

Ultrasound evaluation of the Endometrium

❖ General Outlines:

- Introduction.
- Examination Technique.
- Standardized Endometrial Description.
- Normal Endometrial Variation.
- Individualized Endometrial Pathology

I. Introduction :

The normal endometrium is a dynamic tissue, which changes on a daily basis in response to the hormonal changes of the hypothalamo-pituitary-ovarian (HPO) axis. The sole function of the endometrium is to provide a suitable media and surface to allow implantation of the developing embryo when it arrives in the uterine cavity in order to establish a pregnancy. Thus, the changes occurring in the endometrium are exquisitely timed and tuned to ovulation. Also any abnormalities of the HPO axis will have a downstream effect on the endometrium.

II. Examination Technique :

Method

- The endometrium and uterine cavity is best scanned by transvaginal sonography (TVS). (Figure 1)
- A transabdominal scan (TAS) may be required: (Figure 2)
 - In the presence of large fibroids or a globally enlarged uterus.
 - A mid-positioned (axially placed) uterus.
 - TVS is considered inappropriate (e.g. virgo, vaginismus, imperforate hymen, transverse vaginal septum or secondary vaginal stenosis)

- Transrectal scan should be considered when:
 - TVS is considered inappropriate (e.g. virgin, vaginismus or secondary vaginal stenosis)
 - If the transabdominal scan is inconclusive
- It is best to do both a TAS and a TVS scan, because they complement each other.

Time

The late pre-ovulatory phase of the menstrual cycle (days 8–12) is usually suggested as the optimal time to perform simplified ultrasound-based infertility investigation. Timing also depends on the pathology to be examined e.g. cavity assessment by 3D modality coronal view is best done mid-luteal, while assessment of the presence or absence of an endometrial polyp is best seen during the postmenstrual phase.

Procedure

- Every assessment of the uterus should start with identification of the bladder and the cervix. The position of the uterus is noted and measurements taken.
- The uterus is scanned in the sagittal plane from cornu to cornu and in the transverse plane from the cervix to the fundus. (Video 1)
- 3D is useful for visualization of the coronal section of the uterus which provides better information of the uterine cavity and EMJ (endo-myometrial junction). (Figure 3)

Once an overview of the whole uterus has been established, the magnification should be increased, focusing on the area of interest i.e. *the endometrium*.

Limitation

Difficulties may arise from variations in uterine position (particularly when axial) or with uterine rotation (endometriosis or previous surgery-related adhesions).

In such cases, the examiner can:

- Place the probe in the anterior or posterior fornix and push on the cervix to retrovert or antevert the uterus further, to try and make the endometrium more perpendicular to the beam.
- Pressing on the abdomen with the non-scanning hand.
- Filling the bladder may also be of help.

Further problems may be encountered when the cavity is distorted by coexisting benign pathology such as adenomyosis or fibroids.

When the endometrium is difficult to visualize, it may be helpful to trace it from the endocervical canal. If visualization of the endometrium is suboptimal, then that must be mentioned in the report.

Saline or gel instillation (sonohysterogram) often helps in better evaluation of the endometrium in cases where assessment is difficult or in those with an intracavitary pathology.

III. Standardized Endometrial Description:

The International Endometrial Tumor Analysis (IETA) group put a standardized consensus statement on terms, definitions and measurements that may be used to describe the sonographic features of the endometrium and uterine cavity at gray-scale sonography, color flow imaging and sonohysterography.

Quantitative assessment of endometrial thickness: (Figures 4-7)

- The endometrial thickness is the maximum measurement in the sagittal plane and includes both endometrial layers (double endometrial thickness).
- It is critical to ensure that the uterus is in a midsagittal plane, the whole endometrial stripe is seen from the fundus to the endocervix, the thickest portion is measured, and the image is clear and magnified. (Figure 4)

