Ultrasonographic Evaluation Of Gynecological Masses And Correlation With Multidetector Computed Tomography

by

DR.Shantla

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Under the guidance of

DR. R. C. PATTANSHETTI M.B.B.S M.D.,

PROFESSOR,

DEPARTMENT OF RADIO-DIAGNOSIS & IMAGING

BLDE (DEEMED TO BE UNIVERSITY)

SHRI B. M. PATILMEDICAL COLLEGE, HOSPITAL & RESEARCH CENTRE

VIJAYAPUR – 586103

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ABSTRACT

BACKGROUND & OBJECTIVES

Gynecological masses are the common complaints in menstrual and postmenopausal women. Most common gynaecological pathologies include fibroid and over past few years ovarian tumors are increasing in incidence. Due to vast & complex differential diagnosis, they pose a challenge to Gynaecologists & Radiologists in their diagnosis.

Ultrasound is used as the initial screening modality, but has its limitations of being observer dependent, limited evaluation in obese. With recent advances in imaging, currently Multi Detector Computed Tomography (MDCT) is being used as imaging modality of choice for evaluation of gynaecological masses.

Contrast enhanced CT helps in improving the diagnostic accuracy for detection and characterization of the gynaecological masses. MDCT with its ability of fast data acquisition, multiplanar evaluation & improved spatial resolution, have increased the accuracy of lesion detection as small as 2 cm. MDCT with contrast study is a noninvasive technique that helps in excellent visualization, better characterization, assessment of lymph nodes, involvement blood vessels/viscera, local or regional invasion and distant metastasis.

This study is undertaken to correlate between USG as screening modality & MDCT as a detailed imaging study in better characterization & diagnosis of gynaecological masses.

AIMS & OBJECTIVES OF THE STUDY:

1. To study the spectrum of diverse nature of gynecological masses.
2. To describe the morphology of a gynecological mass such as size, consistency, structure of origin & position which help in its differential diagnosis.

3. To assess the sensitivity & specificity of color Doppler in differentiating benign & malignant lesions.
4. Assessment of relative sensitivity & specificity of CT in diagnosing a gynecological mass and its advantage over USG.

SOURCE OF DATA:

Data for the study will be collected from the patients with suspected gynecological mass attending/referred to the Radiology department in our college.

PERIOD OF COLLECTION OF DATA:

The study was done on patients, who visited the Department of Radio Diagnosis during the period from NOVEMBER 2017 to JUNE 2019 with prior consent.

RESULT:

In this study series of 50 cases, we got 27 uterine masses, 21 ovarian masses, 01 adnecal & 01 vaginal mass. Majority were benign neoplasms accounting for 28 cases, followed by malignant neoplasms accounting for 13 & non-pleastic masses were 09 cases.

INTERPRETATION:

USG is the 1st & most common imaging modality requested for evaluation & diagnosis of gynaecological masses. MDCT is the next imaging modality used for better characterisation of gynaecological masses & helpful in staging malignant masses.

TABLE OF CONTENTS

	TOPICS	PAGE NO.
1	INTRODUCTION	01
2	AIMS AND OBJECTIVES	03
3	METHODOLOGY	04
4	REVIEW OF LITERATURE	07
5	RESULTS AND ANALYSIS	61
6	IMAGING GALLERY	80
7	DISCUSSION	88
8	SUMMARY	95
9	CONCLUSION	99
10	BIBILOGRAPHY	101
11	ANNEXURES	110
	• PROFORMA	111
12	KEY TO MASTER CHART	115
13	MASTER CHART	116

LIST OF TABLES

Table no.	Title	Page no.
1.	Uterine size according to age	18
2.	Endometrium in pre-menopausal women according to phases of ovulation	18
3.	Uterine pathologies	22
4.	Ovarian pathologies	23
5.	Adnexal pathologies	24
6.	Vaginal pathologies	24
7.	Simple IOTA rules for predicting benign or malignant ovarian masses	56
8.	Age -wise distribution	61
9.	Menstrual status	61
10.	Location of masses	62
11.	Site of origin of masses	63
12.	Nature of masses	63
13.	Nature of uterine masses	64
14.	Spectrum of uterine masses	65
15.	Consistency of ovarian masses	65
16.	Size of ovarian masses	66
17.	Nature of ovarian masses	67
18.	Spectrum of ovarian masses	68
19.	Wall thickness of ovarian masses	69
20.	Septal thickness of ovarian masses	69
21.	Inner wall irregularities	70

22.	Vascularity in ovarian masses	71
23.	Spectral Doppler (RI values) in ovarian masses	72
24.	Spectral Doppler (RI values) in ovarian masses	73
25.	Benign uterine masses on USG	74
26.	Malignant uterine masses on USG	74
27.	Benign uterine masses on CT	75
28.	Malignant uterine masses on CT	75
29.	Benign ovarian masses on USG	76
30.	Malignant ovarian masses on USG	76
31.	Benign ovarian masses on CT	77
32.	Malignant ovarian masses on CT	77
33.	Pelvic masses on USG	78
34.	Pelvic masses on CT	79
35.	Comparison of sensitivity & specificity of USG with other studies	115
36.	Comparison of sensitivity & specificity of CT with other studies	115

LIST OF FIGURES

SL. No.	Title	Page No.
1.	Development of gonads	09
2.	Development of uterus	10
3.	Anatomy of pelvis	13
4.	Anatomy of female reproductive system	14
5.	Blood supply to female reproductive tract	14
6.	Ligamentous supports of uterus	16
7.	TAS sagittal section	19
8.	TAS axial section	19
9.	TVS sagittal section	19
10.	CT axial section	20
11.	CT sagittal section	21
12.	Age -wise distribution	61
13.	Menstrual status	62
14.	Location of masses	62
15.	Site of origin of masses	63
16.	Nature of masses	64
17.	Nature of uterine masses	64
18.	Spectrum of uterine masses	65
19.	Consistency of ovarian masses	66
20.	Size of ovarian masses	66
21.	Nature of ovarian masses	67
22.	Spectrum of ovarian masses	67

23.	Wall thickness of ovarian masses	69
24.	Septal thickness of ovarian masses	70
25.	Inner wall irregularities	71
26.	Vascularity in ovarian masses	72
27.	Spectral Doppler (RI values) in ovarian masses	72
28.	Spectral Doppler (RI values) in ovarian masses	73
29.	Simple cyst on USG	80
30.	Simple cyst on CT	80
31.	Complex cyst on USG	80
32.	Complex cyst on CT	80
33.	Hemorrhagic cyst on USG	81
34.	Hemorrhagic cyst on CT	81
35.	Mature cystic teratoma on USG	81
36.	Mature cystic teratoma on CT	81
37.	Serous cytsadenoma on USG	82
38.	Serous cytsadenoma on CT	82
39.	Mucinous cystadenoma on USG	82
40.	Mucinous cystadenoma on CT	82
41.	Mucinous cystadenocarcinoma on USG	83
42.	Mucinous cystadenocarcinoma on CT	83
43.	Serous cystadenocarcinoma on USG	83
44.	Serous cystadenocarcinoma on CT	83
45.	Solid ovarian neoplasm on USG	84
46.	Solid ovarian neoplasm on CT	84

47.	Uterine fibroid on USG	84
48.	Uterine fibroid on CT	84
49.	Endometrial polyp on USG	85
50.	Endometrial polyp on CT	85
51.	Adnomyosis of uterus on USG	85
52.	Adnomyosis of uterus on CT	85
53.	Endometrial carcinoma on USG	86
54.	Endometrial carcinoma on CT	86
55.	Cervical carcinoma on USG	86
56.	Cervical carcinoma on CT	86
57.	Tubo-ovarian abscess on USG	87
58.	Tubo-ovarian abscess on CT	87
59.	Vaginal carcinoma on USG	87
60.	Vaginal carcinoma on CT	87

INTRODUCTION

Gynecological mass lesions are common among women of menstrual and postmenopausal age group. Approximately 20% of women will develop a gynecological mass at some time in their life [1]. Masses are one of the common presentation of gynecological pathology & can range from benign masses like simple cysts to malignant masses like ovarian/uterine cancer [2]. Fortunately benign lesions are most common than malignant lesions.

Gynecologists face difficulty in treating patients with gynecological mass as the differential diagnosis is often difficult and complex. Also the nature of the gynecological mass needs to be classified as benign or malignant, so that appropriate treatment can be planned.

USG is the first imaging modality to be requested in patients with suspicion of gynecological mass. It is an important adjuvant to clinical examination. The advantages of USG are easy availability, inexpensive, non-ionizing, non-invasive, safety & simplicity of examinations - can be repeated. These advantages make USG the first imaging modality of choice for suspected gynecologic masses [3].

Trans abdominal & transvaginal USG are complementary to each other in the evaluation of gynecological mass [4]. Transvaginal sonography allows better characterization of gynecological masses & better resolution as it lies close to the anatomic structures. However limited field of view is the major disadvantage [5]. Transabdominal ultrasound visualizes the entire pelvis & gives a global view.

However, there are shortcomings to this modality like limited field of view, obscuration of pelvic organs by bowel gas, inherent limitations such as depends on patient size and also depends on the skill and experience of the operator. USG examination may be considered as inconclusive in around 20% of the gynecological masses, in confirming the organ of origin or classification of mass as benign or malignant [6]. Radiologists are often in a dilemma while

evaluating gynecological masses because of wide differential diagnosis.

Although USG is the initial modality used in evaluation of a clinically suspected gynecological mass, other imaging modality such as CT has advantage over USG, as it provides multiplanar imaging, high spatial resolution & large field of view.

CT can provide supplemental diagnostic information in cases of suboptimal / inconclusive USG examination & in whom there is a discrepancy between USG findings & physical examination [7].

CT is the commonly used primary imaging modality for evaluating the extent of gynecological masses and for detecting persistent and recurrent tumors. Advantages of CT include oral and rectal contrast opacification of gastrointestinal tract, intravenous contrast enhancement of blood vessels and viscera, fast data acquisition, multiplanar evaluation and high spatial resolution. CT of abdomen and pelvis can diagnose masses and also detect local or regional invasion.

Hence CT scan is accepted as a better modality to diagnose gynecological masses [8].

AIMS AND OBJECTIVES

1. To study the spectrum of diverse nature of gynecological masses.
2. To describe the morphology of a gynecological mass such as size, consistency, position and structure of origin which help in its differential diagnosis.
3. To assess the sensitivity & specificity of color Doppler in differentiating benign & malignant lesions.
4. Assessment of relative sensitivity & specificity of CT in diagnosing a gynecological mass and its advantage over USG.

METHODOLOGY

This study evaluating the correlation between USG & MDCT was done on 50 cases. This study was conducted during the period from NOVEMBER 2017 to JUNE 2019 in Radiology department of our college.

Source of Data:

Data for the study will be collected from the patients with suspected gynecological mass (who fulfill the inclusion criteria) attending/referred to the Radiology department of our college.

Sample size:

A minimum sample size of N = 49 allows estimating correlation (r) = 0.70 between USG & CT within CI [0.55- 0.85]. [2]

By using the formula

$$\sigma_r = \frac{(1 - r^2)}{\sqrt{N - 1}}$$

$$LO = r - 1.96\sigma_r,$$

$$UP = r + 1.96\sigma_r.$$

Statistical analysis:

- Data will be analyzed using Mean +/- SD
- Number and percentage will be used For categorical data
- Chi square test for association
- Comparison of means using t test
- ANOVA for comparison and diagrammatic presentation.

METHOD OF COLLECTION OF DATA:

Female patients of >18 years are referred to Department of Radiodiagnosis, Shri B.M. Patil Medical College Hospital and Research Center with the clinically suspected / incidentally detected cases of gynaecological masses are selected based on the inclusion and exclusion criteria as study subjects. Total 50 subjects were recruited for the study.

Following are the inclusion criteria:

1. Adult patients (>18 yrs) attending our hospital with clinical suspicion of gynecological mass.

2. Adult patients (>18yrs) who were detected with gynecological mass incidentally on USG.

Following are the exclusion criteria:

1. Pregnant patients with gynecological mass.

2. Clinically or sonologically proved cases of ectopic pregnancy.

CONSENT:

Informed consent was taken from all patients who were selected on the basis of

1. Clinical symptoms suggestive of gynaecological mass

2. Incidentally detected cases of gynaecological masses on USG.

TECHNIQUES OF DATA COLLECTION:

All patients clinically suspected of gynecological mass underwent following tests:

TECHNIQUE FOR USG:

2D Ultrasonography (regularly TAS, in selected cases TVS) with color Doppler –

All patients included in the study will undergo abdomen & pelvis ultrasonography with low frequency (3 to 5 MHz) probe and/or transvaginal sonography with TVS probe (5 to 8 MHz)

The machines used in this study are SIEMENS ACUSON X700 and PHILIPS HD11-XE.

TECHNIQUE FOR MDCT:

TECHNIQUE FOR NECT: NECT will be performed on MDCT scanner.

- The patient will be placed on gantry table in supine position with both arms above the head. All scans will be acquired in a cephalocaudal direction.
- A digitized AP scanogram will be obtained in suspended respiration. Non enhanced sections will be obtained throughout the abdomen.
- The AP scanogram is utilized to determine the superior extent of scan i.e. the dome of diaphragm and the inferior extent i.e. 1/4th of proximal shaft of femur.

TECHNIQUE FOR CECT:

Preparation of patient:

- All patients are ideally required with at least 6 hours of fasting before scan.
- Sr. Creatinine value is obtained for patients undergoing CECT.

Contrast:

- 1 litre of diluted negative oral contrast & 700-800 ml of diluted rectal contrast is given.
- All patients received 100-120 ml of IV non iodine contrast with a monophasic injection technique by means of a power injector.
- The contrast material is administrated at a rate of 4 ml/s through antecubital vein.

Technique:

- Oral & rectal contrasts are administered & continuous 1.5mm thick slices were obtained in axial plane with a scan time of 6 seconds at a 130KV tube voltage and 170 mA.
- Before IV contrast injection the patient is asked to hyperventilate so that blood oxygen level would be high and hence they would be comfortable in holding their breath.
- Contrast scan is obtained in two phases after obtaining unenhanced MDCT followed by arterial phase (AP) and venous phase (VP).

The machine used in the study is SIEMENS SOMATOM SCOPE 32 SLICE CONFIGURATION, G-XL-59289.

REVIEW OF LITERATURE

BRIEF HISTORICAL BACKGROUND

The female reproductive system has its first mention by a Greek Scholar Herophilus who taught and practised medicine in 275 BC, claimed uterus to have two chambers; the right one for male & the left one for female embryos. He told, “Uterus is double in all females just like the two testicles in all males”. He thought ovaries were same as testicles. He viewed fallopian tubes (not yet named) as spermatic cords which grow into urinary bladder as in males. He also observed, the cervix and the changes that occur in it during the labour [9].

Female genital organs were often explained as "lesser" male organs due to differences in size, complexion and orientation. Words such as *testes* applied to both male and female reproductive parts, since it was believed that both produce substance by similar means that contributed to generation [10].

"Uterus is also called as *matrix* as it is mother of all" by John Moir in the year 1620 [10].

Vesalius and his followers gave more specificity to uterus. In 1543, Vesalius displayed the two horns of the uterus - he described them as "two blunt angles, which resemble the immature horns on the foreheads of calves" [11].

In 1559, clitoris was discovered by the anatomist Realdo Colombo [9].

In 17th century, more specific vocabulary for the male and female bodies was formed. Terms such as "ovaries" were coined in the era of increased dissection [11].

In 1672, Dutch anatomist Renier de Graaf wrote in his book *On the Generative Organs of Women*, that he mistakenly identified follicles, for which he is remembered for “Graafian follicle” [9].

EMBRYOLOGY OF FEMALE REPRODUCTIVE SYSTEM[12]

DEVELOPMENT OF OVARIES

Gonads appear as a pair of longitudinal genital ridges which are formed by proliferation of epithelium & condensation of underlying mesenchyma. Germ cells appear in genital ridges by 6th week. Primordial germ cells originate in epiblast & migrate through primitive streak & by the 3rd week reach endodermal cells in yolk sac. During 4th week they migrate along dorsal mesentery of hindgut & arrive at primitive gonads by 5th week. Germ cells invade genital ridges at 6th week. At this time, genital ridge proliferates & epithelial cells penetrate underlying mesenchyme forming irregular cords called as primitive sex cords. At this stage, it is impossible to differentiate between male & female hence called indifferent gonad.

In female embryo with XX chromosome & no Y chromosome, primitive sex cords dissociates into irregular cell clusters which contain group of primitive germ cells. The cells occupying medullary part of ovary later disappear & are replaced by vascular stroma. Surface epithelium of ovary continues to proliferate. At 7th week, it gives rise to 2nd generation of cords called as cortical cords which penetrate underlying mesenchyme but remain close to surface. In 3rd month, these cords split into isolated cell clusters. Cells in these clusters continue to proliferate & begin to surround oogonium with a layer of follicular cells constituting primordial follicle.

DEVELOPMENT OF GENITAL DUCTS (FALLOPIAN TUBES, UTERUS & VAGINA)

Initially, both male & female have two pairs of genital ducts – mesonephric duct (Wolffian duct) & paramesonephric duct (Mullarian duct).

Paramesonephric ducts develop into m ain genital ducts of female. 3 parts can be identified – 1. cranial vertical - portion which opens into abdominal cavity, 2. horizontal part - portion which crosses mesonephric duct, 3. caudal vertical - part which fuses with its

partner from opposite side. 1st two parts develop to form fallopian tubes. The cranial end of paramesonephric duct ends in abdominal cavity as a funnel shaped structure which later forms fimbria of fallopian tube. Caudal fused part forms body & cervix of uterus and vaginal fornices. Surrounding mesenchymeforms myometirum & perimetrium.

After the ducts fuse in midline, a broad transverse pelvic fold is established. This fold extends from pelvic wall forming broad ligament which along with uterus divides pelvic cavity into utero-rectal pouch & uterocervical pouch.

Immediately after solid tip of paramesonephric ducts reach the urogenital sinus, two solid evaginations grow out from pelvic part of sinus. These evaginations also called as sinovaginal bulbs proliferate to form a solid vaginal plate. Proliferation continues at cranial end increasing distance between uterus & urogenital sinus. Vagina is canalized at 5th month. Lumen of vagina remains separated from urogenital sinus by hymen.

Remnants of excretory tubules of mesovarium at cranial & caudal ends are called epoophoron & paroophoron respectively. A small caudal portion of mesonphric dust in the wall of uterine/vagina forms Gartner's duct.

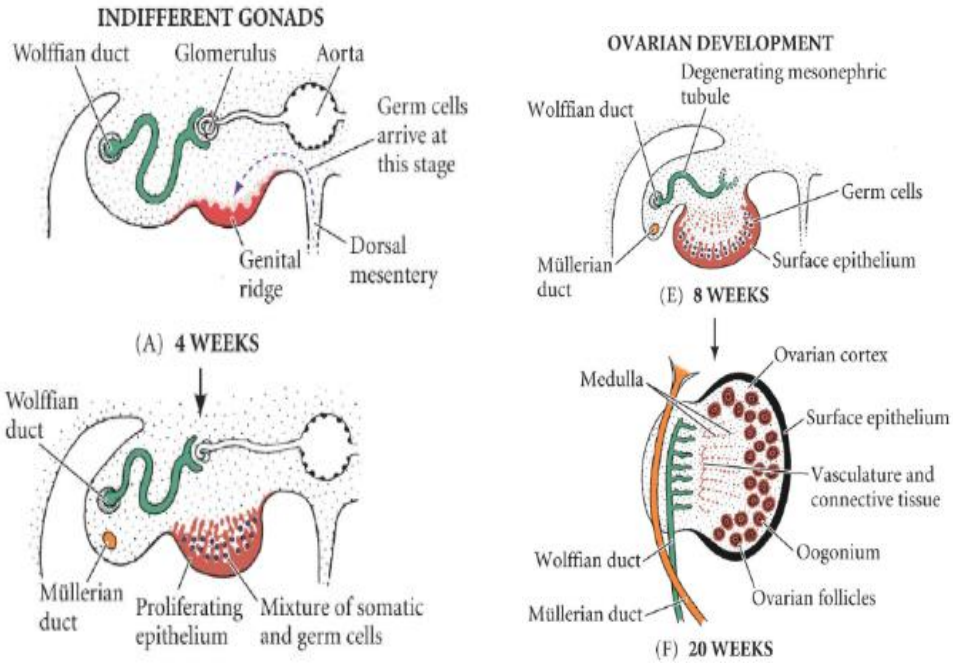


Figure – 01 Development of gonads

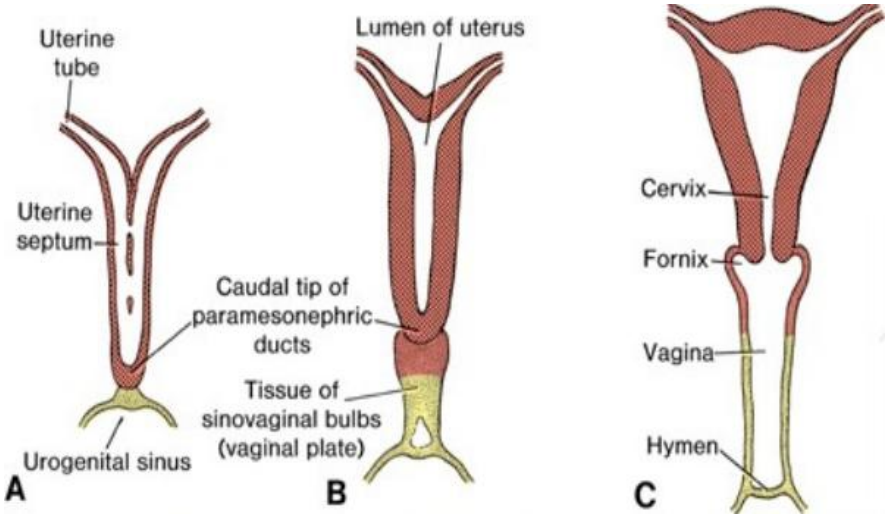


Figure - 02 Development of uterus

ANATOMY OF FEMALE PELVIS[13]

Bony pelvis consists of paired hip bones, sacrum & coccyx. Each hip bone is composed of 3 different bones – ilium, ischium & pubis. These hip bones articulate with each other anteriorly at pubic symphysis pubis & with sacrum posteriorly at sacro-iliac joints.

The cavity of pelvis is limited superiorly by the iliac crest and inferiorly by the urogenital diaphragm. The pelvic cavity is divided into two parts by pelvic brim - false / major pelvis & true /minor pelvis. Pelvic brim also known as pelvic inlet is plane formed by line passing through sacral promontory, ala of sacrum, arcuate lines, pectineal lines & superior margin of pubic symphysis.

Muscles of pelvis are divided into internal muscles (psoas, iliacus, obturators, muscles of pelvic floor/daiphragm) & external muscles (gluteus medius, minimus & maximus)

Female pelvis contains urinary bladder, urethra, reproductive organs, sigmoid colon, rectum & anal canal.

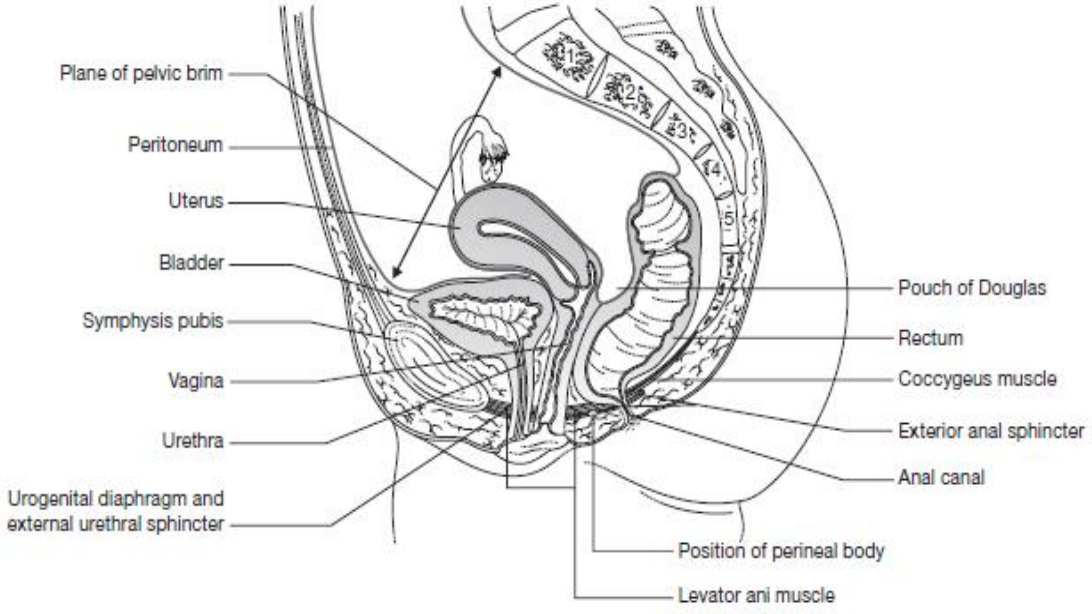


Figure – 03 Anatomy of pelvis

URINARY BLADDER & URETHRA

The urinary bladder is a musculo-membranous sac located on the floor of the pelvic cavity. The superior and lateral surfaces are covered by peritoneum.

The ureters open into the bladder through vesico-ureteric junction at postero-lateral angle.

