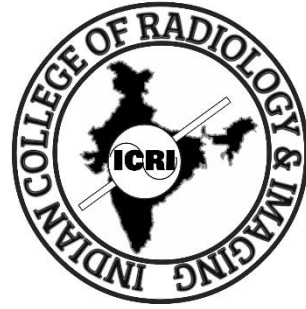




# **ICRI GUIDELINES FOR IMAGING PROTOCOLS IN WOMEN'S IMAGING**



## **ICRI SUB-SPECIALITY GROUP FOR WOMEN'S IMAGING**

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**SECTION 1: HYSTEROSALPINGOGRAPHY**  
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**INTRODUCTION**

Hysterosalpingography (HSG) is a well-known radiological diagnostic procedure which involves the fluoroscopic visualization of the endocervical canal, uterine cavity and the lumen of the fallopian tubes during the injection of radio-opaque contrast material. The procedure is most commonly performed for evaluation of infertility and a wide variety of fallopian tubes as well as uterine abnormalities can be detected on HSG which may be responsible for patient's symptoms. Like other procedures involving X-Rays, the HSG should be performed with minimum radiation exposure necessary to gain sufficient information from the study. Formation of standard practice guidelines will help in maximizing the diagnostic benefits for the patient.

**INDICATIONS FOR HSG[1-5]:**

1. Evaluation of Infertility
2. Abnormal vaginal bleeding
3. Irregular menstrual cycles
4. Pelvic pain
5. To detect anatomic variants and congenital abnormalities of uterus
6. Before or after any tubal surgery such as tubal ligation and tubal recanalization or other intervention like selective salpingography
7. Evaluation of uterine fibroid before myomectomy
8. Postoperative evaluation of uterine cavity to look for intrauterine adhesions.
9. Before treatment with assisted reproductive technologies
10. Thickened or irregular endometrium and polypoidal endometrial lesions
11. To evaluate sequelae of ectopic pregnancy

**CONTRAINDICATIONS [4 &6]:**

1. Pregnancy or possible pregnancy
2. Active pelvic infection
3. Active vaginal bleeding
4. History of severe allergy or idiosyncratic reaction to iodinated contrast agent is a relative contraindication and may need premedication.

### **EQUIPMENT DETAILS [3,4,7& 8]:**

1. Fluoroscopy unit with diagnostic fluoroscopic image quality and recording capability (radiographs, video or digital) and preferably having “last image hold” feature.
2. Uterine cannula (Leech-Wilkinson or Jarcho or Rubin’s cannula) or 8-F pediatric Foley catheter or 5 or 7-F hysterosalpingography balloon catheter. Depending on the clinician’s preference and availability any of these instruments can be used to perform HSG procedure. The balloon catheters are associated with lesser pain and less fluoroscopy time and consequently reduced radiation dose but they have the disadvantage of being more costly than their metal counterparts.
3. Vaginal speculum
4. Vulsellum forceps
5. Appropriate emergency equipment and medications should be available to treat adverse reactions associated with contrast agent. .

### **CONTRAST AGENT [4,6,9-11]:**

Various contrast media have been used in HSG since the emergence of the procedure. Oil-soluble contrast media (Eg. Lipiodol) were mainly used in past, but they were reported to be associated with increased risk of contrast intravasation, oil embolism and granuloma formation, especially in presence of tubal obstruction or inflammation.

For this reason, the water-soluble contrast media subsequently achieved popularity and today, Oil-based medium have been replaced by water-soluble media at most of the centers.

### **TECHNIQUE[3-7,9, 12-14]:**

- A. The **written or electronic request for HSG** should be created by the concerned clinician. The requisition must include 1) Patient’s signs and symptoms, 2) Relevant present and past history and 3) A provisional diagnosis or indication for examination along with other relevant additional informations.
- B. **Patient is informed and the procedure is explained.**
- C. **Consent** should be obtained
- D. **Patient Preparation:**

1. The examination is performed during the follicular phase, after cessation of menstrual flow but before the ovulation ( i.e. Between 7th to 10th day of the menstrual cycle). The patient is asked to abstain from unprotected sexual intercourse from the date of her period until after the investigation to avoid the risk of pregnancy. If the patient has irregular menstrual cycles or there is risk of pregnancy, a pregnancy test may be performed prior to the procedure.
2. Peri-procedural antibiotics are not given routinely and the referring physician may decide in this regard.
3. A Non-steroidal anti-inflammatory drug may be given prior to the procedure, as patients may experience cramping and pain during the examination. If required, locoregional anesthetic agent such as topical application of lidocaine cream to cervix or paracervical lidocaine injection or intrauterine lidocaine instillation can be given prior to the procedure for pain relief.

#### **E. PROCEDURE :**

1. The patient is asked to lie supine on the fluoroscopy table in the lithotomy or modified lithotomy position.
2. The perineum is cleansed with povidone- iodine solution and draped using sterile towels.
3. A sterile speculum is inserted into the vagina and cervix is localized. The cervix is then cleansed with povidone-iodine solution.
4. The anterior lip of the cervix is fixed by using a sterile vulsellum forceps and the cannula is inserted into the cervical canal. If a Foley's catheter is to be used, forceps is usually not needed to fix the cervix.
5. A radio-opaque marker is placed over one side of the patient's pelvis to indicate the right or left side.
6. A plain radiograph of the pelvis is obtained after catheter insertion but before injection of contrast material.
7. An appropriate volume (typically in the range of 10-20 ml) of contrast agent is administered under intermittent fluoroscopic visualization to evaluate the uterus and fallopian tubes. The contrast should be instilled slowly to avoid discomfort and spasm. All air bubbles must be carefully

expelled from the syringe and cannula to avoid confusion in interpretation.

8. Intravenous glucagon or buscopan may be given to relieve the spasm of the uterine cornu.
9. Usually four spot radiographs are obtained with first radiograph acquired during early filling of the uterus and is helpful to evaluate for contour abnormality or small filling defects.
10. Then the second radiograph is acquired with the uterine cavity fully distended. The shape of the uterus is best evaluated at this stage, although small filling defects may be obscured.
11. The third radiograph is obtained to visualize and evaluate the fallopian tubes.
12. The fourth radiograph should show free spillage of contrast material into the peritoneal cavity. It should preferably be obtained after removing all the instruments.
13. Additional spot radiographs may be acquired as and when needed to further evaluate and document any abnormality visualized. Oblique views may allow for better visualization of the fallopian tubes by “elongating” the tubes and displacing the superimposed structures. If hydrosalpinx is observed, care should be taken to avoid over distention of the fallopian tube, and a 10 minute delayed image should be obtained after ambulation.
14. Selective cannulation of the fallopian tubes can be performed to distinguish lack of filling due to spasm from actual tubal obstruction.
15. Post-drainage images may be obtained in cases with suspected endometrial pathology. If a balloon catheter is used, the balloon should be deflated at the end of the procedure to fully evaluate the endometrial cavity and cervical canal.

#### **F. POST PROCEDURE CARE AND COMPLICATIONS [3,4& 6]**

Infection and bleeding are two most common complication associated with HSG procedure. The patient should be briefed about mild post procedural discomfort, light bleeding and cramps. However, clear instructions should be given to contact the referring physician if there is persistent or severe pain, fever, foul smelling discharge or unusual bleeding following the procedure.

Other complications that can occur rarely include-- Vasovagal reaction, Uterine perforation, tubal rupture, Venous or lymphatic contrast intravasation and allergic reaction to contrast agent.

## **RADIATION SAFETY IN HSG [4,17-20]**

Although an average HSG examination appears to carry a low and acceptable level of radiation exposure, efforts should be made to further minimize radiation dose (both radiographic and fluoroscopic) given that the procedure primarily involves exposure of the gonads. Also, the patients undergoing this procedure are usually young females & most of these patients desire a pregnancy. Moreover, there is always a potential of receiving higher radiation doses if the Fluoroscopy duration and/or number of radiographic exposures are extended for any reason.

Therefore, it is necessary that all personnel involved in the procedure must understand the various factors affecting radiation dose and should follow the concept of time, distance and shielding. They must adhere to the key principles of radiation protection i.e. justification, optimization and application of lower dose limits while generating diagnostic quality radiographs (ALARA). The procedure has to be optimized to ensure safety of patient as well as health personnel involved in the procedure.

The basic approach to reduce patient radiation dose is by reducing the fluoroscopic beam on time and limiting the number of radiographs taken (by elimination of the routine oblique projections). The use of digital fluoroscopy systems may further reduce patient radiation exposure.

Use of the last image hold/save grab feature is one of the easiest and most effective ways to reduce patient's radiation exposure. The use of pulsed fluoroscopy mode, keeping the pulsed fluoroscopy frame rate low and film-screen combinations with speed 400 or more is strongly recommended.

Other methods, such as collimation of the primary radiation field, use of kVp-mAs settings adjusted for the patient size, maintaining maximum permissible source-to-skin distance and avoidance of grid can also be used for radiation dose reduction.

Lead aprons, lead gloves, lead barriers and thyroid shields should be used by health personnel performing and assisting the procedure to ensure the protection from scatter radiation.

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## **SECTION 2: ULTRASONOGRAPHY**

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### **INTRODUCTION**

Pelvic ultrasonography is usually the initial imaging modality in the assessment of gynecological abnormalities in women of all ages. The advantages of ultrasonography include widespread availability, low cost and lack of exposure to ionizing radiation, the latter being especially important in imaging of women in the reproductive age group. It is essential to consider the age, menstrual status, last menstrual period and clinical presentation for accurate interpretation of findings.

