Imaging of the female pelvis

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Abstract

Continuing technical advances in clinical radiology maintain the essential role of radiology in the management of gynaecological conditions. Multiple imaging modalities are utilised 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 discusses these imaging techniques, their recommended roles and how these modalities are best employed in the imaging of the female pelvis. The imaging findings of common female pelvic pathology are also discussed and illustrated.

Keywords adenomyoma; diagnostic imaging; endometriosis; gynaecology; leiomyoma; ovarian cysts; ovarian neoplasms; teratoma; uterine cervical cancer; uterine neoplasms

Imaging techniques

Imaging techniques play an important role 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). Each modality plays a different role 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 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, and portable and does not involve ionising radiation. Limitations of US include operator dependency, limited views in obese patients and the presence of overlying bowel gas which obscures the views.

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 identify 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 characterisation 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.

T2-weighted images (T2WI) are 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 T2WI include a high signal intensity endometrium (less than 5 mm in thickness in the postmenopausal 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 similar trilaminar appearance: high signal intensity endocervical canal with a low signal intensity cervical stroma and surrounding muscular layer of intermediate signal intensity.

T1-weighted images (T1WI) are useful to detect enlarged lymph nodes and bone marrow metastases. In addition, it is utilised for lesion characterisation as blood, proteinaceous products and fat are high signal intensity on T1WI. The application of fat suppression to T1WI will cause a fat-containing lesion to become low signal intensity.

Intravenous administration of gadolinium is often used for characterisation of adnexal lesions, for staging endometrial cancer and to distinguish recurrent tumour from post-treatment fibrosis. In addition, post-contrast imaging is used in the evaluation of fibroids and the identification of uterine ovarian artery anastomosis, prior to uterine artery embolisation.

Diffusion weighted imaging (DWI) is a functional imaging technique that provides information about water mobility, tissue cellularity and the integrity of the cellular membranes. It also permits the quantitative evaluation of lesions with the apparent diffusion coefficient (ADC), calculated from DW images with different b-values. DWI has a role in lesion characterisation and tumour staging of both endometrial and cervical tumours. DWI/ADC maps may also be employed to monitor tumour response to treatment. Many studies have reported that a combination of DWI with conventional MRI improves lesion

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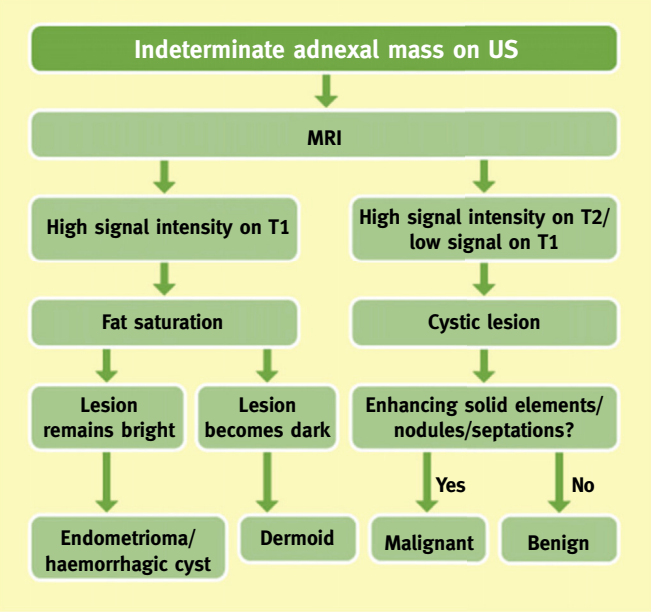

Figure 1 Algorithm to characterise adnexal masses on MRI.

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 staging 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.

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	Characterisation 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

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 which enhances blood vessels and viscera, and allows 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 which might 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 localisation purposes. The most commonly used radiotracer is fluorine-18-fluoro-2-deoxy-D-glucose (FDG), which is metabolised as glucose. Therefore, the increased glucolytic rate of many malignant tumours enables their detection with FDG-PET.

However, it must be remembered that physiological uptake is commonly seen in the uterus, ovarian follicles and corpus lutea in premenopausal patients. FDG uptake can also be seen in certain benign ovarian and uterine tumours as well as inflammatory and infectious processes.

Uterus

Congenital uterine abnormalities

Most congenital anomalies of the female genital tract result from non-development or varying degrees of non-fusion or non-resorption of the Mullerian ducts that form the uterus, cervix and fallopian tubes. These anomalies are associated with menstrual disorders, infertility and obstetric complications. The possibility of such an anomaly should be considered when the uterus appears abnormal in size, shape or position on US imaging. MRI using T2WI is sensitive in the precise classification of anomalies and may also demonstrate any associated urinary tract abnormalities.

Non-development or rudimentary development of the Mullerian ducts results in uterine agenesis or hypoplasia. In Mayer–Rokitansky–Hauser (MRKH) syndrome, there is absence of the uterus and upper vagina, with varying degrees of development of the lower vagina. Non-development or rudimentary development of only one the Mullerian ducts may lead to unicornuate uterus (Figure 3).

Partial fusion of the Mullerian ducts results in a bicornuate uterus. MRI demonstrates an internal septum composed of myometrium dividing the two uterine horns and an intervening cleft in the external fundal myometrium.

Non-fusion of the Mullerian ducts results in a didelphus uterus, with two separate uterine horns and cervices demonstrated on T2WI and a longitudinal vaginal septum is also present in 75% of cases.

Incomplete resorption of the fibrous septum between the two uterine horns results in a septate uterus. The septum may be partial or complete extending to the external cervical os (Figure 4). It is important to make the differentiation between a bicornuate and a septate uterus as the latter is associated with a higher rate of reproductive complications. An arcuate uterus