Pictorial Review - Imaging appearance of Normal Endometrium and Endometrial Disorders

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Learning objectives

This review aims to:

1) Recognize the normal physiological appearances of the endometrium throughout menarche as well as during the prepubertal and postmenopausal years

2) Illustrate the pathological appearances of the endometrium at ultrasound (US) and magnetic resonance (MR) imaging

Background

Endometrial abnormalities are common diagnostic challenges facing the radiologist. Although multimodality imaging is commonly employed, transvaginal ultrasound (TVUS) is the modality of choice for first line imaging. Knowledge of ultrasound appearances of normal and abnormal endometrial conditions is therefore important to aid accurate diagnosis and ensure expeditious management. The appearance of the endometrium is related to multiple factors, including patient's age, stage of menstrual cycle, hormone replacement therapy or tamoxifen therapy.

Imaging findings OR Procedure details

Paediatric Endometrium

Normal Appearance

At birth, the uterus has a cylindrical shape which is almost the same size as the cervix and the endometrium appears as a thin echogenic line, (Fig1)

As the girl approaches puberty, the uterus begins to adopt a more pear-like shape and the endometrium begins to approximate that seen in adulthood and varies with the stage of the menstrual cycle (Fig 2)

Pathological Appearances
The most common pelvic masses in neonates include hydrocolpos, hydrometrocolpos, and ovarian cysts. Hydrocolpos is characterized by distension of the vagina. Hydrometrocolpos is characterized by dilatation of both the uterus and vagina. Both hydrocolpos and hydrometrocolpos result from vaginal or cervical stenosis, hypoplasia, or agenesis which is often associated with congenital anomalies.

On the other hand, haematocolpos and haematometrocolpos in adolescent girls are generally associated with an imperforate hymen without an increase in associated congenital anomalies. US demonstrate an echogenic, tubular, cystic midline mass with internal echoes representing fluid and debris (Fig 3) (1).

**Premenopausal Endometrium**

**Normal Appearance**

Once the woman has reached menarche, the endometrium begins its monthly cyclical changes which can be broadly classified into the menstrual (day 1-5), proliferative (day 6-14) and secretory (day 15-28) phases. During menstruation, the endometrium appears as a thin, echogenic line 1-4 mm in thickness (Fig 4). Once the proliferative phase of the menstrual cycle (days 6-14) begins, the endometrium becomes thicker (5-7 mm) and more echogenic relative to the myometrium. (5) In the late proliferative (periovulatory) phase, the endometrium develops a multilayered appearance (Fig 5a and b). Trilaminar appearance consists of echogenic outer (basal) layer, hypoechoic inner (functional) layer and thin echogenic (median) layer. The layered appearance usually disappears 48 hours after ovulation. During the secretory phase, the endometrium becomes even thicker (7-16 mm) and more echogenic (Fig 6) (4,5).

**MR of the Premenopausal Endometrium**

The MR imaging appearance of normal endometrium is best demonstrated on T2-weighted images. On T2 weighting, the normal endometrium is of uniformly high signal intensity, and the inner myometrium, or junctional zone, is of uniformly low signal intensity (Fig 7)

**Pathological Appearances**

Endometritis, the most common cause of fever in the postpartum period, complicates 2%-3% of vaginal deliveries and up to 85% of caesarean sections. It is also associated with prolonged labour, premature rupture of membranes, retained clots, and
retained products of conception (RPOC). Although the US appearance of the uterus and endometrium may be normal, findings may include a thickened, heterogeneous endometrium, intracavitary fluid, and intrauterine air.

Postpartum haemorrhage is most often caused by uterine atony and RPOC and complicates 1%-2% of vaginal deliveries. There can be considerable overlap in the US appearance of these two entities. They can be distinguished clinically because uterine atony is seen in the immediate postpartum period and RPOC usually causes haemorrhage or infection at a later stage. A normal-appearing uterus and endometrial cavity in the presence of postpartum haemorrhage indicates uterine atony, whereas an echogenic intracavitary mass is suggestive of RPOC (Fig 8)

Postmenopausal Endometrium

Normal Appearance

The postmenopausal examination should take into consideration the patient's clinical history (eg vaginal bleeding) and whether she has undergone hormonal replacement therapy. The normal postmenopausal endometrium should appear thin, homogeneous, and echogenic (Fig 9). Homogeneous, smooth endometria measuring 5 mm or less are considered within the normal range with or without hormonal replacement therapy.

Postmenopausal Bleeding

Although most abnormal vaginal bleeding is caused by endometrial atrophy, it can be indicative of disease including polyps, myomas, endometrial hyperplasia, and cancers of the cervix and endometrium.

In post-menopausal women, the greatest concern is endometrial cancer, which is now the most common invasive gynaecological cancer. Therefore, it is important to determine the cause of all cases of post-menopausal vaginal bleeding.