The trigone is a triangular area located near the apex of the bladder between the two ureteric openings and the urethra.

Female urethra is a tubular structure starting at the neck of the bladder which is around 4 cm long and terminates inferior to clitoris but before the vaginal opening.

SIGMOID COLON

Starts at the terminal part of descending colon & ends at S3 vertebral level to continue as rectum. Sigmoid colon is covered by two layers of peritoneum.

Arterial supply is by inferior mesenteric artery & drains through inferior mesenteric vein. Lymphatic drainage is through para-aortic nodes noted around the inferior mesenteric artery origin.

RECTUM

It is around 12 cm in length, starts at S3 vertebral level & ends in anal canal at the level of tip of coccyx.

Upper 1/3rd is covered by peritoneum on anterior & lateral surfaces. Middle 1/3rd has peritoneum on anterior surface. Lower part of rectum is dilated to form rectal ampulla & does not have perirtoneal covering. It has 4 longitudinal mucosal folds (columns of Morgagni) & 3 lateral folds - left, right & left from top (valves of Houston).

Arterial supply is by superior rectal artery (branch of inferior mesenteric artery), middle rectal artery (branch of internal iliac artery) & inferior rectal artery (branch of internal pudendal artery). Venous drainage is through superior rectal vein (into inferior mesenteric vein), middle rectal vein (into internal iliac vein) & inferior rectal vein (into internal pudendal vein).

Lymphatic drainage is through para-rectal nodes, inferior mesenteric artery group & internal iliac group draining into pre-aortic group.

ANAL CANAL

Narrow muscular canal measures about 2.5 to 4 cm, lies between lower end of rectum & external anal opening. Internal sphincter consists of involuntary muscle (upper 2/3rd) & external sphincter consists of voluntary muscle (lower 2/3rd) with overlapping of sphincters at middle 1/3rd.

The upper 2/3 is lined by mucous membrane & lower 1/3rd is limed by skin, the junction line is called Hilton's white line.

Arterial supply is by superior rectal artery (a branch of inferior mesenteric artery) in upper 2/3rd & inferior rectal artery (branch of internal pudendal artery) in lower 1/3rd. Venous drainage is through respective veins.

Lymphatics from upper part drain into internal iliac nodes & lower part drain into superficial inguinal nodes.

FEMALE REPRODUCTIVE SYSTEM

UTERUS

The uterus is a pear shaped thick-walled muscular organ lying between urinary bladder anteriorly and rectum posteriorly.

In nulliparous woman, measures about 8 x 5 x 4 cm. In a parous woman, dimensions increase by about 1 cm each. In postmenopausal woman size decreases to about *7* x 3 x 2 cm.

The long axis vagina forms an angle to the long axis of uterus known as anteversion. The long axis of cervix forms an angle with long axis of body of uterus known as anteflexion.

It has three parts - fundus, body and cervix. The cavity of the uterus is triangular in coronal section with anterior and posterior walls apposed to each other giving a slit like appearance in sagittal plane. Uterus has 3 layers - inner endometrium, middle muscular layer known as myometrium & outer parametium.

On either side of uterus the peritoneum is seen reflecting to lateral walls of pelvis known as broad ligament, which contains fallopian tubes and ovaries.

Arterial supply is through uterine artery, a branch of the internal iliac, which runs medially in broad ligament to reach the lower part of lateral wall of uterus & then ascends tortuously within the broad ligament to supply the uterus & fallopian tubes and ends by anastomosing with ovarian artery.

Venous drainage is through a venous plexus in the base of the broad ligament into internal iliac vein.

Lymph drainage - fundus of uterus drains along the ovarian vessels into para-aortic nodes; body drains via the nodes in broad ligament into the nodes around the external iliac vessels and via the nodes along round ligament into inguinal nodes; cervix drains into external, internal iliac nodes and presacral nodes.

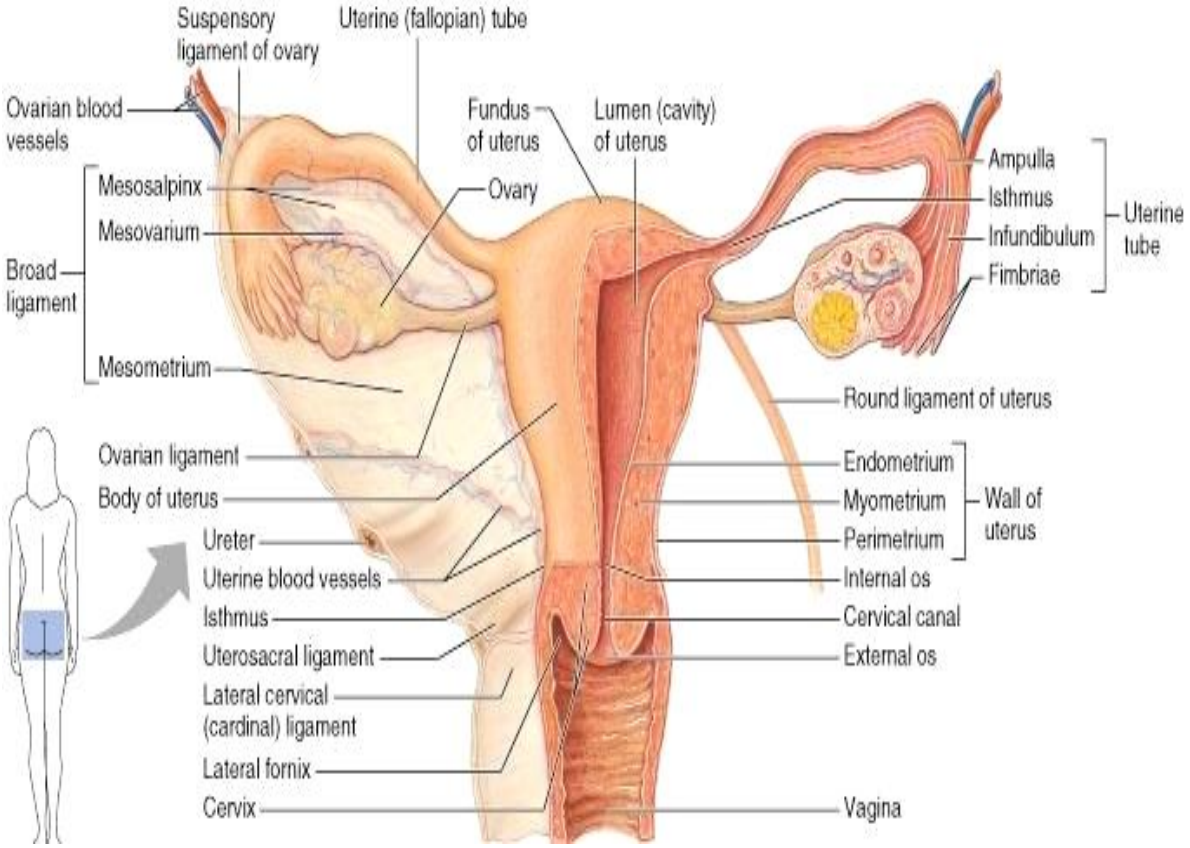


Figure – 04 Anatomy of female reproductive system

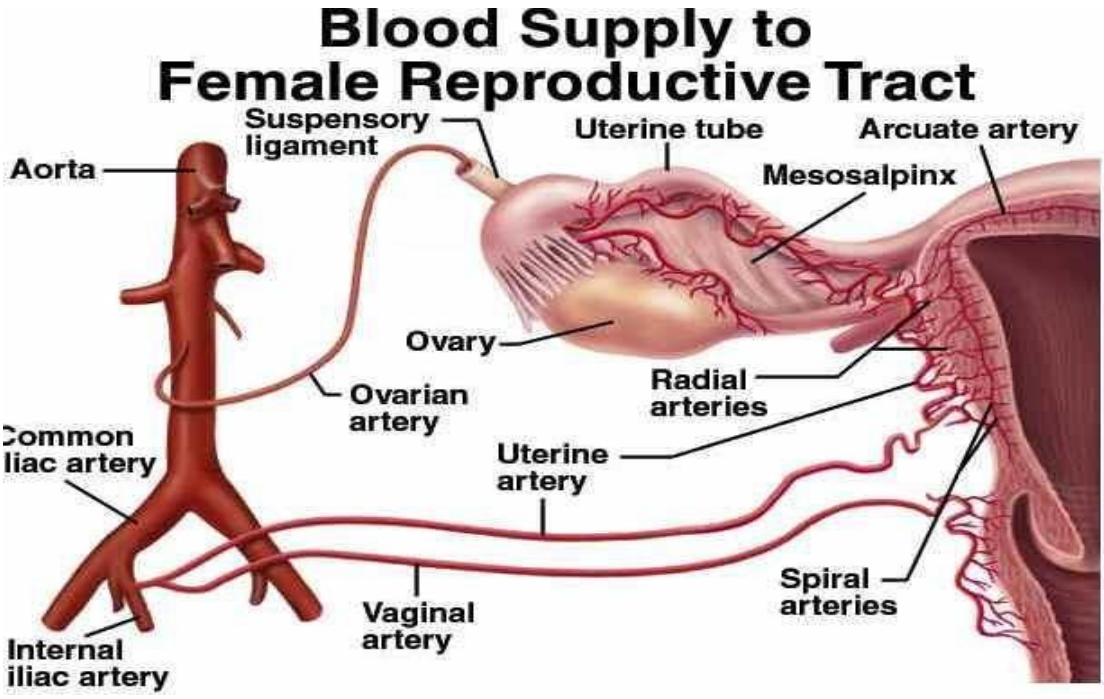


Figure 05 – Blood supply of female reproductive system

Ligamentous supports of the uterus

The parametrial ligaments anchor cervix to the pelvic walls which are condensations of pelvic fascia and comprise of:

• Pubocervical ligament - runs anteriorly from cervix, around the bladder base to the pubic bone;

• Transverse cervical (cardinal) ligaments - run laterally from the cervix & lateral aspect of vaginal fornix to side walls of pelvis;

• Uterosacral ligaments - run postero-superiorly on the upper surface of the levator ani muscle to the midsacrum.

Round ligament is a fibromuscular band which passes from upper lateral part of the uterus through the inguinal canal, ending in the labia majora.

Other uterine supports

In the normal anatomic arrangement, urinary bladder supports the uterus on its upper surface. This anatomic arrangement & transverse cervical ligaments are the main passive supports of uterus. It is also supported by the pelvic floor muscles below, which provide active support by their contraction when intra-abdominal pressure is raised. Of the levator ani muscles, the puborectalis and iliococcygeus form most important uterine supports, as levator ani muscles are in contraction at rest, keeping rectum, vagina and urethra elevated and closed.

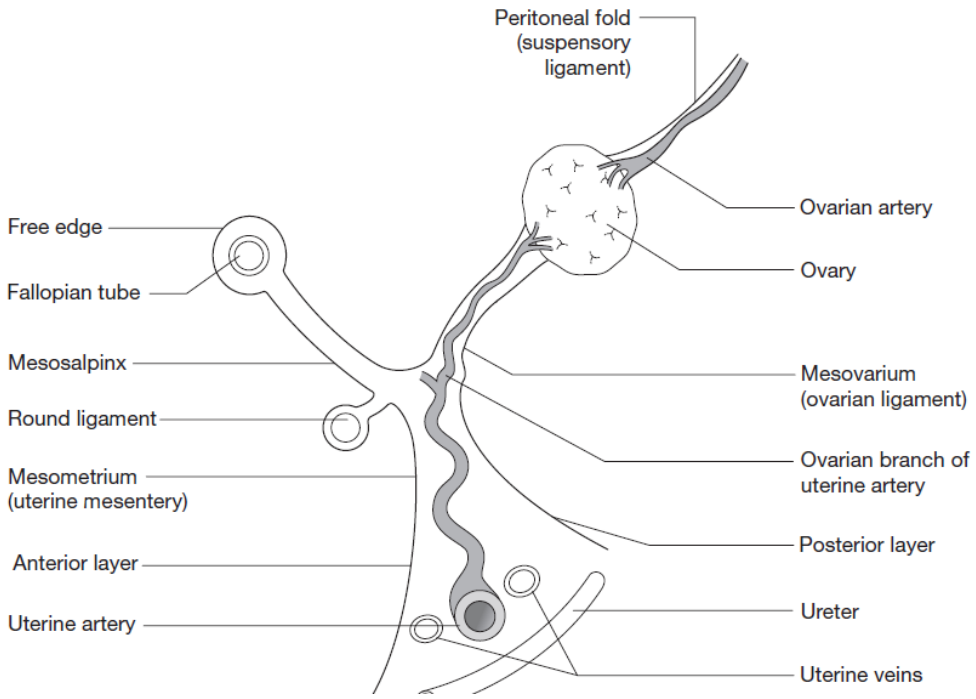


Figure 06 – Ligamentous supports of uterus

THE FALLOPIAN TUBES

They lie in superior free border of broad ligament and open into the uterine cavity at cornua of the uterus.

It is divided into 4 parts: fimbria (ovarian end), infundibulum, ampulla and isthmus (uterine end).

OVARIES

They are paired oval organs oriented vertically on either side of uterus having an upper and a lower pole measuring 3 x 2 x 1 cm.

Arterial supply is via the ovarian artery, which arises directly from the aorta.

Venous drainage is via ovarian vein, right ovarian vein drains directly into inferior vena cava and left ovarian vein drains into left renal vein.

Lymphatic drainage is via nodes along the ovarian vessels into para-aortic nodes.

VAGINA

It is a tubular canal which extends from uterus upto vestibule. The cervix invaginates into upper vagina & divides it into shallow anterior, deeper posterior and lateral fornices.

Behind the upper vagina & infront of the rectum lies a peritoneal lined cavity called pouch of Douglas containing bowel loops.

Arterial supply is through vaginal branches of internal iliac and uterine arteries.

Venous drainage is done by a plexus on its lateral walls into the internal iliac vein.

Lymph drainage - upper $2/3^{rd}$ drains to internal and external iliac nodes, lower third drains to superficial inguinal nodes.

ULTRASOUND

It is the most common imaging method used to visualise female reproductive tract. Transabdominal ultrasound is performed with a moderately full bladder which provides an acoustic window to visualise pelvic organs. Sagittal images are acquired by scanning in the same plane as uterus, parallel to its long axis. Transverse images of uterus are acquired by scanning in a plane right angle to the sagittal plane.

Cervix usually lies in the midline, but uterus can lie obliquely on either side.

Uterine myometrial wall is uniformly hypoechoic.

The endometrium appears as a high echogenic long stripe on sagittal images and a as a central echo on transverse images. A central sharp echo is caused by opposing surfaces of endometrium. Its thickness varies according to the phase of menstrual cycle. It is thicker and more obvious pre-menstrual (secretory) phase & thinner during menstrual phase. Immediately adjacent to central echo lies the functional layer of endometrium which appears relatively hypoechoic during proliferative phase & becomes echogenic during secretory phase, when entire stripe is thicker & homogeneous. A narrow hypoechoic layer of myometrium noted deep to endometrium is known as subendometrial halo. This represents a layer of compact, relatively non-vascular myometrium which is analogous to junctional zone seen on MRI. After menopause, endometrium becomes atrophied & appears as a thin echogenic line measuring not more than 6 mm.

Table 01 – Uterine size according to age[14]

	Length (cm)	Width (cm)	Antero-posterior (cm)
Pre-pubertal	2 - 3.3	1	1
Menarche	6 - 8	3 - 4	2 - 3
Nulliparous	6 - 8.5	3 - 5	2 - 4
Multiparous	8 – 10.5	4 - 6	3 - 5
Post-menopausal	3.5 - 7.5	2 - 4	1.7 - 3.3

Table 02 – Endometrium in pre-menopausal women according to phases of ovulation[15]

	Menstrual phase	Proliferative phase	Pre-ovulatory phase	Secretory phase
Endometrial Thickness (mm)	<4	4 - 8	6 -10	7 - 14
Appearance	Thin, broken echogenic lines	Hypoechoic thickening	Triple layer	Hyperchoic thickening

The normal ovaries are usually visualised lateral or posterolateral to uterus, in a somewhat vertical orientation, with their long axis parallel to internal iliac vessels. When there is tilting of uterus to one side, the ovary on that side is located superior to fundus. However, the ovaries may lie at a higher level in pelvis or may be seen in the pouch of Douglas. In premenopausal women, normal ovary usually contains small anechoic follicles, which help in its identification.

In the later phase of the menstrual cycle a small amount of fluid is commonly seen in pouch of Douglas.

The vagina is seen as a white stripe of increased echogenicity on longitudinal images and as a transverse line on transverse images.

TVS is performed with transducer introduced through the vagina. The basic ultrasound features are same, with a better resolution, however orientation differs as the transducer is inferior to the uterus. There is improved visualization of adnexal area & internal architecture of ovary, uterus & the uterine cavity. The cervix is also better imaged on TVS, its canal & os

can be well demonstrated.

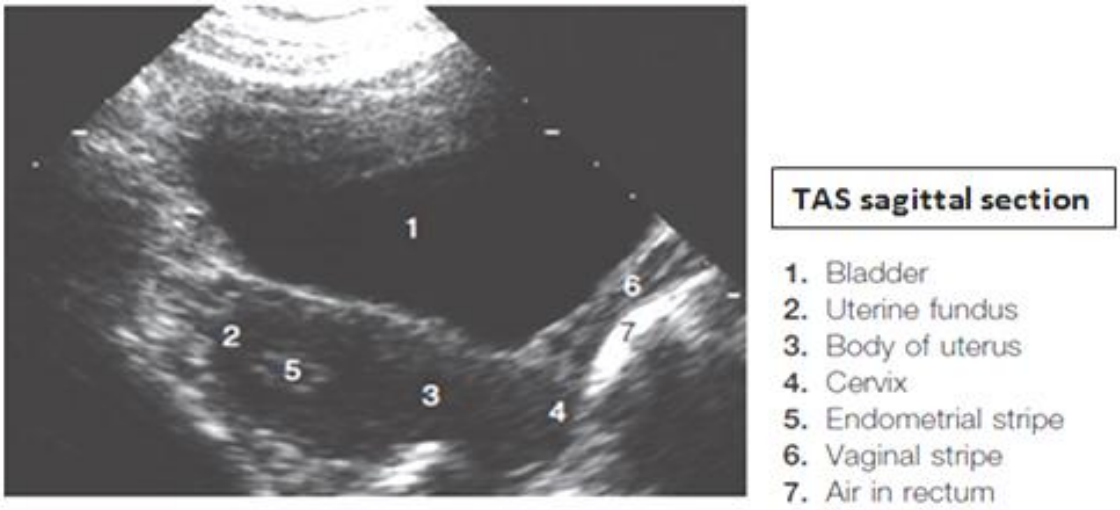


Figure 07 – TAS sagittal section

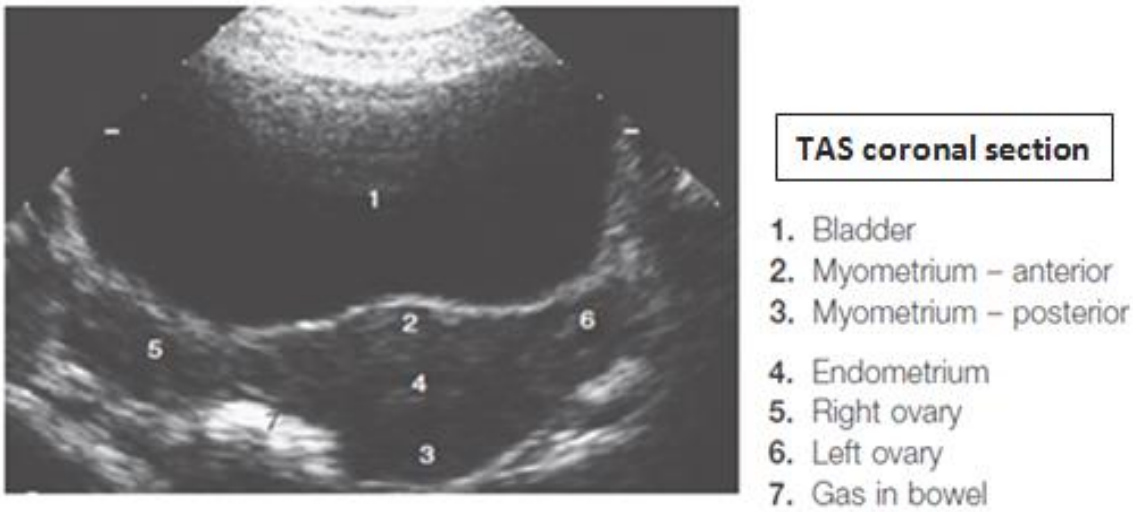


Figure 08 – TAS coronal section

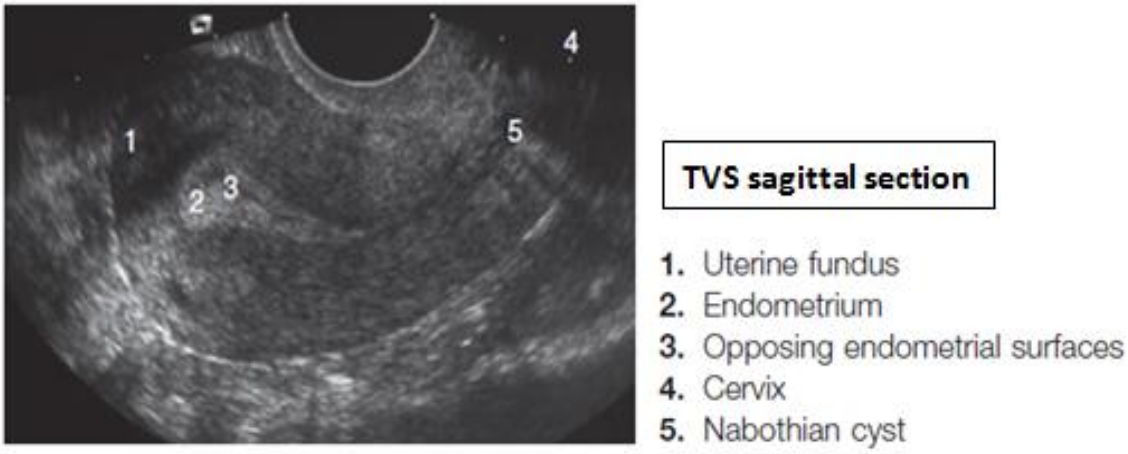


Figure 09 – TVS sagittal section

COMPUTED TOMOGRAPHY

CT has the advantage of cross sectional image acquisition, multiplanar reconstruction and high spatial resolution.

On CT the uterus is seen as a round structure of soft-tissue density lying behind the urinary bladder & infront of rectum. Oral contrast helps to differentiate loops of bowel, which lie on and around it. Intravenous contrast improves contrast between the uterus and surrounding structures. Uterine cavity may contain non-enhancing fluid during the secretory phase of menstrual cycle.

Enhancing vessels may be seen by the side of lower part of uterus.

The broad ligament is visualised only when free fluid is present in pelvis to outline it. The round ligaments are usually seen running anteriorly through the inguinal ring.

The ovaries are usually identified as small round structures of soft tissue density, with small cysts (follicles).

Vagina is identified as rectangular hypodense structure on axial sections & slit like tubular structure on sagittal / coronal sections, containing fluid & few pockets of air.