- The calipers should be placed at the level of the two opposite endometrial–myometrial interfaces. The measurement of the total double-layer thickness should be reported in millimeters, rounded up to one decimal point.
- When intracavitary fluid is present, the thickness of both single layers is measured in the sagittal plane and the sum is recorded (Figure 5), or a single layer thickness is measured where it is thickest, and it should be mentioned in the report that it is a single-layer thickness.
- Intracavitary fluid should be defined by its largest measurement in the sagittal plane.
- If the endometrium is thickened asymmetrically, the anterior and posterior endometrial thicknesses should also be reported separately. (Figure 6)
- When the endometrium cannot be adequately visualized at its entirety, as is sometimes the case with a mid-positioned uterus, distortion by leiomyomas or adenomyosis, or distortion of the endometrial-myometrial interface from endometrial carcinoma, it should be reported as nonmeasurable and incompletely visualized. (Figure 7)

IV. Normal Endometrial Variation in reproductive age group:

Endometrial changes during the menstrual cycle are a mirror for ovulatory cycle changes.

- **Menstrual phase:** During menstruation, the endometrium appears thin regular, homogeneously echogenic, although in some patients, a more heterogeneous pattern can be seen. Occasionally a small amount of fluid is present in the uterine cavity, which should not be included in the measurement. By the end of menstruation, the endometrium is thin, about 1–4 mm in thickness. No subendometrial flow is seen at this time. (Figure 8)

- **Proliferative phase or follicular phase:** The endometrium gradually increases in thickness from 5 mm to about 10–12 mm. The proliferative phase endometrium is typically seen as a three-layer endometrium (the so-called trilaminar layer) with an echogenic basal layer, a hypoechoic inner functional layer and an echogenic midline at the interphase of the two layers. During the late proliferative period and near the time of ovulation, endometrial lining is 8–12 mm in thickness with an accentuated trilaminar appearance. Minimal intracavitary fluid may be seen in the preovulatory phase. (Figures 9-11)
- **Secretory phase or luteal phase:** The endometrial thickness may decrease minimally at ovulation, but after that it increases gradually in thickness (7–15 mm). The trilaminar appearance is lost, with the development of a uniformly hyperechoic stripe. The endometrium becomes hyperechoic starting from the periphery towards the center. (Figure 12)

V. Individualized Endometrial Pathology:

Endometrial Atrophy

- Endometrial atrophy is not a common finding in infertility patient
- Atrophy of the functional layer of the endometrium occurs in response to a prolonged hypo-estrogenic state.
- Transvaginal ultrasound typically demonstrates a thin uniform endometrium measuring less than 5 mm (Figure 13). There may be cystic dilatation of the endometrial glands that may cause pseudo widening of the endometrium often seen in women taking tamoxifen. (Figure 14)
- Saline infusion sonohystrography shows single layer thickness of the endometrium should be less than 2.5 mm without areas of focal thickening or irregularity.

Endometrial Hyperplasia

- Unopposed estrogen stimulation leads to proliferation of endometrial glands.
- Endometrial hyperplasia can be seen with chronic anovulatory states, tamoxifen use, obesity, and estrogen-secreting ovarian tumors.
- Four categories of endometrial hyperplasia based on glandular and stromal architecture and the presence of nuclear atypia.

Ultrasound demonstrates:

- Thickening of the endometrial echo complex, which is typically diffuse, echogenic. Well-defined endometrial-myometrial interface. (Figure 15)
- There may be foci of cystic change, which correspond to dilated endometrial gland.
- More than 16 mm for premenopausal women in the secretory phase of the menstrual cycle is a generally accepted threshold for abnormal thickening; however, its sensitivity and specificity are not optimal (67% & 75% respectively) for detecting endometrial disease.
- There is no accepted threshold value in the proliferative phase.
- In asymptomatic premenopausal women, endometrial thickness alone is not an indication for biopsy.
- Focal endometrial thickening and areas of heterogeneity are less common and better demonstrated with sonohystrography. They are considered abnormal even if below these thresholds for endometrial thickening.

Endometrial Polyps

- Endometrial polyps are hyperplastic growths consisting of dense fibrous tissue or smooth muscle with disorganized endometrial glands.

- Endometrial polyps can be sessile or pedunculated, are multiple in 20% of women. Their size range from 1 mm to a few centimeters. Large size is defined as greater than 1 cm.
- Polyps can be asymptomatic or cause uterine bleeding in premenopausal women
- Polyps can be (hyperplastic, atrophic, or rarely functional).
- Rarely harbor atypia (3.1-4.7%) or foci of malignancy (0.8-1.4%).

