fig. 4: IS, ischial spine; P, pubis; B, bladder.

**Fig. 5:** axial T2-weighted image: the yellow arrow identifies the pubo-vescical ligament, hypointense in the T2-w.

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**Fig. 6:** a-b: a) axial T2-weighted image; b) sagittal T2-weighted image: the yellow arrows identify the utero-sacral ligaments, hypointense in the T2-w.

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Fig. 7: sagittal T2-weighted image: organization of the fascial block forming the utero-sacral and recto-vaginal ligaments, the rectal stalks and the rectosacral fascia. This topographic division of the connective fibers forming the fascia block is arbitrary and depends on their origin and target structure/organ. The blu portion, utero-sacral ligament; the yellow portion, recto-vaginal ligament; the violet portion, rectal stalk.

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Fig. 8: axial T2-weighted image a) urether; b) the yellow portion, vescico-uterine ligament; c) obturator nerve; d) the blu portion, utero-sacral ligament.

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Conclusion

Magnetic Resonance imaging is playing an increasing role in evaluating gynecologic disease because of its excellent soft tissue contrast resolution, no use of ionizing radiations and ability to direct multiplanar imaging (2). Recent technical advances including turbo spin-echo imaging, phased array surface coils and breathold imaging techniques have dramatically improved image quality and shortened examination time, encouraging the use of the MR for the female pelvic pathology. Our results suggest that a complete knowledge of the correspondence between MR images and the female pelvic anatomy may be useful in the preoperative assessment and management of female genital tract pathologies. Knowing this anatomy can in fact help the gynecologist during the surgical choices in order to improve the Patient's postoperative functional outcomes.
References