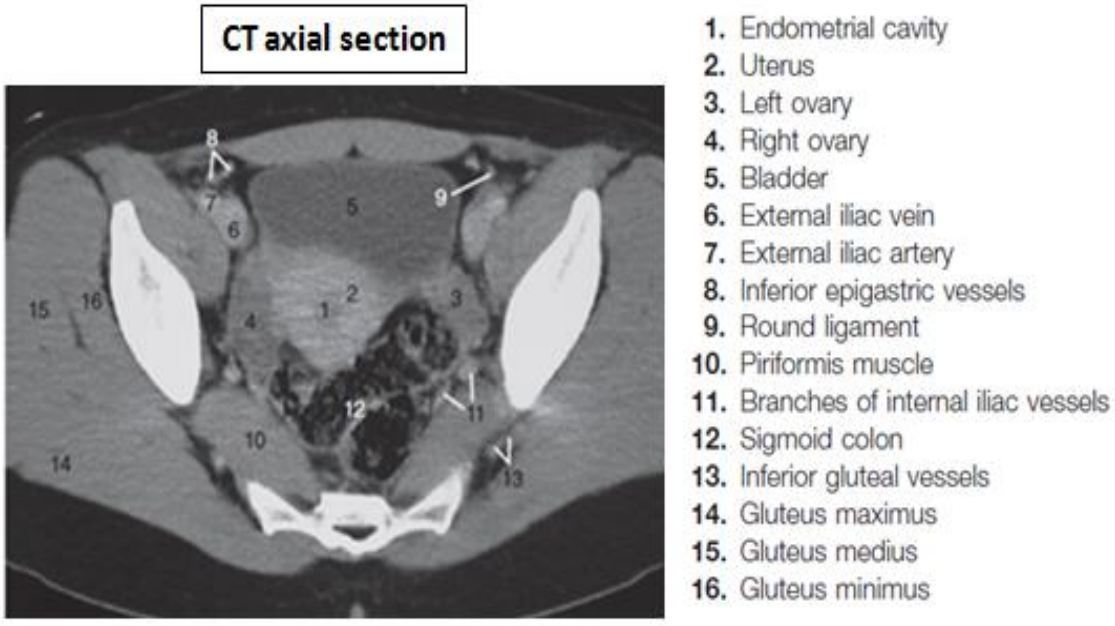


Figure 10 – CT axial section of normal female pelvis

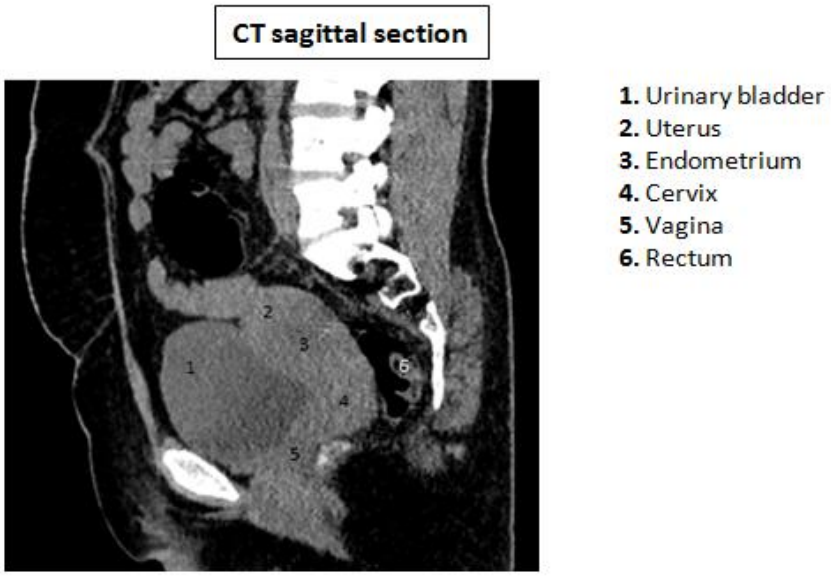


Figure 11 – CT sagittal section of normal female pelvis

SIGNS AND SYMPTOMS OF GYNAECOLOGY MASSES[16]

The common signs and symptoms are:

SYMPTOMS:

- Pain Abdomen
- Mass per abdomen
- Menstrual disturbances - Amenorrhoea/ Menorrhagia / Polymenorrhoea / Dysmenorrhoea
- White discharge
- Bleeding per vagina in post-menopausal women
- Weight loss & Anorexia

SIGNS:

- Mass per abdomen
- Abdominal tenderness
- Ascites
- Bulky uterus
- Mass on per-speculum / per-vaginal examination which bleeds on touch
- Forniceal tenderness on per-vaginal examination

IMAGING MODALITIES:

Following imaging modalities can be used for evaluation of female reproductive system -

- Hysetrosalpingography (HSG)
- Sonohystosalpingography (SHG)
- Ultrasonography (USG)
- Computed tomography (CT)
- Magnetic resonance imaging (MRI)
- Positron emission tomography (PET)

VARIOUS GYNAECOLOGICAL PATHOLOGIES

The gynaecological pathologies are grouped based on the site of origin as uterine, ovarian, adnexal or vaginal which can be further classified into following groups

I. Developmental anomalies
II. Inflammatory conditions
III. Non-neoplastic lesions
IV. Neoplastic lesions

UTERINE PATHOLOGIES –

Table 03 – Uterine pathologies

Developmental anomalies	Inflammatory & non-neoplastic lesions
A. Class I - Hypoplasia or agenesis B. Class II - Unicornuate uterus C. Class III - Uterus didelphys D. Class IV - Bicornuate uterus E. Class V - Septate uterus F. Class VI - Arcuate uterus G. Class VII - DES drug related	A. Endometritis B. Cervicitis C. Genital tuberculosis D. Endometrial hyperplasia E. Endometrial polyp F. Nabothian cysts G. Hydrometra/ Hematometrs H. Arterio-venous malformations

Benign neoplastic lesions	Malignant neoplastic lesions
A. Leiomyoma (Uterine fibroids) B. Lipoleiomyoma (Lipomatous uterine tumors) C. Adenomyosis	A. Endometrial carcinoma B. Cervical carcinoma C. Adenoma malignum

OVARIAN PATHOLOGIES -

Table 04 – Ovarian pathologies

Non-neoplastic	Neoplastic
1. Functional cysts - A. Follicular cyst B. Corpus luteal cyst C. Theca lutein cyst **2. Hemorrhagic cyst** **3. Endometriotic cyst**	**1. Surface epithelial tumor (60-70%) -** A. Ovarian serous tumor B. Ovarian mucinous tumor C. Ovarian endometrioid tumor D. Clear cell ovarian tumor E. Brenner tumor F. Squamous cell carcinoma of ovary G. Ovarian cystadenofibroma H. Ovarian cystadenocarcinofibroma I. Ovarian fibrosarcoma H. Undifferentiated carcinoma of ovary **2. Germ cell ovarian tumor (20 %) -** A. Teratoma of ovary B. Dysgerminoma of ovary C. Yolk sac/endodermal sinus tumor of ovary D. Embryonal carcinoma of ovary E. Choriocarcinoma of ovary F. Malignant mixed germ cell tumor of ovary **3. Sex cord / stromal ovarian tumor (8-10 %) -** A. Fibrothecoma of ovary B. Sclerosing stromal tumor of ovary C. Sertoli-Leydig cell tumor / androblastoma of ovary D. Granulosa cell tumor of the ovary E. Small cell carcinoma of the ovary **4. Mixed -** A. Collision tumors of the ovary B. Carcinosarcoma of ovary **5. Others -** A. Ovarian lymphoma B. Metastases to ovary /Krukenberg tumor

ADNEXAL PATHOLOGIES -

Table 05 – Adnexal pathologies

Inflammatory / infective lesions	**Neoplastic lesions**
A. Hydroslpinx/hematosalpinx/pyosalpinx B. Salpingitis C. Salpingo-ophoritis D. Tubo-ovarian abscess	A. Papillary serous adenocarcinoma (MC) B. Endometrioid carcinoma C. Transitional cell carcinoma

VAGINAL PATHOLOGIES -

Table 06 – Vaginal pathologies

Non-neoplastic lesions	**Neoplastic lesions**
A. Gartner duct cyst B. Bartholin gland cyst C. Bartholin gland abscess D. Epithelial inclusions cysts E. Vaginal adenosis	A. Squamous cell carcinoma B. Adenocarcinoma of vagina C. Clear cell carcinoma D. Primary vaginal melanoma E. Vaginal sacroma

Above tables are showing various gynecological pathologies. Here in this study we will be dealing with common gynecological masses.

UTERINE LESIONS

A) UTERINE FIBROID [17]

Also known as leiomyomas, these are benign neoplasms arising from myometrial smooth muscles. They constitute most common benign tumors of uterus, seen in ~25% of women of reproductive age group.

Fibroids are sensitive to hormones (e.g. stimulated by estrogens), hence they are rare in

prepubertal age, their growth accelerates in pregnancy and they involute after menopause.[125]

Fibroids can have number of locations –

- Intrauterine –
    1. intra-mural - most common type, seen within myometrial musculature
    2. subserosal – 50% of the tumor protruding out of the serosal layer, they can be sessile or pedunculated
    3. submucosal (10 -15 %) – lie in the subendometrial region & have overlying layer of echogenic endometrium
- Extrauterine – broad ligament, cervical
- Diffuse uterine

Subserosal fibroids can be pedunculated mimicking an adnexal mass.

They can undergo various types of degeneration [18] –

- Hyaline degeneration – seen in ~60% cases, is the most common form of degeneration
- Cystic degeneration – seen in ~5% cases
- Myxoid degeneration – it is the uncommon type of degeneration
- Red/carneous degeneration – seen in cases of hemorrhagic infarction, common during pregnancy

USG features –

USG is the 1st modality used to diagnose as well as monitor treatment.

They are usually hypoechoic, few can be isoechoic or hyperechoic. Calcification is commonly seen as echogenic foci with dense posterior shadowing. Cystic areas of necrosis / degeneration may be seen in few cases.

In few cases, Venetian blind artifact (also known as rain shower) may be seen [19].

CT features -

They are usually seen as soft tissue density lesions which usually distort the smooth uterine

contour. Clacification is a common feature. Exhibit variable enhancement patterns on contrast administration.

B) ADENOMYOSIS –

It is a common benign condition of uterus which represents ectopic endometrium within the myometrium. Commonly seen in maltiparous women of reproductive age.

It can be seen in association with co-existant endometriosis in 20 % cases. In around 50% cases, association with fibroid is seen. Other associated conditions are endometrial hyperplasia & endometrial polyps [20].

Radiographic features

Imaging features are variable & in many cases findings very subtle.

Three forms are distinguished based on imaging appearance [21]:

- Diffuse Adenomyosis: it is the most common form, relatively generalized, affecting major portion of uterus (typically posterior wall of uterus), sparing cervical part. Seen as marked enlargement of uterus, however uterine contour is maintained.
- Focal Adenomyosis : in few cases, adenomyosis can be localized forming a mass. In such cases, ‘adenomyoma’ term can be used.
- Cystic adenomyosis / adenomyotic cyst: it is a rare variety. It is believed to be due to repeated focal hemorrhages resulting in cystic areas filled with altered blood products.

USG features -

Pelvic USG is the 1st imaging modality used in diagnosis, USG features are variable.

It is useful to categorize ultrasound findings into three groups that may explain histological findings [19, 22, 23]:

- "adeno": ectopic endometrial glands [24]
    - subendometrial linear echogenic nodules &/or striations extending from endometrium to inner most layer of myometrium
    - hyperechoic islands in myometrium

- irregular endometrial–myometrial junction
- tiny anechoic cysts of 1-5 mm in myometrium & subendometrium (specific sign)

- "myosis": muscular hyperplasia with / without hypertrophy, which appears hypoechoic
  - focal / diffuse myometrial thickening, may be asymmetric, typically seen in fundal region and posterior wall of uterus
  - focal lesions have indistinct borders in comparison to leiomyomas
  - thickening of the transitional zone (≥12 mm) is seen in some cases, visualized as a hypoechoic halo encircling the endometrial layer (less specific)
  - Vascularity on color Doppler is generally increased, reciprocating the lesions distribution. More number of tortuous vessels penetrating myometrium are noted.

A "Venetian blind" / "rain shower" appearance (linear striations/ parallel shadowing) may be seen as a combination of coarsened echotexture of myometrium & acoustic shadowing representing endometrial hyperplastic reaction. This combination of heterogenous subendometrial echogenic linear & nodular striations is similar to USG features of chronic liver parenchymal disease – hence also called as "cirrhosis of the uterus."

CT features -

CT is insensitive for diagnosisng adenomyosis, can only demonstrate uterine enlargement.

Distinguishing adenomyosis from uterine fibroids on CT is difficult, presence of calcifications strongly favors fibroid [25].

C) ENDOMETRIAL POLYP –

They are benign protrusions of endometrial surface. There are two types - sessile or pedunculated.

Its incidence increases with age & are commonly seen in patients taking tamoxifen.

They have a predilection for fundal & cornual regions of uterus. They may be multiple in ~20% cases.

A variant called adenomyomatous polyp is associated with endometriosis.

Radiographic features

USG features -

May be seen as focal mass within the endometrial cavity. At transvaginal USG, they may be seen as non-specific endometrial thickening. A stalk can be seen in pedunculated polyps. Single feeding artery may be seen extending to the polyp on color Doppler. "Visualization of a vascular pedicle is 76% sensitive & 95% specific for endometrial polyps" [26].

Cystic spaces representing dilated glands containing proteinaceous fluid can be seen within polyp which is considered as characteristic feature [27].

It can appear as simple diffuse endometrial thickening without a discrete mass.

3D ultrasound is helpful in delineating the polyp borders.

CT features –

Appearances are similar to those seen on USG & shows homogenous / heterogenous enhancement on contrast administration depending on the type.

D) ENDOMETRIAL CANCER -

It is most common gynaecological malignancy, with peak incidence in 6^{th} decade, however 12% cases are seen in premenopausal age group.

Postmenopausal bleeding is chief complaint present in 90% of patients. Majority are adenocarcinomas.

It is seen commonly associated hereditary non-polyposis colon cancer (HNPCC) with 30-50 times increased risk & precursor lesions such as complex hyperplasia with atypia in around 40% of cases.

It has two subtypes - type I and type II.

Type I endometrial carcinoma - most common type. It is seen in patients with unopposed

hyperestrogenism & endometrial hyperplasia. Commonly seen in females between the age of 55 - 65 years. *PTEN* gene mutation noted in 30-80%. It is well-differentiated with slow progression & good prognosis. Histological type is endometrioid carcinoma .

Increased estrogen exposure is the etiology. Risk factors are:

- estrogen replacement & tamoxifen therapy
- anovulatory cycles & polycystic ovarian syndrome
- obesity, diabetes mellitus
- early menarche and late menopause
- nulliparity
- estrogen secreting ovarian tumors, Ex - granulosa cell cancer

Type II endometrial carcinoma - less common than type I, seen in 20%. It arises in patients with endometrial atrophy, between 65 to 75 yrs. *p53* gene mutations seen in 50%. It is less differentiated form & spreads early through lymphatics or uterine tubes to the peritoneum, hence associated with poor outcome.

Various histological subtypes are seen:

- papillary serous carcinoma: 5-10%
- clear cell carcinoma: 1-5.5%
- adenosquamous carcinoma : ~2%
- adenocarcinoma with squamous differentiation: ~0.5%
- undifferentiated carcinoma of endometrium

Radiographic features -

USG is the initial imaging modality in patients presenting with postmenopausal bleed. TVS is more sensitive than TAS.

USG feature -

Commonly seen as endometrial thickening, however may also appear as polypoidal mass

- In premenopausal patients: normal ET varies at different stages of menstrual

cyclehenc knowledge of patient's menstrual cycle phase is important in diagnosing abnormall thickened endometrium

- In postmenopausal patienst: ET >5 mm is abnormal. ET >8 mm is considered if on hormone replacement therapy (HRT) / tamoxifen [28]

USG findings are non-specific and incraesed ET can also be due to benign conditions like endometrial hyperplasia or polyps.

USG fidnigns suggestive of endometrial carcinoma are [28]:

- irregular and heterogeneous endometrial thickening
- polypoidal mass lesion
- fluid collection in proximal endometrail cavity
- myometrial invasion - is seen as disruption of a subendometrial halo on USG.

CT features -

CT is important in assessing distant metastases.

NECT: difficult to differentiate from normal uterus especially in local disease

CECT: usually shows enhancing diffuse thickening or mass within the endometrial cavity. Less commonly it appears as a hypo-attenuating and hypo-enhancing mass within endometrial cavity [29].

Staging - Most common staging system used is revised FIGO system

"Revised 2009 FIGO staging for carcinoma of the endometrium [30]:

- **stage 0:** carcinoma in situ
- **stage I:** limited to the body of the uterus
    - **stage Ia:** no or ≤ 50% myometrial invasion
    - **stage Ib:** ≥ 50% myometrial invasion
- **stage II:** cervical stromal involvement
- **stage III:** local or regional spread of the tumor
    - **stage IIIa:** invasion of serosa of the uterus and/or adnexa

- **stage IIIb:** vaginal or parametrial invasion
- **stage IIIc:** pelvic or para-aortic lymph node involvement
  - **stage IIIc1:** involvement of pelvic nodes
  - **stage IIIc2:** involvement of para-aortic nodes with or without pelvic nodes

- **stage IV:** involvement of rectum and or bladder mucosa and or distant metastasis
  - **stage IVa:** bladder or rectal mucosal involvement
  - **stage IVb:** distant metastases, malignant ascites, peritoneal involvement"

Around 80% cases present at stage I level of endometrial carcinoma.

E) CARCINOMA OF THE CERVIX is a malignancy arising from cervix. It is 3rd common gynecological malignancy next to endometrial and ovarian malignancies.

Typically presents in young females with mean age of around 45 yrs.

Risk factors

- HPV (human papillomavirus) 16 and 18 infections is indicated for most types except for clear cell & mesonephric types
- multiple sexual partners / a male partner with multiple sexual partners
- young age at 1st intercourse
- multiparity
- immunosuppressed sattus
- oral contraceptives
- nicotine/smoking is indicated for all types except adenocarcinoma variety [31]

Patients usually present with pervaginal bleeding / discharge.

Invasive cervical carcinoma is thought to arise from transformation of pre-existing cervical intraepithelial neoplasm.

Main histological types are: [32]

- squamous cell carcinoma of cervix: accounts for majority of cases i;e 80-90% . It is associated with exposure to HPV

- adenocarcinoma of cervix: rarer form accounting for 5-20% and has several subtypes
    - clear cell carcinoma of cervix
    - endometroid carcinoma of cervix: ~7% of adenocarcinomas
    - mucinous carcinoma of cervix / adenoma malignum: ~3% of adenocarcinomas
    - serous carcinoma of cervix
    - mesonephric carcinoma of cervix: ~3% of adenocarcinomas
- neuroendocrine tumors of cervix
    - small cell carcinoma of cervix: rare subtype (0.5-6%)
- adenosquamous cell carcinoma of cervix: rarest (<0.5%)

Squamous cell carcinoma of cervix is seen arising from squamocolumnar junction while adenocarcinomas arise from endocervix. It is situated on ectocervix in young females this trend regresses into endocervical canal with increased age of female at occurrence. Hence cervical tumors tend to be exophytic in young females and endophytic in females with advancing age.

Radiographic features

Tumors sholud be at least stage Ib or above for detection on CT.

MRI is the imaging modality of choice in diagnosing the primary tumor (especially stage I) and in assessing the local extent. For distant metastatic disease CT or PET are best.

USG features

- hypoechoic or heterogeneous mass at the cervix showing increased vascularity on color Doppler
- USG can also be useful in showing
    - size of the mass (<4 cm / >4 cm)
    - invasion of parametrium
    - invasion of vagina by tumor
    - adjacent organs invasion by tumor

- hydronephrosis which implies stage IIIB.

CT features -

CT is not much useful in the assessing primary tumor, but is useful in assessing the advanced disease like loco-regional invasion, lymph nodal involvement & metastases.

On CT, the primary tumor appears as hypo/iso-attenuating which is hypo/iso-enhancing to normal cervical stroma. [33]

Staging - most commonly adopted staging system is Revised FIGO staging of cervical carcinoma 2018 [34]

"FIGO no longer includes Stage 0 (Tis - carcinoma in situ)

- **stage I:** confined to cervix
  - **stage IA:** invasive carcinoma only diagnosed by microscopy
    - **stage IA1:** stromal invasion <3 mm in depth
    - **stage IA2:** stromal invasion ≥3 mm and <5 mm in depth
  - **stage IB:** invasive carcinoma with measured deepest invasion ≥5 mm (greater than stage IA), lesion limited to the cervix uteri
    - **stage IB1:** invasive carcinoma ≥5 mm depth of stromal invasion and <2 cm in greatest dimension
    - **stage IB2:** invasive carcinoma ≥2 cm and <4 cm in greatest dimension
    - **stage IB3:** invasive carcinoma ≥4 cm in greatest dimension
- **stage II:** spreads beyond the uterus, but has not extended to lower 1/3rd of vagina or to the pelvic wall
  - **stage IIA:** involvement limited to the upper 2/3rd of vagina without parametrial invasion
    - **stage IIA1:** invasive carcinoma <4 cm in greatest dimension
    - **stage IIA2:** invasive carcinoma >4 cm in greatest dimension
  - **stage IIB:** with parametrial involvement but not up to the pelvic wall

- **stage III:** carcinoma involves the lower third of the vagina and/or extends to the pelvic wall and/or causes hydronephrosis or non-functioning kidney and/or involves pelvic and/or paraaortic lymph nodes
    - **stage IIIA:** carcinoma involves the lower third of the vagina, with no extension to the pelvic wall
    - **stage IIIB:** extension to the pelvic wall and/or hydronephrosis or non-functioning kidney (unless known to be due to another cause)
    - **stage IIIC:** involvement of pelvic and/or paraaortic lymph nodes, irrespective of tumor size and extent
        - **stage IIIC1:** pelvic lymph node metastasis only
        - **stage IIIC2:** paraaortic lymph node metastasis
        - with r (imaging) and p (pathology) notations to indicate how lymph nodes were identified
- **stage IV:** carcinoma has extended beyond the true pelvis or has involved (biopsy proven) the mucosa of the bladder or rectum (bullous edema, as such, does not permit a case to be allotted to stage IV)
    - **stage IVA:** spread to adjacent organs
    - **stage IVB:** spread to distant organs"

OVARIAN LESIONS

1. FUNCTIONAL CYSTS

True incidence of functional cysts is unknown as they are asymptomatic & many resolve without intervention. They result from abnormalities in the release of pituitary gonadotrophins.

A) Follicular cyst -

A dominant Graafian follicle sometimes fails to ovulate & does not involute. When it

becomes greater than 3 cm, it is called a follicular cyst & if <3cm, it is called as ovarian follicle. Follicular cysts are most common pelvic masses & usually resolve spontaneously.

USG features –

They appear as thin walled anechoic lesions with posterior acoustic enhancements containing no septa / internal echoes / solid components.

CT features –

Appear as thin walled hypodense lesions containing no septa / solid components. Do not show enhancement on contrast enhancement.

B) Corpus luteal cyst -

If a corpus luteum fails to regress & becomes filled with fluid / blood, it forms a corpus luteal cyst. It is the most common pelvic mass seen during 1st trimester of pregnancy, which usually regresses spontaneously by the end of 2nd trimester. Typically, they are <3cm.

USG features -

It is seen as anechoic cystic lesion with slightly thick wall & few internal echoes. It can also present as a isoechoic / minimally hypoechoic solid appearing area with thick wall due to hemorrhage. Color Doppler demonstrates either no vascularity within the cyst or depicts low resistance blood flow at the periphery, known as hypervascular "ring of fire".

CT features –

It appears as slightly irregular low-attenuating cyst (25 HU) usually <3 cm in diameter with mildly thickened walls, which doesnot enhance on contrast enhancement.

C) Theca lutein cysts -

It develops in response to elevated circulating gonadotropins like B-hCG levels in serum. They are usually multiple & bilateral. Associated with multiple gestation, PCOS, ovulation induction & molar pregnancy.

USG features -

Bilateral enlarged multicystic ovaries are seen. Cysts are thin walled with clear

contents. Solid component corresponding to normal ovarian stroma is present.

CT features -

Ovaries appear enlarged with multiple thin walled cysts & solid ovarian stroma.

2. HEMORRHAGIC CYST -

It occurs as a result of hemorrhage into functional cyst or corpus luteal cyst. It typically resolves spontaneously within 8 weeks. Patients usually complain of sudden onset of pelvic pain.

USG features [35]**-**

A regular cyst with thin walls (2-3 mm) varying appearances are seen

1. Fluid-fluid level
2. Lace like reticular echoes - fine interdigitating septations giving "Fish net appearance"
3. Intracystic solid clot, which may adhere to cyst wall mimicking a mural nodule, however no vascularity on color Doppler.
4. Solid lesion, if the hemorrhage is recent.

CT features -

Thin walled cyst may show fluid-fluid level or non-enhancing solid component (blood clot).

3. ENDOMETRIOTIC CYST (CHOCOLATE CYST) -

Are localised form of endometriosis in the ovary. These cysts are usually smaller measuring 2-5 cm, may sometimes be as large as 20 cm. They are predominantly found in women of child bearing age. As a result of repeated cyclical hemorrhage into cyst, they are composed of thick, dark, degenerated blood products giving appearance of "Chocolate cyst".

Most common site for endometriosis is ovaries and next is the pelvic peritoneum.

The are most common pelvic sites. Less common sites are C-section scar, deep subperitoneal tissues, chest and subcutaneous tissues [36].

USG features -

Classically, they appear as unilocular cyst with homogenous ground glass internal echoes

(which are result of hemorrhagic debris).

Less typical features include,

1. Multiloculated cyst (> 85 % having <5 locules)

2. Hyperechoic wall foci

3. Solid-cystic or purely solid

4. Very rarely it can present as anechoic cyst

CT features -

Classically, its an unilocular cyst whose appearance depends on age of bleed. Less typical findings are similar to USG findings.

It shows wall enhancement on contrast study. Enhancing mural nodule will indicate malignant transformation.

4. OVARIAN NEOPLASMS

Ovarian neoplasms are relatively common accounting to around 6% of malignancies in females.

General risk factors -

- Nulliparous
- Menopause at early age
- Gonadal dysgenesis
- Family history: 15 - 24% patients of epithelial ovarian cancer [37]
    - BRCA1/BRCA2 mutations are implicated in serous tumors
    - Lynch syndrome - associated ovarian cancers commonly have an endometrioid or serous type histology [37]
- Smoking is associated especially in mucinous adenocarcinoma
- Previous history of endometrial, breast or colon cancer (Lynch II syndrome)
- Certain ethnic populations (Ex – Ashkenazi Jewish women) are at a higher risk to develop endometrial & ovarian cancers

Protective factors

- Multiparity / breastfeeding (this is controversial)
- Combined oral contraceptives

Classification

Ovarian tumors are classified on the basis of tumor origin as

1. Epithelial tumors (serous tumors, mucinous tumors, endometrioid carcinoma, clear cell carcinoma & Brenner tumor),
2. Germ cell tumors (mature & immature teratomas, dysgerminoma, yolk sac tumor, embryonal carcinoma),
3. Sex cord–stromal tumors (fibrothecoma, granulosa cell tumor, sclerosing stromal tumor and Sertoli-Leydig cell tumor),
4. Lymphoma & metastatic tumors.