### **INDICATIONS FOR PELVIC ULTRASOUND**

1. Evaluation of symptoms related to gynecological conditions (e.g. pelvic infection, pelvic masses, endocrine abnormalities including polycystic ovaries etc.), such as

- pelvic pain
- dysmenorrhea
- amenorrhea
- abnormal uterine bleeding
- postmenopausal bleeding
- delayed or irregular menses
- vaginal discharge
- urinary incontinence

2. Evaluation of congenital uterine, gonadal, and lower genital tract anomalies

3. Screening for malignancy in high-risk patients

4. Evaluation of infertility

5. Localization of an intrauterine contraceptive device (IUCD)

6. Guidance for interventional or surgical procedures

7. Postoperative evaluation of pelvic structures

8. Follow-up of a previously detected abnormality

9. Evaluation when there is a limited clinical examination of the pelvis

## **EQUIPMENT DETAILS**

The sonographic examination of the female pelvis should be performed on a real-time scanner, using sector, curved linear, and/or endocavitary transducers. The transducer should be adjusted to operate at the highest frequency appropriate for the clinical circumstance, realizing that there is a trade-off between resolution and beam penetration.

## **INFECTION CONTROL**

All transducers should be cleaned after use. Any transducer in contact with mucosa should be covered by a protective sheath prior to use. After the examination, the sheath should be disposed off and the transducer should be cleaned with high-level disinfectant. The method of disinfection is as per the manufacturer's specifications and infectious disease recommendations.

## **APPROACH & TECHNIQUE**

1. Transabdominal approach (TAS)
2. Transvaginal approach (TVS)
3. Transrectal approach
4. Transperineal approach

More than one approach may be needed.

## **TRANSABDOMINAL SONOGRAPHY**

- Transabdominal sonography should ideally be the first ultrasound scan in all patients. It gives a global view and thus provides a complete survey of pelvic anatomy and an orientation of the normal as well as abnormal structures within. It is useful for assessing large masses extending into the abdomen.
- The bladder should be full prior to scanning as it provides an optimal acoustic window and displaces bowel from the field of view. Overdistension of bladder can compromise visualization and a repeat scanning after partial bladder emptying should be done.
- Convex transducers with frequency elements in the range of 2 - 5 MHz should be used for transabdominal sonography. Scanning should be done in both longitudinal and transverse planes. For longitudinal scanning, midline sagittal and parasagittal images should be taken, angled from midline to the periphery of both hemipelvis. Transverse plane images start at midline overlying the bladder and are angled superiorly and inferiorly. Real time evaluation may be done in any plane as required. This technique provides coverage of the entire pelvis.
- If there is limited fluid within the bladder, especially in young children, the transducer can be placed over the lateral aspect of the bladder and directed to the contralateral side for imaging. This helps provide a larger amount of fluid for the US beam to traverse and a better working acoustic window.

- Transabdominal scans provide poor scans in case of obesity and presence of scar tissue. A retroverted uterus cannot be well imaged by TAS.

#### **TRANSVAGINAL SONOGRAPHY**

- Transvaginal sonography gives high resolution images as compared to transabdominal scans and should be performed in all cases of gynaecological abnormality, unless contraindicated i.e. virgo intacta, vaginismus, or mass lesions in the vagina which preclude insertion of the endocavitary transducer. TVS can overcome limitations of TAS.
- A prior TAS facilitates the TVS examination and allows complete examination of large masses which will not be seen in totality by the high frequency TVS probe. TVS may be done as the first and only examination in cases where a targeted exam is required or in follow up studies.
- Presence of a chaperone may be considered as per local policy while performing transvaginal sonography.
- The bladder needs to be emptied before the examination.
- A 5-9 MHz endocavitary transducer is used for transvaginal sonography. The patient is placed in the lithotomy position. The probe is covered with a probe cover/condom sheath with jelly between the two and air bubbles should be avoided. Jelly is also applied to the tip of the probe, which is gently introduced into the vagina by the patient or sonographer under real time monitoring. Longitudinal views (placing the transducer in midline and angling to right and left), and transverse views (angling anterior to posterior) are obtained that allow for high-resolution imaging of the uterus and adnexal regions including both ovaries.
- A gentle pressure applied by the probe or by free hand of examiner can help in assessing the mobility of pelvic structures and localize site specific tenderness.

#### **TRANSRECTAL SONOGRAPHY AND TRANSPERINEAL SONOGRAPHY**

- Transrectal sonography and transperineal sonography can be performed to obtain high resolution US images in patients who are not candidates for introduction of a vaginal transducer and in assessment of a patient with prolapse of a pelvic organ.
- Transperineal imaging is useful to image the lower compartment of the female pelvis and is helpful in evaluating vaginal obstructions, especially in virginal patients.
- Transrectal ultrasound has been used in the diagnosis of transverse vaginal septum, imperforate hymen, hematocolpometra and hematocolpos.

## **DOPPLER**

Doppler helps to pick up blood flow in different tissues and is a useful adjunct to grey scale imaging for ultrasound in gynecology.

### **COLOR AND SPECTRAL DOPPLER ARE USED TO ASSESS:**

- Presence or absence of flow
- Amount of flow
- Direction & location of flow
- Vascular morphology (better seen on 3D colour Doppler)
- Flow impedance & velocities
- Abnormalities in venous or arterial flow signals

### **INDICATIONS**

- To increase accuracy of diagnosis as an adjunct to grey scale imaging
- To differentiate cystic from solid structures
- As an adjunct in differentiating benign from malignant lesions
- To differentiate vessels from non vascular tubular structures
- Color Doppler readily displays iliac vessel flow (often in a plane posterior to the ovaries) and can be used to localize the ovaries

### **TECHNIQUE**

- Colour /power Doppler box should include the area of interest, kept as small as possible, with as much magnification as possible.
- Doppler setting should be optimised to ensure maximal sensitivity for blood flow (for low velocity flow)
  - Low PRF values (between 0.3 to 0.9) should be used with low wall filter setting.
  - Doppler gain should be increased till artefacts appear & then reduced until all colour artefacts disappear.
- The amount of colour within a lesion is reported using the colour score (1 = no colour; 2 = minimal colour; 3 = moderate colour; 4 = abundant colour).

## **ASSESSMENT OF PELVIC STRUCTURES**

The structures that are assessed during pelvic sonography include the uterus, vagina, adnexae including bilateral ovaries and fallopian tubes, cul de sac and urinary bladder.

## UTERUS

Uterus is often the first organ that can be identified on a pelvic scan and acts as a landmark, which can be used as a reference point for other pelvic structures (normal/abnormal).

The following aspects need to be evaluated :

- Uterine size, shape & external contour, orientation
- Myometrium
- Endometrium
- Cervix

**UTERINE SIZE** varies with age and menstrual status of the patient.

- Uterine length is measured in the sagittal view, from fundus to cervix (to external os if it can be identified). It is measured as a straight line from fundus to external os by outer to outer technique.
- Anteroposterior diameter of the uterus is the maximum anteroposterior measurement in the sagittal section of uterus.
- Transverse diameter is the maximum transverse measurement taken in the transverse section of the uterus.
- For uterine corpus volume calculations, the cervical component should be excluded from the uterine length.

**UTERINE SHAPE AND EXTERNAL CONTOUR**

- Normal adult uterus is pear shaped with a corpus to cervix ratio of 2:1 and a smooth, regular outline.
- Can be globular or lobulated when abnormal.

**UTERINE ORIENTATION** in the pelvis may vary with degree of bladder fullness.

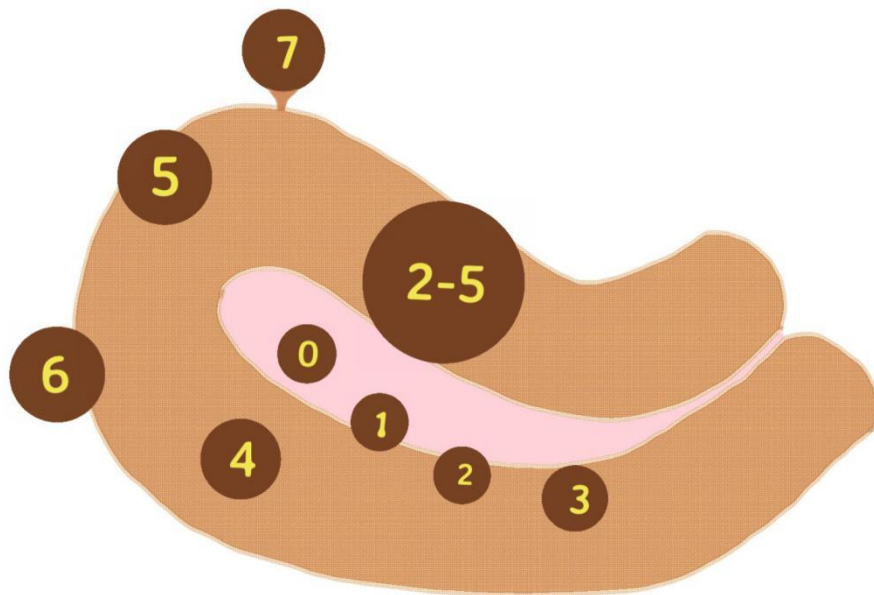
- Anteversion/anteflexion and retroversion/retroflexion should be assessed. Version is the angle between the vagina and the cervix, and flexion is the angle between the cervix and the uterine body. The prefix 'ante' is used to denote forward or anterior (i.e. towards the bladder) and the prefix 'retro' to denote backward or posterior (i.e. away from the bladder).
- Normal anteverted and anteflexed
- Retroflexion often signifies adhesions

**MYOMETRIUM**

- Echogenicity - homogeneous or heterogeneous
- Thickness of anterior and posterior myometrial walls
  - Measured from the external uterine serosa to the endometrial margins. It is done in the sagittal plane where endometrium is thickest, perpendicular to the endometrium.

