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Original Research Paper

Radio-Diagnosis

A STUDY ON :ROLE OF MRI IN THE EVALUATION OF CLINICALLY SUSPECTED UTERO-OVARIAN LESIONS.

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ABSTRACT Utero-ovarian lesions are one of the commonest pathologies encountered by the clinician and the radiologist in routine day to day practice. Since magnetic resonance imaging (MRI) offers high contrast resolution, provides good tissue characterization, and is capable of multiplanar imaging capabilities, it is becoming a useful tool for the evaluation of female pelvic pathology. Since MRI is more expensive and potentially less readily available than ultrasound or CT scan, it is important to know when patients should undergo MRI. MRI is an important technique in the evaluation of pelvic pathology due to its ability to obtain images with a high soft-tissue contrast resolution and discrimination in multiple planes. It is now the primary technique of choice in the staging of pelvic malignancy, with the exception of staging ovarian malignancy, where CT is the preferred technique.

KEYWORDS :

INTRODUCTION

Utero-ovarian lesions are one of the commonest pathologies encountered by the clinician and the radiologist in routine day to day practice. Since magnetic resonance imaging (MRI) offers high contrast resolution, provides good tissue characterization, and is capable of multiplanar imaging capabilities, it is becoming a useful tool for the evaluation of female pelvic pathology. Since MRI is more expensive and potentially less readily available than ultrasound or CT scan, it is important to know when patients should undergo MRI.

MRI is an important technique in the evaluation of pelvic pathology due to its ability to obtain images with a high soft-tissue contrast resolution and discrimination in multiple planes. It is now the primary technique of choice in the staging of pelvic malignancy, with the exception of staging ovarian malignancy, where CT is the preferred technique.

Ultrasound remains the first line of imaging for the female pelvis with high diagnostic accuracy rates for uterine and ovarian abnormalities. However, the shortcomings with this modality includes limited field of view, obscuration of pelvic organs by the presence of bowel gas, inherent limitation dependent on patient size and its dependence on the skill and experience of the operator.

Since MRI is more expensive and potentially less readily available than USG, it is important to know when patients should undergo MRI. MRI because of its superb soft tissue contrast and direct multiplanar capabilities can better delineate and characterize normal uterine anatomy and focal and diffuse uterine conditions. MRI is non-invasive, has no risk of radiation, requires no anesthesia and is less operator dependent. In patients with infertility, MRI can confirm the presence and extent of a septate uterus and define the fibrous and muscular components. In patients with pelvic pain, MRI is more sensitive and specific than USG for the findings of Adenomyosis.

MRI should be considered for the evaluation of uterine, cervical and adnexal pathology when sonographic characteristics are not definitive to determine the origin of the mass and to determine the likelihood of malignancy, which is highly accurate for identifying the origin of a mass and characterizing its tissue content. Thus, use of MRI will prove to be cost-effective in that it reduces unnecessary surgical procedures by its ability to differentiate benign and malignant lesions accurately.

By using a systemic approach to complex pelvic masses, incorporating the patients clinical and surgical history, and using MRI to identify the anatomic origin, shape, composition, and enhancement pattern of the mass ,a short meaningful differential diagnosis ,and often a definitive diagnosis can be made.

MRI is particularly well suited for the evaluation of the female pelvis because the lack of respiratory motion and the multiplanar imaging ability of MRI.

Historical Perspectives

As early as 1826, Colladon, a Swiss physicist had successfully use an underwater bell to determine the speed of sound in the waters of Lake Geneva. High frequency echo – sounding techniques were developed when the pizo electric effect was discovered by Pierre Curie in 1880. A few scattered enthusiasists recognized the potential of ultrasonic energy to provide information in medical diagnosis after the World War II. The first published work of transmission ultrasound investigation of the brain by Dussik of Austria in the year 1942. The practical technology and applications were developed by Donald and his colleagues in 1950s in Glasgow. Availability of the commercial ultrasound allowed the wider dissemination of the art.

The use of ultrasound in the treatment of patients with rheumatic arthritis was reported in 1953 by Jerome Gerten at University of Colarado. Ludwig systematically explored physical characteristics of ultrasound on various tissues, including beef and organs from dogs and hogs. A simple A scan metal flaw detectors and modifications of this equipment were used by Ludwig to locate gall stones and John Julian Wild at the Technical Research Institute in Minnesota to detect breast masses. Greenwood and General Precision Laboratories made available the commercial —Ultrasonic Locator during 1950. Wild together with his engineer John Read published the first 2D images in 1952 but his efforts were directed to tissue characterization of breast tissue.

Decade of 1960s observed a large number of static scanning machines. The first contact machine developed in America was the Physionics which emanated from Howry's laboratory in Denver and was used for Obstetrics and gynecology scanning Horace Thomason and Ken Gottesfeld. Similar style equipments were built in Vienna by Kretztechnic, in Copehagen by Hewlett Packard and Japan by Aloka. Kretztechnic and Aloka developed transvaginal transducers

in 1960s. Richard Soldner of Siemens developed the first real time scanner. Octason static scanner was developed in 1962 by Commonwealth Acoustic Laboratories. Donald and his team described the early diagnosis of hydatid mole, assessment and growth of the early gestation sac and the diagnosis of early pregnancy complications in 1963. In 1966, Ken Gottesfeld and Denver group published first paper in Placentography.

MRI is relatively new technology where its foundations were begun in the year 1946. Felix and Bloch and Edward Purcell independently developed Magnetic resonance Imaging were later awarded Noble prize in 1952. Till 1970s, the MRI was being used for chemical and physical analysis. In 1971, Raymond Damadian showed that nuclear magnetic relaxation times of tissue and tumours differed motivating scientists to use MRI to study disease. In 1973, Paul Lauterbur published first MRI image in Nature. Later part of 1970s witnessed the first human MRI images. First commercial MRI systems were developed in 1980s. The functional MRI in human beings was demonstrated in 1993.

Anatomy of Female Pelvis

Female Reproductive System:

The female reproductive system encompasses;

- Ovaries (female gonads)
- The uterine (fallopian) tube
- Uterus
- Vagina
- External organs (which are collectively known as vulva or pudendum)

Ovaries:

The ovaries are the female gonads appeared as paired glands. The ovaries produce

1) gametes, secondary oocytes that develop into mature ova after fertilization and 2) hormones, including progesterone and estrogens, inhibin, and relaxin. The ovaries, on either side of the uterus descend to brim of the superior portion of pelvic cavity at the month of development. They are hold by series of ligaments. The broad ligament of uterus, which itself is a part of the parietal peritoneum, adheres to ovaries by a double-layered fold of peritoneum called the mesovarium. The ovaries are anchored to uterus by the ovarian ligament, and the suspensory ligament attached them to pelvic wall. Each ovary consist a hilum, the point of entrance and exit for blood vessels and nerves along which the mesovarium is attached. Each ovary consists of following layers.

- The germinal epithelium
- The tunica albuginea
- The ovarian cortex
- The ovarian medulla.
- Ovarian follicles
- Mature (griffin) follicle.
- Corpus luteum

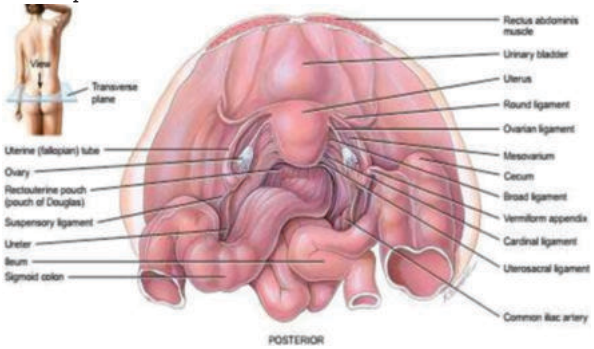


Fig 1: Relative position of ovaries, the uterus and the ligaments that support them.

Uterine tube:

Female pelvic system comprises two uterine (fallopian) tubes or oviducts, which extend laterally from uterus (Fig 2). The tube approximately measure about 10 cm (4 in.) long, situated between the folds of broad ligament of the uterus. They provide the path for sperm to reach an ovum transport secondary oocytes and fertilized ova from ovaries to uterus. The funnel shaped portions of tubes are also known as infundibulum, is near to ovary but open to pelvic cavity. At the end bears the finger like projection known as fimbriae, one of which is attached to lateral end of the ovary.

From the infundibulum the uterine tube further extends medially and eventually inferiorly and links to the superior lateral angle of uterus. The ampulla in uterine tube is widest, longest portion, making up of about the lateral two thirds of its length. The isthmus present in uterine tube is more medial, short, narrow, thick walled portion that attaches to uterus. Histologically it consists of three layers.

1) Mucosa
2) Muscularis
3) Serosa

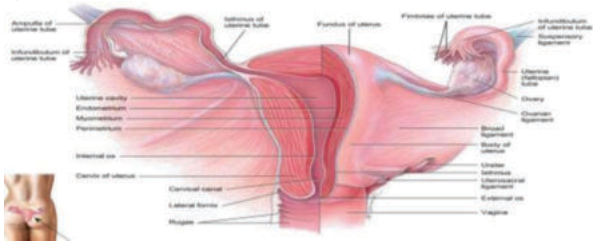


Fig 2: Relationship of uterine tube to ovaries, uterus, and associated structure.

Uterus:

Uterus is site for implantation of fertilized ovum, development of the fetus at the time of pregnancy, and labour. During reproductive cycles when implantation does not occur, the uterus is source of menstrual flow. It is situated between the rectum and urinary bladder, it resemble the shape of inverted pear (Fig 2) In females who never been pregnant, it is about 7.5 cm (3 in) long, 5 cm (2 in) wide, and 2.5 (1 in) thick. The uterus is obtained larger in female who have been recently pregnant, and smaller (atrophied) when sex hormones levels are low, as occurs after menopause.

In anatomic subdivision it include; 1) a domed shaped portion superior to uterine tubes (fundus). 2) A tapering central portions called the body. 3) An inferior narrow portion called the cervix that opens into vagina. Isthmus is present between the body of uterus and cervix, a constricted region about 1 cm (0.5 in.) long. The interior of the body of uterus is known as uterine cavity and the interior of cervix is called as cervical canal. The cervical canal opens into uterine cavity at the internal os and into vagina at external os.

Generally the body of uterus extends anteriorly and superiorly over the urinary bladder in a position called ante flexion. The cervix projects inferiorly and posteriorly and extends to anterior wall of vagina at nearly a right angle. (Fig 3). Several ligaments that are either extension of the parietal peritoneum or fibro muscular cords maintains the position of the uterus (see Fig 2). The paired broad ligaments are double wrap of peritoneum attaching the uterus to either side of pelvic cavity. The paired uterosacral ligaments, also peritoneal extensions, situated on either side of the rectum and connect the uterus to the sacrum. The cardinal (lateral cervical) ligaments are located inferior to the bases of the broad ligaments and extend from the pelvic wall to the cervix and vagina. The round ligaments are bands of fibrous connective tissue between the layers of the broad ligament; they extend from a point on the

uterus just inferior to the uterine tubes to a portion of the labia majora of the external genitalia. Although the ligaments normally maintain the ante flexed position of the uterus, they also allow the uterine body enough movement such that the uterus may become malpositioned. A posterior tilting of the uterus, called retroflexion (retro = backward or behind), is a harmless variation of the normal position of the uterus.