Ultrasound demonstrates: (Figures 16-17, videos 2-4)

- Diffuse or focal echogenic thickening of the endometrial echo complex, 79% of polyps are hyperechoic, with the remainder having variable echogenicity, 59% will have cystic changes which represent dilated endometrial glands.
- Scans should be performed in the proliferative phase. Scans done in the secretory period are rarely diagnostic, the endometrium is normally thick and echogenic, so it often masks the presence of a polyp.
- The endometrial myometrial interface is typically intact, with the polyp forming an acute angle with the endometrium.
- The polyp is considered pedunculated if the maximum transverse diameter of the lesion is larger than its diameter at the level of the endometrium. They most commonly arise in the uterine cornua or fundus and rarely can prolapse through the cervix.
- Color Doppler imaging can be helpful by demonstrating the vascular pedicle, seen in just under half of polyps, mostly *functional polyps*, whereas half of polyps usually the atrophic type; show no flow on color Doppler imaging.
- Diffuse endometrial thickening on TVS is nonspecific and may be caused by focal lesions as well as by diffuse disease. Sonohystrography is particularly

helpful in these conditions by demonstrating focal endometrial lesions with an otherwise normal endometrial thickness elsewhere in the uterine cavity.

Tamoxifen

- Tamoxifen, a selective estrogen receptor modulator (SERM), is used to treat breast cancer or as prophylaxis to prevent breast cancer in high-risk patients.
- Although an antiestrogen agent in breast tissue, tamoxifen has a paradoxical effect in the uterus, inducing endometrial proliferation, which can take the form of hyperplasia, polyp, cancer, or cystic atrophy.
- Up to 50% of women develop endometrial abnormalities while on tamoxifen therapy, usually in the first 36 months of treatment.
- Most patients are asymptomatic and in this population no surveillance imaging is recommended. Symptomatic patients typically have uterine bleeding.

Ultrasound demonstrates: (Figures 14)

- Non specific appearance of endometrial thickening with cystic dilation of the endometrial glands. This may represent endometrial hyperplasia, polyps, or carcinoma, as well as the pseudo-thickening of cystic endometrial atrophy.
- Polyps tend to be multiple and larger in women taking tamoxifen, with a median size of 2.9 cm (range of 0.3-11 cm).
- Following discontinuation of tamoxifen, endometrial thickening slowly decreases at a rate of (1.3 mm per year). Therefore, the endometrium may remain thickened for (6 - 12 months) following discontinuation of therapy.

Intrauterine Adhesions

- Any inflammatory process can cause scarring and on occasion inflammation within the uterine cavity can cause adhesions.

- Previously, intrauterine adhesions were most commonly associated with vigorous curettage, D&C is rarely undertaken in this way now and with gentler suction curettes the problem of adhesions is much less common.
- They can still occur after a formal endometrial ablation procedure, following pregnancy related infection or uterine tuberculosis.
- The pathological appearance is of fibrous bands traversing the endometrial cavity with the formation of synechiae that may retain shed endometrial tissue and blood. So, patient may present with a history of dysmenorrhoea, oligomenorrhoea, infertility or recurrent miscarriage.

Ultrasound demonstrates: (Figures 18 &19)

- Adhesions are usually seen as areas of interrupted endometrial interface.
- Adhesions are usually seen as strands of tissue, same or more echogenic than the myometrium, crossing the endometrial cavity and adjoining the opposing uterine walls.
- Endometrial -myometrial junction is abnormal with loss of basal endometrium continuity.
- Hypoechoic areas with interruptions of endometrial layer may be seen (skip lesions representing entrapped menstrual blood or secretions from preserved functioning).
- If there is fluid in the cavity, the adhesions may be better and more conclusively demonstrated.
- Best diagnosed following saline infusion sonography, hysterosalpingography or hysteroscopy, at which time the adhesions may be divided.

Osseous metaplasia

- Either true osseous metaplasia which is due to metaplasia of mature endometrial stromal cells, caused by chronic inflammation or trauma, or due to the presence and continued ossification of retained fetal bone.