- Normal - Anterior : posterior wall thickness = 1
- Abnormal - Diffuse or focal, asymmetrical thickening
- Junctional zone - a thin, hypoechoic, subendometrial halo
  - Normal - well defined, regular
  - Abnormal - poorly defined, irregular or interrupted
- Shadowing
  - Internal shadowing from mass /fan shaped /edge shadowing
  - Degree of shadowing-mild /moderate /strong
  - Focal /diffuse
  - Associated with focal mass /altered echotexture of myometrium
- Focal abnormalities in myometrium – solid mass or cyst
  - Number
  - Size - Any mass seen within the myometrium is measured in three orthogonal dimensions (three measurements perpendicular to each other), in two images whose plane is perpendicular to each other.
  - Location - intramural /extramural /projecting beyond external contour/relation with endometrium
  - Echogenicity of solid mass - homogenous/ heterogenous, hypoechoic/ isoechoic/ hyperechoic
  - Cystic content - anechoic/ low level echoes/ ground glass/ mixed echogenicity
  - Margin - well-defined /ill-defined, hypo- or hyperechoic
  - A well defined focal lesion can be reported using FIGO classification
 

0 = pedunculated intracavitary; 1 = submucosal, < 50% intramural;  
 2 = submucosal, ≥ 50% intramural; 3 = 100% intramural, but in contact with the endometrium; 4 = intramural; 5 = subserosal, ≥ 50% intramural;  
 6 = subserosal, < 50% intramural; 7 = subserosal pedunculated;  
 8 = other



- Presence of hyperechogenic islands - site, size, number, shape
- Doppler assessment
  - Myometrial vascularity better seen on Power Doppler as normally low velocity flow
  - Normal: Arcuate vessels seen in outer part of the myometrium parallel to the serosa ; Radial arteries and veins perpendicular to arcuate vessels
  - Uterine vascularity - uniform/ non-uniform
  - Lesion vascularity:
    - Site: peripheral/ central/ both
    - Subjective colour score assigned from 1- 4 ( 1-no colour, 2- mild colour, 3- moderate colour & 4- abundant colour)
    - If uneven vascularity seen, most vascular area should be scored

#### ENDOMETRIUM

- Endometrium is best evaluated in early proliferative phase in women before menopause. Appearance and thickness vary with age and menstrual cycle.
- Endometrial thickness measurement
  - Best measured on TVS, however maybe measured on TAS if TVS not possible. It is maximum measurement in sagittal plane including both endometrial layers (double endometrial thickness).
  - Calipers placed at the level of two opposite endometrial-myometrial interfaces and endometrium measured where it appears thickest

perpendicular to the endometrial midline (exclude fluid or adjacent hypoechoic myometrium).

- If asymmetric thickening of the endometrium is seen, then largest anterior and posterior endometrial thickness should be recorded separately.
- In presence of an intracavitary pathology, the total endometrial thickness including the lesion should be recorded (if an intracavitary myoma is noted and is clearly defined, it should not be included in the measurement).
- Measurement should not be included in report if endometrium is not adequately seen in its entirety or is poorly defined.
- Endometrium in reproductive age-group
  - **Menstrual phase** (Cycle day 1-4):
    - By end of menstruation, endometrium is thin, about 1–4 mm
    - Appears hyperechoic/ heteroechoic and complex.
    - No subendometrial flow is seen at this time.
  - **Proliferative phase or follicular phase** (Cycle day 5-13); ovulatory phase (Cycle day 13-15):
    - Endometrial thickness gradually increases from 5 to 10–12 mm.
    - Seen as 3-layered - an echogenic outer layer, a hypoechoic inner functional layer and an echogenic midline at the interphase of two layers.
    - Minimal intracavitary fluid may be seen in preovulatory phase.
    - Vascularity of endometrium gradually increases to a maximum, just prior to ovulation.
  - **Secretory phase or luteal phase** (Cycle day 16–28):
    - Endometrial thickness decreases minimally at ovulation, but after that increases gradually in thickness from 7-15 mm).
    - Endometrium appears diffusely hyperechoic from periphery towards centre.
    - Vascularity is seen as multiple vessels with origin at endomyometrial junction.
- **Postmenopausal endometrium**
  - Thin, homogeneous and echogenic.
  - Thickness - Less than or equal to 4 mm

- Women on oral contraceptives/ using other hormonal contraceptives : endometrium thin throughout menstrual cycle
- **Abnormal endometrium** – Focal/diffuse
- **Focal abnormality**
  - Mass - Site, size, solid/cystic, echogenicity, endomyometrial junction
  - Endometrial/ projecting from myometrium/ projecting into myometrium
- **Diffuse abnormality**
  - Increased/decreased thickness, regular/ irregular, polypoid
  - Echogenicity – heterogeneous/homogeneous, hypoechoic/ isoechoic/ hyperechoic
  - Associated cysts/fluid
- **Intracavitary fluid**
  - Amount – longest dimension in sagittal plane
  - Anechoic/ground glass/ low level echoes, mixed echoes
  - Presence of bands - synechiae within
- If the patient has an intrauterine contraceptive device (IUCD), its location should be documented.
- Doppler evaluation of the endometrium
  - Identify presence of any dominant vessel (defined as one or more distinct vessels - arterial and/ or venous - crossing endomyometrial junction)
    - Single dominant vessel (feeder vessel or pedicle artery sign) or multiple dominant vessels (focal origin at the endometrial myometrial junction or a 'multifocal origin')
  - Scattered vessels in the endometrium, without origin at endometrial myometrial junction
  - Subjective assessment of amount of vascularity by assigning color score 1-4.

## **CERVIX**

- Transabdominal approach provides a global overview of cervix, but may not allow visualization in all cases. Transvaginal approach, where possible, gives more optimal visualization.
- Size - Length of adult cervix on an average is 3–4 cm and diameter is 2–3 cm. It is about half the size of the uterine body in reproductive age group.

- Echotexture: homogeneous, similar to that of the myometrium.
- Central canal lined by cervical mucosa appears hypoechoic and contains the endocervical glands. This cervical mucus makes it easy to identify the cervix and differentiate it from the uterine body above it
- Assess for mass lesions
  - Solid/cystic
  - Single/multiple
  - Well defined/ill defined
  - Relation with central canal
  - Echotexture
- Doppler characteristics and colour score of mass lesion
  - Little or no color seen in normal cervix
  - Increased vascularity can indicate a mass lesion
  - Presence of an abnormal vessel in cervical canal should raise a high suspicion of a feeder vessel of a polyp at the cervix, which may be originating either from the cervix or the endometrium above

## **VAGINA**

- Best seen on mid-sagittal transabdominal scans
- Collapsed tubular structure with central hyperechoic line due to opposed surfaces of vaginal mucosa
- On TVS, the vaginal walls may be visualized on withdrawal of probe

## **ADNEXA INCLUDING OVARIES AND FALLOPIAN TUBES**

The adnexal region should be assessed for abnormalities, especially masses and dilated tubular structures. If an adnexal abnormality is identified, its relationship with the ovaries and uterus should be assessed. Identification of the ovaries serves as a major point of reference for assessing the presence of adnexal pathology.

## **OVARIES**

**Site:** typically on either side of uterus, medial to external iliac vessels, anterior to internal iliac vessels

### **Size:**

- Measured in 3 dimensions (longitudinal, transverse, and anteroposterior diameters) on views obtained in 2 orthogonal planes. Exclude any cyst >1cm from measurement

- Ovarian volume calculated by formula  $0.523 \times \text{length} \times \text{breadth} \times \text{antero-posterior dimensions}$
- Both ovaries approximately equal in volume

**Mobility:** Pressure applied by TVS probe on ovary causes normal ovary to slide/move away from uterus or lateral wall of pelvis

**Appearance:**

- Ovoid in shape
- Homogeneous echotexture, with anechoic follicles
- Presence of follicles & cysts should be correlated with age and menstrual cycle
- Reproductive ovary:
  - Volume 5-6.5cc (range 4-20cc)
  - Antral follicles seen throughout menstrual cycle (unilocular, anechoic, well defined cysts of 2-9 mm).
  - One or more dominant follicles grow to 20-25mm in first half of cycle, rupture at ovulation
  - Corpus luteum formed after rupture – very variable appearance – typical < 3cm, thick walled cyst, irregular margins, turbid contents, low resistance peripheral flow
- Post-menopausal ovary
  - Volume smaller ( >8cc abnormal)
  - Less echogenic, follicles absent
  - Maybe difficult to locate

**ADNEXAL MASS**

- Assess whether mass is of ovarian or non-ovarian origin
  - Ovarian mass – deforms ovary/ presence of beak or claw sign/ crescent sign; ovarian vessels can be traced to the mass
  - Non ovarian mass – normal ovaries seen separate from mass, move separate from mass on probe pressure;
  - Maybe difficult in large masses

## OVARIAN MASS

- Size of mass in 3 dimensions
- Unilateral or bilateral ovarian involvement, if unilateral, status/ appearance of opposite ovary
- Assess morphological features
- Mass described as unilocular cyst, unilocular solid cyst, multilocular cyst, multilocular solid cyst, multilocular cyst with measurable solid component or at least one papillary structure, solid tumor or not classifiable (due to poor visualisation)
- Cyst
  - Contents: anechoic, low level echogenic, ground glass appearance - homogeneously dispersed echoes, hemorrhagic - internal thread like structures representing fibrin strands, mixed echogenic
  - Internal wall: smooth/ irregular
  - Septum: complete/ incomplete, thickness of widest part of septum measured
  - Solid component: area exhibiting high echogenicity suggesting presence of tissue, presence of vascularity helps confirm tissue, largest solid component recorded with three diameters
  - Solid papillary projections:
    - Any solid projections into cyst cavity from cyst wall with height greater than or equal to 3 mm.
    - 'Smooth' or 'Irregular' (e.g. cauliflower-like), number, vascularity – present/ absent, largest projection measured in two perpendicular planes - base and height.
- Solid lesions
  - External wall – outline : Smooth/ Irregular
  - Acoustic shadow: Loss of acoustic echo behind a sound absorbing structure
- Ascites: Present or absent, largest AP diameter in sagittal plane measured
- Doppler characteristics : examine entire mass for presence of vascularity
  - Central / peripheral
  - Site - Wall, septae, solid areas, papillary projection

- Subjective colour score assigned from 1- 4 ( 1- no colour, 2- mild colour, 3- moderate colour & 4- abundant colour)
- Flow indices : RI, PI, PSV (malignant masses generally show flow with low resistance, i.e. an RI of less than 0.4 and PI of less than 1.0), though not very specific
- Absence of flow increases likelihood of the mass being benign. Colour score of 3–4 increases likelihood for malignancy but may also be seen in benign adnexal masses, infections, corpus luteum and trophoblastic tissue.