There is often no cause for the condition, but it may occur after childbirth. Histologically the uterus consists of 3 layers of tissue:

1) Perimetrium
2) Myometrium
3) Endmetrium.

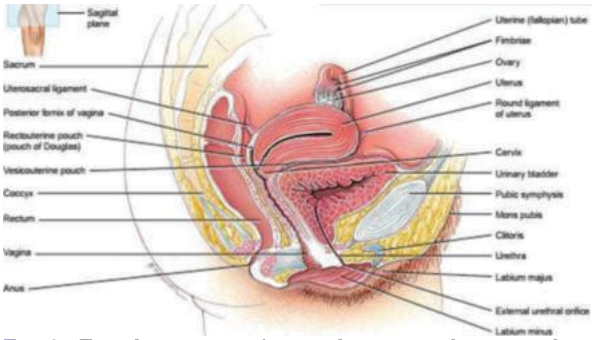


Fig 3: Female organs of reproduction and surrounding structures.

Vagina:

The vagina (sheath) is tubular in shape, 10 cm (4 in.) long fibro-muscular canal lined with mucous membrane that extends from the exterior of the body to uterine cervix (Fig 2 and 3). It is located between the urinary bladder and rectum. Superiorly as well as posteriorly it attaches to uterus. A recess called as fornix (arch or vault) surround the vaginal attachments to the cervix.

The mucosa of vagina is continuous with that of uterus. Histologically it comprises non keratinized stratified squamous epithelium and areolar connective tissue that located in series of transverse fold called rugae. Dendritic cells in mucosa are antigen presenting cells. The mucosa of vagina contains large stores of glycogen, the decomposition of which generates organic acids, which retards the microbial growth as well as harms sperms.

The muscularis is constituted an outer circular layer and an inner longitudinal layer of smooth muscle that can stretch considerably to accommodate the penis during sexual intercourse and during child birth. The adventitia, the outer layer of vagina, consists of areolar connective tissue which anchors vagina to adjacent organs such as the urethra and urinary bladder anteriorly and rectum and anal canal posteriorly.A thin fold of vascularized mucous membrane, called the hymen (membrane), forms a border around and partially closes the inferior end of the vaginal opening to the exterior, the vaginal orifice.

Vulva:

The term vulva or pudendum refers to the external genitals of the female. The vulva consists of; Mons pubis, Labia majora, labia minora and clitoris.

Magnetic Resonance Imaging

Magnetic resonance imaging provides a digital representation of tissue characteristics based on the chemical composition of various tissue types. It takes advantage of the abundant supply of hydrogen atoms (protons) in the body and their interaction with the magnetic fields. The basic technique involves the application of a strong magnetic field to the region of interest and imaging the resultant effect on nuclear hydrogen ions'. The protons of the human body align themselves parallel to the strong, homogenous, static magnetic field produced within the bore of the magnet. Thus the body acquires a slight magnetization that can be indirectly perturbed by application of a radiofrequency (RF) pulse that reorients the protons. Upon removal of the perturbing magnetic field, there is oscillation or resonance of the protons. This is detected as a small current by a surface coil that acts as an antenna. The voltage induced in the coil is measured and stored as digitalized information in the MRI computer. A mathematical technique called 3D Fourier transform allows the data to be converted to an anatomical image5.

The magnetic resonance signal is based on 4 tissue factors:-

1. The proton density of the sample tissue
2. The magnetic relaxation time constants (T1 and T2) of the tissue
3. Motion (blood flow) and
4. Chemical interactions of the protons with the surrounding tissue

These parameters are fixed and governed by the principles of physics as is the strength of the main magnetic field. The T1 relaxation time is the time it takes protons to recover 63% of the equilibrium magnetization parallel to the main magnetic field. The T2 relaxation time is the time it takes for 63% of the transverse magnetization of the perturbed protons to irreversibly disappear, that is, dephase as a function of time.Each tissue has characteristic signal intensity on T1 and T2 weighted images. There are however some parameters that the operator can manipulate to yield the characteristic high soft tissue resolution images for which MRI is calibrated. The time of repetition (TR), time of echo (TE), slice thickness, field of view, resolution, flip angle, localization and sample band width can all be manipulated to this end. TR and TE are two parameters controlled by the operator, which affect the grey scale of the resultant image. The TR is the amount of time between consecutive applications of the RF pulses. The TE is the time between the perturbing RF pulse and the centre of the acquisition period. An image with a short TR and short TE is referred to as a T1 weighted image. By virtue of the short TR; it tends to emphasize the T1 relaxation tissue characteristics. For example, on an image with a short TR, fat (which has a short T1) will be bright, whereas fluid (which has a long T1) will be dark. An image with a long TR and long TE is referred to as a T2 weighted image. By virtue of the long TE, it tends to highlight the T2 differences of the tissue.

The T2 relaxation time is associated with signal dephasing and is the major determinate of tissue contrast. Thus, fluid, which has a long T2 relaxation time, appears brighter than other knee tissues on a long TE image because the other tissues have shorter T2 relaxation times and accentuate quicker.

Pure T1 and T2 weighted images are not possible, as there is some overlap technique .

Advantages of magnetic resonance imaging MRI over other modalities include

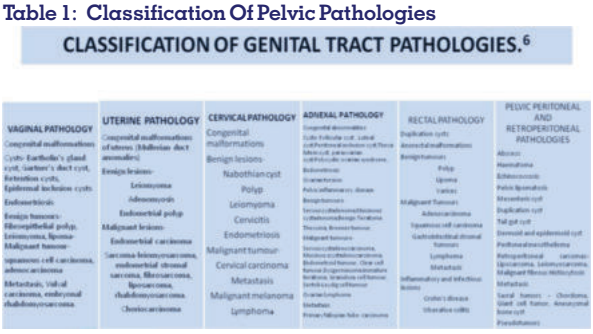
1. Lack of ionizing radiation.
2. Non invasiveness
3. Multiplanar imaging capabilities
4. Excellent soft tissue contrast

Contraindications of magnetic resonance imaging8,9

1. Cardiac Pacemaker
2. Cochlear implants
3. Tissue expanders
4. Ocular prosthesis
5. Dental implants
6. Implantable cardiac defibrillators

MRI is being increasingly used nowadays to evaluate clinically suspected utero-ovarian lesions because of its high contrast resolution, its ability to provide good characterization and its multiplanar imaging capacities. There is a significant difference, however, in the inherent costs of MRI and ultrasound. The dilemma for referring physicians and general radiologists is to decide when it is appropriate to refer patients for MRI. The common pathologies for which MRI proves as a good imaging modality are as follows-

Table 1: Classification Of Pelvic Pathologies



MRI Appearances Of Pelvic Pathologies

Congenital Anomalies

Uterovaginal anomalies are caused by alterations in development or fusion of the müllerian ducts. In the general population, the prevalence of uterine anomalies is 0.5% and of vaginal anomalies is 0.025%.7 The following parameters are recorded in MR images: uterine size, external fundal contour, intercornual distance, zonal anatomy, and presence of uterine or vaginal septa.

Mullerian duct anomalies are classified according to the system established by the American Fertility Society.8

Table 2: Mullerian duct anomalies and their MRI criteria:

DIAGNOSIS	MRI CRITERIA
NORMAL UTERUS AND VAGINA	
Fundus	Convex
Uterine body	Mean endometrial-myometrial width ratio=1:3.6, no septum
Cervix	Single cervix, body-cervix ratio=3:2-3:1, patent endocervical canal
Vagina	Single
CLASS I (AGENESIS)	
Uterine body and fundus	No uterine tissue (agenesis) or uterine tissue but no complete uterus (remnant)
Endometrium	Endometrial tissue may be present
Cervix	Absent, distorted, or length <1/3 of uterine body; absent or distorted endocervical canal
Vagina	Absent or replaced by a thin band of fibrous tissue
Other	Obstruction may be present
CLASS II (UNICORNUATE)	
Uterine body and fundus	Elongated banana-shaped, eccentric uterus One normal sized horn with normal endometrial-myometrial width ratio A rudimentary horn may be present, may have endometrial tissue, and may communicate with main canal Classified according to rudimentary horn as follows: absent rudimentary horn, rudimentary horn present with no endometrial tissue (nonfunctioning), rudimentary horn present with endometrial tissue that communicates with main cavity, and rudimentary horn present with endometrial tissue that does not communicate with main cavity and may obstruct.
Cervix	Normal
CLASS III (DIDELPHYS)	
Uterine body and fundus	Two separate uteri, which can be joined at body; deep
Endometrium	No communication between the endometrial cavities, normal endometrial-myometrial width ratio in each uterus.
Cervix	Double
Vagina	Longitudinal or oblique vaginal septum always present.
CLASS IV (BICORNUATE)	
Fundus	Indented; cleft, 1cm or more deep
Septum	Present, muscular or combined muscular and fibrous Bicollis; septum to external os; unicollis; septum does not reach external os.
Cervix	Single or divided by a septum.
Vagina	Vaginal septum may be present in some cases.
CLASS V (SEPTATE)	
Fundus	Convex, Flat, or minimally indented (cleft<1 cm deep) Morphology of outer fundal contour is key to diagnosis.
Septum	Muscular,fibrous or combined muscular and fibrous Complete: septum to external os; partial: incomplete septum that does not reach external os. A short septum can be difficult to differentiate from arcuate uterus on MRI. In fact, there may be continuum between these two entities.
Cervix	Single, divided by septum, or double
Vagina	Vaginal septum may be present in some cases.
CLASS VI (ARCUATE)	
Fundus	Convex
Endometrial cavity	Short muscular saddle like thickening of fundal myometrium that indents endometrial cavity
Cervix	Single
CLASS VII (DES-RELATED DISORDER)	
Fundus	Convex
Endometrial cavity	Single T-shaped or hypoplastic with irregular margins
Cervix	Single
Note - DES=Diethylstilbestrol.	

Leiomyomas

Uterine leiomyomas, also known as fibroids or myomas, are the most common tumors of the female genital tract.

Degeneration—including hyaline or myxoid degeneration, calcification, and cystic and red degeneration—is related to a lack of blood supply and is more commonly found in postmenopausal women.

According to their location within the uterus :

1. Submucosal
2. Intramural (interstitial)
3. Subserosal – lateral growth of subserosal myomas may extend between the folds of broad ligament (intra-ligamentous leiomyomas). Parasitic leiomyoma is a pedunculated subserosal fibroid that develops a new blood supply from adjacent structures, usually the omentum, and becomes completely detached from the uterus.

Variants of Leiomyomas:

1. Non-degenerated leiomyomas- The typical MR

appearance is solitary or, more commonly, multiple round, well-circumscribed lesions, often with homogeneously decreased signal intensity relative to myometrium on T2W images.

2. Cellular leiomyomas- are composed predominantly of smooth muscle cells. They tend to show homogeneously high signal intensity on T2W images and enhance strongly after intravenous contrast administration.
3. Degenerated leiomyomas- leiomyomas with hyaline or calcific degeneration have low signal intensity on T2W, an appearance similar to standard leiomyomas. Myomas with cystic degeneration have high signal intensity on T2Wand cystic areas don't enhance. Myomas with myxoid degeneration show very high signal intensity on T2W and enhance minimally on post-contrast scan.myomas with red degeneration show peripheral or diffuse high signal on T1W and variable signal intensity with or without a low signal intensity rim on T2W images.
4. Lipoleiomyoma is an otherwise normal leiomyoma that contains a striking amount of fat. They have high signal intensity on T1W images, with signal loss on fat-suppressed T1W images.