- From clinical standpoints; however, the distinction is irrelevant as both entities cause similar symptoms.

Ultrasound demonstrates:

- Multiple hyperechoic structures with posterior shadowing within the uterine cavity. (Figure 20 a)
- It often resembles an IUD.
- The bony tissue often breaches the endometrial myometrial junction and becomes embedded within the myometrium (Figure 20 b).

Endometritis

- Acute endometritis is a common cause of infectious morbidity occurring in up to 2–3% of all vaginal deliveries and 15–20% of caesarean sections.
- The diagnosis of acute endometritis primarily is considered to be clinical; however, accurate diagnosis can be challenging as early signs and symptoms can be mild and non-specific.

Sonographic findings have generally been reported as non-specific.

- Uterine enlargement with heterogeneity of the endometrial echo-complex.
- Presence of fluid within the endometrial cavity has been reported as suggestive of the diagnosis, but these findings also can be seen in healthy post partum individuals making accurate interpretation difficult.
- Echogenic foci with posterior acoustic shadowing can indicate the presence of gas forming organisms within the uterus but intracavitary gas is known to be present for up to 3 weeks in healthy patients after delivery.

❖ Selected References

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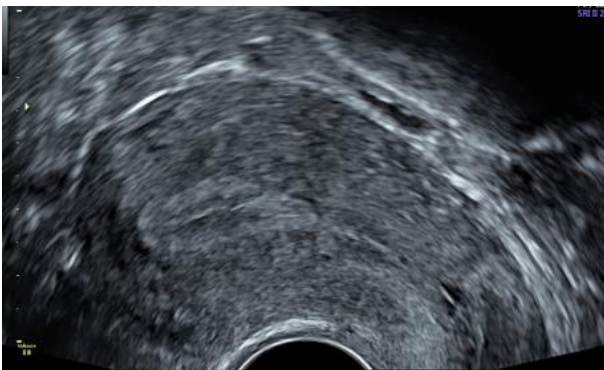


Figure 1: Transvaginal midsagittal plane of an anteverted uterus.

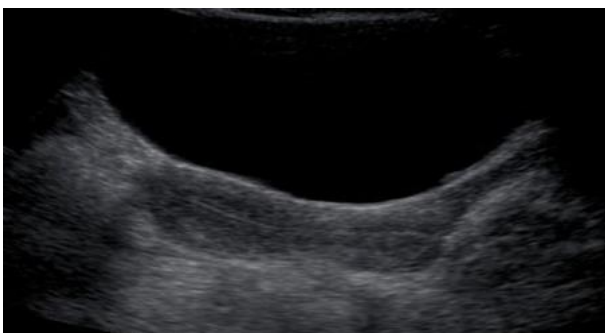


Figure 2: Transabdominal midsagittal plane of the uterus.

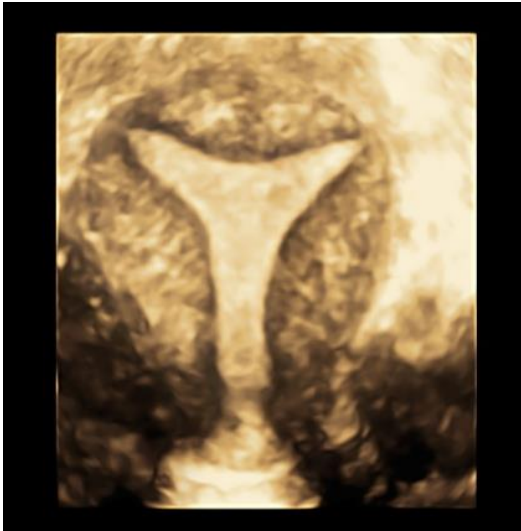


Figure 3: 3D ultrasound demonstrates the coronal plane of the uterus.