### **NON OVARIAN ADNEXAL MASS**

- Should be evaluated and reported in a manner similar to an ovarian mass
- Status/appearance of ovaries should be documented

### **FALLOPIAN TUBES**

- Normal tubes visualized only in presence of surrounding free fluid
- Dilated, fluid filled tubes can be visualized
- Patency of tubes can be confirmed by SHSG (discussed later)

### **CUL DE SAC**

- Assess for presence of free fluid, loculated fluid, or any mass.
- In case a mass is detected its size, position, shape, sonographic characteristics, and relationship with ovaries and uterus should be assessed.
- Rectosigmoid colon wall can be imaged from posterior vaginal fornix and should be assessed for thickness, regularity and nodules.
- Special focus to posterior cul-de-sac is essential in women with pelvic pain, fixed retroflexion of the uterus, or sonographic evidence of posterior adenomyosis and in those with known or clinically suspected endometriosis.
- Absence of normal uterine sliding sign during dynamic imaging indicates presence of adhesions in the cul-de-sac.

### **URINARY BLADDER**

- Urinary bladder should also be examined during pelvic ultrasound
- Walls should be smooth and normal in thickness
- Lumen should be echofree
- Any abnormality detected should be recorded and reported

## **SPECIAL SONOGRAPHIC TECHNIQUES**

### **3-DIMENSIONAL USG:**

Three-dimensional information of entire volume of region of interest can be obtained for analysis. Both gray scale and Doppler images can be processed to create surface and volumetric images. Visualization of the coronal plane in gynaecological imaging is the greatest advantage of 3D imaging.

#### ***Indications***

- Uterus
  - To define uterine shape and assess congenital anomalies of uterus
  - To assess the relationship of a uterine mass with the endometrial cavity
  - To assess thickened and/or heterogeneous endometrium
  - Endomyometrial junction
  - Thickness of junctional zone
  - Accurate location and orientation of an IUCD
- Accurate volume measurement – uterine endometrium, ovarian cysts and follicles
- Integrity of the pelvic floor
- 3D vascular morphology of adnexal masses helps to characterize the masses

#### **TECHNIQUE**

- Data acquisition
  - 2D image of the region of interest (ROI) should be well visualized.
  - Best 2D plane for volume acquisition depends on structure being evaluated, for instance, in cases of uterine anomalies, most commonly used plane - mid sagittal plane of the uterus used
  - Completely include ROI within 3D box
  - Acquire volume sweep as to include entire volume of ROI in 3D sweep
- 3D Visualization: After volume has been acquired, it can be displayed and studied in various ways e.g. multiplanar display, surface rendered image, tomographic display, glass body display, inversion mode and volume analysis.

- Volume/image processing: These are different tools, that can be used to enhance the displayed image e.g. electronic scalpel, contrast and brightness control, colour selection and edit light.
- Storage: Acquired volumes can be stored and assessed later.

### **SONOHYSTEROGRAPHY OR SONOHYSTEROSALPINGOGRAPHY (SHG or SHSG):**

Evaluation of endometrial cavity and/ or fallopian tubes using transcervical injection of sterile fluid.

#### **INDICATIONS**

1. To assess uterine cavity, especially with regard to uterine myomas, polyps, and synechiae
2. To assess grade and resectability of submucous fibroids
3. Tubal patency in cases of infertility

#### **CONTRAINDICATIONS**

1. Pregnancy
2. Pelvic infection or unexplained pelvic tenderness, which could be due to pelvic inflammatory disease.
3. Active vaginal bleeding is not a contraindication to the procedure but can make the interpretation more challenging.

#### **TECHNIQUE**

- Should be performed in the early follicular phase, as close to the end of menstrual period (Day 6 - 10).
- Prophylactic antibiotic may be administered. Pain can be minimized by administering NSAID half an hour to one hour prior to the procedure.
- TVS prior to sonohysterography is useful for measurement of endometrium, evaluation of the uterus, ovaries and pelvic free fluid. It is also useful to exclude pelvic organ tenderness.
- Patient in lithotomy position, clean with Betadine, use speculum to visualize cervix and hold anterior lip of cervix with a vulsellum.
- A size 6-8F catheter (sonohysterography catheter), flushed with saline (to ensure there are no air bubbles), inserted into cervical canal. Catheter balloon inflated (using 1-2 ml of saline). Remove speculum and vulsellum. (infant feeding tube maybe used, which is stiffer and easier to insert, however, instilled saline may drain out quickly, resulting in suboptimal distension of the endometrial cavity)

- Transvaginal probe inserted alongside catheter. Saline (preferably warm) instilled with help of a syringe into endometrial cavity. 10 ml instilled initially, further instillation may be done (up to 40 ml). If balloon of catheter is obscuring visualization, may be deflated.
  - Agitated saline can be used for sonosalpingogram (makes saline hyperechoic and this helps better outlining of tubal lumen)
  - Ultrasound contrast media can also be used (hystero-contrast sonosalpingography - HyCoSy)

## **IMAGING**

- A complete survey of the uterine cavity should be performed after distending it with fluid and representative images obtained to document normal and abnormal findings.
- Evaluation of fallopian tube patency can be assessed by
  - Documenting increase in the amount of free pelvic fluid at the end of the procedure indicates that at least one tube is patent.
  - Tracking flow of saline, contrast through tube and around ovary
- Color Doppler evaluation can be added if the vascularity of an intrauterine abnormality is to be assessed, and for tracking flow through fallopian tubes, spill around ovary and in POD
- Instruct the patient to contact her physician if she develops fever, persistent pain, or unusual bleeding following the procedure. Leaking of fluid, that may be blood-tinged or similar in color as the cleaning solution, may be expected after the procedure.

## **GEL SONOVAGINOGRAPHY:**

- Gel sonovaginography (GSV) is a transvaginal scan technique which provides a stand-off between the transducer and structures which are in close proximity to the probe surface on a regular TVS.
- It is useful in assessing a variety of known or suspected local pathologies of the cervix and vagina such as presence of vaginal septum, cervical polyps, cervical and vagina cancers and involvement of cervix and vagina by deep infiltrating endometriosis.
- After introducing ultrasound gel into the vagina with a syringe, a transvaginal scan is performed and the cervix and vagina can be assessed. This technique should not be performed in pregnancy or if active bleeding is present.

## **ELASTOGRAPHY:**

Elastography is a noninvasive technique that estimates the stiffness of body tissues. It can be used to assess tumors in various organs. Most studies using elastography in gynecology are related to the field of oncology and almost all have used static sonoelastography.

- Cervical elastography allows for differentiation of carcinoma from normal findings, can help in quantifying the region of infiltration.
- Differentiate between endometrial hyperplasia and endometrial carcinoma.
- Differentiate between benign and malignant uterine masses.
- To provide detailed mapping and characterization of uterine fibroids.
- Differentiate between adenomyosis and fibroids.
- Discrimination of low and high grade serous ovarian carcinomas, high grade lesions tend to be less stiff than low grade lesions due to evolving necrosis. Low grade lesions develop relatively slowly, so that their solid areas are stiffer and less elastic.

## **TECHNIQUE**

Elastography can be performed using the transvaginal probe (which provides best resolution) on a machine with elastography software. Elastography colour maps can be superimposed over the B-mode image. Elastography image considered as a relative impression of the stiffness of the tissue in comparison with adjacent tissue that is exposed to the same amount of pressure.

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## **SECTION 3: COMPUTED TOMOGRAPHY**

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### **INTRODUCTION**

During the last two decades, single-slice helical CT has been steadily replaced by multi-detector row CT (MDCT) giving rise to a new era of fast, high-resolution and near-isotropic acquisitions with considerable improvement in volume coverage, thereby enabling formation of high-quality multi-planar reconstructions (MPR) and volume rendered images.

The high speed of current CT scanners allows a complete thoracic, abdominal, and pelvic examination in only one breath-hold, which is of significant importance because a CT pelvic acquisition is rarely performed alone. With the faster scanning, motion artifacts are reduced and various phases of enhancement can be precisely obtained after administration of intravenous contrast.

### **INDICATIONS [1-13]:**

- Defining the origin of a large abdominopelvic mass.
- For detection, characterization and initial staging of carcinoma ovary.
- Evaluation of peritoneal carcinomatosis.
- Assessment of local tumor extension, lymph node, and distant metastases of advanced endometrial carcinoma.
- Assessment of local tumor extension, lymph node and distant metastases of invasive carcinoma cervix
- Detection of residual disease and assessment for recurrence of tumors following surgical resection
- Treatment planning for radiation and chemotherapy for advanced or unresectable gynecological malignancies and evaluation of tumor response to treatment.
- Assessment of abnormalities of pelvic vascular structures
- Guidance for interventional or therapeutic procedures, such as biopsy from a mass, abscess drainage.
- Detection of complications following pelvic surgery and radiotherapy, eg, abscess, hematoma, radiation change, and fistula/sinus tract formation

- Localization and evaluation of acute pelvic pain in the emergency setting when Ultrasound findings are inconclusive.
- Evaluation of patients with postpartum complications, or complications related to pelvic inflammatory disease.

### **CONTRAINDICATIONS [2& 14]:**

There are no absolute contraindications to abdominal-pelvic CT examinations. However, the relative risks and benefits of the CT examination should be taken into consideration before performing the procedure. Appropriate precautions should be taken to minimize patient risks associated with radiation exposure and administration of iodinated contrast.

Relative contraindications include pregnant or potentially pregnant patient, history of previous moderate or severe acute contrast reaction, asthma, and severe allergy (requiring medical treatment), an alternative imaging modality should be considered in such cases.