Leiomyomas are best diagnosed with T2W images, and lesions as small as 5 mm can be routinely depicted by MRI. In pedunculated fibroids, passing vessels may be identified within the stalk. Most myomas enhance similar to or less than the surrounding myometrium on contrast-enhanced MRI.

The differential diagnosis of leiomyomas can be adenomyosis, solid adenexal masses and leiomyosarcomas.

Adenomyosis

Adenomyosis is characterized by the presence of ectopic endometrial tissue within the myometrium. It is typically found in multiparous pre- and perimenopausal women.10 Two types of adenomyosis - the more common diffuse type and the focal type or adenomyoma.

Adenomyosis may result in marked uterine enlargement with a globular contour, but usually only minimal mass effect on the uterine contour or the endometrial cavity is found.10 On T2W images, thickening of the hypointense junctional zone greater than 12 mm reliably diagnoses adenomyosis. Foci of high signal intensity measuring 2 to 6 mm within the low-signal-intensity areas are seen on T2W images and represent endometrial cysts, glands, or hemorrhagic foci.10 Focal adenomyosis or adenomyoma is characterized by uterine enlargement with only mild deformity and ill-defined elliptical or ovoid lesions.

Differentiating leiomyoma from adenomyosis is important because the therapeutic options differ. Mass effect; round contour with sharp delineation, often with a pseudocapsule; and perilesional vessels are typical features of uterine fibroids.11 While adenomyosis have ill defined infiltrating margins, causes minimal mass effect and shows presence of cysts.

MRI	Leiomyoma	Adenomyoma
	Most are well defined hypointense lesions, surrounding hyperintense zone	Lesions are poorly marginated hypointense lesions with hyperintense foci within
	Not related to the junctional zone	Abutting the junctional zone with thickening of the junctional zone

Endometrial Polyps

Endometrial polyps are benign tumors of the endometrial cavity.

On MRI, polyps display intermediate signal intensity on T1W images and often heterogeneous signal intensity on T2W images. A central fibrous core with low signal intensity and small, well-delineated cysts with very high signal intensity on T2W images are features favoring the diagnosis of endometrial polyps.12 After intravenous contrast administration the central core exhibits intense enhancement and can be differentiated from intracavitary clots.

Endometrial Carcinoma

Adenocarcinomas account for 90% of endometrial neoplasm, whereas uterine sarcomas are relatively rare and account for only 2%–6%; the remaining histologic types include adenocarcinoma with squamous cell differentiation and adenosquamous carcinoma. Endometrial cancer is staged with the International Federation of Gynecology and Obstetrics (FIGO) system, which recently underwent a major revision.

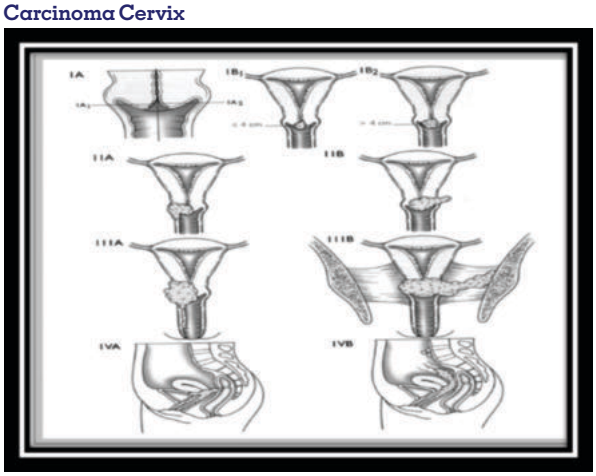
Diffusion-weighted and dynamic multiphase contrast medium–enhanced MR imaging sequences have been shown to improve the accuracy of MR imaging in assessing the depth of myometrial invasion and can be used to assess tumor response to therapy and to differentiate tumor recurrence from post treatment changes.

2009 FIGO Staging System for Endometrial Cancer	
Stage	Description
IA	Tumor confined to uterus, <50% myometrial invasion
IB	Tumor confined to uterus, ≥50% myometrial invasion
II	Cervical stromal invasion
IIIA	Tumor invasion into serosa or adnexa
IIIB	Vaginal or parametrial involvement
IIIC1	Pelvic node involvement
IIIC2	Paraaortic node involvement
IVA	Tumor invasion into bladder or bowel mucosa
IVB	Distant metastases (including abdominal metastases) or inguinal lymph node involvement

Imaging features - endometrial carcinoma is usually isointense relative to the normal endometrium on T1W images and hypointense relative to endometrium on T2W images. On dynamic multiphase contrast-enhanced T1W images, endometrial tumours demonstrate mild homogeneous enhancement that is slower and less avid than that in the adjacent myometrium. At 50–120 seconds after intravenous administration of gadolinium contrast material, the myometrium demonstrates maximal enhancement compared with the relatively low signal intensity of endometrial tumors.

At conventional MR imaging, the depth of myometrial invasion is optimally depicted with T2W sequences.

Carcinoma Cervix



The International Federation of Gynecology and Obstetrics (FIGO) staging system is widely used for treatment planning but more often for standardization of epidemiologic and treatment results .

Imaging Findings- Cervical carcinoma has intermediate signal intensity at T2W imaging and is seen disrupting the low-signal-intensity fibrous stroma. The tumor can demonstrate a wide variety of morphologic features and may be exophytic, infiltrating, or endocervical with a barrel shape. The bulk of the lesion is centered at the level of the cervix, with either protrusion into the vagina or invasion of the lower myometrium. Small tumors may be more readily identified by their early enhancement after dynamic injection of gadopentetate dimeglumine.

Disruption of the hypointense vaginal wall with hyperintense thickening at T2W imaging and contrast material enhancement at T1W imaging are signs of vaginal invasion.

Preservation of a hypointense fibrous stromal ring at T2W MR imaging has a high negative predictive value for parametrial invasion. Complete disruptions of the ring with nodular or irregular tumor signal intensity extending into the parametrium are reliable signs of invasion.

Tumor extending to involve the internal obturator, piriform, or levator ani muscles, with or without a dilated ureter, indicates pelvic wall invasion. Ureteral obstruction at the level of the tumor is considered to be an indication of wall invasion.

Bladder or rectal invasion is present when disruption of their normal hypointense walls is seen at T2W imaging, with or without a mass protruding into the lumen. Dynamic gadolinium-enhanced T1W sequences are helpful for confirming invasion and identifying fistulous tracts.

Lymph Nodes:

Lymph node disease detection is based only on a size criterion, the most widely accepted being a transverse diameter exceeding 10 mm. Lymph nodes are best detected with T2W imaging, at which they demonstrate intermediate signal intensity and are well differentiated from the hypointense muscles and blood vessels.

Correlation between FIGO Staging and MR Imaging Staging.

FIGO Staging		MR Imaging Staging
0	Carcinoma in situ	Not visible
I	Confined to cervix	
	IA Microscopic	
	IA-1 Stromal invasion <3 mm	No tumor visible
	IA-2 >3 mm, <5-mm invasion, <7-mm width	Small enhancing tumor may be seen
	IB Clinically visible (>5 mm)	Tumor visible, intact stromal ring surrounding tumor
	IB-1 <4 cm	…
	IB-2 >4 cm	…
II	Extends beyond uterus but not to pelvic wall or lower one-third of vagina	
	IIA Vaginal extension, no parametrial invasion	Disruption of low-signal-intensity vaginal wall (upper two-thirds)
	IIB Parametrial invasion	Complete disruption of stromal ring with tumor extending into the parametrium
III	Extension to lower one-third of vagina or pelvic wall invasion with hydronephrosis	
	IIIA Extension to lower one-third of vagina	Invasion of lower one-third of vagina
	IIIB Pelvic wall invasion with hydronephrosis	Extension to pelvic muscles or dilated ureter
IV	Located outside true pelvis	
	IVA Bladder or rectal mucosa	Loss of low signal intensity in bladder or rectal wall
	IVB Distant metastasis	…

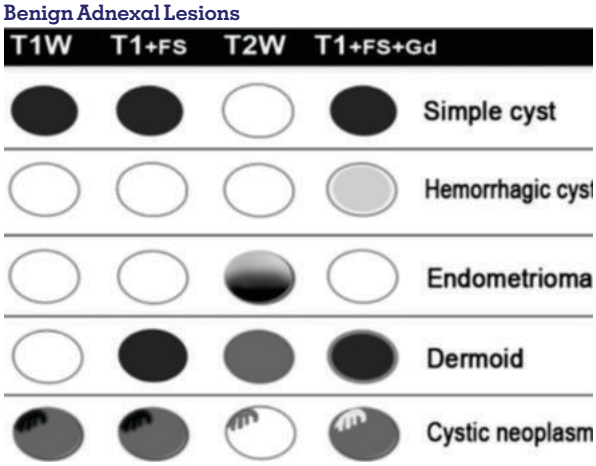
Gestational Trophoblastic Disease

Characterized by abnormal proliferation of trophoblastic tissue. It encompasses a spectrum from hydatiform mole, invasive mole to choriocarcinoma. Presence and course of disease can be monitored with HCG levels.

Imaging Features-

1. Hydatiform mole appears as heterogenous mass of high signal intensity distending the endometrial cavity. Numerous cystic spaces may be seen.
2. Invasive mole is locally invasive and rarely metastasizes.
3. Choriocarcinoma- arises from hydatiform mole in approximately half of cases but may also develop after normal birth or abortion. There is diffuse enlargement of the uterus with presence of an ill-defined mass composed of necrosis and hemorrhage. On MRI it often displays very high signal intensity on T2W images owing to its cystic architecture.

Benign Adnexal Lesions



Physiological ovarian cysts

Ovarian cysts under 3 cm are regarded as physiologic cysts. They include follicles of various stages of development, corpus luteum cysts, and surface inclusion cysts. Most cysts display intermediate to low signal intensity on T1W images, and very high signal intensity on T2W images with thin hypointense wall. Hemorrhagic ovarian cysts and corpus luteum cysts tend to display a high SI on T1 and intermediate to high SI on T2W images. Corpus luteum cysts tend to have thicker walls than follicle cysts, with distinct enhancement.

Paraovarian Cysts

Paraovarian cysts (paratubal) cysts arise from Wolffian duct remnants in the mesovarium.

Paraovarian cysts tend to be large thin-walled unilocular cysts, located typically within the broad ligament. Rarely they may contain internal septations. On MRI, they display typical criteria of ovarian cysts, but are found separate from the ipsilateral ovary.

Peritoneal Inclusion Cysts

Peritoneal inclusion cysts (pseudocysts) are accumulations of fluid produced by the ovaries that become entrapped by peritoneal adhesions. These lesions are typically encountered in patients with previous surgery.

On MRI, peritoneal inclusion cysts appear as unilocular or multilocular cystic lesions. They have irregular contours that are defined by surrounding structures. A finding highly suggestive of peritoneal inclusion cyst is a cystic adnexal mass that contains the ovary in the centre or the periphery of

the lesion. In most cases they contain fluid with low signal intensity on T1W images and very high signal intensity on T2W images.

Polycystic Ovary Syndrome

Polycystic ovary syndrome (PCOS), also known as Stein-Leventhal syndrome, is a complex endocrinologic disorder characterized by hyperandrogenism and chronic anovulation. The classic triad of amenorrhea, hirsutism, and obesity is found in only half of patients. MRI is used as a complement to US to confirm the diagnosis of PCOS or to exclude a virilizing ovarian tumor.