According to morphology

Predominantly cystic lesions:

- mature cystic teratoma
- serous cystadenoma / cystadenocarcinoma
- mucinous cystadenoma / cystadenocarcinoma

Predominantly solid lesions:

- Brenner tumor
- thecoma / fibroma / fibrothecoma
- endometroid / granulosa cell tumor
- dysgerminoma of ovary
- yolk sac tumor (endodermal sinus tumor)
- metastatic tumors

A) SURFACE EPITHELIAL TUMORS

Surface epithelial tumors account for 60 % of all ovarian neoplasms & 80-90% of primary

ovarian malignancies. They originate from surface epithelium of ovary. Occur in both premenopausal & post-menopausal women, however are rare before puberty.

Epithelial tumors are generally cystic, may be unilocular / multilocular & associated with solid component when they are malignant.

The most common types are serous and mucinous tumors. Other types are - ovarian endometrioid tumor, clear cell ovarian tumor, Brenner tumor, squamous cell carcinoma of ovary & undifferentiated carcinoma of ovary.

These tumors have histological resemblance to normal gynecological cell line as mentioned below [38]

- **serous** - resembling epithelium lining the Fallopian tubes
- **mucinous** - resembling epithelium lining endocervix, containing intracytoplasmic mucin
- **endometrioid** - resembling epithlium/stroma of uterine corpus
- **clear cell** - comprising clear & hobnail cells thought to arise from embryonic mesonephros

i) Ovarian serous neoplasms are the commonest of epithelial ovarian tumors.

Serous ovarian neoplasms are subdivided into benign, borderline, and malignant lesions according to their malignant potential.

~ 60% are benign & ~15% are borderline malignant which occur commonly in reproductive age women. ~ 25% are malignant which tend to occur in old women.

Radiological features

Serous ovarian tumors are usually smaller than mucinous tumors in size.

Typically serous tumors are unilocular and homogeneous. Often bilateral, particularly in malignant subtypes. Psammomatous calcifications are a feature of serous cysts, seen in 15 % of benign & 60 % of malignant cases.

USG features –

Appear as sharply marginated unilocular anechoic mass with thin wall, showing no flow on color Doppler.

CT features –

Typically unilocular cystic mass showing homogeneous CT attenuation, with a thin regular wall, which may show minimal / no enhancement on contrast studies.

Features suggestive of malignancy are:

- large size of cystic mass with multilocularity
- thick & irregular walls / septa
- papillary projections / mural nodule
- presence of soft tissue component
- bilaterality
- low RI & PI on spectral Doppler
- enhancement on contrast administration
- ascites

ii) Ovarian mucinous neoplasms account for 20% of ovarian malignancies.

Mucinous ovarian neoplasms are subdivided into benign, borderline, and malignant lesions according to their malignant potential. Benign are commonly seen during 3^{rd} to 5^{th} decades & malignant subtypes are seen during 5^{th} to 7^{th} decades. In malignant subtypes, KRAS association is a common feature.

Bilaterality is rare, accounting for only 2-3%, seen in malignant subtypes.

Radiological features –

Mucinous cysts are usually larger in size than serous counterparts & tend to be multilocular.

Calcification is a rare feature, if present tends to be linear.

In malignant tumors, pseudomyxoma peritonei is most common manifestation of in 15% to 30% of atypically proliferating mucinous tumors that may involve areas beyond the ovaries (Ex – intestines). However, peritoneal carcinomatosis is less common in comparison to

serous tumors.

USG features –

Appear as multilocular mass with thicker wall, septae & few dependent echoes. Benign mass shows no flow on color Doppler.

CT features –

Typically multilocular cystic mass showing thick wall & septae, which may show minimal / no enhancement on contrast studies.

Features suggestive of malignancy are:

- thick & irregular walls / septa > 3mm
- papillary projections / mural nodule
- presence of vascular solid component
- low RI & PI on spectral Doppler
- enhancement on contrast administration
- ascites

iii) Endometrioid carcinomas majority are malignant and invasive. They are second commonest malignant ovarian neoplasm accounting for 8-15% of all ovarian carcinomas. Endometrioid carcinoma is most common malignant neoplasm arising in endometrioma.

They are usually complex nonspecific solid-cystic masses and found associated with endometriosis. Both endometrioid and clear cell neoplasms are frequently seen in associaion with endometriosis. A benign endometrioid carcinomas are uncommon and they tends to be ovarian cystadenofibromas [39].

Coexisting endometrial carcinoma or endometrial hyperplasia may be present in u2/3rd cases.

Bilateral involvement can be seen in 25-40% of cases [39].

Radiographic features

USG features -

Often present as non-specific complex cystic mass with solid components. Some cases may

are predominantly solid. Show vascularity on color Doppler.

May be associated with endometriosis, endometrial thickening, endometrial carcinoma or contralateral similar mass.

CT features –

Complex cystic mass with solid components / papillary projections, showing enhancement on contrast administration. Usually unilateral & bilateral in few cases.

May be associated with endometriosis / endometrial thickening / endometrial carcinoma.

iv) Clear cell tumor a type of malignant ovarian epithelial tumor.

~2-5% of all ovarian carcinomas. Mean age at presentation is around 10 yrs younger than for other ovarian epithelial tumors (peaks at around 55 years)

It is seen as a large unilocular cystic mass with protruding solid nodules. Histologically they are similar to clear cell carcinoma of the endometrium, cervix or vagina.

Clear cell carcinoma can develop in a patient with endometriosis (in ~25% patients), who develop ovarian cancer & may be associated with ARID1A gene mutation [40].

Radiographic features –

USG features -

Seen as unilocular large cyst with solid nodular protrusions into cystic cavity, showing vascularity.

CT features -

Seen as a large unilocular cystic smooth marginated mass with protruding & enhancing solid portions into the lumen.

v) Brenner tumor (transitional cell tumor) –

They are uncommon subtype of surface epithelial tumors of ovary accounting for ~3%. They were originally known as a transitional cell tumor because of their histological similarity to urothelium.

Often found incidentally in women of 5^{th} to 7^{th} decades of life.

Brenner tumors are seen in association with another epithelial ovarian neoplasm of ipsilateral or contralateral ovary in approximately 30% cases. They can be bilateral in 6-7% of cases [41]. They can very rarely occur in testis.

Radiographic features -

Often appear as multilocular cystic lesion with solid component or as a solid mass.

These tumors are usually small measuring <2 cm. Occasionally they can be as large as 10 cm. Absence of local invasion, lymphadenopathy, ascites or metastasis help to distinguish it from other malignant ovarian tumors.

USG features -

Small hypoechoic solid masses, mimic ovarian fibromas/thecomas. Calcifications noted in 50% of cases on USG.

CT features -

Small hypo to isodense mass lesion showing mild to moderate enhancement post-contrast. Calcification noted in ~85% of Brenner tumors on CT.

vi) Squamous cell carcinoma of the ovary is an extremely rare (2%) which usually arises in mature cystic ovarian teratoma [42]. Only parts of the lesion contain malignant tissue, hence difficult to detect malignant transformation in a teratoma pre-operatively, until local invasion to adjacent structures is noted.

Malignant transformation of a mature cystic teratoma is rare, usually seen in postmenopausal women and carries a poor prognosis.

Mean age during diagnosis is ~55 yrs which is more than the mean age for diagnosing mature cystic teratoma (~37.5 years) [43]. Thus advanced patient age is useful in raising the suspicion of malignant transformation of a mature cystic teratoma.

In malignant transformation of mature cystic teratoma, most common histological type is squamous cell carcinoma is the followed by adenocarcinoma & melanoma.

Radiographic features

Due to the heterogeneity of mature cystic teratomas, diagnosis of malignant component is difficult in the absence of obvious local invasion or metastases.

In most of the cases, appearances are similar to benign mature cystic teratoma.

Features are helpful in suspecting malignant transformation,

- large solid component, especially irregular / suggesting adjacent tissue infiltration
- size of the umor is also an important factor - generally, malignant tumors are larger. A study done by Fumitaka Kikkawa et al [43] mean size of mature cystic teratoma was ~88 mm while, squamous cell carcinoma arising from mature cystic teratoma was ~152 mm.

B) GERM CELL TUMORS

Germ cell tumors are 2nd largest group of ovarian tumors & compromise approximately 20%. They are seen from 1st to 6th decades. In children & adolescents, ~60% ovarian neoplasms are of germ cell origin & 1/3rd are malignant. In young adult females, majority are benign mature cystic teratomas.

i) Ovarian teratoma is the most common ovarian neoplasm in young females (of 30 yrs), accounting for ~2 0% of all ovarian neoplasms. These are slow-growing tumors which contain elements derived from multiple germ cell layers.

Although mature cystic teratoma & dermoid cyst are the terms which are used interchangeably, have similar imaging appearances, but the fundamental difference is, a dermoid cyst contains only of dermal and epidermal elements derived from ectodermal origin, whereas teratomas also contain elements of mesodermal and endodermal origin in addition to dermal elements. They are bilateral in 10-15% patienst [44].

Struma ovarii is a variant which contains thyroid elements, sometimes these are separately classified as specialized teratomas of the ovary.

Radiographic features [45]

USG features -

USG is the preferred modality for imaging.

Typically it is seen as a cystic mass with few mural components. Most of them are unilocular.

Spectrum of USG features are:

- completely or partially echogenic mass with posterior acoustic shadowing because of sebaceous material and hair within
- tip of the iceberg sign is an echogenic interface at the edge of mass obscuring deeper structures
- Rokitansky protuberence is a mural hyperechoic nodule / dermoid plug
- Echogenic calcific or tooth components
- fluid-fluid levels
- dot-dash pattern - thin echogenic bands caused by hair within the cyst
- no internal vascularity on color Doppler
- intracystic floating balls are rarely seen, which are characteristic

CT features -

- fat areas within the cyst
- fat-fluid level,
- calcification (sometimes dentiform)
- Rokitansky protuberance
- tufts of hair

When rupture of dermoid cyst occurs, characteristic hypoattenuating fat- fluid level found in anti dependent pockets, generally below right hemidiaphragm is pathognomonic finding.

Features of malignant transformation -

- size exceeding 10 cm
- soft tissue plugs & cauliflower appearance with irregular borders

Immature ovarian teratomas are rare germ cell tumors. They differ from mature ovarian teratomas histologically by presence of immature tissue & clinically by malignant behavior.

Considerably less common than mature cystic teratomas, accounting to less than 1% of

ovarian teratomas. They affect young females, most often in the 1st and 2nd decades of life. They are associated with ipsilateral mature cystic teratoma in ~25% & contralateral immature teratoma in ~10% [46].

Radiographic features

It appears as a typical large, heterogeneous mass with a prominent solid component, ranging from a predominantly cystic to a solid mass. They tend to be larger than benign mature cystic teratomas at presentation.

Metastasis to peritoneum, liver, lung & brain have been reported.

USG features -

It appears as a nonspecific complex adnexal mass. Calcifications may be present.

CT features -

Complex cystic mass with predominant solid component, containing calcifications and small foci of fat. Cystic part may contain fatty, serous, mucinous or sebaceous material. Hemorrhage can be seen in few cases.

ii) Ovarian dysgerminoma is the most common malignant germ cell tumor of ovary accounting for ~1% of all ovarian neoplasms.

They are rare tumors occuring in young women of 2nd to 3rd decades. Approximately 10-20% cases can occur during pregnancy.

Approximately 10-17% of tumors are bilateral.

Radiographic features

USG features -

It presents as a multilobulated solid mass separated by fibrovascular septae. Color Doppler shows prominent vascularity in fibrovascular septae.

CT features -

Characteristic findings are multilobulated solid mass with prominent fibrovascular septa which often show enhancement on contrast study.

Speckled pattern of calcification may be seen.

iii) Ovarian yolk sac tumor, (endodermal sinus tumor) is a rare malignant ovarian germ cell tumor, usually occuring around 2nd decade. It is the most common malignant germ cell tumor in children [47].

They are typically well-encapsulated round to oval masses.

Rarely, ovarian yolk sac tumor can occur in a pre-existing ovarian dermoid cyst.

Radiographic features -

USG features -

Typically, they appear as large, complex mass which extends into the abdomen containing both solid and cystic components.

CT features –

Similar to USG features

C) SEX CORD STROMAL TUMORS

Account for 8-10% of all ovarian tumors.

They arise from two groups of cells:

- stromal cells
- primitive sex cords / coelomic epithelium

This category includes granulosa cells, theca cells, sertoli cells & leydig cells.

i) Ovarian fibroma / thecoma / fibrothecomas are the most common benign solid ovarian tumor.

Ovarian fibromas are benign tumors of sex cord / stromal origin, account for 4% of all ovarian tumors.

Ovarian thecomas are benign tumors of ovarian tumors of sex cord / stromal origin, account for approximately 0.5-1% of all ovarian tumors. These tumors secrete estrogen, hence described as functional ovarian tumors.

Ovarian fibrothecomas contain components of both an ovarian fibroma and an ovarian

thecoma.

These tumors are common in post-menopausal age group, accounting to ~66%.

Radiographic features

Ultrasound

Seen as nonspecific homogeneous hypoechoic mass casting posterior acoustic shadowing.

CT

Majority (~80%) appear as solid mass with a delayed enhancement of contrast medium [48].

Myxoid or cystic degeneration can occur resulting in heterogeneous attenuation. Calcification may be seen in some tumors.

ii) Ovarian Sertoli-Leydig cell tumors / ovarian androblastomas are rare ovarian tumors accounting for ~0.5% of all ovarian tumors. They can present at any age, however typically present in young females <30 yrs.

Most of the tumors are unilateral (>90% of cases). They are characterized by presence of testicular structures producing androgens (30% are hormonally active).

These tumors are divided into four subtypes:

- well-differentiated
- intermediately-differentiated
- poorly-differentiated
- retiform

Radiographic features

They are usually unilateral.

USG features -

Imaging features are nonspecific and variable - may manifest as a well-defined, solid mass or as a cystic lesion, however typically presents as a solid mass with intra-tumoral cysts.

CT features -

Typically, seen as a solid mass with intra-tumoral cysts. Sometimes it can present as a cystic

lesion.

iii) Granulosa cell tumors accounting for approximately 8% of all ovarian tumors and approximately 5% of all ovarian malignancies and are thought to contain combinations of stromal & sex cord components of developing gonad & though of arising from normal proliferating granulosa cells of the late preovulatory follicle [49].

Their ability to secrete estrogen, inhibin & Müllerian inhibiting substance accounts for clinical manifestations. The hyperestrogenemia may produce endometrial hyperplasia / endometrial polyps / endometrial carcinoma in ~15% of cases.

Subtypes

It is divided into two subtypes:

- adult granulosa cell tumor of the ovary: more common and account for ~95% of cases
- juvenile granulosa cell tumor of the ovary - Juvenile granulosa cell tumor is seen in association with Maffucci syndrome.

Radiographic features

It is predominantly solid slow growing mass with cystic change & hemorrhage within.

It is rarely bilateral.

Uterine enlargement / endometrial thickening / hemorrhage on the uterus may be seen as a manifest of estrogenic effects.

USG features -

Its appearance varies, may appear as a solid mass / multiloculated solid cystic mass / a purely cystic lesion.

Varying degrees of hemorrhage or fibrosis is noted.

CT features -

Usually a large, well-defined, low-attenuating ovarian mass shows mild to moderate enhancement.

D) MIXED TUMORS

i) Collision tumor of ovary is uncommon tumor of ovary where co-existence of two adjacent but histologically distinct tumors are seen. However, there is no histological mixture at interface.

ii) Ovary carcinosarcoma / Malignant mixed Mullerian tumors of ovary are a very rare type of ovarian tumor containing both epithelial and stromal components, accounting for less than 1% of all ovarian cancers.

Most common in women of post-menopausal age, usually from 6^{th} to 8^{th} decades.

Radiographic features

It is not possible to differentiate carcinosarcomas from other solid ovarian neoplasms on imaging.

Hemorrhagic ascites is common (>50%) in advanced cases.

E) METASTATIC TUMORS -

Are relatively common with an incidence of 5-30% of all malignant ovarian tumors.

Often a known primary is present at the time of presentation..

They are large lobulated masses with hemorrhagic and necrotic areas within. However the ovarian contour usually maintained. Bilateral lesions are common.

Common route of spread is haematogenous, next is lymphatic route or direct spread by adjacent tumors.

Metastases to ovaries are common from malignancies of GIT, breast, lungs and contralateral ovaries. Other rare primaries include endometrium, melanoma, pancreas, carcinoid, leukemia, renal, hepatocellular , gallbladder , bladder transitional cell, neuroblastoma and reticuloendothelial tumors [50].

Radiographic features

USG features –

Metastatic tumors have mixed echogenicity with vascularity of solid component on Doppler. Hemorrhage & necrosis are common.

CT features -

Soft tissue density with necrotic & hemorrhagic areas. Solid components show heterogeneous enhancement on contrast administration.

Krukenberg tumor (carcinoma mucocellulare) is "signet ring" subtype of metastatic ovarian tumors. Most common primary is from colon and stomach, followed by breast, lung and contralateral ovary. They account for 5-10% of all ovarian tumors and up to 50% of all metastatic ovarian tumors. They are common in reproductive age group [51].

Histologically characteristic mucin secreting "signet ring" cells are noted [51].

The interval between diagnosis of primary neoplasm & development of metastasis to ovaries is highly variable, ranging from few months to 10 yrs.

Radiographic features

Most of the imaging features are non-specific, containing predominantly solid components or combination of cystic and solid areas. It is difficult to differentiate this tumor from primary ovarian neoplasms. There are a variety of ovarian metastatic carcinomas that mimic primary ovarian tumors.

USG features -

They are seen as bilateral solid ovarian tumors with well defined margins. Irregular hyperechoic solid mass & moth eaten like cyst are also considered characteristic of these tumors.

CT features -

CT appearances of ovarian mass may be indistinguishable from primary ovarian malignacies. Feature favoring a Krukenberg tumor is, concurrent gastric or colic mass. Some evidences state that ovarian deposits of stomach cancer are denser on contrast CT than colonic cancers [52].

F) OVARIAN LYMPHOMA –

It can be either primary involvement as in primary ovarian lymphomas or secondary

involvement as with generalized lymphoma.

It is a rare tumor of ovary, usually seen as a part of disseminated disease rather than primary involvement.

USG features –

Appears as a hypoechoic solid mass, showing no significant vascularity.

CT features –

Soft tissue mass, showing no or minimal enhancement on contrast administration.

Staging [53]

CT is the best imaging modality for staging ovarian malignancy.

"Most commonly used ovarian cancer staging system is the FIGO staging system (2014).

- **stage I:** tumor limited to the ovaries
    - **stage Ia:**
        - tumor limited to one ovary
        - capsule intact
        - no tumor on ovarian surface
        - no malignant cells in ascites or peritoneal washings
    - **stage Ib:**
        - tumor involves both ovaries; otherwise similar to stage Ia
    - **stage Ic:**
        - tumor involves one or both ovaries, with any of the following:
            - **stage Ic1:** surgical/intraoperative spill
            - **stage Ic2:** capsule ruptured before surgery, or tumor on ovarian or fallopian tube surface
            - **stage Ic3:** malignant cells in the ascites or peritoneal washings
- **stage II:** tumor involves one or both ovaries with pelvic extension or primary peritoneal cancer (below pelvic brim)

- **stage IIa:** extension or implants on the uterus or fallopian tubes
- **stage IIb:** extension to other pelvic intraperitoneal tissues

- **stage III:** tumor involves one or both ovaries or fallopian tubes with cytologically or histologically confirmed spread to the peritoneum outside the pelvis and/or metastasis to the retroperitoneal lymph nodes
  - **stage IIIa:** positive retroperitoneal lymph nodes and /or microscopic metastasis beyond the pelvis:
    - **stage IIIa1:** positive (cytologically or histologically proven) retroperitoneal lymph nodes only
      - **stage IIIa1(i):** metastatic retroperitoneal node measuring ≤10 mm
      - **stage IIIa1(ii):** metastatic retroperitoneal node measuring >10 mm
    - **stage IIIa2:** microscopic extrapelvic (above the pelvic brim) peritoneal involvement with or without positive retroperitoneal lymph nodes
  - **stage IIIb:** macroscopic peritoneal metastasis beyond the pelvis up ≤2 cm in greatest dimension, with or without metastasis to the retroperitoneal lymph nodes
    - includes extension of tumor to the capsule of liver and spleen
  - **stage IIIc:** macroscopic extrapelvic peritoneal metastases >2 cm in greatest dimension, with or without metastasis to the retroperitoneal lymph nodes
    - includes extension of tumor to the capsule of liver and spleen
- **stage IV:** consists of distant metastasis, excluding peritoneal metastases, and includes the following:
  - **stage IVa:** pleural effusion with positive cytology
  - **stage IVb:** distant metastases
    - parenchymal metastases and metastases to extra-abdominal organs (including inguinal lymph nodes and lymph nodes outside of the abdominal cavity)”

Notes:

- "bilateral ovarian tumors may represent stage I disease, but represent metastases in ~30% of patients
- one of the potential difficulties in differentiating stage II from stage III disease is differentiating between involvement of pelvic and extrapelvic peritoneum
- the majority of ovarian cancers present as stage III
- presence of metastatic lymph nodes is important, but the number of nodes does not carry prognostic significance
- the amount of peritoneal involvement carries prognostic significance, but the 2 cm cut off in the staging system is subjective"

Scoring systems -

The challenging task in diagnosing an ovarian tumor is, its categorization into benign & malignant lesions. To differentiate benign masses from malignant, many scoring systems are used as mentioned below:

A) GYNECOLOGIC IMAGING REPORTING AND DATA SYSTEM (GI-RADS) [54]

It is a reporting system created for reporting the findings in adnexal masses based on TVS.

Classification

Findings are classified into five categories:

- GI-RADS 1 - normal ovaries identified and no adnexal mass seen
- GI-RADS 2 - adnexal functional lesions (follicular cyst, corpus luteal cyst, theca lutein cyst, hemorrhagic cyst)
- GI-RADS 3 - benign neoplastic adnexal lesions
    - endometrioma
    - teratoma
    - simple cyst
    - hydrosalpinx

- paraovarian cyst
- peritoneal pseudocyst
- pedunculated myoma
- changes suggestive of pelvic inflammatory disease

- GI-RADS 4
  - any adnexal lesion not included in GI-RADS 1–3
  - the lesion with one or two findings suggestive of malignancy such as:
    - thick papillary projections
    - thick septations
    - solid areas
    - ascites
    - vascularization within solid areas
    - papillary projections
    - a central area of a solid tumor visualized on color or power Doppler
- GI-RADS 5 - adnexal masses with three or more findings suggestive of malignancy (as listed above)

Risk of malignancy:

- GI-RADS 1: 0%
- GI-RADS 2: <1%
- GI-RADS 3: 1-4%
- GI-RADS 4: 5-20%
- GI-RADS 5: >20%

GI-RADS has a sensitivity and specificity of 92% and 97% of diagnosing malignant tumors when compared to a final histological diagnosis [55].

B) IOTA USG RULES FOR OVARIAN MASSES [56]

International Ovarian Tumor Analysis (IOTA) group USG rules for ovarian masses –it

is a simple set of USG features to classify ovarian masses into benign, malignant or inconclusive. These rules are applied to masses which are not classical ovarian mass (Ex - corpus luteal cyst, endometrioma, dermoid cyst) having pathognomonic imaging features.

Ovarian masses can be classified as either benign or malignant with the help of simple imaging features on USG. Ovarian masses which cannot be classified (~25%) into either benign or malignant group are classified as inconclusive.

"When the rules can be applied (~75% of masses), there is a sensitivity of ~90% and a specificity of ~95%."

10 simple USG rules (five B rules & five M rules) are used to classify ovarian tumors into benign & malignant.

Table 07 – simple IOTA rules for predicting benign or malignant ovarian masses

Rules for predicting benign tumor (B rules)	Rules for predicting malignant tumor (M rules)
B1 – unilocular cyst	M1 – irregular solid tumor
B2 – presence of solid components, where solid component is <7 mm in lagest diameter	M2 – presence of ascites
B3 – presence of acoustic shadowing	M3 – atleast four papillary structures
B4 – smooth multilocular tumor with largest diameter <100 mm	M4 – irregular multilocular tumor with largest diameter ≥100 mm
B5 – no blood flow (color score 1)	M5 – very strong flow (color score 4)

"On application of one or more M-rules in the absence of a B-rule, or one or more B-rules in the absence of a M-rule, the mass is classified as malignant or benign respectively. If both M-rules and B-rules apply, or if no rule applies, the mass could not be classified, and was labeled as inconclusive."

C) COLOR DOPPLER SCORING OF OVARIAN MASSES

There are two different scoring methods using color Doppler.

I. One method uses the amount of blood flow within the mass as the basis & masses are scored as follows [57]:

Score 1 - no blood flow detected in the lesion

Score 2 - minimal blood flow could be detected

Score 3 - when moderate flow was present

Score 4 - highly vascular ovarian mass with marked blood flow.

A color score ≥ 3 was considered suggestive of malignancy.

II. Second method uses RI & PI values as the basis for differentiation [58].

Multiparameter analysis of patients with ovarian tumors using grey scale USG, color Doppler and spectral Doppler forms the mainstay in differentiating benign & malignant lesions. Specificity of 84.1 % and sensitivity of 97.5 % was proven by comparing PI & RI values with histopathology. PI & RI values of <1.0 and <0.6 respectively, are highly significant in differentiating between malignant and benign ovarian tumors.