### **EQUIPMENT DETAILS [2]**

- A) To obtain clinically acceptable CT scans, a scanner should meet or exceed the following specifications:
1. Helical acquisition with a pitch between 0.8 and 2
  2. Scan rotation time:  $\leq 1$  sec
  3. Minimum slice thickness:  $\leq 2$  mm
  4. Limiting spatial resolution:  $\geq 8$  lp/cm for  $\geq 32$ -cm display field of view (DFOV) and  $\geq 10$  lp/cm for  $< 24$  cm DFOV
- B) A soft-copy workstation (PACS station) should be available to the radiologist for review and reporting.
- C) Appropriate medications and emergency equipment must be available to treat adverse reactions associated with contrast administration.

### **CT TECHNIQUE [2& 14-16]**

### **PATIENT PREPARATION**

- The written or electronic request for the CT should be generated by the concerned clinician.

- The requisition must include 1) patient's signs and symptoms, 2) relevant clinical history and 3) Additional information regarding provisional diagnosis or the specific reason for the examination.
- Pre-procedural inquiry should be made about the patient's medical history, routine medications, and any potential contraindications to contrast media administration, (such as history of previous moderate or severe acute contrast reaction).
- Although not a formal contraindication to CT, any possibility of pregnancy should be excluded prior to the CT examination of any reproductive age female patient.
- The patient is explained about the procedure and Consent is obtained.
- Volume expansion: Oral hydration should be advised in outpatients. Isotonic intravenous fluids, such as ringer lactate or 0.9% normal saline are preferred for hydration in Inpatients.
- The patient is generally advised to fast for at least 4 hours and empty the bladder around one hour before the examination, so that patient has moderately full bladder at the time of scan.
- Oral administration of 1 to 1.5 liters of a neutral or positive enteric agent (depending upon the indication) over a period of 1 hour before the examination.
- Rectal contrast may be given in selected cases. For e.g.- to differentiate an adnexal process from primary pathology of the rectosigmoid region, to rule out an invasion of rectosigmoid by adnexal malignancy and in evaluation of fistula.
- The scanning is performed on a Multi-slice Helical CT scanner.
- While scanning, the patient is placed in the center of the CT gantry in supine position with arms raised above their heads.

#### **SCAN PARAMETERS (BASIC PROTOCOL):[14,17-18]**

- The volumetric acquisition is standard with modern scanners
- Coverage: From the 1cm superior to diaphragm till lesser trochanter (owing to the fact that an ideal routine gynecological/pelvic CT scan also includes the abdomen).

- Scan field of view and scan phases should be optimized for each patient. When indicated other phases (NCCT, Arterial, and delayed) should also be included.
- Scans are generally acquired during suspended respiration but for certain indications (such as radiation therapy planning) scans are acquired during free breathing.
- Contrast non-ionic – 100-150ml; injection rate of 2-3 ml/second (preferably using a power injector) followed by saline chase.
- Scan phase- for routine indications, a single-phase scan (at 55-80 seconds delay) is adequate.
- Scan direction- Cranial to caudal
- KV/MAs/Rotation Time-120KV/200-300MAs/0.3 -0.5sec (Depends on the scanner)
- Dfov- 32 to 40 cm (depend on the scanner)
- Slice thickness- 5mm, 3mm & 0.75mm
- Reconstruction interval- 5mm, 3mm or 0.5mm
- Pitch 0.7 to 1.37– a balance between good image and reduction of radiation (based on the built of the patient and on the scanner).
- Thin reconstructions up to 1mm to 2.5 mm; bone and soft tissue window as appropriate
- Multiplanar reconstructions (coronal/sagittal/oblique) are done with 3mm or 5mm slice thickness and interval of 3mm/ 5mm.
- Reporting should preferably be done using a workstation or PACS.

#### **TECHNICAL VARIATIONS TO THE BASIC PROTOCOL [7,9,11,14]**

- While evaluating for carcinoma cervix or carcinoma endometrium- Scanning should be performed from caudal to cranial to image the uterus and cervix during the phase of maximal vascular enhancement
- In cases of advanced malignancy-- the Arterial phase (bolus tracking method or fix scan delay of 25-35sec) should be added with coverage limited to the region of liver (to look for metastatic liver lesions). CT chest should also be included to detect lung metastases, pleural deposits, mediastinal and hilar lymphadenopathy.
- A non-contrast scan of the pelvis (from iliac crest till pubic symphysis) done prior to routine, is helpful in diagnosis pelvic hematoma, to rule out alternate

diagnosis of pelvic pain (for eg urolithiasis) and in detecting calcification in a lesion or mass.

- In cases of suspected vascular abnormality- Arterial phase scanning of the pelvis should be included (details described in CT angiography section).
- Delayed phase scanning (3–5 min delay) is recommended whenever pelvic vein thrombosis is suspected.
- Delayed phase scanning (5–10 min delay) in cases where the bladder and ureteral opacification is needed. The use of split bolus technique obviates the need for separate delayed phase scanning.

## **SPECIAL CT PROTOCOLS**

### **A) CT ANGIOGRAM: [17-22]**

#### **Clinical Indication:**

- Localization and characterization of vascular malformations, treatment planning and assessment of treatment response
- To perform pre-embolization uterine artery mapping in cases of postpartum hemorrhage and uterine fibroids.
- To establish the vascular anatomy of tumours for the prognostication and before planning the endovascular or surgical treatment.
- For assessment of treatment response after endovascular or surgical treatment.

#### **Coverage:**

From the iliac crest till the inferior pubic ramus (may be increased according to the size and extent of pathology).

#### **CT protocol & acquisition parameters**

- First, an unenhanced scan is obtained from the iliac crest to the inferior pubic ramus with a section thickness of 5 mm. It helps to detect hematoma or calcification and also acts as a mask for bone subtraction
- After this, 150 mL of non-ionic iodinated contrast medium is administered with a pressure injector at a flow rate of 3–4 mL/s, followed by 20ml saline chase and arterial phase scanning is performed.

- Technical parameters for image data acquisition - reconstruction interval of 1–5 mm, a pitch of 0.6–1.25 mm, tube voltage of 120KV and slice thickness of 1.5mm or less.
- The delay time for arterial phase scanning can be determined with a bolus- tracking method with a region of interest placed at the level of the abdominal aorta and image acquisition triggered at an attenuation threshold of 150 HU. Alternatively, a fixed delay of 25-30 sec can be used.
- Portal venous phase scanning is performed at a fixed delay of 70 seconds.
- The scan range for arterial phase CT is taken identical to that for unenhanced CT, while the scan range for portal venous phase CT is from the 1cm above the diaphragm to the inferior pubic ramus, (i.e, entire abdomen and pelvic region).
- A neutral enteric contrast medium is used in cases where oral contrast is required (Amount of oral contrast and method of intake is similar to that of basic CT protocol).
- Images are then reconstructed at 0.5mm slice thickness and 0.25mm interval to form multiple volumes representing all phases of the scan.
- Post-processing is done to construct multiplanar/curved reformations, bone subtraction, volume renderings, and maximum intensity projection images

## **B) CT PERFUSION:[23-25]**

Perfusion imaging evaluates the neovascularity within the lesion allowing morphological as well as functional assessment of tumors and thus aiding to differentiation of benign from malignant lesions.

- It helps in prediction of tumor behavior and assessment of the treatment response.

### **Coverage:**

Determined by the size of the tumor and scanner configuration

## **CT protocol & acquisition parameters**

-Approximately 1.0 to 1.5 L of water or diluted (1.5%- 2 %) iodinated contrast is given orally over a period of 45–60 min, followed by administration of approximately 150-200 mL of the solution per rectally.

-First, an unenhanced CT sections of the pelvis is performed to localize the mass and to define its superior and inferior most extent

-An appropriate tissue area to be included in the contrast enhanced dynamic imaging range is selected. The coverage area is limited along the z axis direction and depends upon the scanner configuration. It increases as the numbers of detector rows used are increased (for e.g 2cm in a 16 slice CT scanner and 4cm in a 64 slice CT scanner).

-Next, a non-ionic iodinated contrast medium is administered intravenously (approximately 50-70 mL at the rate of 4-6 mL/s) and dynamic imaging of the selected region is performed in multiple passes with the following acquisition parameters; rotation time – 1 s; acquisition time – 60 s; scan delay – 5 s; tube voltage – 100-120 kV& automatic tube current modulation.

-The first pass study for the perfusion measurements comprises of cine acquisition of images in initial phase for approximately 40 to 60 seconds. A second phase ranging from 2 to 10 minutes is supplemented after the first pass study and is used for obtaining permeability measurements.

-After the completion of perfusion CT (PCT), a whole abdomen contrast-enhanced CT may be done in the portal venous phase.

-Raw perfusion data is evaluated on a workstation using dedicated perfusion software and different parametric maps are generated for various perfusion parameters.

-Permeability maps are obtained after setting the arterial input in the internal iliac artery. The permeability surface area product (PS); blood volume (BV); blood flow (BF) and time to maximum of the tissue residue function (Tmax) are calculated.

-For each adnexal mass, four ROIs are drawn in four different regions within the solid component of complex adnexal masses and the mean PCT parameters from these four ROIs are computed.

-In the similar manner, the mean PCT parameters are also computed for the contralateral normal ovary, which serves as the control.

### **C) VIRTUAL (CT) HYSTEROSALPINGOGRAPHY: [26-29]**

Clinical indications and contraindications are similar to those for conventional hysterosalpingography.

The examination should be performed on day 7–10 of the menstrual cycle

#### **CT PROTOCOL & PARAMETERS**

-The patient is positioned supine on the CT table in lithotomy position and perineum is cleansed with povidone-iodine solution,

-The vagina is dilated with the help of speculum and the cervix is also cleansed with povidone-iodine solution

-After this, with the speculum in place, a scout view of the pelvis is obtained and localizer is adjusted

-Next, without cervical clamping a specially designed plastic cannula (10-F) is placed in the cervical canal, and 15 mL of diluted contrast material (2.5 mL iodinated contrast diluted with 12.5 mL saline solution) is injected slowly into the cervical canal, preferably using a pressure injector (at the rate of 0.3ml/sec). Fast injection should be avoided as it causes patient discomfort due to rapid expansion of the uterus.

