**1) Imaging Techniques in Gynecology - Dr. Nasreen**

**Female Genital Tract**

- Imaging techniques are:
  - US is usually the principle examination.
  - Conventional radiology plays always no major part, the major exception of HSG
  - CT scan.
  - MRI

**US in Gynecology**

**TAS**

- It performed through the full urinary bladder.
- It provides a wider field of view than TVS.
- Thus visualization of the pelvic organs is limited by body habitus owing to sonic attenuation of the intervening of the anterior abdominal wall, subcutaneous & properitoneal fat, & fat in the mesentery & omentum.
- Most transvesical examinations are performed with 3,5-MHs.

**TVS**

- EVS has numerous advantages over TAS. Because of the proximity of the vaginal fornices to the uterus & adnexa, the problem of sonic attenuation is much less significant with EVS in the evaluation of the viscera of the true pelvis. It needs a high frequency probe to be placed close to the target organs so it demonstrate anatomic details of the uterus, ovaries and adnexa

**Normal Anatomy**

- The pelvis is divided into two compartments, the true and false pelvis. The division is defined by the sacral promontory and the linea terminalis (is the arcuate line of the ilium, the iliopectineal line, and the crest of the pelvis).
- The false pelvis is bounded by flanged portions of the iliac bones, the base of the sacrum posteriorly and the anterior abdominal wall anteriorly and laterally.
- The true pelvis is bounded anteriorly by the pubis and pubic rami, posteriorly by the sacrum & coccyx, laterally by the fused ilium & ischium, inferiorly by the muscles of pelvic floor.
- Disadvantages of TVS compared with TAS is limited field of view & inability to examine the false pelvis adequately. In TAS it needs full bladder. Post voiding us is advised to search for small mass in the falls pelvis.

**The Uterus**

- The uterus is located in the true pelvis between the urinary bladder anteriorly & the rectosigmoid posteriorly. The anterior surface of the uterus is covered with peritoneum to the level of the junction between the uterine corpus & cervix. The peritoneal space anterior to the uterus is the vesicouterine pouch or anterior cul-de-sac it is usually empty but may contain loop of small bowel. Posteriorly the peritoneal reflection extends to the posterior fornix of vagina forming posterior cul-de-sac. Laterally the peritoneal reflection forms the broad ligaments.
- The uterus is divided into the fundus, body, and cervix regions. With sonographic sagittal appearance is a dumbbell – shaped organ with a more bulbous fundus & cervix & a narrow middle body.
The muscular of the uterus (myometrium) is composed of three distinct layers that can be differentiated sonographically.

1. The outer layer of the myometrium consists of longitudinally oriented fibers. It is separated from the intermediate layer by the arcuate vessels and is hypoechoic compared with the intermediate layer.
2. The intermediate layer is the thickest of the three layers. The muscle fibers consist of spiral bands. The intermediate layer is more echogenic than the outer and inner layers.
3. The inner layer consists of longitudinal and circular fibers. The sonographic appearance is that of a thin hypoechoic halo surrounding the endometrium.

The Endometrium

- The endometrium is a thin echogenic strip composed of a superficial layer (zona functionalis) and a deep basal layer. The thickness and sonographic appearance change cyclically with the menstrual cycle. In the menstrual phase, the endometrium is thin and echogenic as the superficial layer is shed. During the early proliferative phase (days 5-9), the endometrium is thin, echogenic line. In the late proliferative phase (days 10-14), the functional zone of the endometrium increases in thickness under the influence of estrogen, appearing sonographically hypoechoic compared with the basal layer. During the secretory phase (days 15-28), the functional layer becomes thickened, soft, and edematous under the influence of progesterone.
- Measurement of the endometrium should be performed in the sagittal plane, this is referred to as double-layer thickness.
- The endometrium varies in thickness depending on the menstrual phase, age, parity, and estrogen replacement therapy.
- Total endometrial thickness should not exceed 14 to 16 mm premenopausally and 8 mm in the postmenopausal patient. In postmenopausal women, the endometrium should measure <8 mm. Remember that this measurement is for normal asymptomatic patients. While patients with postmenopausal bleeding and endometrial double layer thickness of >5 mm should have further evaluation, and patients receiving hormone therapy have a wider range of endometrial thickness than those receiving no hormone.
- Uterine position is highly variable and changes with varying degrees of bladder and rectal distention.
- The cervix and the vagina form a 90-degree angle; this condition is referred to as anteversion (A/V), the more movable corpus is usually flexed anteriorly on the cervix (anteverted).
- Contraction wave of the myometrium can be demonstrated sonographically. Contraction increases in frequency in the periovulatory phase.
- Contraction waves of the inner layer may play a role in sperm transport, implantation, and maintenance of pregnancy.