The imaging findings in PCOS include bilateral moderately enlarged (up to 5 cm) spherical ovaries with an abnormally high number of peripherally distributed follicles. At least ten follicles ranging between 2 and 8 mm in size encircle the abnormally hypointense central stroma.

Figure: Mr Imaging Of The Sonographically Indeterminate Adenexal Mass.

MR criteria indicative of benignity:

- Dimensions less than 4 cm
- Entirely cystic structure
- Thin walls (lesser than 3 mm)
- Absence of internal septations or mural nodules
- Absence of ascites, lymphadenopathies and peritoneal carcinosis.

MR signs suggestive of malignancy:

- Dimensions greater than 4 cm
- Thick walls (greater than 3 mm)
- Septations
- Solid lobulated mass
- Mixed structure (cystic and solid)
- Intralesional circles
- Psammomatous calcifications
- Mural nodules or solid components in cystic lesions
- Necrosis within solid components (most predictive element) Peritoneal carcinosis
- Lymphadenopathies
- Ascites (particularly if abundant and/or sparing of the recto uterine pouch)

Endometriosis

Endometriosis, which is defined as the presence of ectopic endometrial glands and stroma outside the uterus, is a common cause of pelvic pain and infertility, affecting as many as 10% of premenopausal women.

The three hallmarks of endometriosis are:

- peritoneal endometrial implants
- endometriomas (endometriotic cysts)
- Adhesions.

The most common peritoneal sites of involvement (in decreasing order of frequency) are the ovaries, uterine ligaments, cul-de-sac, and pelvic peritoneum reflected over the uterus, fallopian tubes, recto sigmoid, and bladder. Rare extra peritoneal sites include the lungs and the central nervous system.

Imaging features:

Endometriomas ("chocolate cysts") of the ovary contain dark gelatinous material surrounded by a fibrous wall of variable thickness. Endometriomas are usually multiple and bilateral.18

They are characteristically homogeneously hyperintense on T1W sequences with relatively low signal intensity on T2W sequences (T2-shading effect).This loss of signal intensity on the T2W sequences is caused by high concentrations of intracystic methemoglobin and other protein or iron products. Some lesions are heterogeneous in signal intensity because the blood products are in various stages of degradation from multiple episodes of bleeding.

Deep endometriotic lesions are found at vesicouterine pouch, vesicovaginal septum, bladder, uterine ligaments, vaginal fornices, retrocervical area, pouch of Douglas, rectovaginal septum and recto sigmoid junction.

Pelvic Inflammatory Disease

Pelvic inflammatory disease (PID) represents a spectrum of acute to chronic inflammatory conditions of the upper genital tract, including the endometrium, ovaries, and fallopian tubes; it commonly involves the adjacent pelvic peritoneum as well.

MRI may show mildly enlarged and inhomogeneously enhancing ovaries. Haziness of the pelvic fat, periovarian stranding, and enhancement of the adjacent peritoneum are common associated findings.19 Inhomogeneous high signal intensity on T2W images and wall enhancement on MRI support the diagnosis of inflammatory changes.

Tubo-ovarian Abscess

The vast majority of tubo-ovarian abscesses (TOAs) result from complications of PID.

On imaging, a unilateral or bilateral, unilocular or, more frequently, multilocular thick-walled adnexal lesion accompanied by tubal dilation is the typical finding of TOA. The fluid within the abscess has variable signal intensity but usually exhibits low to intermediate signal intensity on T1W images and very high signal intensity on T2W images. On post contrast study there is enhancement of the fallopian tube due to pyosalpinx, of the abscess wall, and of adjacent tissues due to peritonitis.

Ovarian Tumors

Ovarian tumors are classified as epithelial tumors, germ cell tumors, sex cord–stromal cell tumors, and metastatic tumors on the basis of tumor origin.

Benign Ovarian Tumors

Mature Cystic Teratoma

Dermoid cysts, also known as mature cystic teratomas or dermoids, are benign germ cell tumors that account for the most common ovarian neoplasm in women of reproductive age and may be bilateral in approximately 10% to 25% of cases.

The specific MRI feature of a dermoid is fat within a cystic, often unilocular, encapsulated ovarian lesion .20 Fat demonstrates high signal intensity on T1W images, Frequency-selective fat saturation must be used to differentiate fat from hemorrhagic contents. The use of short tau inversion recovery (STIR) imaging is not recommended because signal suppression may be observed in endometriomas as well.85 Chemical shift imaging may assist in the depiction of microscopic foci of fat in the cyst wall or dermoid plug.

Cystadenoma

Cystadenomas account for the majority of epithelial ovarian tumors. Cystadenomas present as thin-walled, unilocular or multilocular cystic lesions filled with serous, mucinous, and sometimes hemorrhagic contents. Cystadenomas appear as cystic ovarian masses with thin, regular walls; thin, enhancing septations (<3mm) may be present.21 Serous cystadenomas tend to present as unilocular or bilocular cystic tumors. Signal intensity on T1 are similar to that of water, with very high signal intensity on T2W images.21 Mucinous cystadenomas are often large (>10cm) at diagnosis and may fill the pelvis and abdomen. In contrast to serous cystadenomas, mucinous

cystadenomas often present as multilocular cystic lesions with varying contents on T1W and T2W images.21

Fibroma and Fibrothecoma

Fibromas, fibrothecomas, and thecomas are benign tumors of stromal origin and constitute 3% to 4% of all ovarian tumors.

On MRI, Fibromas and fibrothecomas are well-circumscribed solid ovarian tumors with low to intermediate signal intensity on T1W images and very low signal intensity on T2W images and show mild or delayed contrast enhancement on MRI.

Malignant Ovarian Tumours

Ovarian cancer can be categorized as surface epithelial neoplasms (epithelial carcinomas), germ cell tumors, sex cord–stromal neoplasms, and lymphoma. The vast majority (86%) of these tumors arise from the surface epithelium.

Epithelial Ovarian Cancer 6

The incidence of ovarian cancer rises continuously between the ages 30 and 70 years and peaks at age 59 years. Histologically, ovarian cancer can be categorized as serous cystadenocarcinoma cancer (40% to 65%); mucinous cancer (10%), endometrioid cancer (10%), and clear cell cancer (5%); malignant Brenner tumor (2%); and undifferentiated cancers (5% to 10%).

Imaging Findings:

Findings that strongly support the diagnosis of ovarian cancer include a unilateral or bilateral solid and cystic ovarian mass. Other typical features of ovarian cancer are a multiloculated lesion with thick (>3 mm), sometimes irregular enhancing septations; enhancing solid, nonfibrous components; and papillary excrescences. Cystic components within the tumor may contain serous, hemorrhagic, or mucinous fluid, which is best characterized on T2W images. Secondary signs supporting the diagnosis of metastatic spread are ascites, peritoneal implants, or lymph node enlargement.23 It is impossible to differentiate the subtypes of ovarian cancer by imaging, but serous cancers are commonly bilateral and may contain calcifications

Modified International Federation of Gynecology and Obstetrics (FIGO) Staging of Ovarian Cancer by CT and MRI

Stage	Imaging Findings
I	Tumor limited to the ovaries
IA	Limited to one ovary, no ascites
IB	Limited to both ovaries, no ascites
IC	Stage IA or IB with ascites
II	Tumor involving one or both ovaries, with pelvic extension
IIA	Extension or metastases to the uterus or fallopian tubes
IIB	Extension to other pelvic tissues
IIC	Stage IIA or IIB with ascites
III	Tumor involving one or both ovaries, peritoneal implants outside the pelvis, or implants in retroperitoneal or inguinal lymph nodes
IIIA	Tumor grossly limited to the true pelvis, large volume of ascites
IIIB	≤2 cm implants in abdominal peritoneal surfaces
IIIC	>2 cm implants in abdominal peritoneal surface or retroperitoneal or inguinal lymph nodes
IV	Growth involving one or both ovaries, distant metastases, parenchymal liver metastases, pleural effusion with positive cytology

Uterine invasion is suggested by distortion or irregularity between the interface of the tumor and the myometrium. Invasion of bowel or bladder may be suggested by loss of the tissue plane between the solid components of the tumor, encasement, or localized wall thickening. A distance less than 3 mm between the ovarian mass and the muscular pelvic sidewall or displacement or encasement of the iliac vessels is highly suggestive of pelvic side wall invasion.

Sex Cord–Stromal Tumors

Granulosa cell tumor6

Granulosa cell tumor of the ovary is the most common malignant sex cord–stromal tumor as well as the most common estrogen-producing ovarian tumor. Two types – Adult (most common) and juvenile.

Ovarian granulosa cell tumors vary widely and range from solid masses, to tumors with varying degrees of hemorrhagic or fibrotic changes, to multilocular cystic lesions, to completely cystic tumors. Estrogenic effects on the uterus may manifest as uterine enlargement or as endometrial thickening or hemorrhage.

Sertoli – Leydig cell tumor

Sertoli-Leydig cell tumors occur in young women (<30 years of age) and are considered to be a low-grade malignancy. These tumors constitute 0.5% of ovarian tumors and are the most common virilizing tumor. Signal intensity at MR imaging reflects the extent of fibrous stroma.6

Dysgerminoma

Dysgerminomas are the most common malignant germ cell subtype. They typically occur in children and young women, with 80% of those affected being younger than 30 years.

On MRI, dysgerminomas typically present as unilateral, multilobulated, well-delineated solid masses. On MRI, they exhibit low signal intensity on T1-weighted images and intermediate signal on T2-weighted images. Strongly enhancing internal fibrovascular septations and central areas of necrosis or hemorrhage may be seen.

Ovarian Lymphoma

Lymphoma affecting the ovary is most often a manifestation of generalized disease, particularly B-cell lymphomas. Primary lymphoma of the ovary is extremely rare, with Burkitt's lymphoma being the most common type.

On imaging, ovarian lymphomas appear as unilateral or, more commonly, bilateral solid, mildly enhancing, homogeneous masses without ascites, necrosis, or calcifications. On MRI, ovarian lymphoma exhibits intermediate signal intensity on T1W images and low to intermediate signal intensity on T2W images.

Metastases to the Ovaries23

Approximately 5% to 15% of malignant ovarian tumors are metastases. Stomach, colon, breast, and lung cancers are the most common neoplasms that metastasize to the ovaries. Bilateral involvement is a typical feature, occurring in up to 75% of cases of ovarian metastasis.

On imaging, two types of ovarian metastases can be differentiated. Krukenberg's tumors display characteristic imaging features, including bilateral oval, often lobulated tumors that tend to preserve the contour of the ovary. They are solid or predominantly solid with central necrosis or cysts.

On MRI they display medium signal intensity on T1-weighted images and an inhomogeneous low to intermediate signal intensity on T2-weighted images. 23 On CT and MRI they tend to show strong contrast enhancement of solid components or septations. Imaging findings in non-Krukenberg ovarian metastases may be similar to those in primary ovarian cancer, making definitive differentiation impossible.

Vaginal pathologies

Vaginal septum:

It is type of vertical fusional defect. It can occur at almost any level of the vagina commonly at the level of superior and mid vagina. Transverse vaginal septum be either perforate (incomplete) or imperforate (complete) and results from varying degrees of failure in reabsorbtion of the tissue between the vaginal plate and the caudal aspect of the fused mullerian ducts.

MRI is uself to depict pelvic anatomy and thickness of septum.