ADNEXAL LESIONS

A) HYDROSALPINX

It refers to dilatation of fallopian tube filled with fluid. If the fluid within is infected (pus), it is called pyosalpinx. If the fluid is bloody, then it is called hematosalpinx.

Single or both fallopian tubes may be involved. Occlusion at distal end of fallopian tube results in accumulation of secretions leading to hydrosalpinx.

Causes

- PID (Ex - chlamydial or gonococcal infection): a hydrosalpinx is most commonly a sequela of adhesions resulting from PID
- endometriosis (often hematosalpinx)
- ovulation induction
- post-hysterectomy without salpingo-oophorectomy - can be unilateral / bilateral
- tubal ligation
- tubal malignancies: both primary or secondary tumors of fallopian tube

Radiographic features

USG features -

It appears as elongated, tubular, folded, C / S-shaped fluid-filled structure in adnexa distinct from the uterus and ovary. It can be thin- or thick-walled (in chronic cases)

Longitudinal folds of a normal fallopian tube can become thickened in hydrosalpinx & gives a characteristic "cogwheel**"** appearance cross sectional imaging which is pathognomonic of hydrosalpinx. Indentations on opposite sides of the wall are called as the "waist sign" is a strong predictor of hydrosalpinx. Incomplete septa may give a "beads on a string" sign. [59]

CT features -

A hydrosalpinx may be seen as tubular fluid attenuation adnexal structure, separate from uterus & ovary. The tubal wall may show enhancement on CECT.

B) TUBO-OVARIAN ABSCESS is one of the late complications of PID.

Risk factors

Risk factors include:

- previous PID
- IUCD
- multiple sexual partners
- diabetes mellitus & immunocompromised status
- history of uterine surgery: complication of hysterectomy

Tubo-ovarian abscesses are commonly polymicrobial with predominance of anaerobic organisms.

Radiographic features [60] -

Some differentiate tow forms -

- Tubo-ovarian abscess - ovary & tube cannot be separately distinguished within the mass
- Tubo-ovarian complex - tube & ovary are separately distinguished within the mass

USG features -

TAS & TVS are preferred initial imaging modalities. Findings are:

- complex multilocular adnexal or retrouterine mass with debris, septations, and irregular thick walls
- commonly bilateral involvement is noted
- echogenic debris & fluid within the pelvis
- lymphadenopathy & ascites

CT features -

Can be a helpful in determining the extent of disease.

It appears as complex thick walled multilocular pelvic mass which may contain fluid-fluid levels. In few cases may show presence of gas within the mass. Wall & septae show enhancement on contrast admistration.

VAGINAL LESIONS

PRIMARY VAGINAL CARCINOMA [61]

Incidence is rare overall, still it is the 5th commonest gynecological malignancy.

Primary vaginal carcinoma is a neoplasm which arises from vagina with no involvement of external os of cervix superiorly & vulva inferiorly.

It accounts for 1-3% of all gynecologic cancers. Its incidence is common in 6th to 7th decade.

It characteristically arises from posterior wall of upper 1/3rd of vagina.

The common patterns of disease are:

- ulcerating / fungating mass
- annular constricting lesion

Many histological subtypes are described -

- squamous cell carcinoma of vagina: commonest subtype accounting for ~80-85%, presents in older females
- adenocarcinoma of vagina: second commonest subtype accounting for ~15%, presents in young females which arises from vaginal adenosis

- clear cell carcinoma of vagina: is rare & is associated with previous diethylstilbestrol (DES) exposure
- primary vaginal melanoma
- vaginal sarcoma:
    - rhabdomyosarcoma in pediatric population
    - botryoid rhabdomyosarcoma

Radiographic features -

MRI is the imaging modality of choice in diagnosing the primary vaginal tumor and in assessing the local extent. For distant metastatic disease CT or PET are best.

USG features -

USG is not the choice of imaging modality in diagnosing vaginal cancer.

It is seen as an hypoechoic mass involving the vagina showing vascularity on color Doppler.

CT features -

CT is not much useful in the assessing primary vaginal tumor, but is useful in assessing the advanced disease like loco-regional invasion, lymph nodal involvement & metastases.

On CT, the primary tumor appears as hypo/iso-attenuating which is hypo/iso-enhancing.

Staging –

"FIGO staging system is adopted for staging primary vaginal cancer, it covers all histological subtypes and is as follows

- **stage 0:** carcinoma in situ
- **stage I:** tumor confined to vagina
- **stage II:** invasion of paravaginal tissues but no extension beyond pelvic side walls
- **stage III:** extension to pelvic side walls
- **stage IV:** spread beyond the true pelvis
    - **stage IVa:** invasion of bladder/rectum and/or extension beyond true pelvis
    - **stage IVb:** distant metastatic disease"

RESULTS & ANALYSIS

Table 08 – Age-wise distribution

Age (years)	No. of patients	Percentage
18 – 30	06	12
31 – 40	18	36
41 – 50	12	24
51 – 60	08	16
61 – 70	04	08
>70	02	04
Total	**50**	**100**

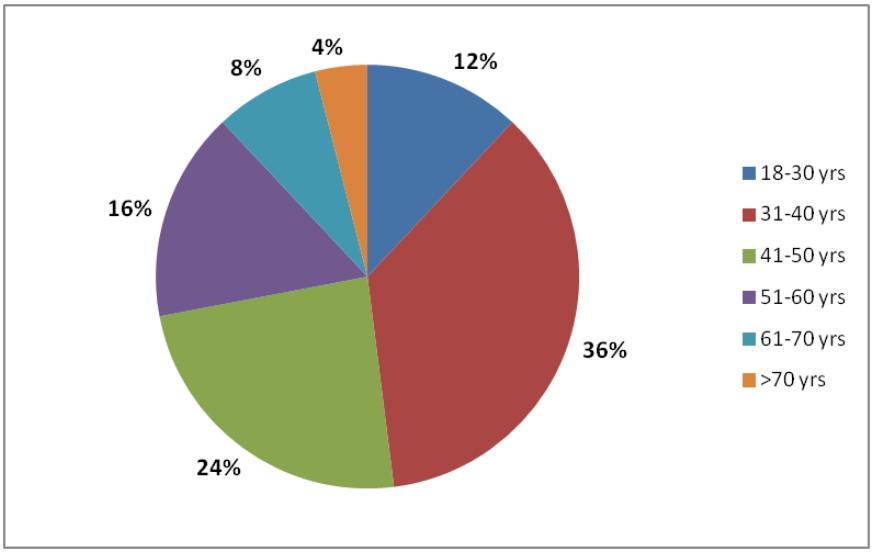


Figure 12 – Age wise distribution

The patient ages in my study are in the range of 18 – 80 years with a mean age of 49 years. Maximum cases are between 31- 40 years accounting for 36%. Only 4% cases are >70 years. Patients in the age group of 31-50 years are 60 in number accounting for more than half of the cases.

Table 09 – Menstrual status

Menstrual status	No. of patients	Percentage
Pre-menopausal	35	70
Post-menopausal	15	30
Total	**50**	**100**

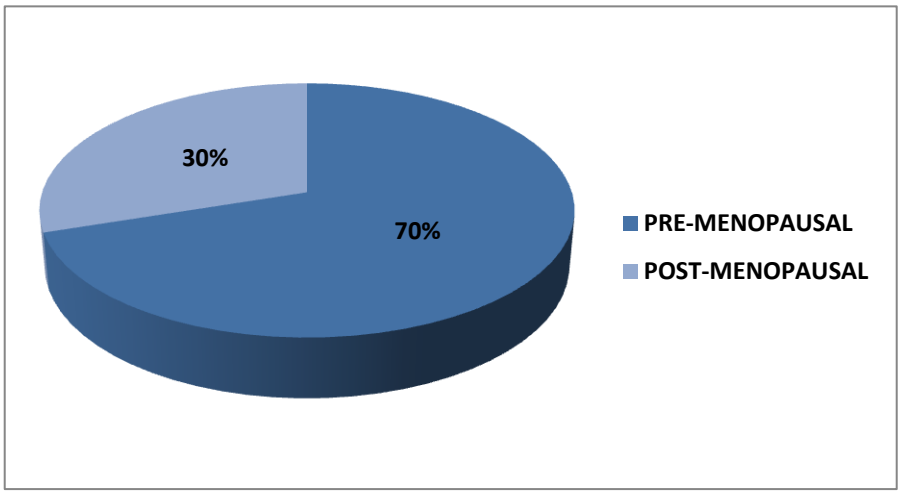


Figure – 13 Menstrual status

Majority of the cases are in premenopausal age group (70%). Whereas only 30% cases are postmenopausal.

Table 10 – Location of masses

Location of masses	No. of patients	Percentage
Midline	22	44
Right adnexa	13	26
Left adnexa	10	20
Bilateral adnexa	05	10
Total	**50**	**100**

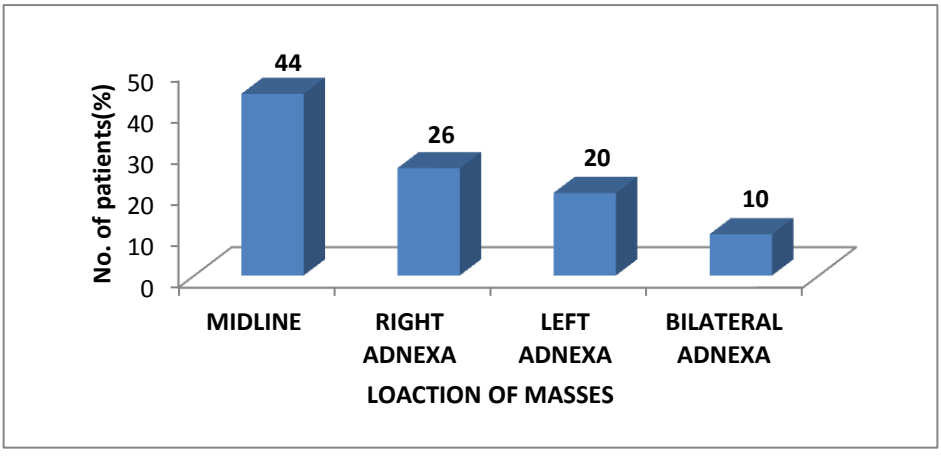


Figure – 14 Location of masses

In my study, commonest location of the masses is midline (42%) & 10% cases are involving bilateral adnexa. However combined adnexal lesions are more than midline lesions.

Table 11 – Site of origin of masses

Site of origin	No. of patients	Percentage
Uterus	27	54
Ovaries	21	42
Adnexal	01	02
Vaginal	01	02
Total	**50**	**100**

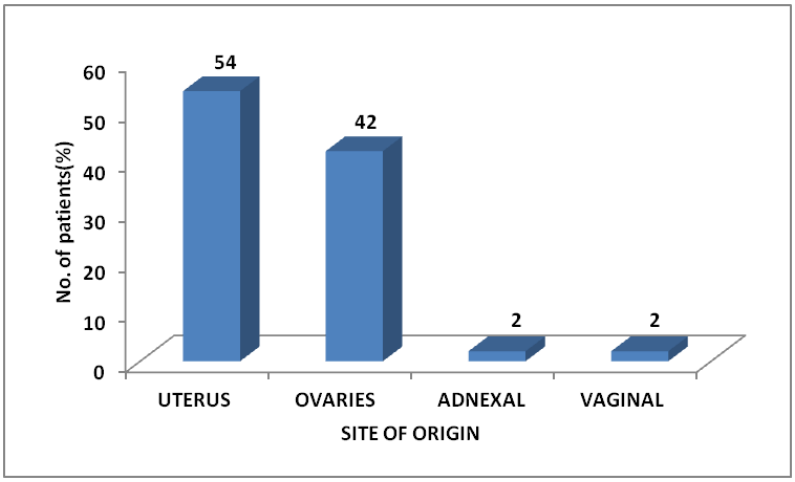


Figure 15 – Site of origin of masses

Of the 50 cases in my study, majority of the cases are of uterine origin (54%) & second common site of origin is ovarian (42%).

Table 12 – Nature of masses

Nature of mass	USG		CT		HPR	
	No	**%**	**No**	**%**	**No**	**%**
Non-neoplastic	09	18	09	18	09	18
Benign neoplastic	21	42	25	50	28	56
Malignant neoplastic	11	22	13	26	13	26
Indeterminate	09	18	03	06	-	-
Total	**50**	**100**	**50**	**100**	**50**	**100**

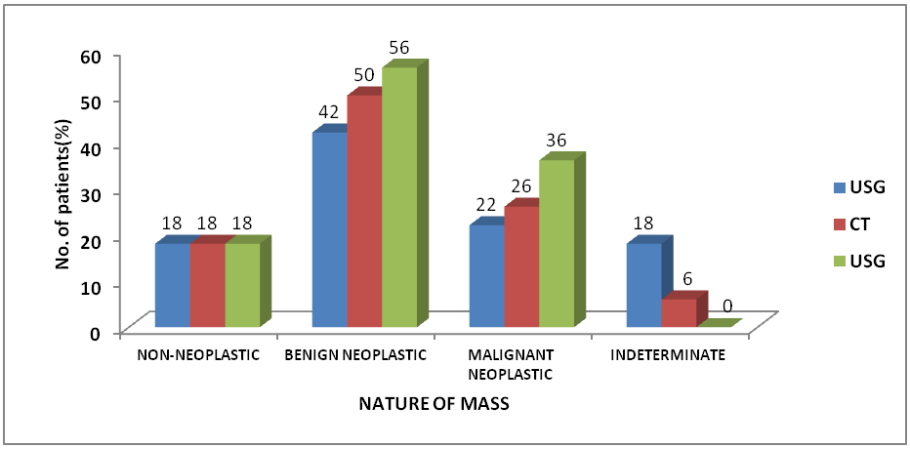


Figure 16 – Nature of masses

Among all masses in my study, neoplastic lesions are the majority accounting to 82%. Most common cases are benign neoplastic lesions (56%) & least common are non-neoplastic lesions (18%).

Table 13 – Nature of uterine masses

Nature of mass	USG		CT		HPR	
	No	%	No	%	No	%
Non-neoplastic	01	3.7	01	3.7	01	3.7
Benign neoplastic	15	55.5	18	66.6	20	74.1
Malignant neoplastic	05	18.5	06	22.3	06	22.3
Indeterminate	06	22.3	02	7.4	-	-
Total	**27**	**100**	**27**	**100**	**27**	**100**

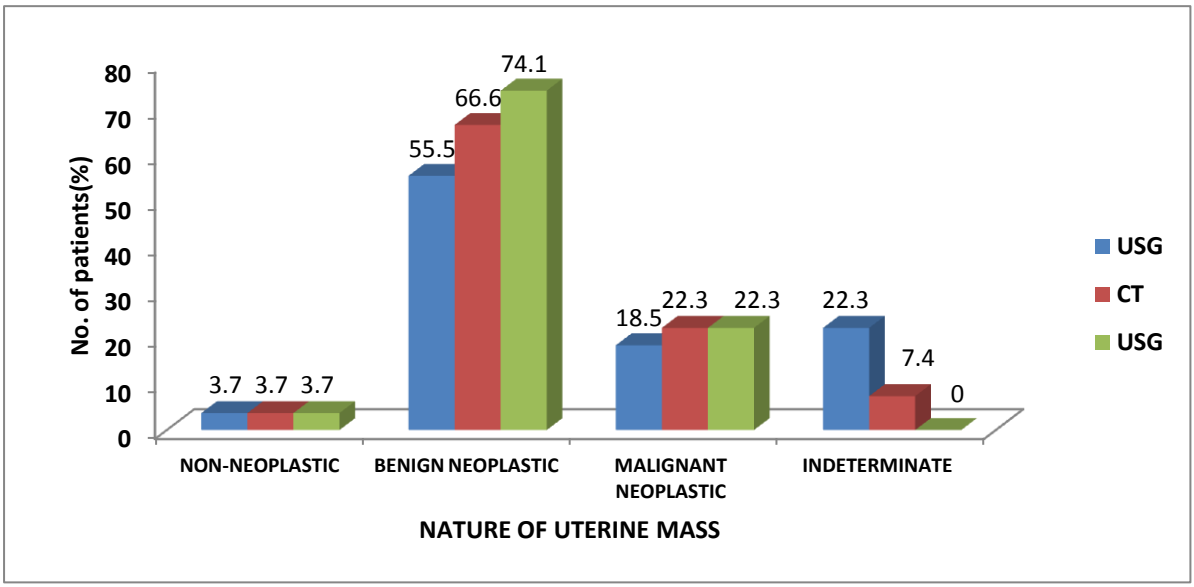


Figure 17 – Nature of uterine masses

Among uterine masses, neoplastic lesions are the most common in my study. Most common cases are benign neoplastic lesions (74.1%) & least common are non-neoplastic lesions (3.7%).

Table 14 – Spectrum of uterine masses

Lesion	No. of patients	Percentage
Fibroid	18	66.6
Adenomyosis	02	7.4
Endometrial polyp	01	3.7
Cervical carcinoma	04	14.8
Endometrial carcinoma	02	7.4
Total	**27**	**100**

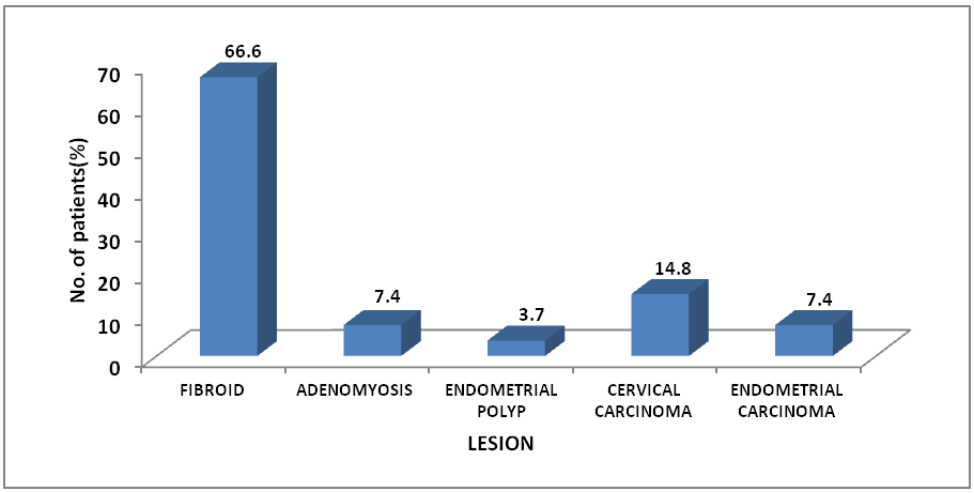


Figure 18 – Spectrum of uterine masses

Among 27 uterine lesions seen in my study, most common lesion was fibroid (66.6 %) and least common was non-neoplastic lesion, endometrial polyp (3.7%).

Table 15 – Consistency of ovarian masses

Consistency	No. of patients	Percentage
Solid	03	14.3
Solid-cystic	04	19
Unilocular cyst	08	38.1
Multilocular cyst	06	28.6
Total	**21**	**100**

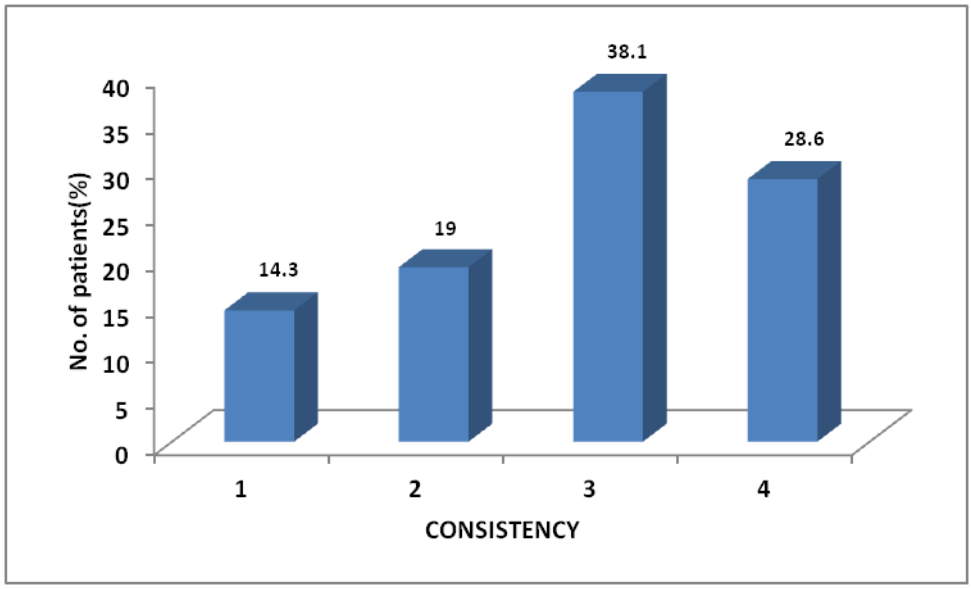


Figure 19 – Consistency of ovarian masses

Among 21 ovarian lesions seen in my study, majority are unilocular cysts (38.1 %) and least common are solid lesions (14.3 %).

Table 16 – Size of ovarian masses

Size	Non-neoplastic	Benign	Malignant	Total
< 5 cm	06 (28.6%)	01 (4.7%)	01 (4.7%)	**08 (38.1%)**
5 – 10 cm	01 (14.3%)	02 (9.5%)	01 (4.7%)	**04 (19%)**
10 – 15 cm	-	03 (14.3%)	01 (4.7%)	**04 (19%)**
>15 cm	-	02 (9.5%)	03 (14.3%)	**05 (23.8%)**
Total	**07 (33.3 %)**	**08 (38.1%)**	**06 (28.6%)**	**21**
Chi square test	X^2=8.736 p=0.042 Sign			
Sign: Significant				

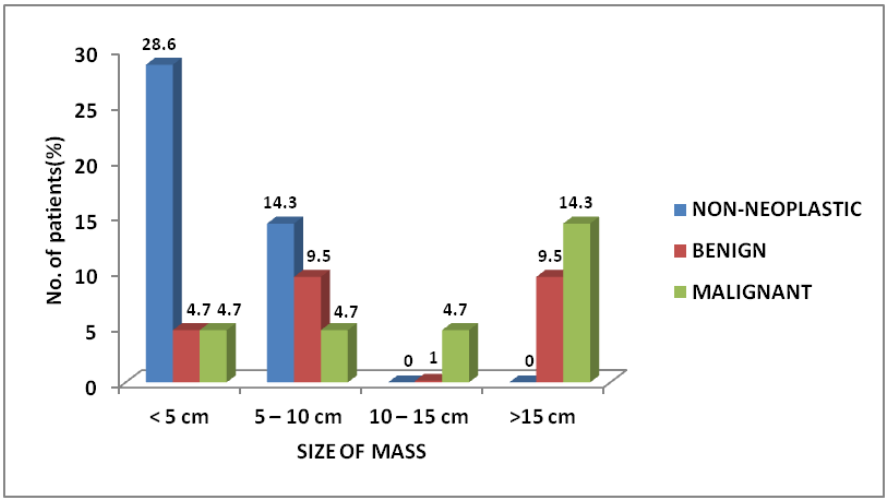


Figure 20 – Size of ovarian masses

Chi square test p<0.05 (significant) stating that

- majority of non-neoplastic masses have size is <5cm (6 out of 7 cases)
- majority of neoplastic masses have size > 5cm.
- among 6 malignant cases, 5 cases have size > 5cm accounting for > 80% cases

Table 17 - Nature of ovarian masses

Nature of mass	USG		CT		HPR	
	No	%	No	%	No	%
Non-neoplastic	07	33.3	07	33.3	07	33.3
Benign neoplastic	06	28.6	07	33.3	08	38.1
Malignant neoplastic	05	23.8	06	23.8	06	28.6
Indeterminate	03	14.3	01	4.7	-	-
Total	**21**	**100**	**21**	**100**	**21**	**100**

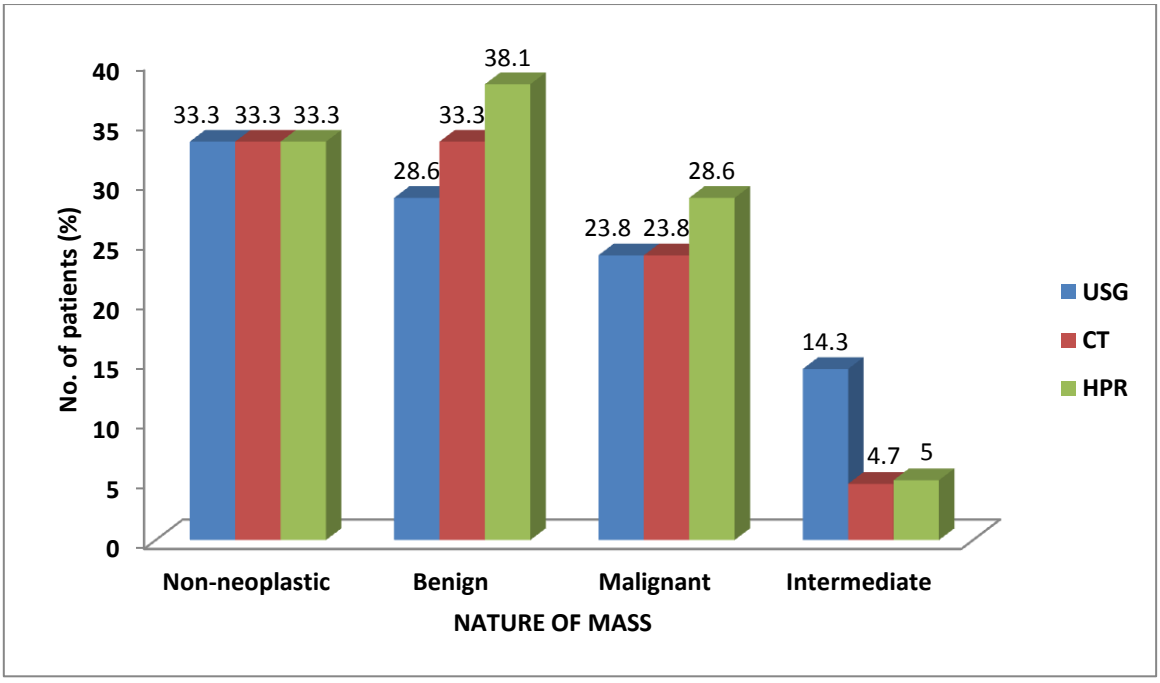


Figure 21 – Nature of ovarian masses

In my study, majority of ovarian masses are neoplastic lesions accounting for 64.7%. Among them, benign neoplasms are commoner than malignant. Non-neoplastic masses accounting for 33.3%.