The Cervix

- The cervix is the endocervical canal, the continuation of the endometrial canal. It appears as a strip of echogenic line. Fluid is sometimes seen in the endocervical canal, particularly in the periovulatory period.
- Numerous cervical glands extend from the endocervical mucosa into the adjacent connective tissue of the cervix. Occlusion of cervical gland results in the formation of retention cysts, known as nabothian cysts.

The Vagina

- The vagina is seen as a hypoechoic tubular structure with an echogenic lumen. The bladder trigone and urethra are anterior to the vagina, and the rectum is posterior. The distal ureters are lateral to the upper vagina, and pass anteriorly to enter the urinary bladder. The cervix projects through the anterior vaginal wall, separating the vagina into anterior, posterior, and two lateral fornices. The posterior fornix is continuous with the posterior cul-de-sac.
CT Scan
- The quality of pelvic CT has improved with faster, spiral or multislice CT resulting in less movement artifact. The diagnostic quality of pelvic scans is also improved with use of oral & IV contrast.
- The vagina is seen as a linear structure between the urethra & the rectum, immediately above the vagina the cervix is seen as rounded soft tissue structure approximately 3 cm in length. The body of the uterus merges with cervix, its precise appearance depending on the lie of the uterus. The broad ligaments and the fallopian tubes cannot be visualized, the ovaries cannot usually be identified.
- Oral contrast media is used in pelvic examination to differentiate between the bowel and adjacent structures, & IV contrast media used for blood vessels, mass & lymph nodes.

MRI
- The pelvic anatomy is very well demonstrated because of the excellent soft tissue contrast afforded by MRI. Images are usually taken in sagittal, coronal, & axial.
- On T2-weighted scan the body of the uterus is easily recognized the myometrium shows intermediate signal & the endometrium has a high signal. The ovaries are of intermediate signal often contain multiple high signal follicles, the broad ligaments can also identified.
- The ovaries & the broad ligament can also visualized.
- The cervix show a low signals on T2 waited.

Benign Conditions

Adenomyosis
- Endometriosis is defined as ectopic endometrial glands and stroma, which undergo cyclic change. When the myometrium is involved (at least 2.5 mm deep to the basalis layer), the ectopic endometrium is termed adenomyosis it is either focal form or diffused form although the pathology are same in both but the etiology & presentation are different. By ultrasound adenomyosis it show increase or decrease in echogrnecity of that area or even cystic changes. TVS in symptomatic patients can be sensitive but not specific for diagnosis of focal adenomyosis. MRI can also be of value the features are different between focal & diffuse forms, the latter are more commonly recognized, the lesion are high signal on T2-weighted sequences.
- Age incidence is 40-50 ys, etiology is in multiple pregnancies & deliveries with uterine shrinkage, aggressive curettage and elevated estrogen level. The glands of the adenomyosis are atrophic or underdeveloped & do not easily respond to hormonal therapy.

Endometeriosis
- Presence of endometrial tissue out side the uterus in the pelvis.
- US show a cystic or hypoechoic mass in the adnexal region or in pouch of douglas.
- It is chocolate cyst found in pathology.
- Age incidence 25 – 35 ys.
- Complications.
- MRI give characteristic appearance because of recurrent bleeding (high signals in T1-wt), if the endometeriosis has bled in peritoneal cavity as it commonly does at the time of the menstruation, fluid may be detected in the pouch of douglas.
Endometrial hyperplasia

- is the most common cause of vaginal bleeding in both pre- & postmenopausal women result from unopposed estrogen stimulation. On ultrasound it manifests as pronounced endometrial thickening stripe, it may be indistinguishable from polyp or carcinoma.

Polyp

- Polyp represent area of over growth of endometrial glands & stroma covered by endometrial epithelium. The lesion may be pedunculated or sessile. They usually arise in the fundus & are multiple in 20%, & 10% seen at autopsy. They may be asymptomatic. The typical presentation in patient who are symptomatic is vaginal bleeding or mucous discharge. When very large, they may prolapse externally. Small polyp may slough during menstruation.
- In US polyp appear as focal of increased endometrial thickening. TAS may be normal. Whereas the TVS images show focal irregularity of the endometrial stripe. In post menopausal women, specially those being investigated for bleeding, the major differential diagnosis are, 1- hyperplasia, 2- sub-mucous fibroid, 3- or less commonly endometrial carcinoma. (hysterosonography) HSG permit more accurate TVS identification of the lesion & more accurate distinction among hyperplasia, polyp, fibroid, or carcinoma. Alternately MRI can be used to confirm a lesion suspected to be polyp, which has moderately high signal on T2, versus fibroids, which, especially when small, have low signal.