Vesicovaginal fistula

Abnormal fistulous connection between bladder and vagina. It can be due to obstructed/prolonged labor, surgery, radiotherapy, pelvic malignancy and uterine rupture.

Vaginal carcinoma:

It arises from the posterior wall of the upper third of the vagina most often as an ulcerating or fungating mass or an annular constricting lesion with squamous cell carcinoma of the vagina as the most common histological subtype. On MRI they are of low signal intensity on T1W and intermediate to high signal intensity on T2W images.

Staging of vaginal carcinoma. 26

Stage I	Cancer is found in the vaginal wall only.
Stage II	Cancer has spread through the wall of the vagina to the tissue around the vagina. Cancer has not spread to the wall of the pelvis.
stage III	Cancer has spread to the wall of the pelvis.
Stage IV A	Cancer may have spread to one or more of the following areas: • The lining of the bladder. • The lining of the rectum. • Beyond the area of the pelvis that has the bladder, uterus, ovaries, and cervix.
Stage IVB	Cancer has spread to parts of the body that are not near the vagina, such as the lung or bone.

MATERIAL AND METHODS

Sources of Data Data for the study will be collected from patient referred to the department of radio diagnosis in a tertiary care centre.

Technique

Imaging will be done with 3 tesla Siemen machine using abdominal surface coils. The following sequences will be selected as required.

a) T1WI, T2WI AND STIR (in axial plane).
b) T2WI and STIR (in coronal plane).
c) T2WI and STIR (in sagittal plane).
d) coronal single-shot fast spin-echo (FSE)
e) Axial in-phase and opposed-phase T1-weighted (T1W) gradient-recalled echo (GRE)

Contrast will be used as and when required. Gadolinium will be used as intravenous contrast material in a dose of 0.1 mmol/kg body weight.

Post contrast study includes T1W FAT SUPPRESSED Sequence (in axial, coronal and sagittal planes).

Additional sequences as per requirement of case.

Method of collection of Data (including sampling procedures if any)

All patients referred to the department of Radio diagnosis with clinically suspected uterine and adnexal masses in a period of 18 months from Jan 2019 to Sept 2021 will be subjected for the study.

The study will be conducted on a minimum of 40 cases focusing mainly on sonographically indeterminate uterine and ovarian and cervical. However, the scope of increasing the number of cases exists depending upon the availability within the study period. Confirmation of the lesion will be done by histopathology whenever it is required and by taking follow up of cases. Cost of the investigation will be done by the investigator.

Duration of study: 18 Months

Data Analysis: By proportional scale.

Inclusion Criteria:

- All patients with clinically suspected uterine and adnexal masses with indeterminate diagnosis on sonography.
- For staging of known malignant conditions.
- Patients of all age groups.

Exclusion Criteria:

- Mimics of adnexal masses such as an ectopic pregnancy.
- All Patients having cardiac pacemakers, prosthetic heart valves, cochlear implants or any metallic implants.
- Patients having history of claustrophobia.
- All patients who do not consent to be a part of the study.

Does the Study require any investigations or interventions to be conducted on patients or other humans or animals? If so please describe briefly.

YES. The study is mainly based on investigations as Radiology itself is a tool of investigation. Interventions would be done as and when it is indicated alone. The study involves only humans. Informed consent would be taken after explaining about and before any procedure.

RESULTS

About 40 female patients of clinically or ultrasonographically suspected pelvic lesions underwent MRI examination after clinical and ultrasonographic examination.

Table 1. Distribution of the study group according to age group

Age group	No. of cases	Percentage
0-20 year	9	22.5%
20-45	19	47.5%
>45	12	30%

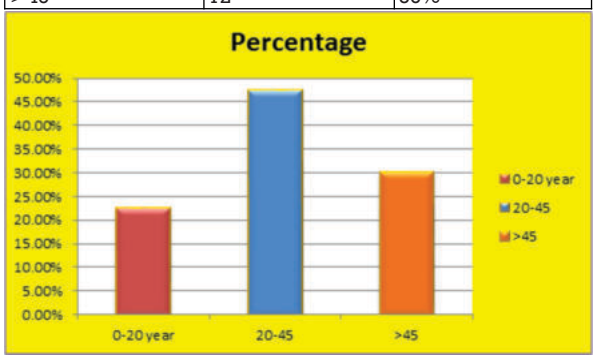


Chart 1. Distribution of the study group according to age group

In our study, about 22.5% of the study group belonged to less than 20 years of age, 47.5% belonged to 20-45 years of age group and 30% belonged to >45 years of age group.

Table 2. Distribution of the study group according to Chief complaints

Chief complaints	No. of cases	Percent
Abdominal pain	6	15
Infertility	2	5
Fever, lower abdominal pain	1	2.5

vaginal discharge	1	2.5
Irregular cycles with dysmenorrhea	2	5
Heavy menstrual bleeding	3	7.5
Cyclical pain in lower abdomen	1	2.5
Retention of urine	1	2.5
Lower abdominal pain	4	10
Retention of urine	1	2.5
Mass per abdomen with irregular cycles	2	5
Burning micturition	1	2.5
Pain abdomen with distension	1	2.5
Pain abdomen with irregular cycles	2	5
Primary amenorrhea	3	7.5
Follow up malignancy pt	4	10
Post menopausal vaginal bleeding	5	12.5
Total	40	100

In our study had shown that, 15% had pain abdomen, 5% had Infertility, 2.5% fever, lower abdominal pain,1%vaginal discharge,5 %Irregular cycles with dysmenorrhea 7.5% had heavy menstrual bleeding,2.5% Cyclical pain in lower abdomen,2.5 %Retention of urine & Burning micturition,5% Mass per abdomen with irregular cycles,2.5 %Pain abdomen with distension,5% Pain abdomen with irregular cycles7.5% Primary amenorrhea 12.5% Post-menopausal vaginal bleeding.

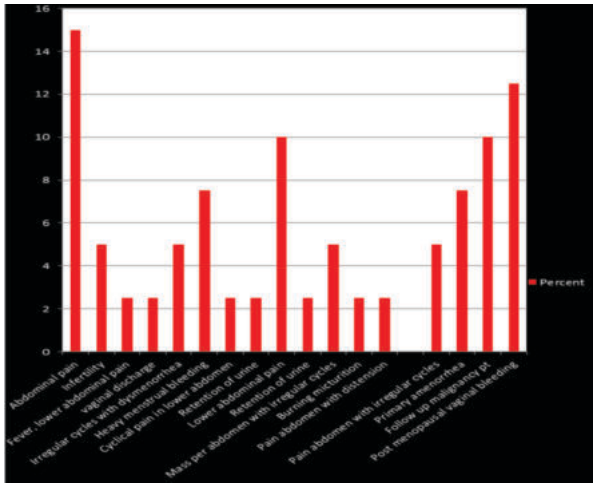


Chart 2. Distribution of the study group according to Chief complaints:

Table 3. Distribution of study subjects according to menstrual stage:

Menstrual stage	No. of cases	Percentage
Premenstrual	5	12.5
Menstrual	17	42.5
Perimenopausal	3	7.5
Postmenopausal	15	37.5
Total	40	100

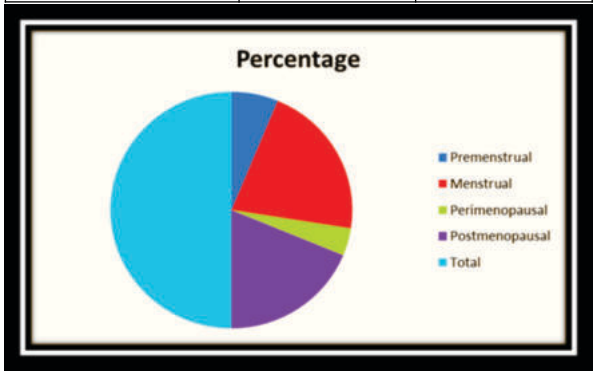


Chart 3. Distribution of the study group according to Menstrual stage:

Table 4. Distribution of the study group according to duration of symptoms

Duration of symptoms	No. of cases	Percent
Not specified	3	7.5
Less than 15 days	4	10
15 days-less than 1 month	2	5
1month – less than 6 month	18	45
6month-less than 1 year	3	7.5
1year&More than 1 year	10	25
Total	40	100

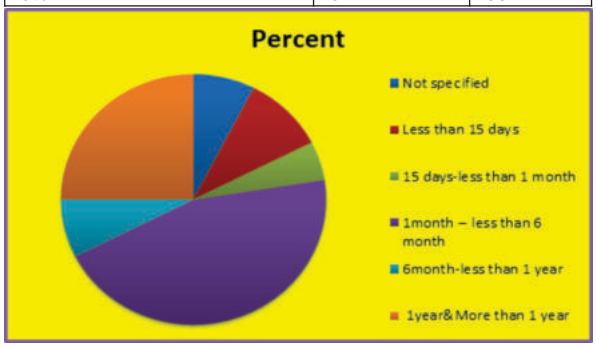


Chart 4. Distribution of the study group according to duration of symptoms

About 10% of the women had the symptoms since less than15 week, 5% had symptoms since 15 days – 1 month, 45% had the symptoms since 1 month- less than 6 month, 7.5% had symptoms from 6 months to less than 1year & 25 % had symptoms since more than 1year.

Table 5. Distribution of the study group according to ultrasound findings:

SR. No		No. of cases	Percentage
1	Large well defined complex lobulated lesion in left adnexa s/o ?large mesenteric dermoid?? Left adnexal pedunculated derrmoid.	1	2.5
2	Solid cystic lesion arising from left ovary ,low level organized echo within	1	2.5
3	Heterogeneous mass lesion involving lower cervix? Ca cervix	4	10
4	Solid cystic lesion in right adnexa. low level organized echo within	1	2.5
5	Heterogeneous echo texture of cervix with small cystic area within	1	2.5
6	Bulky uterus with loss of endomyometrial junction with thickened endometrium	3	7.5
7	Well defined cystic lesion in pod likely simple cyst	1	2.5
8	solid cystic lesion in right adnexa ,right ovary is not seen seperately from the lesion, right ovarian neoplastic	3	7.5
9	Heterogeneously hypo echoic lesion is seen in fundal region of uterus likely sub mucosal fibroid	1	2.5
10	Large well defined hetrogeneously hypoechoic lesion noted in pelvis extending to umbilicus.Uterus is not seen seperately from the lesion.	1	2.5
11	Large cystic mass in right adnexa .It shows multiple thin & thick complete & incomplete sepatetion within,Right ovary is not seen seperatey from mass, no e/o septal vascularity is seen .f/s/o complex right ovarian cyst.	1	2.5
12	Gross hyper echoic collection with echoes within in uterine cavity ? Hematometra.	1	2.5