Table 18 - Spectrum of ovarian masses

Lesion	No. of patients	Percentage
Simple cyst	03	14.3
Complex cyst	02	9.5
Hemorrhagic cyst	02	9.5
Mature cystic teratoma	01	4.7
Serous cystadenoma	04	19
Mucinous cystadenoma	03	14.3
Serous cystadenocarcinoma	02	9.5
Mucinous cystadenocarcinoma	01	4.7
Dysgerminoma	01	4.7
Yolk sac tumor	01	4.7
Fibrosarcoma	01	4.7
Total	**21**	**100**

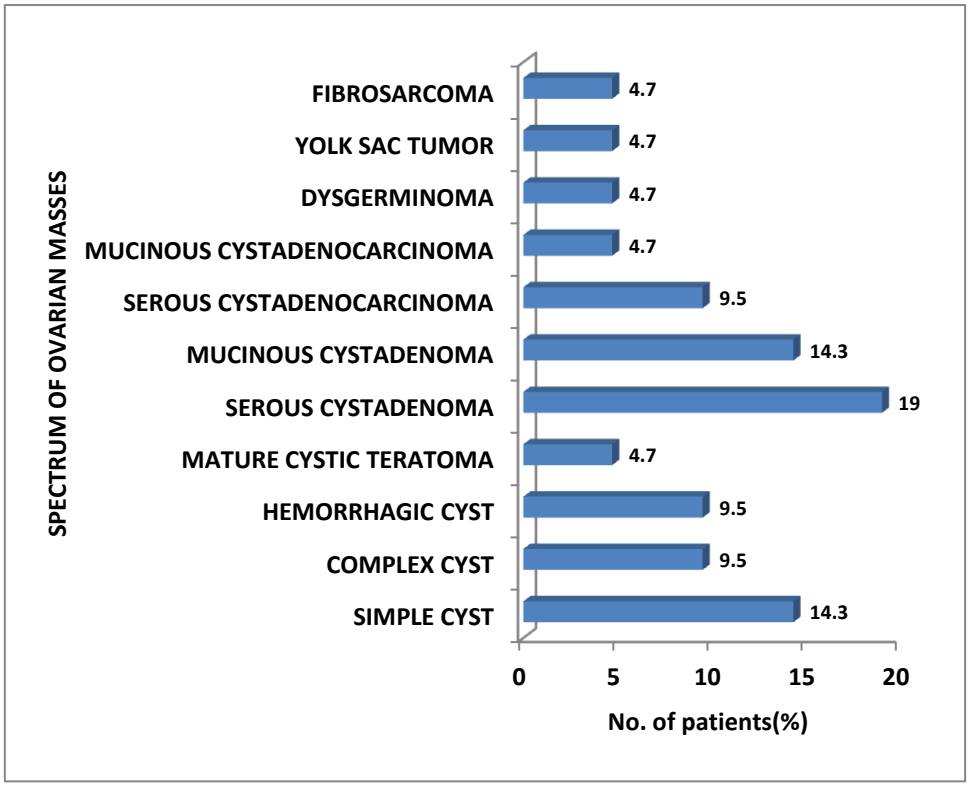


Figure 22 – Spectrum of ovarian masses

Among 21 ovarian masses, serous cystadenoma was the most common lesion accounting for 19 %. Next common is simple cyst accounting to 14.3%.

Table 19 – Wall thickness in ovarian masses

Wall thickness	USG		CT	
	Benign	**Malignant**	**Benign**	**Malignant**
> 3mm	02(15.4%)	02(40%)	02(15.4%)	03(50%)
< 3 mm	11(84.6%)	01(60%)	11(84.6%)	-
NA (solid)	02	03(20%)	-	03(50%)
Total	**13**	**06**	**13**	**06**
Chi square test	X^2=23.378 p=0.0007 HS			
HS: Highly significant				

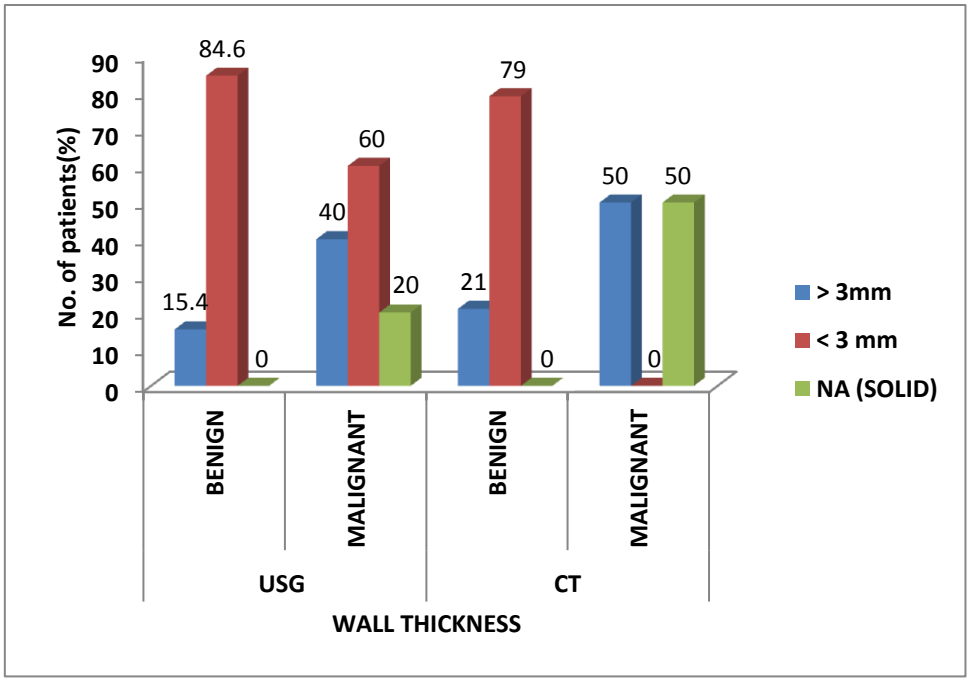


Figure 23 – Wall thickness in ovarian masses

Chi square test p<0.001 (highly significant) stating that -

- all malignant cystic neoplasms have wall thickness of > 3mm
- among 13 benign lesions (non-neoplastic & benign neoplastic) only 2 lesions have wall thickness of >3mm, rest having <3mm.

Table 20 – Septal thickness in ovarian masses

Septal thickness	USG		CT	
	Benign	**Malignant**	**Benign**	**Malignant**
> 3mm	02(15.4%)	02(33.3%)	02(14.3)	03(50)
< 3 mm	08(61.5%)	01(16.6%)	08(61.5)	-
No septa	05(33.3%)	03(50%)	05(33.3%)	03(50)
Total	**15**	**06**	**15**	**06**
Chi square test	X^2=8.916 p=0.0304 Sign			
Sign: significant association				

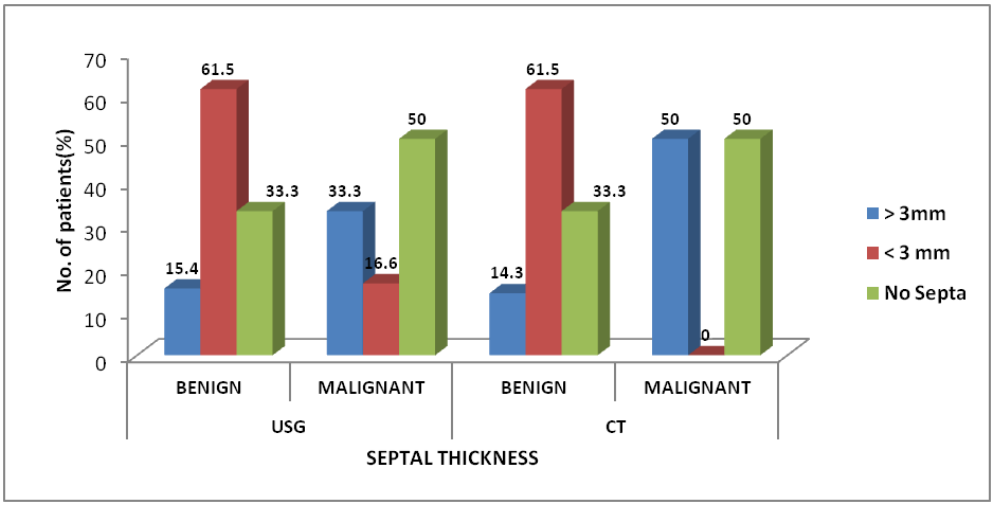


Figure 24 – Septal thickness of ovarian masses

Chi square test $p<0.05$ (significant) stating that -

- all malignant cystic neoplasms have septal thickness of > 3mm
- among 15 benign lesions (non-neoplastic & benign neoplastic) 8 lesions having septal thickness <3mm accounting to 61.5%, only 2 lesions have >3mm & 5 lesions having no septa.

Table 21 – Inner wall irregularities in ovarian masses

Inner wall	USG		CT	
	Benign	**Malignant**	**Benign**	**Malignant**
Smooth	10(66.6%)	-	09(60%)	-
Papillary projections	03(20%)	01(33.3)	03(20%)	01(33.3)
Mural nodule	-	-	-	01(33.3)
Solid component	02(13.3%)	02(66.7)	03(20%)	01(33.3)
Total	**15**	**03**	**15**	**03**
Chi square test	$X^2=18.663$ p=0.0282 sign			
Sign: significant association				

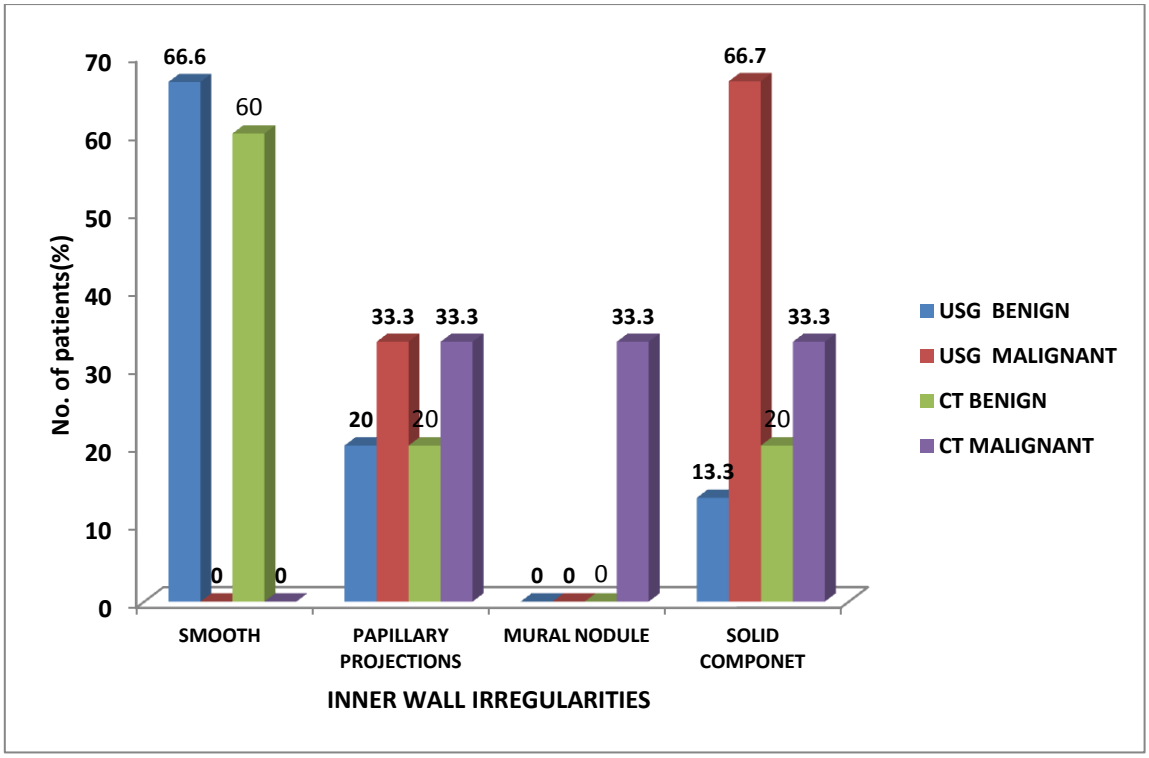


Figure 25 - Inner wall irregularities in ovarian masses

Chi square test $p<0.05$ (significant) stating that -

- among 3 malignant cystic neoplasms all have inner wall irregularities in the form of enhancing solid components, papillary projections or mural nodule
- among 15 benign lesions (non-neoplastic & benign neoplastic) 5 lesions have wall inner wall irregularities on USG, however on CECT, none showed enhancement, as 3 lesions having papillary projections <3 mm & 2 lesions with solid component having blood clot in hemorrhagic cyst

Table 22 – Vascularity in ovarian masses

Vascularity	Benign	Malignant	Total
Central	02(13.33)	04(66.6)	**06(28.6)**
Peripheral	06(40)	01(16.7)	**07(33.3)**
Septal	04(26.7)	01(16.7)	**05(13.8)**
No vascularity	03(20)	0	**03(14.3)**
Total	**15**	**06**	**21**
Chi square test	X^2=6.347 p=0.0959 NS		
NS: Not significant			

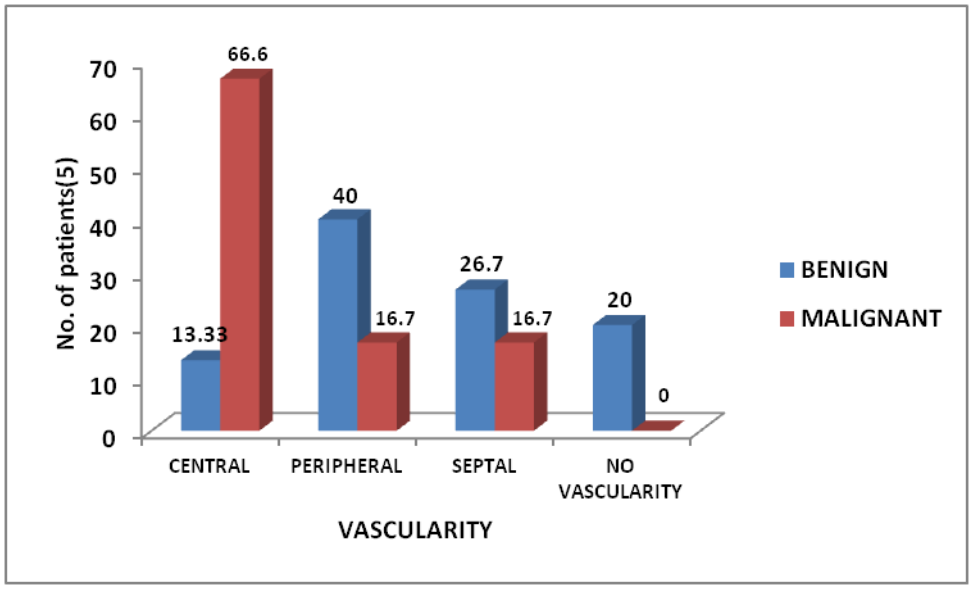


Figure 26 – Vascularity of mass on color Doppler

All the malignant lesions showed vascularity on color Doppler, most of the malignant lesions (66.6%) showed central vascularity. Peripheral vascularity was commonly seen in benign lesions (40%). However Chi square test p>0.05 states that vascularity is not significant in differentiating benign & malignant.

Table 23 – Spectral Doppler (RI values) in ovarian masses

RI	Benign	Malignant	Total
>0.6	09(75)	01(16.6)	**10(55.6%)**
<0.6	03(25)	05(83.3)	**08(44.4%)**
Total	**12**	**06**	**18**
Chi square test	**X^2=5.513 p=0.0187 HS**		
HS: Highly significant			

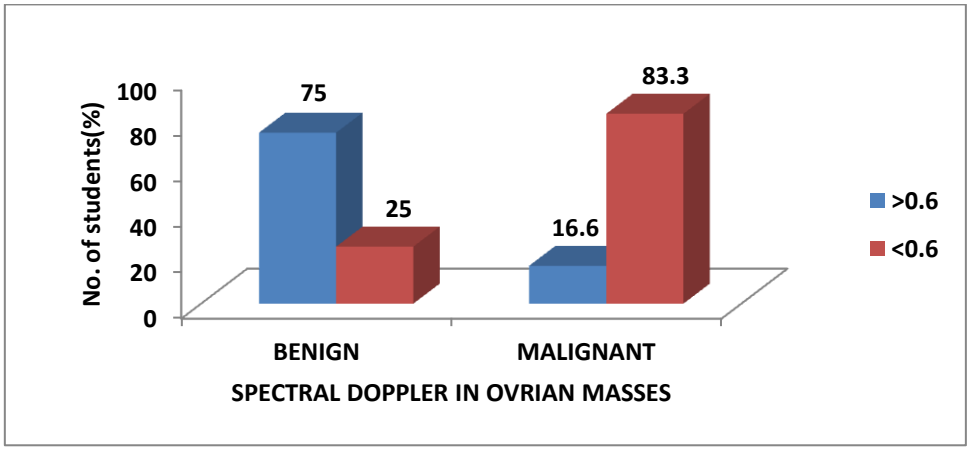


Figure 27 - Spectral Doppler (RI values) in ovarian masses

Chi square test p<0.001 (highly significant) stating that -

- majority of malignant neoplasms (83.3%) have RI <0.6
- among 12 benign lesions showing vascularity, 9 cases have RI > 0.6 accounting to 75%, only 3 cases have RI < 0.6 accounting to 25%

Table 24 – Spectral Doppler (PI values) in ovarian masses

PI	Benign	Malignant	Total
>1.0	08(66.6%)	01(16.6%)	**09(50%)**
<1.0	04(33.3%)	05(83.3%)	**09(50%)**
Total	**12**	**06**	**18**
Chi square test	**X^2=4.00 p=0.0455 S**		
S: significant			

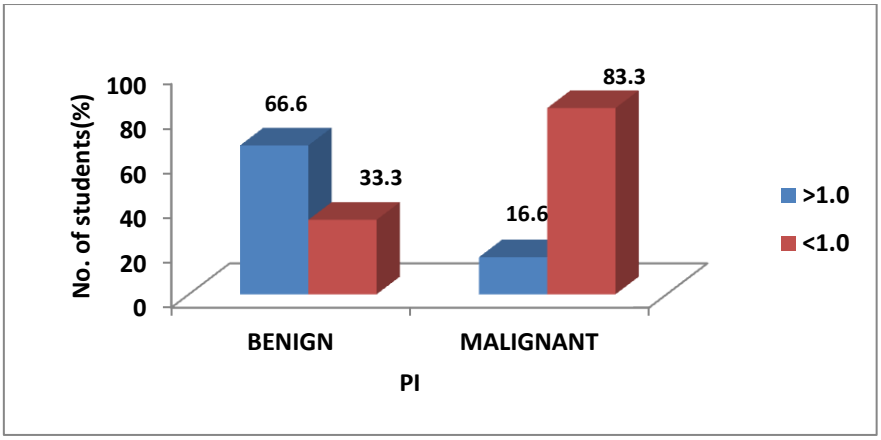


Figure 28 - Spectral Doppler (PI values) in ovarian masses

Chi square test p<0.001 (highly significant) stating that -

- majority of malignant neoplasms (83.3%) have PI <1.0
- among 12 benign lesions showing vascularity, 8 cases have PI > 1.0 accounting to 66.6%, only 4 cases have PI < 1.0 accounting to 33.3%

Table 25 - Benign uterine masses on USG

HPR / USG	Benign	Malignant
Benign	**17**	**01**
Malignant	**04**	**05**

Statistic	Value	95% CI
Sensitivity	**80.95%**	**58.09% to 94.55%**
Specificity	**83.33%**	**35.88% to 99.58%**
PPV	**94.44%**	**73.73% to 99.04%**
NPV	**55.56%**	**32.5% to 76.4%**
Accuracy	**81.45%**	**61.70% to 93%**

In my study, USG has a sensitivity of 80.9% & specificity of 83.3 % in diagnosing benign uterine masses (non-malignant & benign neoplasms).

Table 26 - Malignant uterine masses on USG

HPR / USG	Malignant	Benign
Malignant	**05**	**04**
Benign	**01**	**17**

Statistic	Value	95% CI
Sensitivity	**83.33%**	**35.88% to 99.58%**
Specificity	**80.95%**	**58.09% to 94.55%**
PPV	**55.55%**	**35.55% to 76.40%**
NPV	**94.44%**	**73.73% to 99.04%**
Accuracy	**81.48%**	**61.72%to 93.70%**

In my study, USG has a sensitivity of 83.3% & specificity of 80.9% in diagnosing malignant uterine masses.

Table 27 - Benign uterine masses on CT

HPR / CT	Benign	Malignant
Benign	**20**	**01**
Malignant	**01**	**05**

Statistic	Value	95% CI
Sensitivity	**95.24%**	**76.18% to 99.88%**
Specificity	**83.33%**	**35.88% to 95.58%**
PPV	**95.24%**	**76.92% to 99.17%**
NPV	**83.33%**	**41.67% to 97.22%**
Accuracy	**92.59%**	**75.71%to 99.09%**

In my study, CT has a sensitivity of 95.2% & specificity of 83.3% in diagnosing benign uterine masses (non-malignant & benign neoplasms).

Table 28 - Malignant uterine masses on CT

HPR / CT	Malignant	Benign
Malignant	**05**	**01**
Benign	**01**	**20**

Statistic	Value	95% CI
Sensitivity	**83.33%**	**35.88% to 99.58%**
Specificity	**95.24%**	**76.18% to 99.88%**
PPV	**83.33%**	**41.67% to 97.22%**
NPV	**95.24%**	**76.92% to 99.17%**
Accuracy	**92.59%**	**75.71%to 99.09%**

In my study, CT has a sensitivity of 83.3% & specificity of 95.2% in diagnosing malignant uterine masses.

Table 29 - Benign ovarian masses on USG

HPR / USG	Benign	Malignant
Benign	**13**	**01**
Malignant	**02**	**05**

Statistic	Value	95% CI
Sensitivity	**86.67%**	**59.54% to 93.84%**
Specificity	**83.33%**	**35.88% to 99.58%**
PPV	**92.86%**	**68.24% to 98.74 %**
NPV	**71.43%**	**39.59% to 90.51%**
Accuracy	**85.71%**	**63.66% to 96.95 %**

In my study, USG has a sensitivity of 86.6% & specificity of 83.3% in diagnosing benign ovarian masses (non-malignant & benign neoplasms).

Table 30 - Malignant ovarian masses on USG

HPR / USG	Malignant	Benign
Malignant	**05**	**02**
Benign	**01**	**13**

Statistic	Value	95% CI
Sensitivity	**83.33%**	**35.88% to 99.58%**
Specificity	**86.67%**	**59.54% to 98.34%**
PPV	**71.43%**	**39.59% to 90.51 %**
NPV	**92.86%**	**68.24% to 98.74%**
Accuracy	**85.71%**	**63.66% to 96.95 %**

In my study, USG has a sensitivity of 83.3% & specificity of 8% in diagnosing malignant ovarian masses.

Table 31 - Benign Ovarian Masses on CT

HPR / CT	Benign	Malignant
Benign	**14**	**01**
Malignant	**01**	**05**

Statistic	Value	95% CI
Sensitivity	**93.33%**	**68.05% to 99.83%**
Specificity	**83.33%**	**35.88% to 99.58%**
PPV	**93.33%**	**69.95% to 98.93 %**
NPV	**83.33%**	**42.13% to 97.17%**
Accuracy	**90.48%**	**69.62% to 98.83 %**

In my study, CT has a sensitivity of 93.3% & specificity of 83.3% in diagnosing benign ovarian masses (non-malignant & benign neoplasms).

Table 32 - Malignant ovarian masses on CT

HPR / CT	Malignant	Benign
Malignant	**05**	**01**
Benign	**01**	**14**

Statistic	Value	95% CI
Sensitivity	**83.33%**	**35.88% to 99.58%**
Specificity	**93.33%**	**68.05% to 99.83 %**
PPV	**83.33%**	**42.13% to 97.17%**
NPV	**93.33%**	**69.95% to 98.83 %**
Accuracy	**90.48%**	**69.62% to 98.83 %**

In my study, CT has a sensitivity of 83.3 % & specificity of 93.3% in diagnosing malignant ovarian masses.