-Scanning is initiated around 35- 45 seconds after the start of contrast injection, with section thickness: 0.9 mm; reconstruction interval: 0.45 mm; 120 kV; scanning time:3–4 seconds and with automatic tube current modulation (range, 120–250 mAs).

-Original CT data is then transferred to a workstation and then post-processing is done using various tools such as:--

- Maximum intensity projection (MIP) image which resembles the conventional HSG,
- Multiplanar reconstructions (MPR) in coronal, sagittal, oblique and curved images for better visualization of the fallopian tube, uterine cavity and cervical canal,
- Virtual endoscopic images to show the lumen of uterus, cervix and fallopian tube
- 3Dvolume rendering images that allow the evaluation of uterine external contour.

#### **D) DUAL ENERGY CT [30-34]**

Dual-energy CT has the potential to characterize different materials based on their elemental composition.

-It can be used to differentiate simple cysts from complex adnexal tumors, owing to the higher sensitivity of DECT for enhancement in septations and solid areas.

-In cases of advanced gynaecological malignancies, DECT can improve the detection of subdiaphragmatic, perihepatic, and perisplenic implants as well as hepatic metastases.

- It also allows better detection of skeletal metastases because of increased image contrast at lower energies and on material density images.

#### **CT protocol and acquisition Parameters:**

- Approximately 900- 1500ml of positive or neutral contrast medium is given orally over a period on one hour followed by 200 ml of rectal contrast instilled when patient is on table.

Technical parameters used for image data acquisition include- Acquisition time of 0.5 s, pitch of 0.9, and a slice thickness of 0.625 mm and tube voltage- typically 80 and 140 kVp (used to acquire images that can be processed to generate additional datasets)

-Iodinated contrast media, 1.2ml/kg (approximately 60ml to 100ml) is injected at a rate of 3-4 mL/s using a power injector followed by saline chase and the imaging is usually performed at a 60-75second delay after the onset of injection of IV contrast medium.

-Dual-energy CT data can be displayed by reconstruction of several image types and Maps. The two most common of which are monochromatic energy images and material decomposition images, such as the iodine minus water image, the water image, and the calcium minus water image.

- Spectral attenuation curves can be plotted by placing multiple ROIs on an image, and assessing the possible chemical composition. ROIs containing different type material composition will have non-parallel curves while the ROIs containing the same material in differing concentrations will have parallel spectral attenuation curves.

### **RADIATION SAFETY IN CT IMAGING: [35-36]**

There is concern about the radiation dose in the pelvic CT as it involves the exposure of gonads and a substantial number of female patients undergoing pelvic CT examination are of childbearing age. *Therefore, all personnel that work with ionizing radiation must be aware with the key principles of occupational and public radiation protection (justification, optimization and application of dose limits) and follow the “As Low As Reasonably Achievable” (ALARA) principle. The radiation exposure should be optimized using dose reduction techniques such as low kVp scanning, tube current modulation, and iterative reconstruction to reduce the radiation dose.*

Other strategies that can be employed to reduce dose are to:

- The patient should be asked for any previous imaging to ensure that the similar exam has not been performed recently at another location (to avoid duplicate exams).
- Before performing CT examination, ensure that no alternative imaging modality like ultrasound or magnetic resonance imaging (MRI) could provide the same information without radiation exposure.
- Where possible, use pre-load specific CT protocols provided on CT scanner to prevent any potential error while entering the scan parameters. Select a specific CT protocol, that provides the optimal quality images to address the clinical question while keeping the radiation dose to minimum.

- The patient should be positioned carefully in the center of CT gantry since asymmetric positioning can result in reduced image quality and increased radiation dose to the patient.
- Multiphase exams should only be performed for specific indications and not to be used routinely.
- The “split bolus” technique can be used to gain different physiologic information (as in multiphase exams) with one radiation exposure. For example, while performing CT scan for an adnexal mass, the use split bolus technique can provide information about the ureters as well as the abdominopelvic pathology in question with only one radiation exposure.
- While advising follow-up imaging, use recommended guidelines and consider using modalities that involves lower or no radiation dose such as ultrasound or MRI.
- Run regular periodic quality improvement (QI) sessions on CT exams to make sure the dose is within prescribed ranges.

## **CONTRAST AGENTS [ 14,16& 37]**

### **ENTERIC CONTRAST MEDIA**

An enteric contrast media is frequently used in abdominopelvic imaging, it may be positive or neutral contrast agent and can be administered orally, rectally, or by nasogastric or other tubes to provide adequate distention and visualization of the gastrointestinal tract. The type of enteric agent used is determined by the clinical indication.

Positive enteric contrast media provide improved delineation of abscesses, fluid collections, suspected leaks, intra-abdominal tumors, tube checks, serosal or mesenteric deposits, however small, calcified deposits may be masked by their use. In such clinical scenario, neutral enteric contrast agents, such as water or a nonabsorbable agent with similar x-ray attenuation as water (eg Mannitol, 0.1% barium, milk) are preferred; but, it may reduce sensitivity for masses or fluid collections.

Among the positive enteric agents, iodinated solutions are preferable over barium suspensions due to its moderate effect on peristalsis and easier distribution along

the digestive tract, while the barium suspensions are more prone to flocculate and may give rise to streak artifacts. Typically, 1000–1500 mL of diluted contrast medium (2% dilution) is ingested in separate doses 45–60 min before the examination. Barium agents, if used for CT, should be less than 3% wt/wt.

Rectal contrast is given when the patient is on the scanning table with the help of a catheter and an enema bag. Approximately 200 mL of contrast is required to opacifies the rectum and the sigmoid colon adequately, whereas to opacify the entire colon 900– 1200 mL of contrast may be required.

### **INTRAVENOUS IODINE-BASED CONTRAST MEDIA**

Intravenous iodine-based contrast media are usually given as a rapid bolus via an IV cannula, by using a pressure injector.

For Patients with history of asthma, allergy (requiring medical treatment) and previous reaction to an iodine-based contrast agent, an alternative imaging modality not requiring the use of an iodine-based contrast media should be considered

For patients with impaired renal function (eGFR less 30 mL/min/1.73 m<sup>2</sup>), an alternative imaging method without iodine-based contrast media should be considered. However, if contrast administration is unavoidable, volume expansion /hydration should be done before and after procedure.

Caution should be observed while using IV iodine-based contrast agents in patients taking metformin, having significant renal impairment as there is risk of lactic acidosis. Patients with an eGFR <30 mL/min/1.73 m<sup>2</sup> should stop metformin 48 h before study and metformin should be restarted 48 h after the examination only if renal function has not deteriorated. However, in patients with eGFR more than 30 mL/ min/1.73 m<sup>2</sup>, there is no need to discontinue metformin

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## SECTION 4: MAGNETIC RESONANCE IMAGING

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### INTRODUCTION

The predominant clinical symptoms are pelvic mass, pain, abnormal uterine bleeding and urinary or fecal incontinence. In most circumstances, the patient has undergone a baseline ultrasound evaluation and MRI female pelvis is indicated with a provisional diagnosis. This includes the evaluation of both benign and malignant etiologies (Table 1). The MRI requisition form should provide adequate information in terms of signs and symptoms; relevant history (with specific note of potential contraindications to MRI/ MR contrast media) and details of previous investigations (radiological and laboratory). In cases of repeat evaluation/ follow-up imaging, it is essential to obtain previous imaging and plan the acquisition in a comparable manner.

**Table 1. Common indications for MRI pelvis**

| Benign entities                                                                                                                                                                                                          | Malignancies                                                                                                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| Characterization of adnexal mass<br>Endometriosis<br>Leiomyoma<br>Congenital anomalies of the female genital tract<br>Pelvic floor imaging<br>Gynecological emergencies<br>Vaginal mass evaluation<br>Fistula evaluation | Cervical cancer<br>Cancers of the uterine corpus<br>Staging and follow-up of ovarian cancer<br>Vulvar cancer |

### EQUIPMENT

- High-field (3T) MRI offers improved signal-to-noise ratio (SNR), spatial resolution, and anatomic detail as well as faster scanning techniques.
- Parallel imaging techniques increase SNR with reasonable specific absorption rates while markedly speeding up acquisition.
- Use of phase-array surface abdominopelvic coil on both 1.5T and 3.0T scanners.
- Endoluminal coils (endovaginal or endorectal) for localization of cervical cancers are available in few institutes, but these do not have a significant benefit versus small FOV sequences and may be avoided.
- Patient position: Supine
- Saturation bands placed anterior and superior.
- Detailed evaluation of patient should be done according to MR (and MR contrast) safety guidelines. All appropriate emergency equipment and medications for adverse reactions should be available in the MRI suite and be appropriately monitored for expiry dates.

## PATIENT PREPARATION

- Fasting for 4 hours, but water intake is encouraged prior to the scan.
- Patient asked to void about 30-45 minutes prior to the examination (to obtain a moderately full bladder during the scan).
- Serum Creatinine to be in check, ideally <1.2 mg/dl, above which, the eGFR is calculated. Contrast enhanced scan can be safely performed for eGFR >30mL/min.
- Avoid vaginal tampons.

### **Optional:**

- Rectal enema (one day prior and morning of the exam).
- Antispasmodic drugs to reduce bowel motion  
(40 mg of butylscopolamine IM/IV before the exam or 0.5-1.0 mg IV/ IM of glucagon after ruling out contraindications like myasthenia gravis, megacolon or glaucoma)
- Vaginal opacification with ultrasound gel (**Technique:** Under all aseptic precautions, about 10cc of lignocaine 2% jelly is instilled into the vagina using a 14F urethral catheter and a 10cc plastic syringe. The proximal end of urethral catheter is cut so that the syringe hub gets well attached into the catheter. The syringe and catheter are flushed with the jelly to exclude air bubbles. This is done cautiously, to avoid bubble artifacts. The catheter tip is also lubricated with jelly, and gently inserted per vaginum, upto a length of 6-8cm; following which the jelly is instilled.)