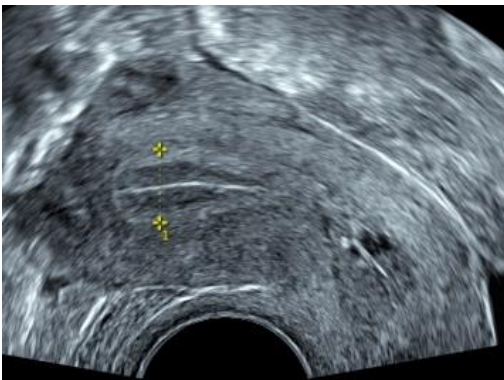


Figure (4) Transvaginal ultrasound of a sagittal view of the uterus demonstrates the measurement of the total double-layer thickness of the endometrium. The calipers are placed at the level of the two opposite endometrial–myometrial interfaces.



Figure (5) Transvaginal ultrasound of a sagittal view of an RVF uterus during the periovulatory phase. The measurements of the anterior and posterior endometrial layers are summed, resulting in an endometrial thickness of 8.8mm. The intracavitary fluid is not included in the measurement.

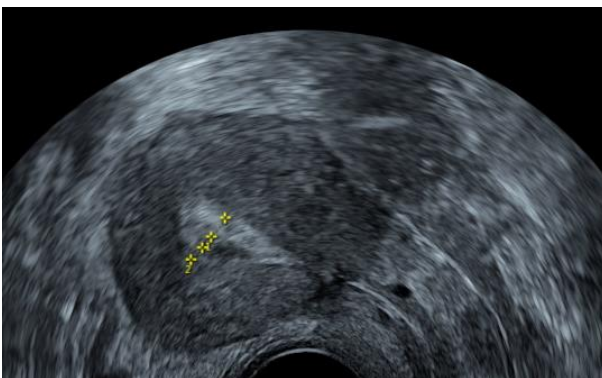


Figure (6) TVS of a sagittal view of the uterus demonstrates asymmetrically thickened endometrium, the anterior and posterior endometrial thicknesses should be measured and reported separately.

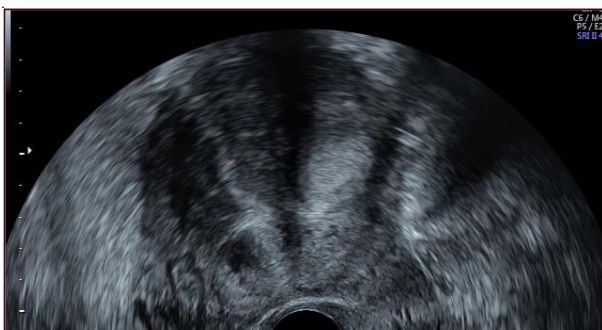


Figure 7: Transvaginal ultrasound. Visualization of the endometrium is suboptimal due to shadowing by the fibroids.



Figure (8) TVS of a sagittal view of the uterus during menstruation. A small amount of fluid is present in the uterine cavity.

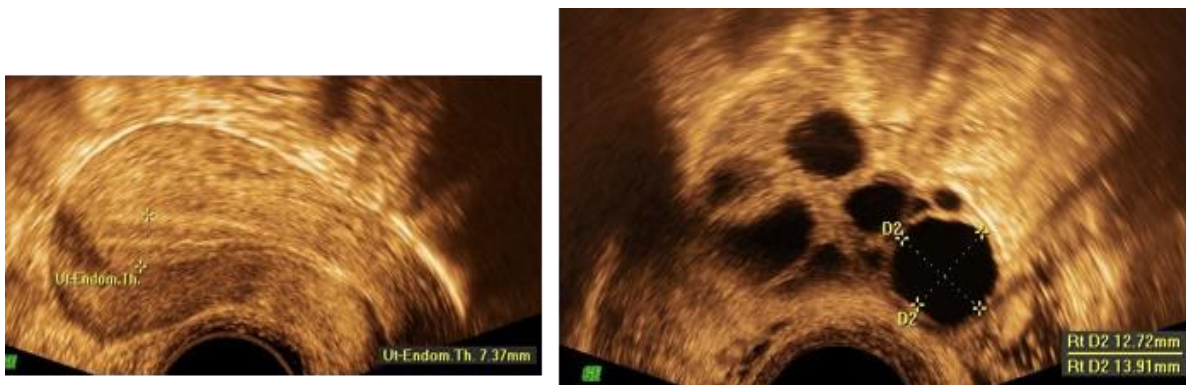


Figure (9) TVS of a sagittal view of the uterus in early proliferative phase. The endometrium can be shown to be continuous with the endocervical canal. Note the trilaminar pattern.