Table 33 - Pelvic masses on USG

HPR / USG	Benign	Malignant
Benign	**30**	**02**
Malignant	**07**	**11**

Statistic	Value	95% CI
Sensitivity	**81.08%**	**64.84% to 92.04%**
Specificity	**84.62 %**	**54.55% to 98.08%**
PPV	**93.75%**	**80.59% to 98.19%**
NPV	**61.11 %**	**43.68% to 76.10%**
Accuracy	**82.00%**	**68.56% to 91.42%**

In my study, USG has an overall sensitivity of 81% & specificity of 84.6% in diagnosing pelvic masses with an accuracy of 82%.

Table 34 - Pelvic masses on CT

HPR / CT	Benign	Malignant
Benign	**34**	**02**
Malignant	**01**	**13**

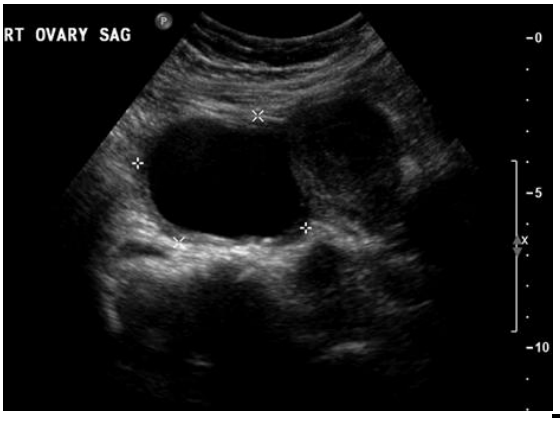
Statistic	Value	95% CI
Sensitivity	**97.06%**	**84.67% to 99.93%**
Specificity	**86.67 %**	**59.54% to 98.34%**
PPV	**94.29%**	**81.93% to 98.36%**
NPV	**92.86 %**	**65.11% to 98.91%**
Accuracy	**93.88%**	**83.13% to 98.72%**

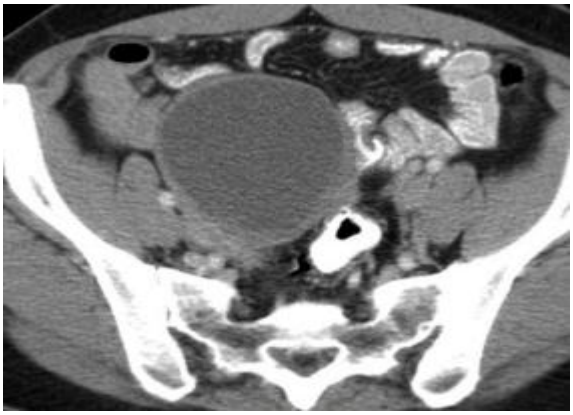
In my study, CT has an overall sensitivity of 97% & specificity of 86.6% in diagnosing pelvic masses with an accuracy of 93.8%.

- Sensitivity of CT (97%) for diagnosing gynaecological masses is more with respect to sensitivity of USG (81%).
- Specificity of CT (86.6%) for diagnosing gynaecological masses is more with respect to sensitivity of USG (84.6%).
- Accuracy for CT scan was 93.8% in diagnosis gynaecological masses is more than accuracy of USG (82%).

IMAGING GALLERY

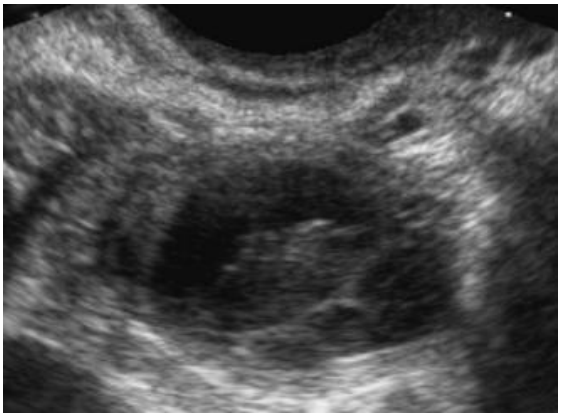
1.Simple cyst (Figures 29 & 30):

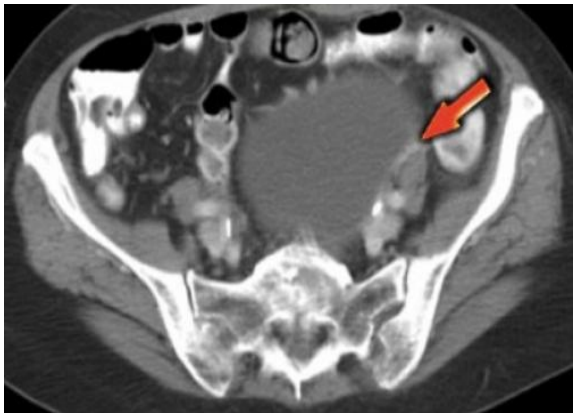




- Fig.29: USG showing a large thin walled anechoic area in right ovary, with no evidence of internal echoes & septations. Showing no vascularity on color Doppler.
- Fig.30: CECT showing a large thin walled non-enhancing hypodense area in right ovary, with no evidence of internal debris or septations.

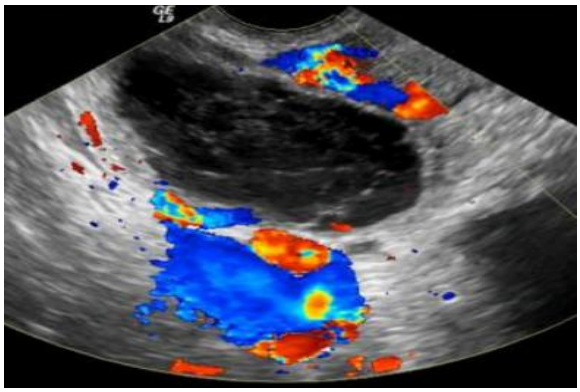
2.Complex cyst (Figures 31 & 32):

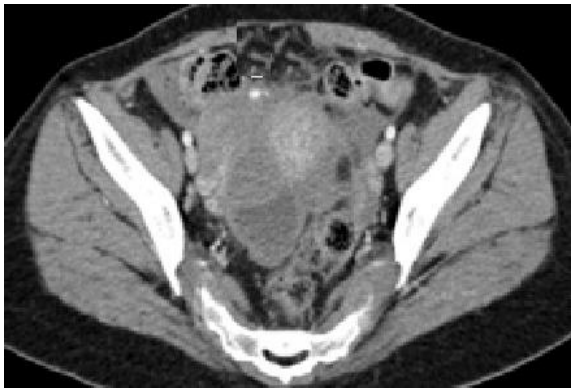




- Fig.31: USG showing a large thin walled anechoic area in left ovary, with septations within. Showing no vascularity on color Doppler.
- Fig.32: CECT showing a large thin walled non-enhancing hypodense area in left ovary, with no evidence of internal debris or septations, looks like simple cyst on CECT.

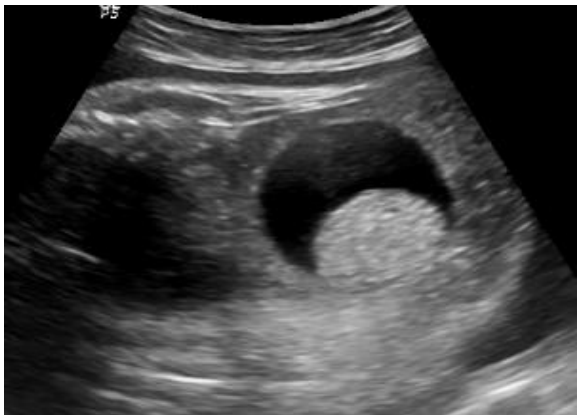
3.Hemorrhagic cyst (Figures 33 & 34):

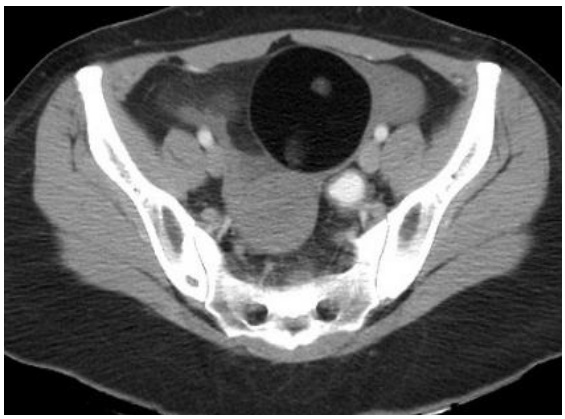




- Fig.33: USG showing a thin walled anechoic area in right ovary, with multiple fine interdigitating septations giving "Fish net appearance". Showing no vascularity on color Doppler.
- Fig.34: CECT showing a large thin walled mildly enhancing hypodense area in right ovary, with few thin non-enhancing septations.

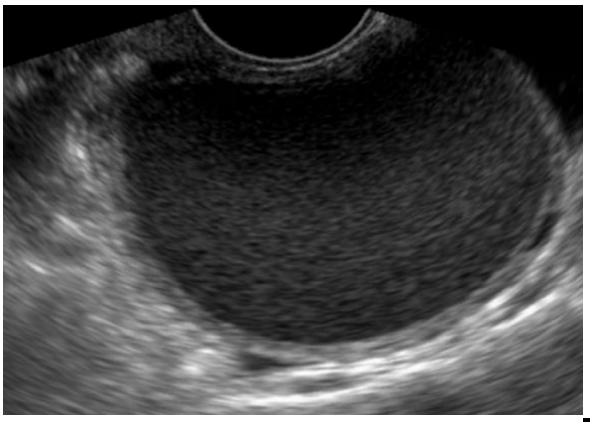
4.Mature cystic teratoma (Figures 35 & 36):

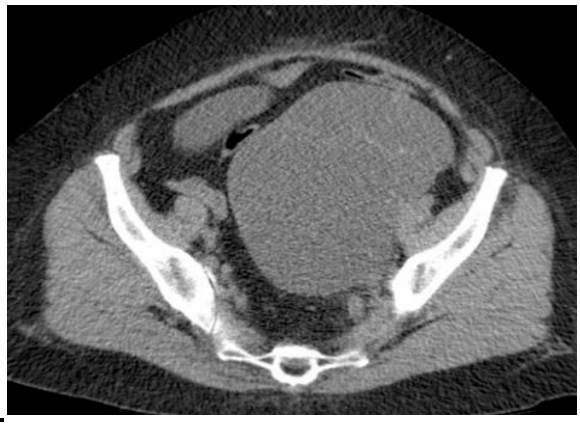




- Fig.35: USG showing a thin walled anechoic area in left ovary, with hyperechoic fat content. Showing no vascularity on color Doppler.
- Fig.36: CECT showing a non-enhancing cystic lesions containing fat content within, noted in left ovary.

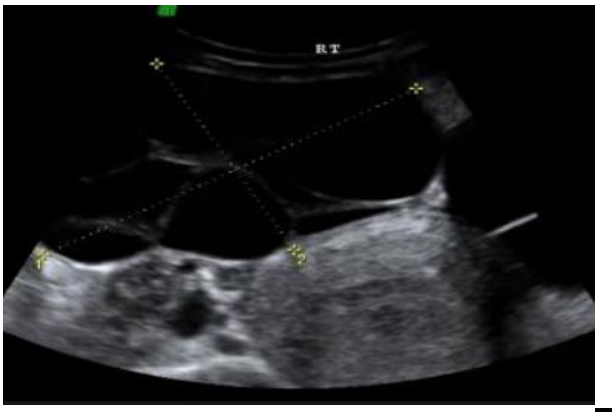
5.Serous cystadenoma (Figures 37 & 38):

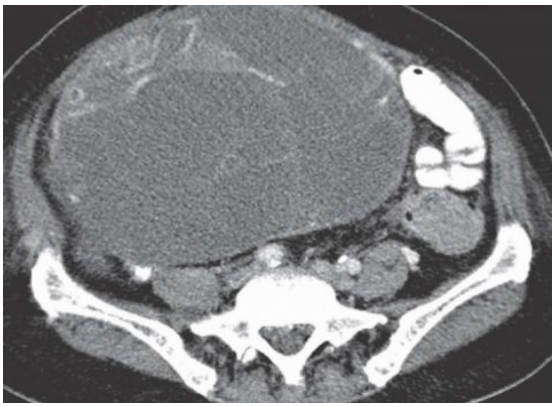




- ❖ Fig.37: USG showing a large thin walled unilocular anechoic area in left ovary, with no evidence of septations within. Showing no vascularity on color Doppler.
- ❖ Fig.38: CECT showing a large non-enhancing unilocular cystic lesion in left ovary.

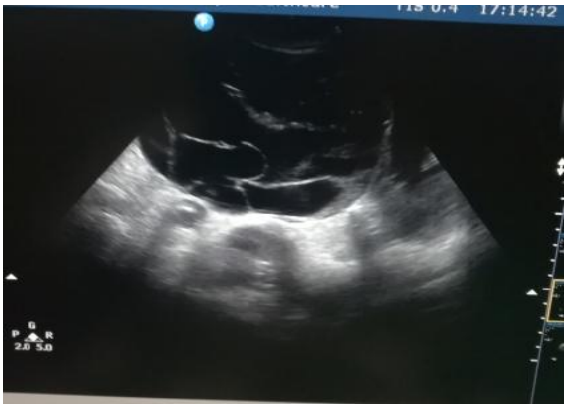
6. Mucinous cystadenoma (Figures 39 & 40):

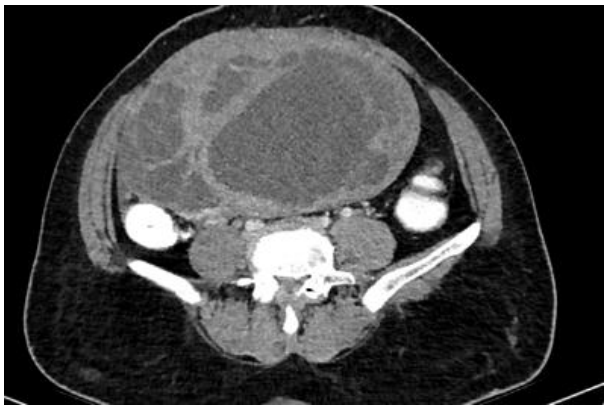




- ❖ Fig.39: USG showing a large multilocular anechoic area in right ovary, with thin multiple septations within. Wall & septa showing vascularity on color Doppler.
- ❖ Fig.40: CECT showing a large peripherally enhancing multilocular cystic lesion in right ovary.

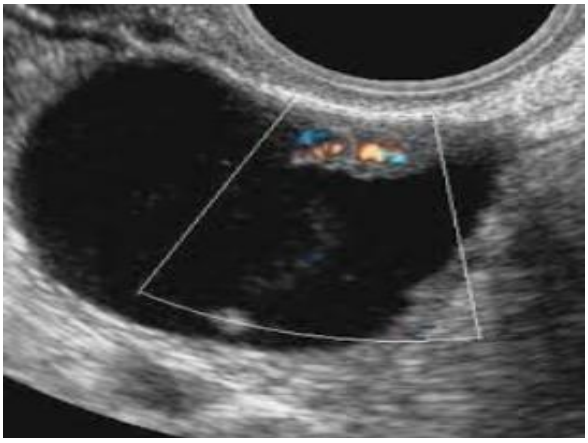
7. Mucinous cystadenocarcinoma (Figures 41 & 42):

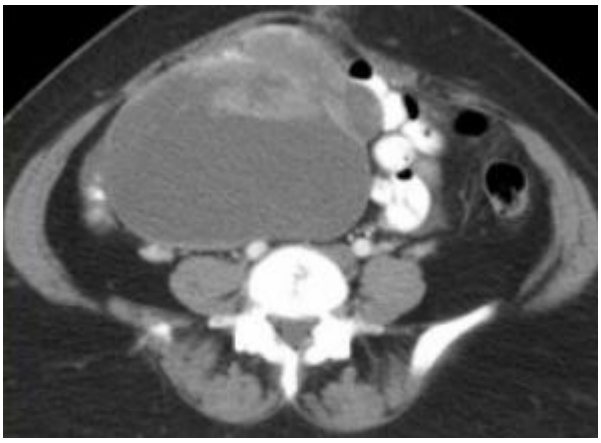




- ❖ Fig.41: USG showing a large multilocular cyst in right ovary, with multiple thick septations & solid component within. Solid component & septa showing vascularity on color Doppler.
- ❖ Fig.42: CECT showing a large multilocular cystic lesion in right ovary, showing enhancement of wall, septa & solid components.

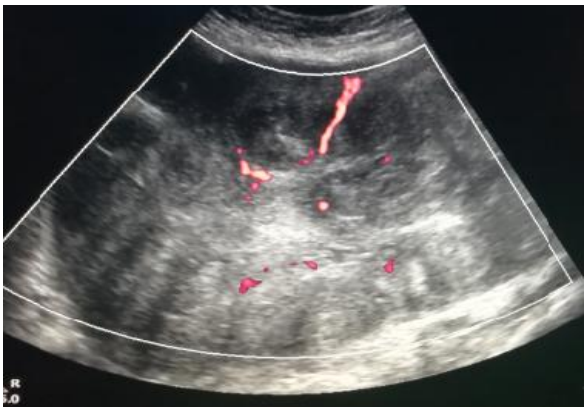
8. Serous cystadenocarcinoma (Figures 43 & 44):

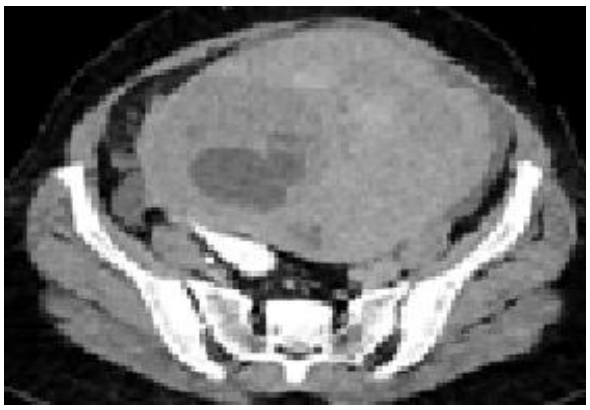




- ❖ Fig.43: USG showing a large unilocular cyst in right ovary, with vascular mural nodule within.
- ❖ Fig.44: CECT showing a large unilocular cystic lesion in right ovary, with enhancing mural nodule within.

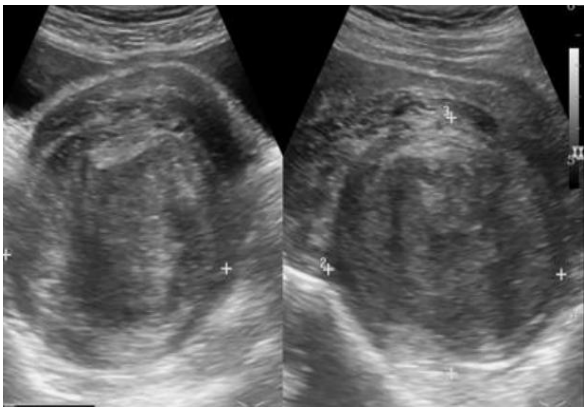
9. Solid ovarian neoplasm (Figures 45 & 46):

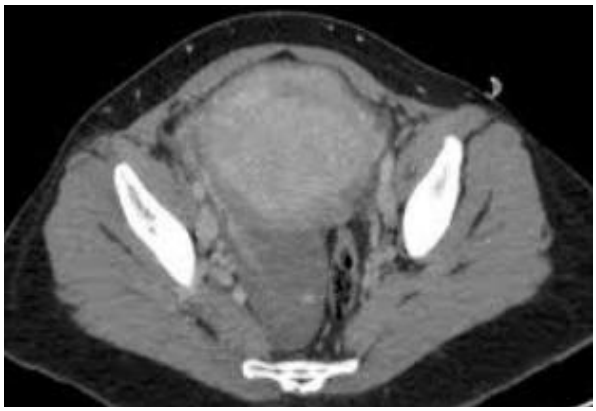




- Fig.45: USG showing a large solid lesion in pelvis, with few cystic areas within & internal vascularity on color Doppler.
- Fig.46: CECT showing a large solid lesion in pelvis showing heterogenous enhancement with few non-enhancing areas within.

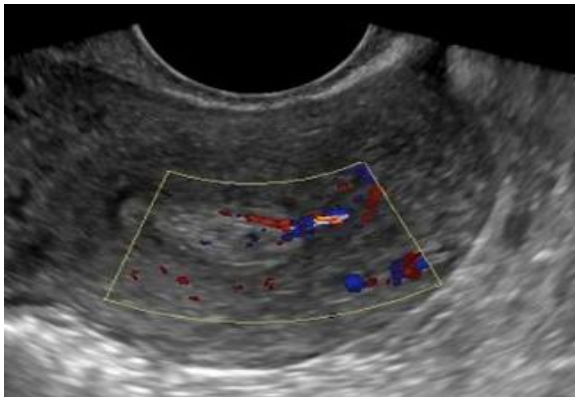
10. Uterine fibroid (Figures 47 & 48):

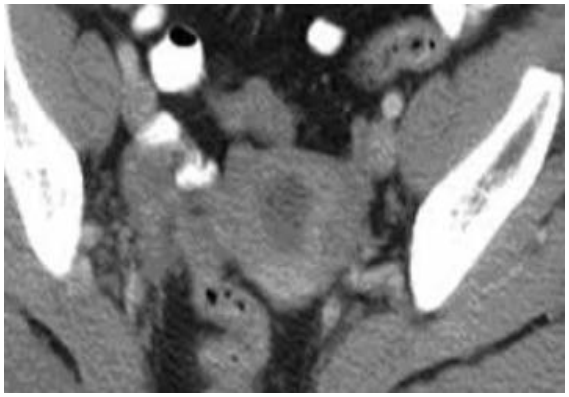




- Fig.47: USG shows a well defined heteroechoic lesion arising from fundus of uterus with peripheral vascularity on color Doppler.
- Fig.48: CECT showing a well defined heterogenous soft tissue density lesion arising from fundus of uterus showing heterogenous enhancement.

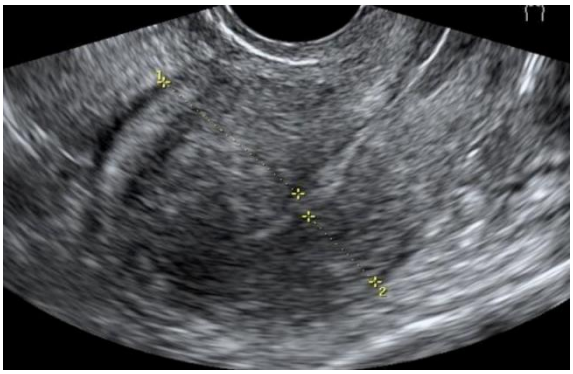
11. Endometrial polyp (Figures 49 & 50):

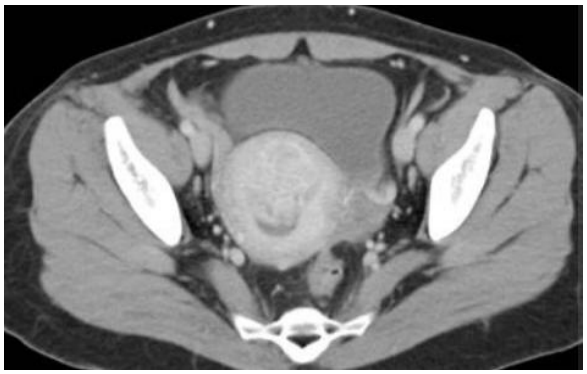




- Fig.49: USG shows a well defined polypoidal lesion in the endometrial cavity with a vascular pedicle.
- Fig.50: CECT showing a non-enhancing hypodense polypoidal lesion in the endometrial cavity.

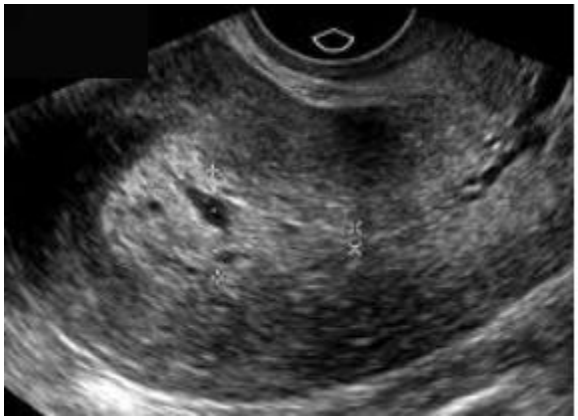
12. Adenomyosis of uterus (Figures 51 & 52):

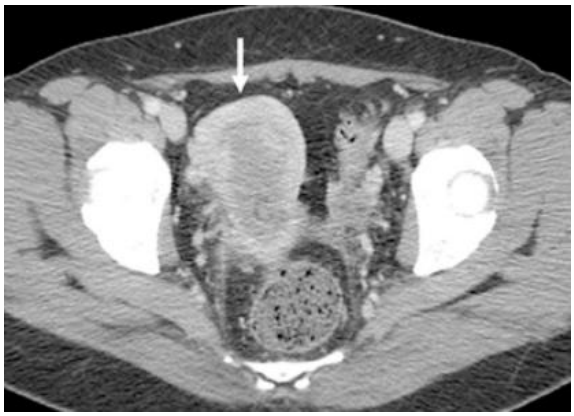




- Fig.51: USG shows bulky uterus with increased thickness of anterior myometrial wall in comparison to posterior wall. It shows heteroechoic echotexture with increased vascularity on color Doppler.
- Fig.52: CECT showing bulky uterus with thickened anterior wall, which shows heterogenous enhancement.