## GENERAL TECHNIQUE AND SEQUENCES

In the pelvis, T2W FSE sequences are the mainstay of evaluation.

T2 FSE: TR 4000-5000, TE 90-110 ms

T1 FSE: TR 650, TE 10 ms

Sequences are oriented in relation to pelvis or dedicated to uterine/ cervix axis for uterine/ cervical pathology.

Small and Large field of view Sequences:

- For small FOV, 512 × 256 matrix, 24 cm FOV
- For large FOV, 256 × 256 matrix, 32 cm FOV

### **I. T2W FSE Sequence:**

1. Axial pelvis:
  - FOV: True axial of the whole pelvis
  - Slice thickness: 4 mm
  - Interslice gap: 0.4 mm
2. Sagittal pelvis:
  - FOV: Sagittal from one hip to another
  - Slice thickness: 4 mm
  - Interslice gap: 0.4 mm
3. Coronal pelvis:
  - FOV: Coronal, whole pelvis
  - Slice thickness: 4 mm
  - Interslice gap: 0.4 mm
4. Axial of cervix:

- FOV: Small, dedicated to area of interest, perpendicular to endocervical canal longitudinal axis
  - Slice thickness: 4 mm
  - Interslice gap: 0.4 mm
5. Axial of the uterus:
    - FOV: Small, dedicated to area of interest, perpendicular to uterine body longitudinal axis
    - Slice thickness: 4 mm
    - Interslice gap: 0.4 mm
  6. Coronal of the uterus (or Axial of the ovaries):
    - FOV: Small, dedicated to area of interest, parallel to uterine body longitudinal axis
    - Slice thickness: 4 mm
    - Interslice gap: 0.4 mm
  7. Axial of the vagina:
    - FOV: Small, dedicated to area of interest, perpendicular to vaginal canal longitudinal axis, includes the perineum
    - Slice thickness: 4 mm
    - Interslice gap: 0.4 mm
  8. Oblique scan (for endometriosis):
    - FOV: Axial oblique plane perpendicular to uterine cervix, depends on uterine topography
    - Slice thickness: 3 mm
    - Interslice gap: 0.3 mm
  9. Whole abdomen:
    - FOV: Large from renal hilum to pubic symphysis/ from diaphragm to iliac crests
    - Slice thickness: 5-6 mm
    - Interslice gap: 1 mm

## **II. T1 weighted images:**

### **T1W FSE with and without fat saturation**

- Essential to distinguish fat from hemorrhage in lesions with high signal intensity on T1W images
- Plane: Axial
- FOV: Whole pelvis
- Slice thickness: 5 mm
- Interslice gap: 0.5 mm

### **Whole abdomen:**

- FOV: Large from diaphragm to iliac crests
- Slice thickness: 5-6 mm
- Interslice gap: 1 mm

### **III. Contrast administration:**

- Gadolinium contrast medium dose: 0.1mmol/kg body weight, followed by a saline flush of 20 ml.
- Pre and post contrast acquisition is done in axial plane. Dynamic scans are tailored according to the disease entity (mentioned in subsequent sections) (contrast @ 2-3 mL/s). 3D T1W GRE (FS) sequence of the whole pelvis can be obtained post contrast.

### **IV. Diffusion weighted images:**

These are obtained for pelvis and abdomen.

1. Pelvis:
  - b value- 0, 200 and 1000.
  - Plane: Axial
  - FOV: Whole pelvis
  - Slice thickness: 4-5 mm
  - Interslice gap: 0.4-0.5 mm
2. Abdomen:
  - b value- 0, 500 and 1000.
  - Plane: Axial
  - FOV: Large, from diaphragm to iliac crests
  - Slice thickness: 6 mm
  - Interslice gap: 1 mm
3. In cervical/ endometrial malignancies, small FOV DWI (in axial cervix/ axial uterine body plane respectively) can be done.

- V. Susceptibility-weighted imaging:** These are currently being evaluated in endometriosis

## **IMAGING PROTOCOLS:**

The protocols may vary according to the clinical indication. Following is a brief summary of the sequences required to cover the benign and malignant conditions mentioned above.

### **I. BENIGN ENTITIES:**

#### **1. CHARACTERIZATION OF ADNEXAL MASS:**

- USG is the baseline imaging modality and MRI is the investigation of choice in sonographically indeterminate or complex adnexal masses.
- Indications of MRI:
  - In case of indeterminate adnexal lesion on USG
- Sequences:
  - Sagittal T2 FSE pelvis
  - T2 FSE Axial and coronal views of the pelvis (Fat saturated sequence to be included)
  - T1W sequence of pelvis in axial plane before and after fat suppression
  - DWI pelvis
  - Dynamic contrast enhanced MRI: In this DCE acquisition, there should be a minimum time resolution of 15 seconds per acquisition. If fat

saturation is not possible with this temporal resolution, subtracted images can be used to suppress any pre contrast high T1 SI. The acquisition should start prior to contrast injection (at least 30 seconds prior to contrast injection) and should continue for at least 3 minutes.

- This scan should be acquired in a plane that includes both the solid component of the mass and the myometrium. Time intensity curves for the lesion and the myometrium should be generated and analysed.
- Post gadolinium 3D T1 GRE sequence
- Whole abdomen evaluation will depend on clinical symptoms and pelvis findings (T2 and T1WI): For associated hydronephrosis, ascites, lymphadenopathy
- *Key points:*
  - Slice thickness of 3 mm or less for T2WI and contrast enhanced T1WI is recommended as the papillary projections within ovarian neoplasms can be small (<3 mm)
  - If origin of mass is not clear, then T1WI and T2WI in axial plane of the ovary (coronal of the uterus) may be obtained

## 2. ENDOMETRIOSIS:

- USG is the baseline imaging modality for endometriosis with CT having no role in evaluation
- Indications of MRI:
  - In case of indeterminate adnexal lesion on USG
  - Imaging in complex cases/ deep pelvic endometriosis/ for surgical planning
  - Suspicion of malignant transformation
- Sequences:
  - At least two 2D T2W sequences of pelvis in orthogonal planes (axial and sagittal)
  - T1W sequence of pelvis in axial plane before and after fat suppression
  - DWI and dynamic contrast-enhanced sequences: When evaluating indeterminate adnexal mass or suspected malignancy
  - Whole abdomen evaluation will depend on clinical symptoms and pelvis findings (T2 and T1WI)
- Follow-up:
  - Imaging follow-up: not routinely performed
  - Maybe required in case of new symptoms or to assess effectiveness of medical treatment

## 3. LEIOMYOMAS:

- USG is the first line investigation for lesion detection, characterization and localization.
- Indications of MRI:
  - In case of indeterminate adnexal lesion on USG (eg. pedunculated subserosal leiomyoma versus a solid ovarian mass like fibrothecoma)
  - Acute setting: suspected leiomyoma degeneration or torsion.
  - Patients scheduled for uterine sparing surgery or uterine artery embolization (UAE)
  - Suspicion of malignant transformation

- In a study by Vu KN et al (2019), MRI pelvis yielded additional information in patients with leiomyoma having pelvic pain and multiple leiomyomas on USG
- Sequences:
  - At least two 2D T2W sequences of pelvis in orthogonal planes (axial and sagittal)
  - T2 FSE Axial and coronal views of the uterus
  - T1W sequence of pelvis in axial plane before and after fat suppression
  - DWI pelvis
  - Dynamic contrast enhanced MRI (in select cases): One pre-contrast acquisition and five post-contrast injection acquisitions with 20 seconds of delay between them, until 150 seconds in axial plane of uterus (for assessing enhancement characteristics and viability of the lesion).
  - MR angiography: MRA is done prior to UAE. 3D GRE acquired in coronal planes with maximum- intensity-projection (MIP) reconstructions (slab with 60 slices, 2.0 mm slice thickness, 0.4 mm gap, 13-degree flip angle and matrix of 512 x 436)
  - Whole abdomen evaluation will depend on clinical symptoms and pelvis findings (T2 and T1WI): For associated hydronephrosis, ascites, lymphadenopathy
- Follow-up:
  - Imaging follow-up: not routinely performed, if required USG is the investigation of choice.
  - To monitor response to interventional therapy.

#### 4. ENDOMETRIAL PATHOLOGY

- USG is the baseline imaging modality for endometriosis with CT having no role in evaluation
- Indications of MRI:
  - In case of indeterminate adnexal lesion on USG
  - Imaging in complex cases/ deep pelvic endometriosis/ for surgical planning
  - Suspicion of malignant transformation
- Sequences:
  - Sagittal T2 FSE pelvis
  - T2 FSE Axial and coronal views of the uterus
  - T1W sequence of pelvis in axial plane before and after fat suppression
  - DWI pelvis
  - Dynamic contrast enhanced MRI: One pre-contrast acquisition and five post-contrast acquisitions with 20 seconds of delay between them, until 150 seconds in sagittal plane or axial plane of uterus (0, 30, 60, 90, 120 and 150 seconds). A delayed scan at 240 seconds for cervical stromal invasion (in case of endometrial malignancy)
  - Post gadolinium 3D T1 GRE sequence
  - Whole abdomen evaluation will depend on clinical symptoms and pelvis findings (T2 and T1WI): For associated hydronephrosis, ascites, lymphadenopathy