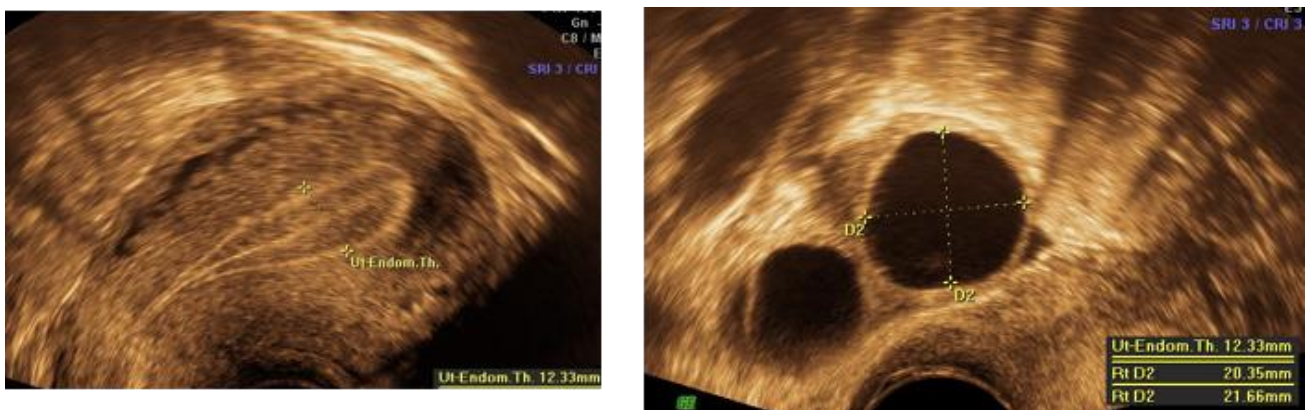


Figure (10) TVS of a sagittal view of the uterus in late proliferative. Note the accentuated trilaminar pattern.

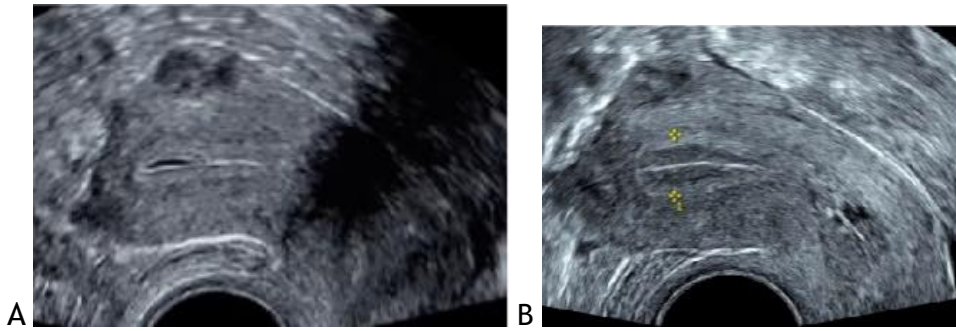


Figure (11) TVS of a sagittal view of the uterus in the same patient; A: day 5 endometrial thickness 5 mm, B: Day 12 endometrial thickness 10 mm trilaminar pattern.

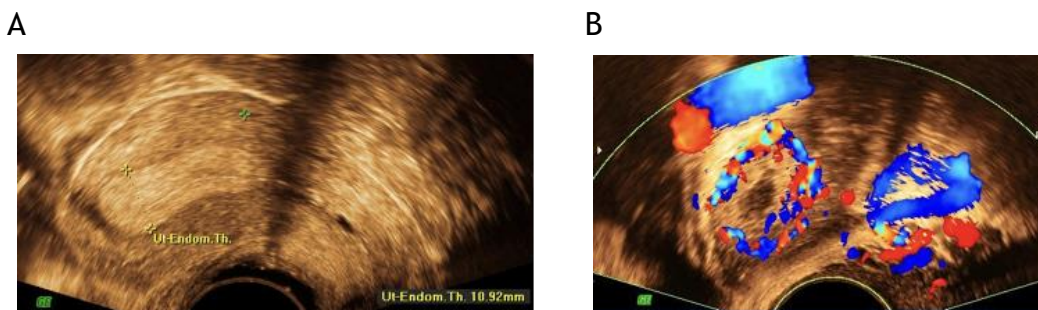


Figure (12) TVS of a sagittal view of the uterus in secretory phase.