Endometrial Polyp

Endometrial polyps are a common cause of postmenopausal bleeding and are most frequently seen in patients receiving tamoxifen. It is present in 10% of women and up to 30% of those with abnormal uterine bleeding.
On US, benign polyps have well-defined, echogenic, solid appearances. They may have cystic changes (less common). They may also be sessile or pedunculated with a vascular pedicle.

On MR, they show a low T2 signal intracavitatory fibrous core, high signal cysts. Their enhancement signal lies between the endometrium and myometrium signal patterns. Their overall average signal intensity is higher than carcinomas, although imaging alone cannot discriminate between a benign polyp, endometrial hyperplasia and endometrial cancer and a biopsy is required to make a definitive diagnosis.

Some examples of benign polyps are shown in Fig 10 - 11.

**Submucosal Fibroid**

These are benign soft tissue tumours which are found in 10% of women presenting with abnormal uterine bleeding. They occur in women of all ages and may involute after the menopause.

On US, these appear as hypoechoic solid masses, but they may be heterogeneous or hyperechoic, depending on the degree of degeneration and calcification.

On MR, these can be homogenously hypointense or less commonly hyperintense on T2 weighted sequences. Examples of submucosal fibroids are shown in Fig 12 - 13

**Endometrial Hyperplasia**

Endometrial hyperplasia is an abnormal proliferation of endometrial stroma and glands and represents a spectrum of endometrial changes ranging from glandular atypia to frank neoplasia. Endometrial hyperplasia is seen in 4-8% of patients with abnormal uterine bleeding. Risk factors include unopposed oestrogen, tamoxifen, nulliparity, hypertension and diabetes.

As mentioned earlier, definitive diagnosis can be made only with biopsy, and imaging cannot reliably allow differentiation between hyperplasia and carcinoma. Up to one-third of endometrial carcinoma is believed to be preceded by hyperplasia. This can be either focal or diffuse depending on whether it involves less or more than 25% of the endometrial surface area respectively. (Fig 14)
**Endometrial carcinoma**

Endometrial adenocarcinoma is the most common invasive gynaecologic malignancy. More than 90% of the cases of endometrial cancer occur in women over 50 and this disease accounts for approximately 10% of the cases of vaginal bleeding in post-menopausal women.

US signs of endometrial carcinoma include heterogeneity and irregular endometrial thickening. A more specific US sign is irregularity of the endometrium-myometrium border, a finding that indicates invasive disease. MR imaging is valuable in the evaluation of endometrial cancer. Endometrial carcinoma usually manifests as a mass that, relative to normal endometrium, is hypo- to isointense on T1-weighted images and variable signal on T2-weighted images. Tumours are staged on the basis of depth of myometrial invasion and this influences surgical management. (Fig 15-16) MR is particularly used for local staging (assessing depth of invasion) and both MR imaging and CT are useful in demonstrating extra uterine spread and lymphadenopathy.

**Tamoxifen-associated Changes**

Women who are being treated with tamoxifen are at increased risk of developing endometrial cancer but TVUS can be misleading in these patients. Tamoxifen can cause sub-endometrial cyst development, which makes the endometrium appear thickened in transvaginal sonograms. It has also been reported that the degree of endometrial thickening corresponds to the duration of tamoxifen therapy. (Fig 17)

**Endometrial Adhesions**

Also known as Asherman's syndrome, it is defined as scarring within the endometrium. Scar tissue within the uterine cavity can partially or completely obliterate the normal cavity and can interfere with conception and pregnancy. It is most commonly caused by trauma to the lining from dilatation and curettage procedures. Occasionally, it develops following myomectomy and Caesarean section.

Although adhesions are best evaluated during the secretory phase in the cycle, they have nonspecific features on US. They are characterised by bridging septa (Fig 18) known as synechiae.

**Endometrial Atrophy**
This usually occurs in post-menopausal women, but it can occur following radiation therapy. It is characterised by endometrial thickness of less than 4mm (Fig 19 a and b) on page . It can be symptomatic in the form of abnormal uterine bleeding, in which case, it usually warrants follow-up or biopsy.

**Endometritis**

Endometritis is defined as inflammation of the endometrium. It is most commonly caused by sexually transmitted diseases and intrauterine surgical procedures. The imaging features include thickening and increased vascularity of the endometrium with or without fluid in the cavity.

In endemic areas, endometritis can be caused by genital tuberculosis. Endometrial tuberculosis often goes undiagnosed because it is either asymptomatic or presents with non-specific symptoms. The US appearances show features of endometritis in the acute setting, but in chronic cases, focal or diffuse endometrial calcification is seen (Fig 20a and b).