13	Normal uterus with minimal endometrial collection	1	2.5
14	No significant abnormality in uterus & cervix	2	5
15	Heterogeneous vaginal stump	1	2.5
16	Bulky & heterogeneous uterus with ill defined altered echo texture in anterior uterine wall	1	2.5
17	Hypoplastic uterus with bilateral bulky ovaries	1	2.5
18	Heterogeneously hypo echoic lesion is seen arising from pelvis upto umbilicus shows internal low resistance vascularity within, with loss of uterine architecture likely fibroid	1	2.5
19	Two endometrial cavity is seen suggesting bicornuate uterus	1	2.5
20	Large complex solid mass lesion in right adnexa extension to POD. Infiltrating uterus posteriorly ,bilateral ovaries not seen separately;?gist??ovarian malignancy	1	2.5
21	Bulky and heterogeneous cervix? Cervicitis ?? Neoplastic etiology	2	5
22	Heterogeneous echotexture of cervix with small cystic area within	1	2.5
23	Multiple peripherally arranged follicles with central echogenic stroma s/o polycystic ovary disease	2	5
24	Well defined cystic lesion in endometrial cavity with hyperechoic content within	1	2.5
25	Mildly bulky uterus with thickened ET	1	2.5
26	Large solid cystic lesion noted in pelvis,probably arsing from uterus suggesting intramural fibroid	1	2.5
27	Uterus with two separate horns &endometrial cavities are seen, Large coolection is seen in lower uterine segment with echoes within	1	2.5
28	Multiple cystic lesions are seen in bilateral adnexa, uterus appears normal	1	2.5
29	Uterus and bilateral ovaries are not seen	2	5
Total		40	100

Table 6. Distribution of the study group according to MRI T1 weighted images

MRI T1 weighted image	Frequency	Percent
Heterogenous intensity	3	9
Hyperintense	6	18.18
Hypointense	16	48
Isointense	8	24.2
Total	33	100

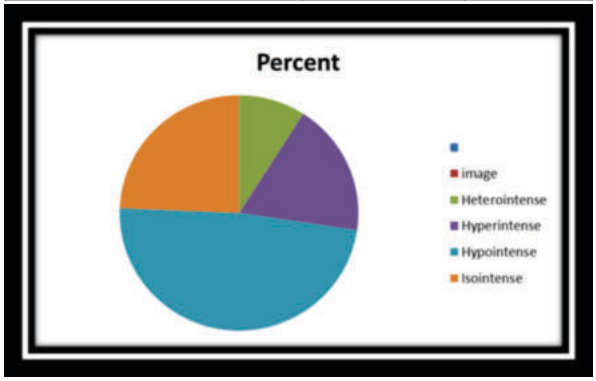


Chart 5. Distribution of the study group according to MRI T1 weighted images

The T_1 weighted image had shown hypointense lesions in 48% of the study subjects, hyperintense lesions in 18% of the study subjects, 9% of the study subjects shows heterogenous lesions in 24% of the study subjects shows hypointense lesion of the study subjects.

Table 7. Distribution of the study group according to MRI T2 weighted images

MRI T_2 weighted image	Frequency	Percent
Heterogenous intensity	12	36.3
Hyperintense	16	48.48
Hypointense	5	12.12
Isointense	0	
Total	33	100.0

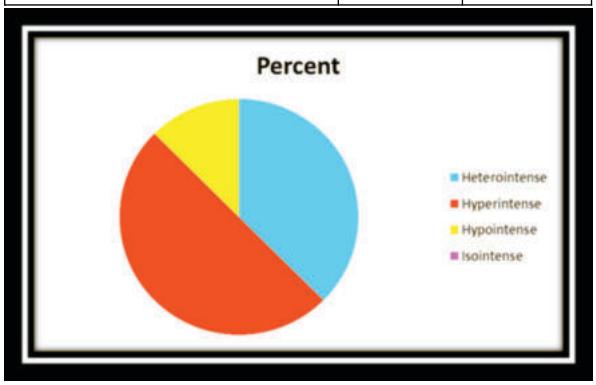


Chart 6. Distribution of the study group according to MRI T2 weighted images

The T_2 weighted images had shown hyperintense lesions in 48.4% of the study subjects, heterogenous lesions in 36.2% of the study subjects, hypointense lesions in 12.2 % of the study subjects,

Table 8. Distribution of the study group according to MRI Internal characteristics:

SR. No.	MRI Internal characteristics	No. of cases	Per cent
1	Well defined lobulated altered signal intensity complex solid cystic lesion in the suprapubic pelvis in the midline and slightly towards left side. left ovary not seen separately	1	2.5
2	Well defined ovoid solid cystic lesion with predominant heterogeneous solid component noted in left adnexa	1	2.5
3	Thick (16mm) annular constricting, vaginal altered signal intensity	1	2.5
4	Abnormal signal intensity solid cystic lesion arising from pelvis extending into bilateral adnexa/l ovaries are not seen separately. Uterus is seen separately from the lesion. multiple varying sized enhancing deposits noted along peritoneum	1	2.5
5	Cervix appears heterogeneous with small cystic areas within measures 3.4 cm in length anterior lip measures 11 mm, posterior lip measures 10 mm and predominantly hypointense on T1W/T2W /STIR images without diffusion restriction.	1	2.5
6	Diffuse adenomyotic changes with ill-defined early enhancing altered signal intensity lesion in body region and lower uterine segment showing multiple focal areas of invasion (less than 50%) into endomyometrium more predominantly in lower uterine segment. (Stage Ia)	1	2.5

7	Altered signal intensity lesion in fundoanterior wall in endometrial cavity (more on left side) with loss of endo-myometrial interface, showing early enhancement and restriction on diffusion s/o neoplastic etiology	1	2.5
8	Well defined tubular altered signal intensity cystic lesion posterior to the uterus in the pouch of Douglas extending antero-superiorly and left laterally ,No obvious solid component and maintained fat planes with uterus anteriorly and rectum posteriorly	1	2.5
9	large well defined predominantly cystic lesion arising from right ovary. The lesion shows multiple thick walled septations within with max. thickness upto 4.5 mm at the periphery near the superior pole on left side. Heterogeneous mural solid component also noted within the lesion peripherally.	1	2.5
10	Absent uterus and upper vagina without any renal and vertebral abnormalities. Small blind lower vaginal pouch ,bilateral ovaries are seen	1	2.5
11	Heterogenous on T2WI. Mass shows peripheral hypointense signal on T2 suggesting solid areas with multiple central T2 hyperintense areas within s/o necrosis / cystic degeneration.	1	2.5
12	Well defined abnormal signal intensity lesion is attached to the fundus with small stalk and grows into the endometrial cavity and causing distension of the endometrial cavity and fills almost entire cavity.	1	2.5
13	It appears heterogeneously hypointense on T1 and T2 weighted image with few hyperintense areas within. It is not showing restriction of diffusion.	1	2.5
14	On dynamic post contrast examination- it shows inhomogeneous gradual moderate enhancement.	1	2.5
15	Abnormal signal intensity mass lesion noted involving entire cervix causing obliteration of internal OS with secondary distention of uterus,loss of fat planes with posterior wall of urinary bladder with extension into bladder,Bilateral hydroureteronephrosis with vertebral metastasis.	1	2.5
16	Large hematometra secondary to endocervical/lower endometrial stenosis with few small intramural fbroids in compressed myometrium	1	2.5
17	Heterogeneous signal intensity mass lesion nvolving cervix (epicentered at both cervical lip) and lower 2/3rd of uterus extending into upper 1/3rd of vagina. with multiple small non-enhancing necrotic areas within extending into lower uterine segment obstructing endometrial canal with resultant minimal collection in endometrial cavity in fundus.	1	2.5
18	Subtle T2/STIR hyperntensity in post vaginal wall in right side likely post biopsy changes. Rest findings are not significant	1	2.5
19	Post radiotherapy changes are seen. No e/o recurrent lesion	2	5
21	Ill defined altered signal involving right lateral uterine wall involving the endometrium with myometrial invasion Enlarged bilateral ovaries with multiple enlarged luteal cysts	1	2.5
22	Well defined solid cystic altered signal intensity mass lesion with predominant solid component in right adnexa, right ovary is not separately, with degenerative changes in uterus	1	2.5
23	well defined ovoid T2hypointense area with central T2 hyper intensity noted medial to left ovary may represent rudimentary horn of uterus ,uterus is not visualized in normal anatomical position. Right ovary appears bulky with multiple developing follicles are seen, left ovary appears normal.	1	2.5
24	Large well-defined altered signal intensity lesion arising from anterior wall of uterus (intramural in location). It is extending from pelvis up to umbilical region.	1	2.5
25	Two uterine cavities separated by a hypointense septum which extends to the external Os of cervix with a flat contour of the fundus.	1	2.5
26	Ill-defined altered signal intensity mass lesion involving posterior lip of external Os of cervix posteriorly the lesion extending to vaginal fornix .Rest of vagina appears normal.	1	2.5
27	Large complex solid cystic lesion in pelvis with size and extension as described. both the ovaries are not visualized separately. Multiple peritoneal deposits in RIF	1	2.5
28	Heterogeneous mass lesion involving cervix and upper 1/3rd of vagina.	1	2.5
29	Heterogeneous mass lesion involving cervix and lower 1/3rd of uterus. No parametrical infiltration is seen.	1	2.5
30	Relatively well-defined an altered signal intensity lesion of arising from posterior uterine wall, lesion grows into the endometrial cavity	1	2.5
31	Uterine fundal indentation approximately measuring 1.3cm (CC) with intercornuate distance approximately measuring 4.0cm. This myometrial fundal indentation appears smooth and broad showing normal signal intensity. No e/o deep fundal cleft in outer uterine contour.	1	2.5
32	Bilateral ovaries appear enlarged in size with multiple varying sized small follicles within.	2	5
34	Well-defined thick-walled cystic lesion in right lateral wall of body of uterus and it is surrounded by myometrium. No obvious communication of this lesion with endometrial cavity.	1	2.5
35	Relatively long segment circumferential wall thickening is seen involving rectum as described, more likely suggestive of post radiation induced proctitis.	1	2.5
36	Uterus is retroverted , mildly bulky in fundal region. Endo-myometrial junctional zone appears normal. No e/o any focal lesion. Cervix appears normal.No e/o abnormal signal intensity	1	2.5
37	well-defined, heterogeneous solid-cystic midline pelvic mass arising from anterior uterine wall. It is extending superiorly to supraumbilical region,	1	2.5

38	Large collection with its epicenter in the upper vaginal region and cervix causing splaying of the cervical canal extending into the lower uterine corpus,not extending beyond the upper vaginal region, S/O Hematocolpos with hematometra in left cornu with left Hematosalpinx. in its early to late Subacute stage probably due to transverse vaginal septum.Unicornuate uterus with right rudimentary non communicating horn.	1	2.5
39	Abnormal signal intensity tubular intercommunicating cystic structure with in bilateral adnexa approx few curvilinear fat signal intensity areas at periphery of the lesion likely represents mesosalpinx. They also shows multiple incomplete septae within with mildly bulky right ovary with heterogeneous postcontrast enhancement of bilateral ovaries	1	2.5
40	Agenesis of uterus, cervix and vagina with normal bilateral ovaries	1	2.5
	Total	40	100

The MR imaging of internal contents had shown that 10.5% had unilocular cystic lesion with no internal septations and 5.3% had fat with thin internal septae, few hypointense foci in this study.

Table 9. Distribution of the study group according to MRI post contrast

MRI post contrast	Frequency	Percent
Not done	11	27.5
Done	29	72.5
Total	40	100

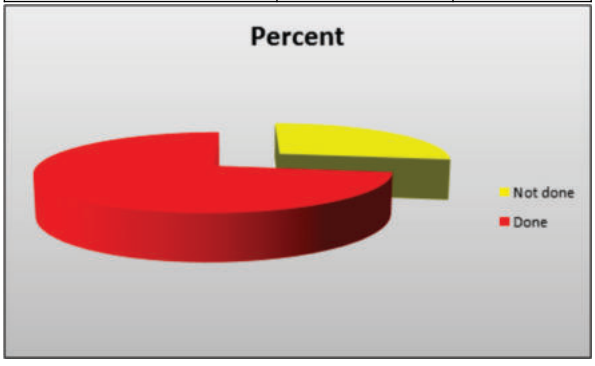


Chart 7. Distribution of the study group according to MRI post contrast

The contrast was not used 27.5% of the study subjects and used in 72.5% of the studysubjects.

