Imaging abnormalities of the female genital tract

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There are three major groups of disease that occur in the female genital tract and imaging has a role to play in each of these. These include the benign diseases (infection, endometriosis and benign tumours), the malignant tumours and congenital abnormalities. Over the last four decades ultrasound, CT, isotope imaging (including positron emission tomography (PET)) and MRI have made increasing contributions to the diagnosis and management of genital tract disorders.

Knowledge of normal development of the female genital tract is an essential basis for understanding disease. The female genital tract undergoes considerable change between childhood and adulthood due to hormonal influences. As well as age, hormonal status and cycle-related changes are important in both the size of the ovaries and their follicular derivatives. The ovaries change in size with age from about 0.8ml in the neonate, to 12ml at 12 years and 10ml in the premenopausal adult. Following the menopause ovarian volume drops to about 2.5ml.

There are cycle-related changes of the endometrium. The endometrium comprises a basal layer that remains constant throughout the cycle and the functional layer that shows cyclic variation. During the menstrual phase (day 1-5 of the menstrual cycle) the endometrium is thin and measures less than 4mm. It increases to 4-8mm in the proliferative phase (days 6-14) and can reach a maximum of 16mm during the following secretory phase.1

Benign disease
Pelvic inflammatory disease can arise from sexually transmitted infection or as a complication of instrumentation, such as termination of pregnancy or insertion of an intrauterine device. Patients often present with lower abdominal pain, with or without a vaginal discharge. Although imaging is not necessary for diagnosis, it can help where there is clinical uncertainty or an abscess is suspected. Transvaginal ultrasound is often the first line investigation. Endometrial fluid and pelvic free-fluid are common findings. A tubo-ovarian abscess appears as an ill-defined mass with surrounding inflammatory changes. On ultrasound the abnormally thick ovaries are seen on MRI. Peritoneal enhancement may be present. CT and MRI appearances and are well demarcated with posterior acoustic shadowing and circumferential vessels on Doppler. CT and ultrasound may show tumour calcification. The MR appearances are variable and generally they enhance more than surrounding myometrium.

Malignant disease
The major primary cancers of the female genital tract are endometrial, cervical and ovarian carcinoma and primary peritoneal cancer. Other cancers, such as vulval and vaginal tumours and cancers of the fallopian tubes are much less common. In addition, secondary metastatic cancer can spread to the pelvis; secondary tumours involving the ovaries are known as Krukenberg tumours.

Endometrial cancer is the commonest of the female gynaecological malignancies, followed by cervical and then ovarian. When a post-menopausal patient presents with abnormal vaginal bleeding, malignancy must be considered, although studies have shown that cancer is the cause in only about 10% of cases. If transvaginal ultrasound shows an endometrial thickness of <5mm, endometrial cancer is virtually excluded. With proven endometrial cancer, MRI is used for assessing the depth of myometrial invasion and local pelvic spread (figure 2). CT is useful for identifying any metastatic spread.
Ovarian cancer has a life-time risk of 1 in 70 for women. It is often clinically silent and 75% of women present with advanced disease, making it one of the most deadly cancers in women with an overall five-year survival of 38%-53%.

Surgical staging is still the gold standard, but preoperative imaging informs patient management. Imaging can guide targeted biopsies and can show the surgeon disease that may be hard to find intra-operatively, eg diaphragmatic and lesser sac deposits. Imaging helps identify patients that would benefit from neoadjuvant therapy.

While CT and MRI demonstrate similar sensitivities and specificities in the staging of ovarian carcinoma, CT is more commonly used due to availability and shorter scan times.

Cervical cancer is the second most common cancer after breast cancer in women under 35. MRI is the imaging of choice for staging local disease. While the image findings can be normal in very early stage disease, as the disease progresses there is thickening of the endocervical tissue followed by invasion of the low signal stroma (figure 3). FIGO Stage IIA and Stage IIb disease must be distinguished as the treatment of the former is surgical and chemoradiation is used in the latter.

Fertility sparing surgery (trachelectomy) can be performed if there is a rim of normal cervical tissue equal or greater than 1cm distal to the internal os. MRI is used in the follow-up of cervical cancer patients to diagnose recurrence and to show treatment related complications such as fistula and sacral insufficiency fractures. More recently MRI is being used to help plan brachytherapy.

PET scanning is being used increasingly for the detection of metastatic and recurrent tumours.

Congenital abnormalities
The female genital tract is largely derived from the embryological Mullerian (paramesonephric) ducts. There are two Mullerian ducts that fuse to form the uterus, the fallopian tubes and the proximal third of the vagina. The distal vagina is derived from the urogenital sinus. Disruption of normal development in an XX female causes a variety of abnormalities that vary from lack of development (the aplasias), through to lack of fusion of the ducts (fusion defects), to failed absorption of the septum separating the fused ducts (absorption defects).

There are a number of classifications of the Mullerian anomalies but none is perfect. There are some relatively common anomalies including the arcuate uterus, which can be considered a normal variant. In MKRH syndrome, the uterus does not develop properly and may either be absent or seen as rudimentary buds (figure 4). The septate uterus occurs when the septum separating the two tubes does not break down and these patients have a high incidence of miscarriage. If the uterus functions but is obstructed, the genital tract above the level of the obstruction will become distended with blood and the patient will present with cyclic abdominal pain and eventually a mass.

In congenital abnormalities, MR in particular has a key role in both diagnosis and the management of the disease. It is essential for surgical planning to ensure that an appropriate operation is undertaken.

Summary
Imaging is widely used for the diagnosis and assessment of a broad spectrum of diseases of the female pelvis and has an important role in guiding patient management.

References
FIGURE 3
Cervical carcinoma. Sagittal T2-weighted SE image through the pelvis. Bulky tumour involving the cervical stroma (arrow).

FIGURE 4
MKRH syndrome. Axial T2-weighted SE image of the pelvis. Rudimentary left uterine bud (anterior arrow) anterior to the normal left ovary (posterior arrow).