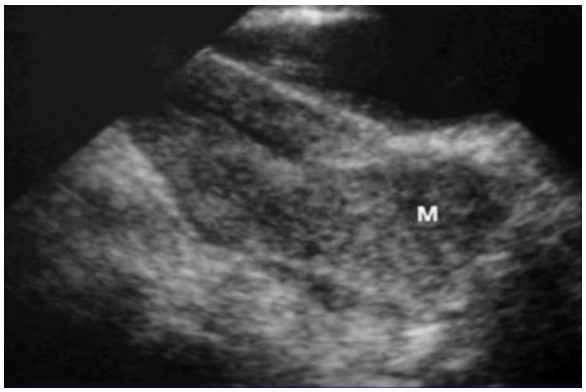
13. Endometrial carcinoma (Figures 53 & 54):

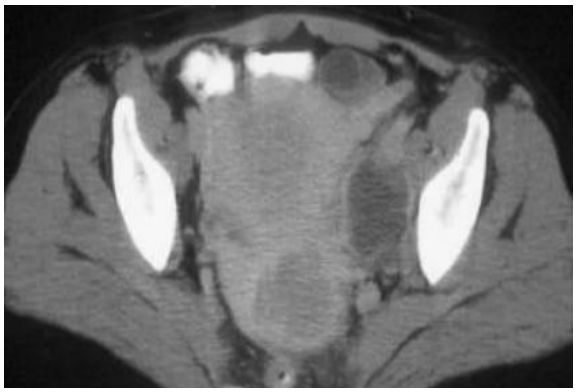




- Fig.53: USG shows irregularly thickened heteroechoic endometrium with increased vascularity on color Doppler.
- Fig.54: CECT shows diffuse hypo-attenuating irregular thickening of endometrium which shows hypo-enhancement in comparison to myometrium.

14. Cervical carcinoma (Figures 55 & 56):





- Fig.53: USG shows ill defined isoechoic mass lesion in the cervix involving both anterior & posterior lips. It showed increased vascularity on color Doppler.
- Fig.54: CECT shows bulky cervix with heterogenous enhancement & few non-enhancing areas within.

DISCUSSION

A total of 50 patients referred for gynaecological masses were studied using both USG & MDCT which included uterine, ovarian, adnexal & vaginal masses.

Ultrasound has been utilized as a first screening & imaging modality in evaluating and detecting pelvic masses. Advantages of USG are - it is safe; non invasive and less expensive [62].

USG is the initial investigation for examining female pelvic masses. Ideally, both TAS & TVS are performed. TVS is more sensitive in diagnosing of small pelvic mass. TAS often have limited value if the patient is obese, TAS scanning is preferred to TVS [63].

DEMOGRAPHICS:

Majority of study population (60%) are in the age group of 31 - 50 years. Mean age of patients in this study was ~49years (18 - 80years). 70% of females were in premenopausal age group & only 30% in postmenopausal age group.

These findings are comparable to study done by Shobha S Pillai in which there were 65% cases in 31-50 years age group & 72.8% were pre-menopausal [64].

Out of 50 cases, majority of the masses (54%) were originating from uterus followed by 42% from ovary, least from fallopian tube & vagina (2% each).

These findings are comparable to a study done by Gupta et al, in which there were 32 % cases arising from uterus, 42% arising from ovaries & 2% [65].

Uterine masses -

Of the 50 cases, most common masses were fibroids (36%). This finding is also comparable to Shobha S Pillai's study [64].

Fibroids are the most common uterine masses composed of uterine smooth muscles & some amount of fibrous tissue [65].

Out of total 18 cases of fibroids, 04 cases posed difficulties in diagnosis on USG, as the

origin of the mass could not be localized to the uterus or ovary. 03 cases were localized to uterine origin on CT, while one case reported as cervical fibroid was proven to be malignant on histopathology.

Out of 18 cases, 08 were intramural fibroids, 05 cases were subserosal, 02 cases were submucosal & 03 were pedunculated fibroids. It is comparable to a study by Eze et al [66].

In this study, there were 04% cases of adenomyosis diagnosed, which was comparable to the study done by Gupta et al [65].

Adenomyosis causes enlargement of uterus which differs from fibroid related enlargement as in adenomyosis, uterinr contour is maintained, which will be lost in case of fibroid. Focal areas of reduced echogenicity with thickened myometrium or a heterogenous appearance of myometrium is seen in about 75% cases. Other features indicative of adenomyosis are loss of definition of endo-myometrial junction, the presence of myometrial cysts (< 5 mm) (seen in upto 50% cases), echogenic lines / spots within myometrium [67.]

04 cases of cervical carcinoma (08%) & 02 cases of endometrial carcinoma (04%) were diagnosed in this study. This is comparable to a study done by Gupta et al, in which there were 8 % cases of carcinoma cervix & 06% cases of endometrial carcinoma [65].

01 case of endometrial polyp (02%) was diagnosed on both USG & CT, which is comparable to study by Shobha S pillai [64].

Charles Et al stated in their study that sonographically enlarged uterus in postmenopausal females is indicator of malignancy taking upper limit of antero posterior diameter 3cm and length 8cm [68].

Endometrial carcinoma is seen on USG as thickening of endometrium. Invasion of myometrial is suspected by the loss of subendometrial halo or by the heterogenous echotexture of myometrium with areas of increased echogenecity noted dispersed within the myometrium [69].

On CECT endometrial cancer is usually slightly lower in attenuation than myometrium.

Distant metastases are seen most commonly in the extrapelvic lymph nodes & peritoneum. Peritoneal disease manifests as peritoneal thickening, nodules, soft tissue masses and ascites [69].

On USG, carcinoma cervix is seen as heterogeneously hypoechoic mass showing increased vascularity on color Doppler. Although cervical carcinoma is clinically staged, USG can be an adjunct by demonstrating -

size (<4 cm or >4 cm), invasion to parametrial/ vagina / adjacent organs (bladder & bowel) and hydronephrosis (implies stage IIIB) [70].

On CECT, primary tumor can be seen as hypo to isoenhancing to normal cervical parenchyma [70].

Ovarian masses –

In this study, there were 21 ovarian masses, out of which 07 were non-neoplastic, 08 were benign neoplasms & 06 were malignant. 07 non-neoplasic lesions were well identified on both USG & CT. On USG, 06 were diagnosed as benign neoplasms & 05 were malignant, while 03 cases were indeterminate. Out of 03 indeterminate cases, 01 was proved benign neoplasm (serous cystadenoma) & 01 (serous cystadenocarcinoma) was proved malignant mass. While 01 case was indeterminate on CT, which was proved as benign lesion (mucinous cystadenoma) on histopathology.

Pelvic ultrasonography (US) remains the most frequently used imaging modality to detect & characterize ovarian masses. Evaluation of ovarian masses is mainly aimed at distinguishing benign & malignant masses. Around 90% of ovarian masses are adequately characterized with USG alone [71].

In general, USG features indicating malignancy include – solid components (particularly if there is visible flow in it at Doppler evaluation), thick septa and ascites. Other features of lesser importance which have been associated with malignancy include – size of the mass, wall

thickness and Doppler US characteristics (PI & RI values) [71].

Septations in cystic ovarian mass are likely to indicate malignancy if they are > 3 mm in thickness or have vascularity on color Doppler [72].

Out of 21 cases, 03 were solid in consistency, 04 cases were solid-cystic, 08 were unilocular cysts & 06 were multilocular cysts. One of the unilocular cyst was malignant & 02 of multicular cysts were benign. All 03 solid masses were malignant. Hence, consistency of ovarian masses can help in characterisation of benign & malignant masses.

In a study by Mc Donald et al., they proved risk of malignancy is very low in unilocular cystic ovarian tumors. This morphology was present in 31% adnexal tumors, among them no patient had borderline or invasive malignancy [73].

Out of 18 cystic ovarian lesions, 13 benign lesions & 01 malignant lesions had <3mm wall on USG & 13 benign lesions & none of the malignant lesions had <3 mm wall on CT. While wall thickness is >3mm in 02 benign lesions, both were hemorrhagic cysts. >3 mm wall is seen in 02 malignant lesions on USG & 03 malignant lesions on CT. Wall thickness of >3 mm is reliable indicator for characterisation of benign & malignant masses.

Out of 10 multilocular cystic ovarian lesions, 08 benign lesions & 01 malignant lesions had <3mm septal on USG & 08 benign lesions & none of the malignant lesions had <3 mm septal thickness on CT. While septal thickness is >3mm in 02 benign lesions, both were hemorrhagic cysts. >3 mm septal is seen in 02 malignant lesions on USG & 03 malignant lesions on CT. Septal thickness of >3 mm is reliable indicator for characterisation of benign & malignant masses.

USG demonstration of solid component in a cystic mass is the most important predictor of malignancy & malignancy is unlikely in the absence of solid component [74].

Description of the inner wall irregularities varies - papillary projection, excrescence, solid component and nodule. The differentiation between wall irregularity & small papillary projections can be difficult on USG [72].

Inner wall irregularities were present in all the cystic malignancies, while 02 of the benign lesions also had solid components on USG. On CT, solid components in malignant lesions showed enhancement, while solid components in benign lesions did not show enhancement.

In our study, 04 cases had ascites, 03 cases were ovarian malignancies, 01 was cervical carcinoma. 02 cases had mild fluid in cul-de-sac, 01 was hemorrhagic cyst & other was tubo-ovarian abscess.

Ascites is an indirect indicator of malignancy which is commonly seen with peritoneal tumor spread. Ascites allows better visualization of peritoneal implants [75].

A small amount of fluid is normal in cul-de-sac in premenopausal women. Increased risk of malignancy has been reported if fluid in cul-de-sac measures > 15 mm in AP dimension [76].

Hence presence of ascites was specific for malignancy.

In this study, color Doppler did not prove to be a reliable indicator in characterisation of ovarian masses as both benign & malignant masses showed vascularity.

However, spectral Doppler was useful in characterizing ovarian masses. PI < 1.0 was seen in 83.3% of malignant cases, while it is seen only in 33.3% of benign cases. RI < 0.6 was seen in 83.3 % malignant cases, while only in 25% cases of benign lesions. These findings are comparable to study done by Dharita S et al. In a study by Dharita et al., adnexal masses were evaluated using color Doppler, PI and RI for malignancy, color Doppler showed vascularity in 97.5 % of malignant masses & only 68.1 % of benign masses. Study showed, PI < 1.0 in 87.5 % of malignant tumors in contrast to only 4.54 % of benign tumors and RI < 0.6 in 82.5 % of malignant tumors in contrast to only 6.81 % of benign tumors [77].

Using cut-off of PI<0.8 & RI<0.4, Kurjak et al. showed high sensitivity and specificity in postmenopausal women [78].

After USG, CT is the next most common used imaging modality used for imaging the female reproductive system. It shows significant features in the characterization of the adnexal masses, and is superior to USG and has very high degree of accuracy in diagnosis [79].

In a study by oztoprak et al., they proved that presence of 3 or more CT criteria among the 8 criteria - tumoral diameter (>50 mm), thick septa, wall thickness, solid component, contrast involvement, invasion, ascites and bilaterality, can suspect malignancy in ovarian masses with 76% sensitivity & 70%specificity [79].

In a study conducted by Zhang et al., A solid ovarian mass was more likely to be malignant; likelihood of malignancy was still high if the solid mass was heterogeneous with irregular contour. Other findings, like pleural effusion, ascites, peritoneal implants and lymphadenopathy, were also predictive of malignancy in ovarian masses. For cystic masses, multilocularity, focal cystic wall thickening, irregular cystic walls, presence of vegetations, diffusely or focally thickened and irregular septations are the features that arise suspicion for malignancy [80].

Even CT has low false-negative rate in diagnosis of malignancy in adnexal lesions (8% on a per-lesion basis and 0% on a per-patient basis), certain benign lesions such as cystadenoma / cystadenofibromas, hemorrhagic/ corpus luteum cysts or endometriosis can have complex appearance which mimics a malignant tumor & are difficult to differentiate from malignant lesions based on their CT appearance [80].

In another study by Tsili et al, CT features suggestive of benignity were: a lesion size of less than 4 cm, entirely cystic components, lack of internal wall structures, a wall thickness of < 3 mm & absence of ascites / invasive disease / peritoneal metastases / lymphadenopathy [81].

Primary features suggestive of malignancy in an ovarian mass were: size > 4 cm, bilateral adnexal masses, a mass partly cystic and solid, solid components enhancing after contrast administration & presence of necrotic areas within a solid tumor. In cystic and solid-cystic masses, multilocularity & enhancement of the wall or septa were important in the characterization of ovarian masses. The presence of an irregular, thick wall or septum (>3mm), enhancing papillary projections, were indicative of malignancy. Ancillary findings like pelvic organ / pelvic sidewall invasion, ascites, peritoneal metastases &

lymphadenopathy were used to diagnose malignancy. Ovarian mass was characterized as malignant if at least two primary criteria or one primary and one ancillary finding were present [81].

Fat attenuation within a cyst, with or without calcification in the wall was considered diagnostic of a mature cystic teratoma [82].

Comparison of sensitivity & specificity of USG & CT in my study with other studies in diagnosing pelvic masses –

Table 35 – Comparison of USG sensitivity & specificity

Study series for USG	Sensitivity	Specificity
Present Study	81.08%	84.62%
Gupta et al	98%	97.4%
Firoozabadi	79.02%	85.6%

The sensitivity & specificity of USG in diagnosis of pelvic masses in my study are comparable to study by Firoozabadi et al.

Table 36 – Comparison of CT sensitivity & specificity

Study series for CT	Sensitivity	Specificity
Present Study	97.06%	91.6%
Firoozabadi et al.	79.2%	97.4%
Gatreh et al.	92.8%	88%
Mubarak et al.	97%	91%
Tsili et al.	90%	86.67%

The sensitivity & specificity of CT in diagnosis of pelvic masses in my study are comparable to study by Muabrak et al & are slightly higher than Mubarak et al Tsili et al syudies.

SUMMARY

In this prospective study, a maximum number of patients were in the age group of 31 -40 years, which account for 36%. >70 years age group has least common gynaecological masses representing only 4% cases.

In this study, majority of the cases were in premenopausal age group accounting for 70% & postmenopausal age group are 30%.

In this study, most common masses were from uterus followed by ovarian, least were from adnexa & vaginal. Uterine masses account for 54%, ovarian 42%, adnexa & vaginal both accounting for 2% each.

In this study, majority of cases were benign neoplastic, followed by malignant lesions & least common were non-neoplastic lesion, accounting for 56%, 26% & 18% respectively.

Out of 27 uterine cases, on USG 15 (55.5%) cases were diagnosed as benign masses, 01 (3.7%) case as non-neoplastic, 05 (18.5%) as malignant. 06 (22.3%) cases were indeterminate. While 18 (66.6%) cases were diagnosed as benign masses, 01 (3.7%) case as non-neoplastic, 06 (22.3%) as malignant on CT. 02 (7.4%) cases were indeterminate.

Out of 06 indeterminate cases on USG, 03 cases were proved to be benign on CT & 01 case proved to be malignant. Out of 02 indeterminate cases on CT, 01 case was misdiagnosed as endometrial polyp on both USG & CT, which was proved to be adenomyosis on HPR. Other was cervical mass, which was misdiagnosed as malignant cervical lesion both on USG & CT, but histopathology proved it to be fibroid.

Most common uterine masses were fibroids accounting for 66.6% i;e 18 cases out of 27 uterine masses & least common is endometrial polyp accounting for 3.7% i;e 01 case.

Sensitivity & specificity of USG in diagnosing benign uterine masses was 80.9% & 83.3% respectively. While sensitivity & specificity of CT in diagnosing benign uterine masses was 95.2% & 83.3% respectively.

In this study, there were 06 cases of uterine malignancy, out of which 04 were cervical carcinoma & 02 are endometrial carcinoma. Out of 04 carcinoma cervix cases, 03 were diagnosed o USG, while one was misinterpreted as cervical fibroid on USG, but was proved to be cervical malignancy on CT.

Out of 06 cases of malignancy, all o6 were positive for lymph nodes on CT, 03 had loco-regional invasion & only one case was positive for metastasis to liver & lungs.

USG had a sensitivity of 80.9% & specificity of 83.3 % in diagnosing benign uterine masses, while it has a sensitivity of 83.3% & specificity of 80.9% in diagnosing malignant uterine masses. However, CT had a sensitivity of 95.2% & specificity of 83.3% in diagnosing benign uterine masses while it has a sensitivity of 83.3% & specificity of 95.2% in diagnosing malignant uterine masses.

In this study, there were 21 ovarian masses, out of which 07 were non-neoplastic, 08 were benign neoplasms & 06 were malignant. 07 non-neoplastic lesions were well identified on both USG & CT. On USG, 06 were diagnosed as benign neoplasms & 05 were malignant, while 03 cases were indeterminate. Out of 03 indeterminate cases, 01 was proved benign neoplasm (serous cystadenoma) & 01 (serous cystadenocarcinoma) was proved malignant mass. While 01 case was indeterminate on CT, which was proved as benign lesion (mucinous cystadenoma) on histopathology.

Out of 14 neoplastic cases, epithelial tumors were common accounting to 10 cases 71.5%, 03 were germ cell tumors & 01 was sex cord/stromal cell tumor.

In this study, 06 out of 07 non-neoplastic lesions have size <5cm, only 01 case had 5-10 cm size. While among neoplastic lesions, only 01 benign & 01 malignant cases have size < 5cm.

03 out of 06 malignant neoplasms & 01 0ut of 08 benign neoplasms have >15 cm size. While other benign lesions were between 5-15cm. Hence, in this study, size of masses was not reliable for characterisation of benign & malignant masses.

Out of 21 cases, 03 were solid in consistency, o4 cases were solid-cystic, 08 were unilocular cysts & 06 were multilocular cysts. One of the unilocular cyst was malignant & 02 of multicular cysts were benign. All 03 solid masses were malignant. Hence, consistency of ovarian masses can help in characterisation of benign & malignant masses.

Out of 18 cystic ovarian lesions, 13 benign lesions & 01 malignant lesions had <3mm wall on USG & 13 benign lesions & none of the malignant lesions had <3 mm wall on CT. While wall thickness is >3mm in 02 benign lesions, both were hemorrhagic cysts. >3 mm wall is seen in 02 malignant lesions on USG & 03 malignant lesions on CT. Wall thickness of >3 mm is reliable indicator for characterisation of benign & malignant masses.

Out of 10 multilocular cystic ovarian lesions, 08 benign lesions & 01 malignant lesions had <3mm septal on USG & 08 benign lesions & none of the malignant lesions had <3 mm septal on CT. While septal thickness is >3mm in 02 benign lesions, both were hemorrhagic cysts. >3 mm septal is seen in 02 malignant lesions on USG & 03 malignant lesions on CT. Septal thickness of >3 mm is reliable indicator for characterisation of benign & malignant masses.

Inner wall irregularities were present in all the cystic malignancies, while 02 of the benign lesions also had solid components on USG. On CT, solid components in malignant lesions showed enhancement, while solid components in benign lesions did not show enhancement.

In this study, color Doppler did not prove to be a reliable indicator in characterisation of ovarian masses as both benign & malignant masses showed vascularity.

However, spectral Doppler was useful in characterizing ovarian masses. PI < 1.0 was seen in 83.3% of malignant cases, while it is seen only in 33.3% of benign cases. RI < 0.6 was seen in 83.3 % malignant cases, while only in 25% cases of benign lesions.

USG had 86.6% sensitivity & 83.3 % specificity in diagnosing benign ovarian masses, while it has 83.3% sensitivity & 86.6% specificity in diagnosing malignant ovarian masses. However, CT had 93.3% sensitivity & 83.3% specificity in diagnosing benign ovarian masses while it has 83.3% sensitivity & 93.3% specificity in diagnosing malignant ovarian masses.

In this study, one case of tubo-ovarian abscess was diagnosed, on USG it was misdiagnosed as a complex cyst, CT proved the correct diagnosis.

In this study, one case of carcinoma vagina was encountered, USG was not conclusive in differentiating it as either arising from cervix or vagina, CT proved it to be arising from vagina, which had loco-regional invasion, lymph nodes, ascites & also distant metastasis to liver.

USG had overall sensitivity of 81% & specificity of 84.6% in diagnosing pelvic masses with 82% accuracy, while CT has a sensitivity of 97% & specificity of 86.6% in diagnosing pelvic masses with an accuracy of 93.8%.

CONCLUSION

A prospective study of 50 patients was carried out in suspected / clinically proved cases of gynaecological masses with USG & MDCT.

The aims of the study were to evaluate and characterize gynaecological masses using USG & MDCT.

Following are the conclusions of the study –

1. Pelvic masses were more common in the age group 31- 50 years, common in premenopausal women.
2. Most common lesions were from uterine origin.
3. Most common were benign neoplastic masses.
4. Malignant masses have a larger size in comparison to benign masses.
5. All solid ovarian masses are malignant. Multilocularity was common feature of malignant lesions.
6. USG is the primary imaging modality for detecting / evaluating gynecological masses.
7. USG has good sensitivity & specificity in diagnosing & characterising the gynaecological masses.
8. USG is the best modality to differentiate between the solid & cystic lesions.
9. Morphological characteristics of the mass can be well assessed on USG.
10. Wall & septal thickness of > 3 mm showing vascularity, generally indicate malignancy in a gynaecological mass.
11. Inner wall irregularities like solid components, papillary projections & mural nodules showing vascularity are definite indicators of malignancy.
12. Vascularity as such is not a poor indicator of malignancy. Spectral Doppler with RI <0.6 & PI <1.0 are better indicators of malignancy.
13. Presence of ascites, lymph nodes, loco-regional invasion & metastasis are also

indicators of malignancy.

14. MDCT is a detailed imaging modality in USG proven cases of gynaceological masses.
15. MDCT has a better resolution, three dimensional reconstruction & global view of the whole of the pelvis & abdomen in comparison to USG. CECT has an added advantage of
16. MDCT is more sensitive in identifying wall & septal thickness in comparison to USG.
17. MDCT is more accurate in detecting papillary projections & mural nodules in malignant masses.
18. MDCT has a better sensitivity & specificity in comparison to USG in diagnosis & characterization of pelvic masses.

Limitations of this study -

1. Radiation exposure during MDCT.
2. Even though MDCT has better sensitivity & specificity than USG, it lacks soft tissue characterization, which can be vsiualsied better on MRI.
3. MRI is highly sensitive in identifying small grade I cervical carcinomas, which are confined to cervix.
4. MRI is helpful in identifying loco-regional invasion without contrast administration.

However MDCT has following advantages over MRI -

1. Easy availability at small places
2. Less expensive
3. Most important is, MDCT is better in evaluating lymph nodes, peritoneal deposits & distant metastasis.

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ANNEXURES

CASE SHEET PROFORMA

NAME:

AGE:

SEX:

IP/OP NO:

CHIEF COMPLAINTS:

DETAILED HISTORY:

RELEVANT CLINICAL EXAMINATION FINDINGS:

GENERAL EXAMINATION:

PER ABDOMINAL EXAMINATION:

PER SPECULUM EXAMINATION:

BIMANUAL EXAMINATION:

PROVISIONAL CLINICAL DIAGNOSIS:

RADIOLOGICAL FINDINGS:

USG FINDINGS –

Characteristics	Yes	no
Size > 5 cm		
Well defined / regular margin		
Wall thickness > 3mm		
Bilaterality		
Cystic		
Multilocularity		
Solid components within		
Solid mass with cystic components/necrotic areas		
Septa (if yes, fine or thick)		
Vascularity		
High resistance flow on Doppler		
POD fluid		
Ascites		

MDCT FINDINGS –

Characteristics	Yes	no
Size > 5 cm		
Well defined / regular margin		
Wall thickness > 3mm		
Bilaterality		
Cystic		
Multilocularity		
Solid components within		
Solid mass with cystic components/necrotic areas		
Septa (if yes, fine or thick)		
Enhancement pattern opcs		
Ascites		
Local / regional invasion		
Lymph nodes involvement		

FINAL DIAGNOSIS:

HPR REPORT:

KEY TO MASTER CHART

CECT	-	CONTRAST ENHANCED COMPUTERISED TOMOGRAPHY
ET	-	ENDOMETRIAL THICKNESS
EX	-	EXAMPLE
HETERO	-	HETEROGENOUS ENHANCEMENT
HOMO	-	HOMOGENOUS ENHANCEMENT
HPV	-	HUMAN PAPILLOMA VIRUS
HU	-	HOUNSFEILD UNITS
HYPO	-	HYPOVASCULAR
IUCD	-	INTRAUTERINE CONTRACEPTIVE DEVICE
MDCT	-	MULTIDETECTOR COMPUTERISED TOMOGRAPHY
MRI	-	MAGNETIC RESONANCE IMAGING
NA	-	NOT APPLICABLE
NON	-	NON-ENHANCING
NECT	-	NON-ENHANCED COMPUTERISED TOMOGRAPHY
PET	-	POSITRON EMISSION TOMOGRAPHY
PI	-	PULSATILITY INDEX
PID	-	PELVIC INFLAMMATORY DISEASE
RI	-	RESISTIVITY INDEX
TAS	-	TRANS ABDOMINAL SCAN
TVS	-	TRANS VAGINAL SCAN