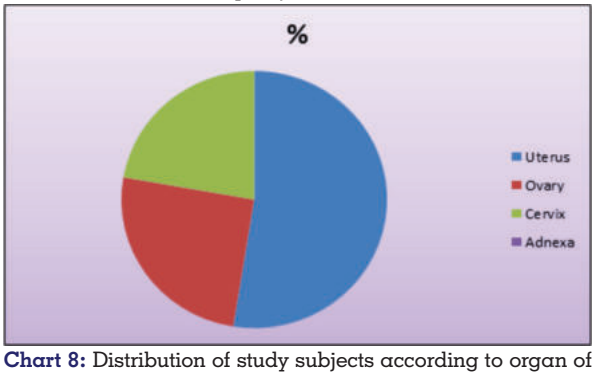


Chart 8: Distribution of study subjects according to organ of site: On USG

Table 10: Distribution of study subjects according to organ of site:

Origin of lesion	USG	%	MRI	%
Uterus	21	52	21	52
Ovary	9	22	10	25
Cervix	9	22	9	22
Adnexa	1	2.5	0	0

In our study, Among 40 cases ,On MRI maximum(52%) of patients having uterine lesions, followed by ovary (25%) and then cervix (22%). This correlated well with histopathology results, which showed the maximum number of patients were having uterine lesions (52%)followed by ovarian lesions (25%), cervix (22).

In a study conducted by Dwiwedi et.al, on MRI, the maximum number of patients was having uterine lesions (48) followed by ovarian lesions (40), inconclusive adnexal/ovarian lesions (6), adnexal lesions (4). Two patients had normal findings. This correlated well with histopathology results, which showed the maximum number of patients were having uterine lesions (48) followed by ovarian lesions (41), adnexal lesions (5). Normal findings were observed in two patients.

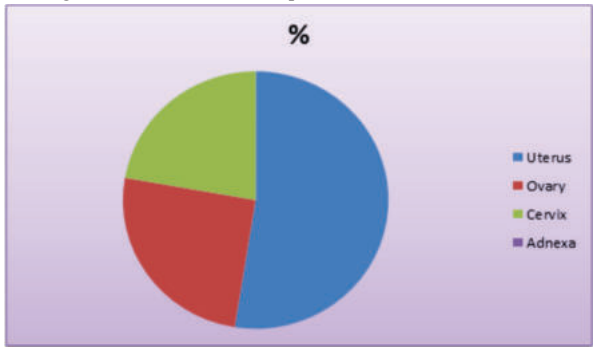


Chart 9: Distribution of study subjects according to organ of site: On MRI

Table 11. Distribution of the study group according to MRI diagnosis

MRI diagnosis	No. of cases	Per cent
Mature teratoma with protenaceous cystic content	1	2.5
Complex adnexal lesion of left ovarian origin possibly neoplastic etiology.	1	2.5
Ca vaginaFIGO stage IVa.	1	2.5
Ovarian neoplastic etiology with peritoneal deposits and intraabdominal lymphadenopathy	1	2.5
No e/o residual/recurrent lesion in cervix	3	7.5
CA Endometrium	1	2.5
Benign complex cystic lesion.	1	2.5
Right ovarian neoplastic etiology	2	5
Mayer-Rokitansky-Kuster-Hauser syndrome (MRKH)- type I.	1	2.5
Bulky uterus with large fundal submucosal fibroid with cystic degeneration / necrosis and small area of hemorrhage within.	1	2.5
Endometrial polyp	1	2.5
Large fibroid along right lateral wall of uterus with internal degeneration probably arising from Broad ligament / rudimentary horn.	1	2.5
right hydrosalpinx.	1	2.5
Ca Cervix	5	12.5
Hematometra	1	2.5
Post biopsy changes in vagina	1	2.5
Residual invasive mole	1	2.5
Rudimentary horn of uterus	1	2.5
Large anterior intramural uterine fibroid	1	2.5
Class V Mullerian duct anomaly.	1	2.5
Right ovarian malignancy with peritoneal carcinomatosis.	1	2.5

Submucosal fibroid.	1	2.5
Arcuate uterus	1	2.5
Bilateral polycystic ovary disease	2	5
Hematometra with non-communicating right horn of uterus.2. Less likely, Cystic adenomyotic lesion.	1	2.5
Post radiation induced proctitis,cervix appears normal	1	2.5
No significant abnormality	1	2.5
Bulky uterus with large anterior intramural fibroid showing myxoid degeneration	1	2.5
Unicornuate uterus, Class 2b Mullerian duct anomaly. (According to Classification of MDAs according to American Society for reproductive medicine system).	1	2.5
Bilateral tubo- ovarian complex more likely infective etiology.	1	2.5
Mayer Rokitansky Kuster Hauser syndrome (Type A) / class 1 Mullerian duct anomaly.	1	2.5
Total	40	100

Table 12. Distribution of the study group according to Histopathological diagnosis

Histopathological diagnosis	No. of cases	Percent
Mature teratoma	1	2.5
Serous cystadenocarcinoma of left ovary	1	2.5
Moderately differentiated squamous cell carcinoma of vagina	1	2.5
Serous cystadenoma of left ovary	2	5
k/c/o ca cervix(Squamous cell carcinoma)/on chemoradiotherapy	1	2.5
Endometrial adenocarcinoma	2	5
Serous cystadenocarcinoma of right ovary	3	7.5
Submucosal fibroid	2	5
Polypoidal endocervicitis	1	2.5
Broad ligament fibroid	1	2.5
Intramural fibroids	2	5
squamous cell carcinoma of cervix	4	10
residual mole	1	2.5
Serous cyst adenoma of right ovary	0	0
Other cases	18	45
Total	40	100

The Histo pathological diagnosis had shown squamous cell carcinoma of cervix in 10% of the cases, In other cases including those patients where there is no need of histopath such as mullerian duct anomalies, polycystic ovarian diseases.

Table 13. Distribution of the study group according to correlation between MRI and Histopathological diagnosis

MRI	Total	Histopathology	
		Benign	Malignant
Benign	15	13	2
Malignant	12	1	11
Total	27	14	13

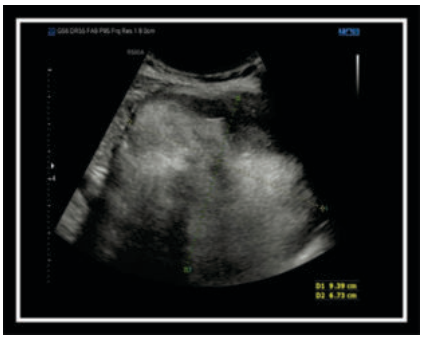
Among the 15 benign lesions characterized by MRI, histopathology was able to prove up 13 cases and 1cases were classified as malignant. Among the 12 malignant cases characterized by MRI, histopathology 1 cases were classified as benign.

Table 14. Sensitivity, Specificity, PPV and NPV of MRI

	MRI
Sensitivity	93%
Specificity	85%
Positive predictive value	87%
Negative predictive value	92%

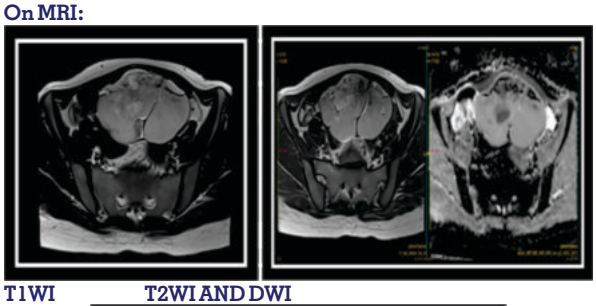
The sensitivity of MRI to pick up the utero-ovarian lesions in women was 93% and specificity was 85%. The positive predictive value was 87% and negative predictive value was 92% in this study.**Case mature teratoma:**

On USG:

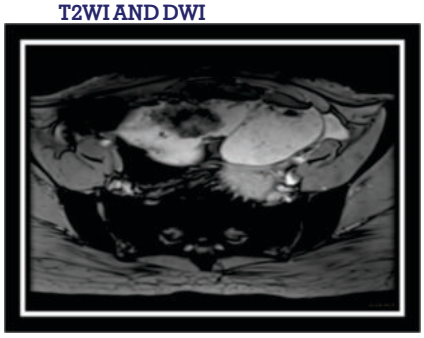


Large well defined complex lobulated lesion in left adnexa s/o ?large mesenteric dermoid?? Left adnexal pedunculated derrmoid.

On MRI:



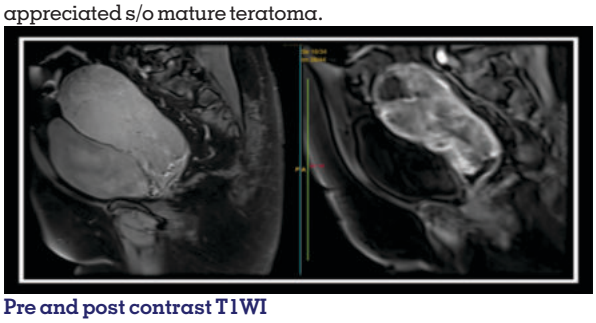
T1WI **T2WI AND DWI**



GRE Sequence

Image description:

There is well defined lobulated altered signal intensity complex solid cystic lesion in the suprapubic pelvis in the midline and slightly towards left side. Left ovary not seen separately from the lesion. Internal contents show heterogenous signal with multiple areas with fat signal intensity appearing bright signal on T1W and T2 which get suppressed on fat suppressed image. Multiple focal nodular areas with blooming on GRE images likely represent calcification. Dependent part of the lesion shows T2W intermediate and T1W hyperintense without suppression on fat suppress image likely represent proteineous cystic contents. Post contrast images reveals no significant enhance appreciated s/o mature teratoma.



Pre and post contrast T1WI

Image description
Heterogeneous signal intensity mass lesion involving cervix (epicentered at both cervical lip) and lower 2/3rd of uterus extending into upper 1/3rd of vagina with multiple small non enhancing necrotic areas within extending into lower uterine segment obstructing endometrial canal with resultant minimal collection in endometrial cavity in fundus likely s/o malignant neoplastic etiology.

DISCUSSION:

Complex echogenic adnexal lesions on ultrasound may represent hemorrhagic cysts, endometrioma, dermoids or ovarian neoplasm. Ascertaining the nature of the utero-ovarian lesions whether benign or malignant, where one can ensure appropriate treatment for the condition.

Diagnosis of a benign nature of utero-ovarian lesions in females may not only save the patients from unnecessary surgery but also prevents the unnecessary psychological consequences. Ultrasonography (US), Computed Tomography (CT), and the Magnetic Resonance imaging (MRI) are currently available methods for the diagnostic evaluation of the utero-ovarian lesions.

MRI had been found to be highly accurate in the characterization of utero-ovarian lesions. MRI is non-invasive, has no risk of radiation and is less operator dependent. MRI can also provide information about hemorrhage, fat and collagen. MRI is also able to identify different types contained in pelvic masses, distinguishing benign from malignant ovarian tumors, with an overall The sensitivity of MRI to pick up the utero-ovarian lesions in women was 93% and specificity was 85%. The positive predictive value was 87% and negative predictive value was 92% in this study.