A: the endometrium is uniformly hyperechoic, B: Corpus luteum surrounded by a vascular ring

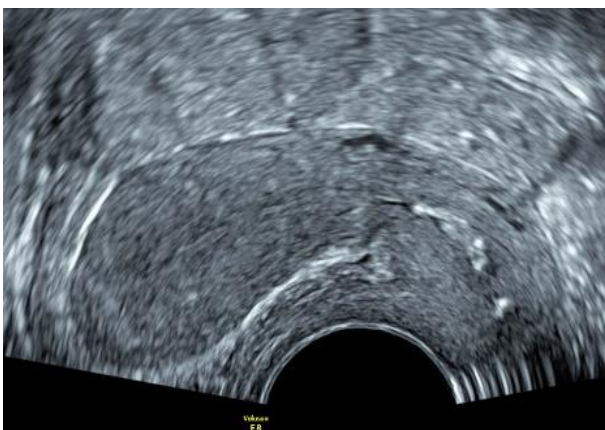


Figure (13) TVS of a sagittal view of the uterus. Note the thin ill defined endometrium



Figure (14) TVS of a sagittal view of the uterus of a patient on tamoxifen. Note the pseudo-thickening of cystic endometrial atrophy



Figure (15) TVS of a sagittal view of the uterus in the secretory phase. Note the thickened non uniform echogenic endometrium with minute cystic spaces. Endometrial thickness is 27mm.

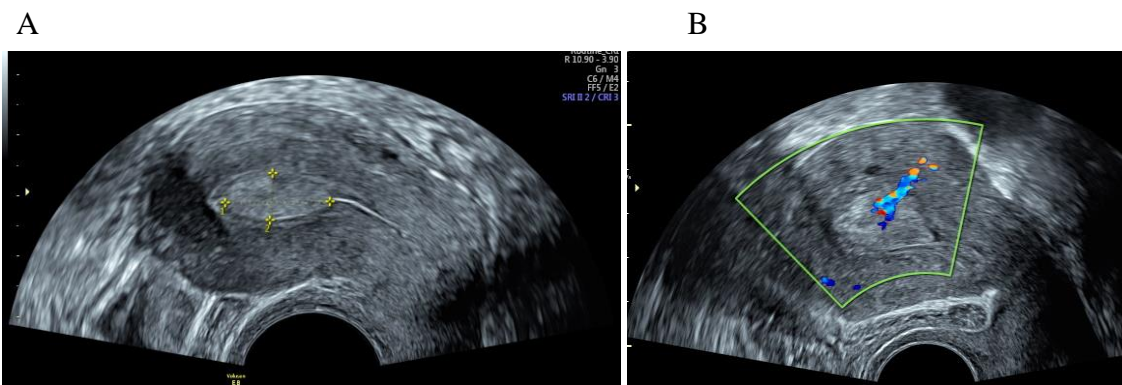


Figure 16: A, TVS of a sagittal view of the uterus demonstrates a trilaminar appearance of the endometrium and a focal echogenic lesion (calipers) representing an endometrial polyp. Note The 'bright edge' formed by the interface between the polyp and the endometrium. B, color Doppler image shows a feeding vessel supplying the polyp.

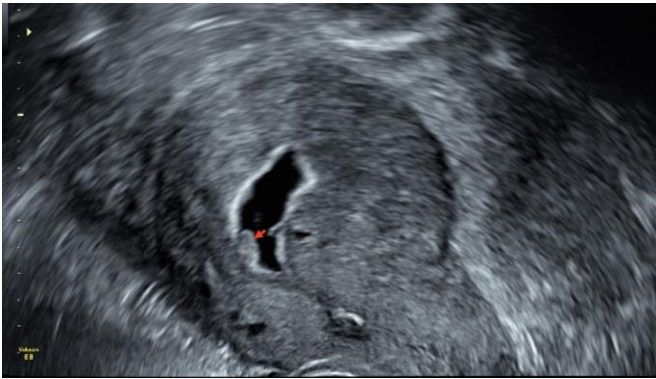


Figure (17) Saline infusion sonohysterography (SIS) shows an anterior sessile endometrial polyp (red arrow); maximum diameter of the lesion is smaller than its base consistent with a sessile polyp.