## 5. CONGENITAL ANOMALIES OF FEMALE GENITAL TRACT:

- Female genital tract congenital anomalies (FGTCA) affect the uterus, cervix, ovary, vagina, vulvar introitus and fallopian tubes. They may be associated with malformations of the urinary tract and skeletal system.
- Indications of MRI:
  - Suspected anomaly at USG, HSG
  - Primary amenorrhoea, pelvic pain, dysmenorrhoea, dyspareunia
  - Characterization of the anomaly and assessment of associated complications
  - For surgical planning
- Sequences:
  - Scheduling the exam according to the menstrual cycle is not necessary
  - Vaginal opacification with ultrasound gel is useful (approximately 60 ml)
  - T2 TSE pelvis sagittal plane
  - T2 axial of uterus and coronal of uterus (Dedicated planes along the short and long axis of uterus are mandatory for FGTCA evaluation)
  - T1W sequence of pelvis in axial plane before and after fat suppression
  - T2 HASTE/ SSFSE coronal (large FOV for whole abdomen: kidney, ectopic ovary evaluation)
  - Optional Sequences: T2 axial of cervix, T2 axial of vagina
  - 3D T2 weighted images are an option to replace multiplanar T2WI
  - *Role of contrast agent:* To assess incidentally detected coexisting conditions. Delayed contrast-enhanced imaging in cases of suspected anomalous ureteral insertion

## 6. PELVIC FLOOR IMAGING:

- USG is the baseline imaging modality for endometriosis with CT having no role in evaluation
- Indications of MRI:
  - In case of indeterminate adnexal lesion on USG
  - Imaging in complex cases/ deep pelvic endometriosis/ for surgical planning
  - Suspicion of malignant transformation

## 7. GYNECOLOGICAL EMERGENCIES:

- USG is the baseline imaging modality for acute pelvic pain and CT is preferred when USG is equivocal or if gastrointestinal or urinary pathology is suspected
- MRI is preferred in pregnant patients; and when there are inconclusive sonographic and CT findings
- Sequences:
  - Axial and coronal pelvis T2WI
  - Axial T1WI pelvis with and without fat suppression
  - DWI axial pelvis
  - T2\* gradient echo sequence axial plane is optional (to detect hemorrhage and air bubbles)
  - Pre and post contrast 3D T1 weighted gradient echo sequences in all 3 orthogonal planes, 10 minutes delayed urographic phase (in axial and coronal planes) maybe done if clinically required

## **8. VAGINAL MASS EVALUATION:**

- Primary malignancy (squamous cell carcinoma) is rare, however secondary involvement by neoplasms of adjacent organs or metastases is more common.
- Indications of MRI:
  - For the localization, size and extension of the lesion
  - Cysts, leiomyomas, endometriosis, tumors (angiomyxoma, rhabdomyosarcoma, SCC, melanoma, lymphoma, metastases), foreign body
  - Malignancy: Primary staging and recurrence evaluation
- Sequences:
  - Vaginal opacification with ultrasound gel is useful (approximately 60 ml)
  - At least two 2D T2W sequences of pelvis in orthogonal planes (axial and sagittal) and axial plane of the vagina
  - T1W sequence of pelvis in axial plane before and after fat suppression
  - DWI of pelvis
  - T1W post contrast sequence of the pelvis with fat saturation in axial and sagittal plane

## **9. FISTULA EVALUATION:**

- Vaginal fistulas are seen in the postoperative/ post radiotherapy settings, trauma and inflammatory conditions.
- Rectovaginal and vesicovaginal fistulas are most common fistulas with enterovaginal or colovaginal fistulas being rare.
- Indications of MRI:
  - To delineate extent of the tract and branching anatomy of fistula
- Sequences:
  - Vaginal opacification with ultrasound gel is useful (approximately 60 ml)
  - In case of rectovaginal fistulas: instillation of 100ml ultrasound gel into the rectum
  - At least two 2D T2W sequences of pelvis in orthogonal planes (axial and sagittal) and axial plane of the vagina
  - T2 FS images in axial plane of the vagina and a second plane where the fistula is best seen
  - T1W sequence of pelvis in axial plane
  - T1W post contrast sequence of the pelvis with fat saturation in axial and sagittal plane or a 3D T1FS acquisition with multiplanar reconstruction.

## **II. MALIGNANT ENTITIES:**

### **1. CERVICAL CANCER**

- USG is the baseline imaging modality for abnormal per vaginal bleeding. When carcinoma cervix is suspected, for early disease, the primary imaging modality of choice is an MRI.

- CT is the imaging modality of choice for advanced disease with staging purpose.
- Indications of MRI:
  - Imaging modality of choice for locoregional extent of cervical cancer.
  - It is particularly indicated in two clinical scenarios.
    - i. Early stage cancer for locoregional assessment, which determines the management pathway.
    - ii. Advanced stage where MRI assists in planning radiation therapy.
  - Imaging for assessment of response to radiation therapy
  - Early detection of recurrence in post op and/or post radiation therapy
- Sequences:
  - Per-vaginum sterile jelly must be instilled.
  - At least two 2D small FOV T2W sequences of pelvis in orthogonal planes (axial and sagittal)
  - T1W sequence of pelvis in axial plane before and after fat suppression
  - DWI and dynamic contrast-enhanced sequences: For assessment of differential enhancement in the cervical mass and parametrial infiltration.
  - Whole abdomen evaluation will depend on clinical symptoms and pelvis findings (T2 and T1WI)
- Follow-up:
  - Imaging follow-up: not routinely performed
  - Maybe required in case of new symptoms or to assess effectiveness of medical or radiation treatment

## 2. CARCINOMA OF THE UTERINE CORPUS/ ENDOMETRIAL MALIGNANCIES

- USG is the baseline imaging modality for abnormal per vaginal bleeding, to estimate the endometrial thickness, heterogeneity in its echotexture as well as vascularity. A note of intact junctional zone is also carefully evaluated. When carcinoma of the endometrium is suspected, for early disease, the primary imaging modality of choice is an MRI.
- CT is the imaging modality of choice for advanced disease with staging purpose.
- Indications of MRI:
  - Contrast enhanced evaluation of abnormal endometrial thickness.
  - Evaluating cystic changes of endometrial hyperplasia.
  - Imaging modality of choice for locoregional extent of endometrial cancer.
  - Required for T staging by estimating the depth of myometrial invasion as less than or more than 50%, for prognostication and treatment planning.
  - Imaging for assessment of serosal involvement.
  - Early detection of recurrence by vault imaging in the post op setting.

- Sequences:
  - At least two 2D small FOV T2W sequences of pelvis in oblique orthogonal planes along the axis of uterine body (axial and sagittal)
  - T1W sequence of pelvis in axial plane before and after fat suppression
  - DWI and dynamic contrast-enhanced sequences: For assessment of preservation of endometrial halo and differential enhancement of the endometrial soft tissue versus myometrium. Dynamic scan can be acquired in the orthogonal axial or sagittal plane, depending on the configuration of the endometrial mass.
  - Whole abdomen evaluation will depend on clinical symptoms and pelvis findings (T2 and T1WI)
- Follow-up:
  - Imaging follow-up: not routinely performed
  - Indicated for suspicious recurrence at the vault.

### 3. STAGING AND FOLLOW-UP OF OVARIAN CANCER

- USG is the baseline imaging modality for suspected ovarian pathology. Classically benign cysts and classically complex masses are well evaluated on USG.
- CT is the imaging modality of choice for classically complex adnexal mass for assessment of solid enhancing components and staging purpose.
- Indications of MRI:
  - Indeterminate adnexal masses.
  - Diagnosis of adnexal masses suggesting greater likelihood of benignity, such as endometriosis or fat containing lesions.
  - Dynamic fat saturated subtracted images for characterisation of solid components.
  - MR Adnex score for estimating greater likelihood of malignancy.
  - Imaging for assessment of serosal involvement.
  - MRI abdomen screening for adenopathy.
  - Diffusion for evaluation of surface deposits in the surgical hidden areas such as undersurface of diaphragm, ligamentum teres, porta hepatis and splenic hilum.
- Sequences:
  - At least two 2D small FOV T2W sequences of pelvis in orthogonal anatomical planes along the axis of uterine body (axial and sagittal)
  - T1W sequence of pelvis in axial plane before and after fat suppression
  - DWI for pelvis for assessment of suspicious components in the adnexal mass, serosal deposits and masses along the root of the mesentery.
  - DWI for abdomen for evaluation of omental and surface deposits in the surgical hidden areas such as undersurface of diaphragm, ligamentum teres, porta hepatis and splenic hilum.
  - Dynamic contrast-enhanced sequences: For wash in and wash out characteristics, calculation of MR Adnexal score and subtracted images assisting in detecting true enhancement against the background of hemorrhage.

- Abdomen screening (T2WI, T1WI and post contrast) must be incorporated, unless CT for chest and abdomen is planned for staging purpose.
- **FOLLOW-UP:**
  - Imaging follow-up: not routinely performed
  - Indicated for suspicious questionable recurrence in the pelvis or at the vault.

#### 4. VULVAR CANCER

- Clinical examination is usually of most importance in vulvar cancers with limited role of imaging.
- USG is often the baseline imaging modality for ruling out uterocervical associated pathologies and adenopathy.
- CT is the imaging modality of choice for advanced disease with staging purpose.
- Indications of MRI:
  - Contrast enhanced evaluation of abnormal endometrial thickness.
  - Evaluating cystic changes of endometrial hyperplasia.
  - Imaging modality of choice for locoregional extent of endometrial cancer.
  - Required for T staging by estimating the depth of myometrial invasion as less than or more than 50%, for prognostication and treatment planning.
  - Imaging for assessment of serosal involvement.
  - Early detection of recurrence by vault imaging in the post op setting.
- Sequences:
  - Per-vaginum sterile jelly must be instilled.
  - At least two 2D small FOV T2W sequences of pelvis in oblique orthogonal planes along the axis of uterine body (axial and sagittal) T2wWI with fat suppression is preferred in cases of vulval cancer.
  - T1W sequence of pelvis in axial plane before and after fat suppression
  - DWI: For assessment of cellularity, and assessment of true extent of disease.
  - Dynamic post contrast subtracted images : Depicts smaller lesions that seen on other modalities.
  - Locoregional assessment, to rule out involvement of urethra, bladder, vagina and adjoining organs.
  - Assessment of pelvic adenopathy.
  - Whole abdomen evaluation will depend on clinical symptoms and pelvis findings (T2 and T1WI)
- Follow-up:
  - Imaging follow-up: not routinely performed
  - Indicated for suspicious recurrence.

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