Background
Findings and procedure details

Ultrasound

Pelvic ultrasound, both abdominal and transvaginal is useful for the initial evaluation of infertility. It provides information on the echogenicity and size of the uterus, yielding information about the anatomy. US can detect uterine anatomical abnormalities, which can be further evaluated with MRI. Fibroids or leiomyoma may be detected on ultrasound. Figure 1 illustrates two large hypoechoic lesions in the fundus and body of the uterus, consistent with intramural fibroids. Structural information about the ovaries can be obtained, including sonographic evidence of polycystic ovarian syndrome (PCOS). The classic appearance on US in PCOS is enlarged ovaries, with echogenic stroma and multiple peripherally placed follicular cysts. Figure 2 illustrates ovaries with multiple small peripherally located cysts. However, it must be noted that patients with these features may not have a diagnosis of PCOS and patients with PCOS may not exhibit these sonographic features. Endometriosis is defined as the presence of endometrial glands outside the uterus. Evidence of endometriosis can be detected at ultrasound such as haemorrhagic cysts, called endometriomas or kissing ovaries Figure 3 and 4.

Hysterosalpingogram:

This is performed by placing a small sterile catheter through the cervix into the endometrial cavity. Radio-opaque contrast material is injected into the endometrial cavity under direct fluoroscopic observation. Contrast medium is hand injected slowly, with close observation of the fallopian tubes looking for active spillage of contrast material. HSG contraindications include active pelvic inflammatory disease and pregnancy. The fallopian tube appears as a very thin, curvilinear structure on HSG that gradually widens in the ampullary portion and HSG easily depicts the course, size, and contour as well as patency of the tubes. Tubal spasm is a cause of a false positive tubal occlusion and an antispasmodic such as glucagon is usually administered to reduce it. Peritubal abnormalities due to pelvic adhesions or endometriosis may be detected. HSG is useful for diagnosing endometrial and uterine abnormalities such as adhesions, polyps, fibroids, and müllerian duct anomalies by detecting filling defects or contour irregularities. It is useful for evaluation of tubal abnormalities and occlusion. An example of a T-shaped uterus is illustrated in Figure 5. Tubal occlusion at HSG with no flow into the fallopian tubes and filling of lymphatics on delayed imaging is shown in Figure 6. Tubal abnormalities such as hydrosalpinx can be detected on HSG. An example of this is in Figure 7 where the left fallopian tube is widely patent but there is a hydrosalpinx of the right tube.

HyCosy and hysterosogram
This is performed in a manner similar to HSG but it does not involve the use of ionizing radiation. Images of the endometrium are obtained transvaginally. The endometrial cavity is distended with echogenic contrast material and the fallopian tubes are assessed for patency. Figure 8 depicts echogenic contrast material in the right fallopian tube with peritoneal spillage. It is useful for detecting tubal occlusion as a cause for infertility. Intruterine filling defects observed at HSG are best evaluated with hysteroscopic US, which can help confirm the presence and characteristics of uterine synechiae, endometrial polyps, and submucosal fibroids. Figure 9 are static images from a hysterosonogram illustrating a fibroid with minimal extension into the endometrial cavity. An endometrial polyp evaluated with hysterosonogram is depicted in Figure 10.

MRI

Magnetic resonance remains the imaging modality of choice for the detection and characterization of endometriosis. While pelvic US may be helpful for further evaluation of uterine contour abnormalities, MR imaging is especially useful for differentiating between adenomyosis and uterine fibroids. MR imaging provides optimal and accurate characterization of müllerian duct anomalies.

Müllerian duct abnormalities can be divided in seven classes.

Class I, uterine agenesis and hypoplasia, is illustrated in Figure 11, where an 18 year old girl presented with primary amenorrhoea and a uterus could not be detected on US. MR confirms the absence of the uterus, cervix and vagina. Two normal ovaries are identified lateral to the psoas muscles in a superior location.

Class II, Unicornuate uterus includes a laterally placed uterine horn with a single fallopian tube.

Class III is Uterus Didelphys is characterized by two widely divergent uterine horns and two cervices. Figure 12 includes axial and coronal images depicting two uterine horns and 2 cervices.

Bicornuate uterus (Class IV) is due to incomplete fusion of the müllerian ducts, with two asymmetric but divergent horns. In bicornuate bicollics uterus there are two cervices. This can be differentiated from a uterus didelphys by increased myometrial fusion between the uterine horns inferiorly. The MR features of a bicornuate bicollics uterus are shown in Figure 13, where there are 2 uterine cavities with divergent uterine horns and 2 cervices. A bicornuate unicollis uterus is illustrated in Figure 14, where are 2 divergent uterine horns and a single cervical canal.
Septate uterus (Class V) is the most common anatomical uterine abnormality. It is similar to bicornuate uterus but has a normal convex, flat, or minimally concave (< 1-cm-deep) external fundal contour. Figure 15 is a TVUS illustrating splaying of the endometrial cavity at the fundus, with a smooth uterine fundus with minimal superior indentation. In Figure 16, an MR of the uterine, there are divergent uterine horns with an intercornual distance approximately 3 cm. There is slight concave outer fundal contour (<1cm).

