

Imaging of the female pelvis

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Abstract

Recent advances in cross-sectional imaging have led to an increasingly important role for radiology in the management of gynaecological conditions. Multiple imaging modalities are utilized to investigate the female pelvis including: ultrasound; computed tomography; magnetic resonance imaging; and positron emission tomography/computed tomography. Each modality has a different role in screening, diagnosis, staging, treatment selection and follow-up. This review will discuss the various imaging techniques and recommended roles for each modality and how these modalities are best employed in the imaging of the female pelvis. The imaging findings of common female pelvic pathology are discussed and illustrated.

Keywords adenomyoma; ectopic; endometriosis; leiomyoma; ovarian cysts; ovarian hyperstimulation syndrome; ovarian neoplasms; pelvic inflammatory disease; teratoma; uterine cervical cancer

Imaging techniques

Recent advances in cross-sectional imaging have led to an increasingly important role for radiology in the management of gynaecological conditions. A number of imaging modalities can be used to investigate the female pelvis including: ultrasound (US); computed tomography (CT); magnetic resonance imaging (MRI); and fluorine-18-fluoro-2-deoxy-D-glucose (FDG) positron emission tomography/computed tomography (PET/CT). These modalities have different roles in screening, diagnosis, staging, treatment selection and follow-up.

This review will discuss the various imaging techniques and recommended roles for US, CT, MRI and FDG-PET and how these

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modalities are best employed in the imaging of the female pelvis. We also review the imaging findings of common female pelvic pathology.

Ultrasound (US)

US is the primary imaging modality in the initial assessment of suspected gynaecological pathology. The advantages of US over other imaging modalities are that it is widely available, inexpensive, quick, portable and does not involve ionizing radiation. Disadvantages of US include operator dependency and limited views in obese patients or the presence of overlying bowel gas.

The patient must have a full bladder to provide a sonic window for optimal views of the uterus and ovaries on transabdominal US. For more detailed views of the endometrium and of the adnexa, a transvaginal US is essential. The patient must then have an empty bladder for close apposition of the probe with the pelvic organs. Colour, power and spectral Doppler are used to assess abnormal vascularity. US can also assist in image guided fine-needle aspiration cytology or biopsy, as well as percutaneous drainage.

Magnetic resonance imaging (MRI) and Diffusion Weighted Imaging (DWI)

MRI is widely used to evaluate female pelvic pathology, offering excellent soft tissue contrast and spatial resolution as well as multi-planar capability. It is the imaging modality of choice to assess congenital anomalies of the uterus and vagina. It is superior to CT in assessment of uterine and cervical cancer and for characterization of adnexal lesions when the US findings are indeterminate (Figure 1). See Table 1 for a summary of the main indications for MRI of the female pelvis.

T1-weighted sequence is useful to detect enlarged lymph nodes and bone marrow metastases. In addition, blood, proteinaceous products or fat appear as high signal intensity on T1. Fat suppression is utilized to distinguish between these substances. A fat-containing lesion will become low signal, when fat suppression

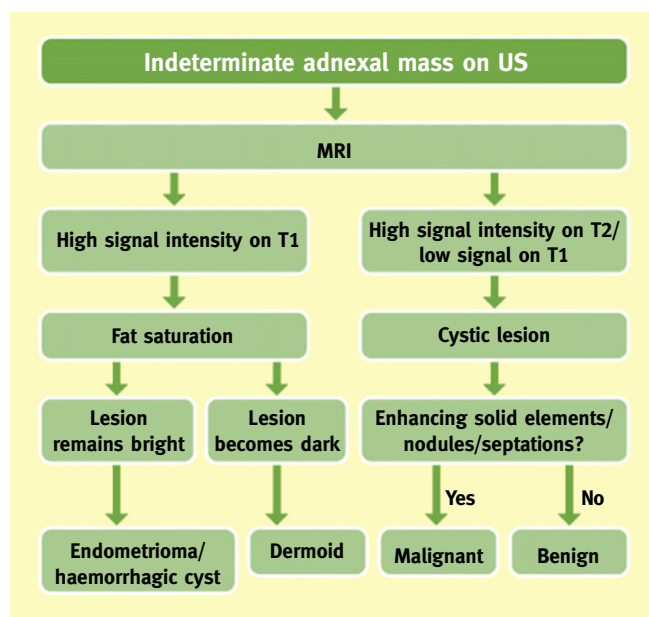


Figure 1 Algorithm to characterize adnexal masses on MRI.

Main indications for MRI of the female pelvis

Organ	Indication
Uterus	Evaluation of congenital anomalies Evaluation of possible adenomyosis Evaluation of leiomyomas pre- and post-treatment Staging of endometrial and cervical cancer
Adnexa	Characterization of adnexal masses
Vagina/vulva	Evaluation of congenital anomalies Staging of vaginal and vulvar cancer Evaluation of colovaginal and vesicovaginal fistulas
Other	Evaluation of recurrent endometrial, cervical, ovarian cancer

MRI, magnetic resonance imaging.