Figure (18) Intrauterine synechia. Strands of tissue, crossing the endometrial cavity, adjoining the opposing uterine walls and entrapping fluid.

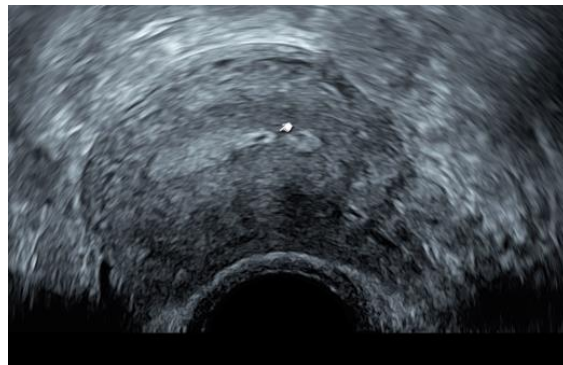
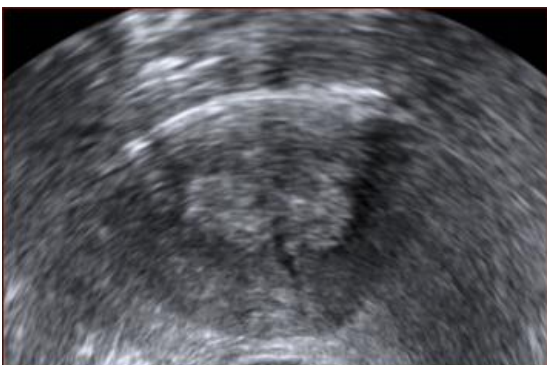


Figure (19) Intrauterine adhesions appears as areas of interrupted endometrial interface

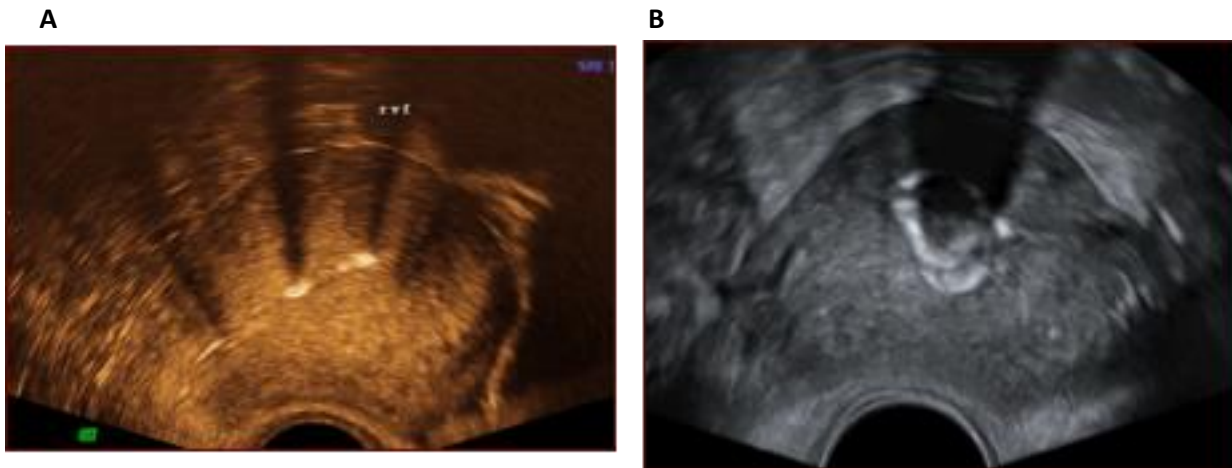


Figure (20) osseous metaplasia. Calcified intrauterine retained fetal parts. Highly echogenic materials with marked shadowing indicating calcification within the endometrial cavity (a), and embedded within the myometrium (b).