Leiomyomas (fibromyomas or fibroids)

- Are composed of interleaved bundles of smooth muscle. They constitute the most common pelvic tumor, becoming increasingly with age. 25% of white & 50% of black women older than 30 years have at least one leiomyoma, their number are more usually multiple. They may be submucos, intramural, or subserous. Only 5-10% are submucosal but they are the most symptomatic may cause menorrhagia, metrorrhagia or postmenopausal bleeding.
- The US findings of leiomyoma depend on the size, site, and age of the tumor and correspondingly it is varied. The role manifestation of fibroids may simply be uterine enlargement or nodularity of the contour. In the early stage it appear as hypoechoic solid mass (this is account for one third of cases) , then increasing echogenicity marks the start of fibrous degeneration, with tiny cystic areas acting as echogenic foci .With further aging leiomyoma may undergo cystic degeneration (e.g hemorrhagic, proteolytic) presenting as an anechoic mass, then calcification appear as highly echogenic portions & associated acoustic shadowing from the area of calcification vary from small foci of calcification to extensive calcifications, more usually seen in older women. Calcified myomas has typical appearance on plain radiography of abdomen.
- MRI may be used to help clarify and confirm cases that are not as definitive on US . On MRI fibroids also present a variable appearance, they are usually of low signal . However degenerated fibroids can have moderately high signal intensity on T2 weighted scan. The definitive diagnosis can be made by showing the (claw sign) analogous to renal masses, stretching of the of the myometrium around the base of the lesion.

Degenerative changes in fibroid

- Degenerative changes can take place in fibroids with areas of necrosis and hemorrhage and result in varying appearances from cystic to inhomogenous appearances. In fact, it may be difficult to differentiate a large complicated ovarian cyst from a degenerated fibroid.
Dystrophic calcification of the uterus

- A dense calcification involving the inner myometrium and endometrium. The cause is usually instrumentation or procedures like curettage. These have little clinical significance. However, bony remnants of any previously aborted fetus must be excluded.

Miscellaneous benign processes

Pelvic inflammatory disease (PID)

- This is rarely confined to the uterus. The endometrium shows the histological changes of inflammation in more than 70% of women with acute PID and 40% with mucopurulent cervicitis. Discrete endometritis is more likely to be seen postpartum or postinstrumentation.
- US Findings on pelvic sonograms frequently appear normal in the early stages or in uncomplicated conditions. In severe or advanced conditions, sonographic findings include:
  1. Endometrial thickening with or without endometrial fluid and gas.
  2. Ovarian enlargement with indistinct ovarian borders.
  3. Uterine enlargement with indistinct uterine contours.
  4. And free intraperitoneal fluid.
  5. Ascending extrauterine disease may cause tuboovarian complexes, originating as a combination of dilated inflamed fallopian tubes and enlarged inflamed ovaries, or frank tuboovarian abscess.
- May be due to the venereal infection, commonly gonorrhea, which in the acute stages give rise to tuboovarian abscess.
- Pelvic inflammation & abscess formation may also occur following pelvic surgery, childbirth, or abortion or may be seen in association with IUCD, appendicitis or diverticular disease.
- The usual imaging technique is US which show a hypoechoic or complex mass in the adnexa or in the pouch of Douglas (cul-de-sac), what ever is the cause. Blockage of fallopian tube may cause a hydrosalpinx appear as hypoechoic adnexal mass which is often tubular in shape.
- DD from endoeteriosis & ectopic pregnancy.

Pyometra

- (pus in the uterine cavity) may complicate cervical stenosis. Cervical stenosis most commonly involve the internal os. The acquired causes include, 1- infection, 2- neoplasm, and 3- iatrogenic factors (radiation therapy, or surgery). The clinical findings is more pronounced in premenopause than in post menopause. US appearance is a dilated fluid-filled endometrial cavity. The echogenicity of the cavity varies with the amount of debris or clot. Distinction from endometrial polyp or even carcinoma is some time impossible when the fluid becomes uniformly echogenic.

Hydrometrocolpos is seen when the hymen is imperforated, allowing the accumulation of secretions within the uterus & vagina.

In asherman syndrome, intrauterine fibrous adhesions cross the endometrial cavity. The synechiae form a mesh or spiders web within the uterine lumen, and this may cause infertility or hypo- or amenorrhea. The fibrous strand may calcify and give characteristic sonographic appearance.

Nabothian cysts are obstructed & dilated inclusion cysts, of no clinical significance, located located within the cervix.