An arcuate uterus (Class VI) is the mildest form of uterine anomaly, where there is near complete septal resorption resulting in a shallow, smooth, broad-based impression on the uterine cavity. Figure 17 illustrates an arcuate uterus on US where is a normal fundal contour with minimal indentation of the fundal endometrial canal.

Class VII includes DES abnormalities which are best depicted on HSG (Figure 5).

MR imaging features of endometriosis include cystic masses with internal high signal intensity on T1-weighted images and low signal intensity on T2-weighted images. Other high- signal-intensity features seen on T1-weighted images may include hydrosalpinx (which may include blood products) and endometrial implants. An example of endometriosis on MR is highlighted in Figure 18, where there are bilateral well-defined, thick walled pelvic lesions which display high signal on T1, low signal on T2 and do not enhance post contrast.

At MR imaging, the ovaries in patients with polycystic ovary syndrome classically demonstrate a low-signal-intensity central stroma surrounded by small peripheral cysts on T2-weighted images. An example of this is illustrated in Figure 19.

Common Causes of Female Infertility (Figure 20)

**Uterine Abnormalities**

Endometriosis (Figure 3,4, 18)

Endometrial polyps (Figure 10)

Uterine adhesions or synechiae

Adenomyosis

Leiomyomas (Figure 1,9)

Anatomical Abnormalities

Class I - Uterine agenesis and hypoplasia (Figure 11)
Class II - Unicornuate uterus

Class III - Uterus Didelphys (Figure 12)

Class IV - Bicornuate uterus

Bicornuate bicollis (Figure 13)

Bicornuate unicollis (Figure 14)

Class V - Septate Uterus (Figure 15,16)

Class VII - Arcuate Uterus (Figure 17)

Class VII - DES related uterine abnormalities (Figure 5)

**Cervical Abnormalities**

Cervical Stenosis

Cervical Factor Infertility - Doesn't involve imaging

**Ovarian Abnormalities**

Polycystic ovarian syndrome (Figure 2, 19)

Gonadal dysgenesis - Primary

Nonfuctional ovaries - Primary

Premature ovarian failure

**Tubal Abnormalities**

Tubal Occlusion (Figure 6)

Spasm

Infection

Prior Surgery

Hydrosaplinx (Figure 7)

Tubal irregularity
Salpingitis isthmica nodosa

Peritubal abnormalities

Peritubal adhesions
Fig. 1: US pelvis showing two well-defined hypo echoic nodules in the body and fundus of the uterus, with posterior acoustic shadowing consistent with intramural uterine fibroids.

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**Fig. 2:** Enlarged ovaries bilaterally with echogenic stroma and multiple peripherally sited small follicular cysts. Whilst these findings are considered typical for PCOS not all patients with PCOS will demonstrate these sonographic findings and not all patients with the above US findings will be confirmed as PCOS biochemically.

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**Fig. 3:** US showing bilateral haemorrhagic cysts.

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**Fig. 4:** US showing bilateral haemorrhagic cysts with the ovaries in close proximity. This 'kissing ovaries' feature is associated with endometriosis.

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Fig. 5: HSG showing T-shaped uterus, usually related to prior DES exposure.

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Fig. 6: Serial HSG images show filling of the endometrial cavity with contrast but no filling of the fallopian tube. On delayed filling there is filling of the adjacent lymphatics, denoted by the asterix in image 4.

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Fig. 7: HSG illustrating contrast in the endometrial cavity with normal left fallopian tube and a dilated right fallopian tube consistent with hydrosalpinx.

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Fig. 8: Static image from a Hycosy study with echogenic contrast material in the right fallopian tube.

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**Fig. 9:** US images from hysterosonogram showing a small submucosal endometrial fibroid with minimal protrusion into endometrial cavity.

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**Fig. 10:** Static US images from hysterosonogram showing a small echogenic endometrial polyp.

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**Fig. 11:** Sagittal and axial T2 weighted MR images showing absence of the uterus and vagina. The ovaries are present bilaterally but are sited superiorly and lateral to the psoas muscles.

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**Fig. 12:** MR images of uterus didelphys uterus with 2 divergent, separate uterine cavities and two cervices.

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**Fig. 13:** MR images of a bicornuate bicollis uterus with 2 divergent, separate uterine cavities and 2 cervices.

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**Fig. 14:** MR images of a bicornuate, unicollis uterus with 2 divergent, separate uterine cavities and a single cervix.

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Fig. 15: US images showing increased interconal distance with only mild concavity of the fundal contour (<1cm), consistent with a septate uterus.

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**Fig. 16:** MR appearances of separate uterus with separation of the uterine horns and increased interconal distance whilst maintaining an almost smooth uterine fundal contour.

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**Fig. 17:** US images of arcuate uterus showing a smooth fundal contour with mild superior indentation of the fundal endometrial cavity.

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**Fig. 18:** Axial T2, T1, T1 fat sat pre and post contrast MR images illustrating bilateral ovarian lesions, displaying high signal on T1 and low signal on T2 consistent with bilateral endometriomas.
Fig. 19: Axial and sagittal T2 weighted MR images showing bilateral enlarged ovaries, with low signal stroma and multiple peripherally sited follicular cysts.
Fig. 20: Common causes of infertility

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Olpin JD, Kennedy A Secondary infertility in women: Radiologic evaluation. Reports in Medical Imaging 2011:4 1-14