**Intrauterine contraceptive device**

Intrauterine contraceptive devices (IUD) should lie within the fundus of the endometrial cavity and serve to prevent implantation of the embryo. IUDs are readily detected at US as highly echogenic structures with distal acoustic shadowing (Fig 21).

**Images for this section:**
Fig. 1: Normal paediatric endometrium. Sagittal US image of the uterus in a 2-year-old girl demonstrates a thin endometrium
Normal paediatric endometrium

Fig. 2: Sagittal US and T2 weighted MRI image showing uterine shape and endometrial appearances in a pre-pubertal 10 year old girl. The low signal within the uterine cavity represents the endometrium (blue arrow). The right ovary and bladder are also seen (yellow and green arrows respectively).
Fig. 3: Haematometrocolpos in a 12-year-old girl with abdominal pain. Sagittal US image demonstrates a markedly distended vagina and uterine cavity.
Fig. 4: Normal premenopausal endometrium. Sagittal US image of the uterus obtained during menstruation shows a thin endometrial lining
Fig. 5: Early proliferative phase 5a. The endometrium gradually becomes thicker. Late proliferative phase 5b demonstrates the endometrium with a multilayered appearance.
Fig. 6: 3D US reconstruction of the endometrium in the secretory phase. Trilaminar appearance begins to disappear (blue arrow) and the endometrium becomes thicker.
Fig. 7: Sagittal T2 MR AND 3 D IMAGE through the normal uterus. The endometrium is bright along with any fluid that may be in the uterine cavity (blue arrow). The dark layer immediately beneath is the junctional zone (yellow arrow). The myometrium has an intermediate signal.
Retained Products of Conception

Fig. 8: RPOC. (a) US image shows complex fluid and endometrial mass within the endometrial canal (arrows). (b) Color Doppler US image demonstrates increased flow within the endometrial cavity.
**Normal Postmenopausal endometrium**

![Image of postmenopausal endometrium on ultrasound and T2 weighted MRI]

**Fig. 9:** Postmenopausal endometrium on ultrasound and T2 weighted MRI. The postmenopausal endometrium is thin (between 2-3 mm) (blue arrow) with no cyclical variation. Similar endometrial appearances seen in the prepubertal and post-radiation therapy endometrium.
Endometrial polyp

**Fig. 10:** Axial US (a) and Sagittal (b) and Axial (c) T2-weighted MRI showing a large sausage-shaped soft tissue polyp arising within the endometrium and filling most of the uterine cavity. On the US, it is well-defined, slightly echogenic relative to the surrounding the myometrium. On the MR, the differences in tissue contrast are clearer.
Fig. 11: Axial MR imaging (a) showing a small intracavitatory polyp. 3D US (b) of an endometrial polyp.
Large Sub mucosal fibroid

Fig. 12: Trans abdominal ultrasound reveals a large submucosal fibroid
Fig. 13: a and b T2 weighted axial (a) and sagittal (b) MR images reveal heterogenous submucosal fibroid (blue arrows) distorting the endometrium (yellow arrows). Evidence of fibroid change is seen elsewhere in the uterus (green arrows).
Endometrial hyperplasia

**Fig. 14:** TV US images of different patients showing focal and diffuse thickening of the endometrium (blue arrows), due to hyperplasia. This was confirmed at biopsy.
Endometrial cancer (Stage 1B)

MRI shows large endometrial mass distending the endometrial cavity with invasion of the myometrium to more than 50%

Fig. 15: Fig 15
Endometrial Cancer (Stage 3A)

T1 and T2 weighted images showing endometrial cancer (arrow) with myometrial invasion to the serosa on the right. Possible spread of disease beyond the serosa would upstage the tumour to FIGO stage 3A.

**Fig. 16:** Fig 16
Tamoxifen associated Changes

**Fig. 17:** Endometrial thickening associated with tamoxifen therapy. US image reveals marked endometrial thickening (arrowheads) associated with subendometrial cysts (arrows) resulting from tamoxifen therapy.
Fig. 18: Sagittal TV US showing fluid and synechiae (branching strands) within the endometrial cavity (blue arrows).
Endometrial Atrophy

Fig. 19: a and b Sagittal US and T2w MRI showing thinning (atrophy) of the endometrium.
Endometrial calcification

**Fig. 20:** a and b Sagittal TV US showing focal endometrial calcification (blue arrow) in TB endometritis. Note the posterior acoustic shadowing.
Intrauterine contraceptive device

Fig. 21: US image shows a hyperechoic linear structure within the endometrial canal (arrow) representing an IUD.
Conclusion

MR and US are useful and complementary modalities to assess the endometrium effectively. It is important for the radiologist to be familiar with the more common benign disorders of the endometrium as it will obviate unnecessary invasive investigation and patient anxiety. Correlation of individual clinical history with imaging features is beneficial for narrowing down the diagnostic possibilities.

Personal Information

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References