Table 1

is applied to T1-weighted images (T1WI). The T2-weighted sequence is helpful in demonstrating pathology, as the presence of tumour causes distortion of the normal anatomy and signal characteristics on MRI. Normal signal characteristics of the uterus on T2-weighted sequence include a high signal intensity endometrium (less than 5 mm in thickness in the post-menopausal patient), a junctional zone (JZ) of low signal intensity (normally measuring less than 8 mm) and a myometrium of intermediate signal intensity. The cervix has a high signal intensity endocervical canal with a low signal intensity cervical stroma and surrounding muscular layer of intermediate signal intensity.

Intravenous administration of gadolinium is used for characterization of adnexal lesions, for staging endometrial cancer and to distinguish recurrent tumour from post-treatment fibrosis.

DWI is a functional imaging technique that displays information about water mobility, tissue cellularity and the integrity of the cellular membranes. It permits the quantitative evaluation of the apparent diffusion coefficient (ADC) from images with different b-

values. Because image contrast is derived from inherent differences in the restriction of water molecule movements, no exogenous contrast medium administration is necessary, allowing the use of DWI sequences in routine imaging protocols in only 3 minutes. ADC values are inversely related to the cellularity of tumours, which is useful for distinguishing between benign and malignant tissues and for monitoring tumour response to treatment. Many studies have reported that a combination of DWI with conventional MRI improves lesion detection and radiologist confidence in imaging interpretation in the primary tumour, involved lymph nodes and metastases (Figure 2).

Computed tomography (CT)

CT has a limited role in the imaging of the female pelvis due to poor soft tissue contrast. New multi-detector CT provides higher resolution imaging and when this is combined with multi-planar reformatting, there has been some improvement in delineating pelvic pathology. However, MRI remains the gold standard. CT is important in other gynaecological malignancies by identifying enlarged lymph nodes, distant metastases and detecting recurrent pelvic tumours. It can have a role in evaluation of post-surgical complications.

Contrast-enhanced CT of the abdomen and pelvis is performed in the portal venous phase, 70 seconds following an injection of intravenous low osmolar contrast medium; this enhances blood vessels and viscera, allowing easier identification of lymphadenopathy and parenchymal lesions, especially in the liver. Oral contrast medium is mandatory in order to opacify the bowel, which allows detection of bowel serosal deposits that may occur in ovarian and endometrial tumours.

FDG-positron emission tomography/computed tomography (FDG-PET/CT)

FDG-PET/CT is a functional imaging tool that uses short-lived radionuclides attached to tracers to image metabolic processes in the body in combination with a low-dose CT for localization purposes. The most commonly used radiotracer is FDG, which is metabolized as glucose. Many malignant tumours are, therefore, identifiable due to their increased glycolytic rate.

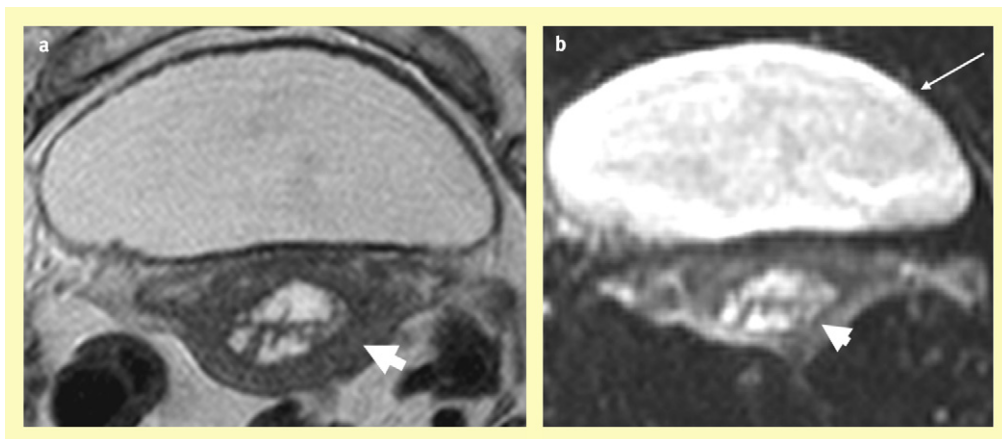


Figure 2 (a) Axial T2W magnetic resonance image demonstrating a high signal tumour within the endometrial cavity (white arrow head). (b) Corresponding axial DWI image demonstrating increased signal representing restricted diffusion within the malignant tissue (white arrow head). As DWI images are inherently T2W, urine in the bladder remains high signal (long white arrow).

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