In order to study the importance of MRI in diagnosis of utero-ovarian lesions, a prospective observational study was undertaken on women with clinical suspicion or ultrasound detected with utero-ovarian lesions to 3 tesla Magnetic resonance Imaging (MRI) using abdominal surface coils between Jan 2019 to Sept 2021.

A total number of 40 cases met the inclusion and exclusion criteria. A thorough clinical history was taken from each patient under the study followed by physical examination. Clinically or ultrasonographically detected suspicious pelvic masses were subjected to MRI and correlated histopathologically.

Age group
Majority of the study subject in this study belonged to 20-45 years of age group. In a study by Dwivedi et al, about 57.7% of the patients with benign lesions belonged to 20 – 39 years of age group and 64.7% of the malignant lesions belonged to more than 60 year of age group. In a study by Nasr et al, the mean age was 38.85 years ranging from 13 to 70 years. In a study by Paul et al, the age of presentation ranged from 8 to 12 years, 68% belonged to 16 – 20 years, 20% belonged to 13 – 15 years and 12% belonged to 8 – 12 years.

Menstrual stage
In our study 42.5% of female belong to menstrual stage,37/5% belong to post menopausal stage,12.5% belong to premenstrual stage,7.5% belong to perimenopausal stage. The very fact that a woman is in menopause presents a risk that the adnexal mass is of malignant nature, which is confirmed by the results of our study. On the other hand, patients in the reproductive period more often have benign lesions. This result is seen in similar studies by Sharadha et al83 and Jha et al75 where there were highly significant differences among tumor types (benign, malignant) regarding menstrual status of examined women with malignant tumors being more frequent in postmenopausal group.

Chief complaints
In this study, 15.8% had pain abdomen, 10.5% had lower abdominal pain and equal number attended for regular checkup, 7.9% had irregular cycles, 5.3% each of the patients had abdominal distention, acute pelvic pain and pain abdomen with distention. In a study by Paul et al, 48% of the cases presented with palpable mass in the lower abdomen, 20% presented with pain in the lower abdomen and 20% presented with both palpable mass and pain abdomen. In a study by Paul et al, 48% of the cases presented with palpable mass in the lower abdomen, 20% presented with pain in the lower abdomen and 20% presented with both palpable mass and pain abdomen. **Targeting women with specific symptoms and possibility of development of a symptom index has been recommended by a study from USA.**

Duration of Symptoms
About 10% of the women had the symptoms since less than15 week, 5% had symptoms since 15 days – 1 month, 45% had the symptoms since 1 month- less than 6 month, 7.5% had symptoms from 6 months to less than 1year & 25 % had symptoms since more than 1year. No studies were available to compare these results.

According to Fauconnier ,Fertil steril, 2002, The patients symptoms guide us the most likely location of deep endometriotic lesions.

Symptom		Type of lesion
Dysmenorrhea	-	Adenomyosis, adhesions.
Dyspareunia	-	Sacrouterine ligaments
Pain at defecation	-	Vagina, rectum.
Chronic pelvic pain	-	Bowel.
Hematuria	-	Bladder

T_1 weighted image
The T_1 weighted image had shown hypointense lesions in 48% of the study subjects, hyperintense lesions in 18% of the study subjects, 9% of the study subjects shows heterogenous lesions in 24% of the study subjects shows hypointense lesion of the study subjects. The studies were lacking to compare these results.

T_2 weighted image
The T_2 weighted images had shown hyperintense lesions in 48.4% of the study subjects, heterogenous lesions in 36.2% of the study subjects, hypointense lesions in 12.2 % of the study subjects, The studies were not available to compare these results.

Contrast
The contrast was not used 27.5% of the study subjects and used in 72.5% of the study subjects. No available study compared these results. As patients of pcos, mullerian duct anomaly there is no need of contrast for diagnosis.

MRI diagnosis
This study had shown that, 12.5% the study subjects had cervical malignancy,5 % cases shows right ovarian neoplastic etiology, 2.5 % each shows teratoma, complex adnexal lesion of left ovary, proctitis, pcos, bilateral tubo-ovarian complex, intramural fibroid with myxoid degeneration, ca endometrium.15 % shows mullerian anomaly . Nasr et al had shown that, 10 cases showed typical criteria of malignant lesions by MRI. In a study by Rathore et al, 73.3% of the benign lesions were solid, 62.5% were complex solid cystic and 97.4% were cystic lesions. Among the malignant lesion, 26.7% were solid, 37.5% were complex solid cystic and 2.5% were cystic lesions.

Histopathological diagnosis
The Histopathological diagnosis had shown benign mature teratoma in 2.5% of the cases, serous cystadenoma of left

ovary in 5% of cases, serous cystadenocarcinoma of right ovary in 7.5% of cases, fibroid in 12.5% of cases,residual mole in 5% of cases, cervical malignancy in 10% of cases, endometrial carcinoma in 5% of cases, squamous cell carcinoma of vagina in 5% of cases, cervicitis 2.5% & other cases where histopath is not needed including 45%.That means among histopath proven cases maximum percentage of cases are fall under fibroid. In a study conducted by Pramod Ramchnand Shaha ,The maximum cases in MRI diagnosis group were those of fibroid uterus (22=46% of the uterine lesions) followed by endometrial carcinoma (10=21% of the uterine lesions) and carcinoma cervix (10=21% of the uterine lesions) .

In a study by Paul et al, the histopathologcial diagnosis for epithelial tumor included 2 serous cyst adenoma, 1 mucinous cyst adenoma, 16% patients had bilateral ovarian lesion. In a study by Yogambal et al, the commonest histological patterns observed in the study were epithelial tumors (71.64%) including both benign and malignant epithelial tumors. Serous Cystadenoma was the commonest tumor followed by mature cystic teratoma.

Characterization of lesion by MRI and histopathology

Among the 15 benign lesions characterized by MRI, histopathology was able to prove up 13 cases and 1case were classified as malignant. Among the 12 malignant cases characterized by MRI, histopathology 1 case were classified as benign.

Correlation of MRI in diagnosis of lesions

The sensitivity of MRI to pick up the utero-ovarian lesions in women was 93% and specificity was 85%. The positive predictive value was 87% and negative predictive value was 92% in this study.

A study by Dwivedi et al had shown that, the sensitivity of mass of ovarian origin was 97.7% and specificity was 73.1% and diagnostic accuracy was 99.1% on MRI. In a study by Nasr et al, the sensitivity was 60%, specificity was 91%, the PPV was 85% and NPV was 73.2%. In a study by Rathore et al, out of 50 patients, 26 patients were operated and these findings on MRI and USG were correlated with operative and histopathological findings.

CONCLUSION

This study was mainly undertaken to study the role of MRI in diagnosis of utero-ovarian lesions with their histopathological correlation. The MRI in this study had good sensitivity but lacked the specificity. The negative predictive value was good lacked the positive predictive value in delineating the lesion as benign or malignant especially in postmenopausal women. These study is not without limitation as the specificity is lacking. But this was a novel study to determine the usefulness of MRI in diagnosis of utero-ovarian lesions especially in the postmenopausal women. Further research in this direction can bring more facts about the usefulness of MRI in diagnosis of utero-ovarian lesions especially in postmenopausal women.

REFERENCES:

1. ACR Practice Guideline for the Performance of Pelvic Ultrasound in Females. Reston, VA: American College of Radiology; 2006
2. Hricak H, Chen M, Coakley F, et al. Complex adnexal masses: Detection and characterization with MR imaging--multivariate analysis. Radiology. 2000; 214:39-46.
3. Togashi K et al: Enlarged uterus: differentiation between adenomyosis & leiomyoma with MR imaging Radiology 171:531, 1989.
4. Smith FW,Cherryman GR,Bayliss AP ,et al :Comparitive study of the accuracy of ultrasound imaging,x-ray computerized tomography & low field MRI diagnosis of ovarian malignancy. Magnetic Resonance Imaging 6:225, 1988.
5. Punwani S. Contrast enhanced MR imaging of female pelvic cancers: Established methods and emerging applications. Eur J Radiol. 2011;78:2-11.
6. Haaga JR, Doogra VS, Gilkeson RC, HA HK, Sundarm M. CT and MRI of the whole body, Mosby Elsevier 2007, 44.
7. Evans TN, Poland ML, Boving RL. Vaginal malformations. Am J Obstet Gynecol 1981; 141:910-920.
8. The American Fertility Society classifications of adnexal adhesions, distal tubal occlusion, tubal occlusion secondary to tubal ligation, tubal pregnancies, mullerian anomalies and intrauterine adhesions.Fertil Steril1988;49:944-955.
9. Ascher SM, Jha RC, Reinhold C: Benign myometrial conditions: Leiomyomas and adenomyosis. Top Magn Reson Imaging 2003; 14:281-304.
10. Reinhold C, McCarthy S, Bret P, et al: Uterine adenomyosis: Comparison of endovaginal US and MRI with histopathological correlation. Radiology 1996; 199:155-158.
11. Togashi K, Osaza H, Konishi I, et al: Enlarged uterus: Differentiation between adenomyosis and leiomyoma with MR imaging. Radiology 1989; 171:531-534.
12. Grasel RP, Outwater EK, Siegelman ES, et al: Endometrial polyps: MR imaging features and distinction from endometrial carcinoma. Radiology 2000; 214:47-52.
13. Freeman S J, Aly A M, Kataoka M Y, Addley H C,Reinhold C ; The revised FIGO staging system for staging of uterine malignancies: Implications for MR imaging. RadioGraphics 2012; 32:1805–1827 .
14. Stoupis C, Ros PR, Abbitt PL, et al: Bubbles in the belly: Imaging of cystic mesenteric or omental masses. Radiographics 1994; 14:729-737. Kier R (1992) Nonovarian gynaecologic cysts: MR imaging findings. AJR 158:1265–1269.
15. Tamai K, Koyama T, Saga T, et al: MR features of physiologic and benign conditions of the ovary. Eur Radiol 2006; 16:2700-2711.
16. John A.Spencer et al: MR imaging of the sonographically indeterminate adenexal mass. Radiology 2010;256:677-694.
17. L. Olivetti, L. Grazioli (eds.), Imaging of Urogenital Diseases, Chapter 22 Diseases of the female reproductive system. Springer-Verlag Italia 2009.
18. Coutinho A, Bittencourt L K : MR imaging in deep pelvic endometriosis: A pictoral essay. RadioGraphics 2011; 31:549–567.
19. Sam JW, Jacobs JE, Birnbaum BA: Spectrum of CT findings in acute pyogenic pelvic inflammatory disease. Radiographics 2002; 22:1327-1334.
20. Rha SE, Byun JY, Jung SE, et al: Atypical CT and MRI manifestations of mature ovarian cystic teratomas. AJR Am J Roentgenol 2004; 183:743-750.
21. Sung SE, Lee JM, Rha SE, et al: CT and MRI of ovarian tumors with emphasis on the differential diagnosis. Radiographics 2002; 22:1305-1325.
22. Troiano RN, Lazzarini KM, Scoutt LM, et al: Fibroma and fibrothecoma of the ovary: MR imaging findings. Radiology 1997; 204:795-798.
23. Ha HK, Baek SY, Kim SH, et al: Krukenberg's tumors of the ovary: MR imaging features. AJR Am J Roentgenol 1995; 164:1435-1439.
24. Tanaka YU, Kurosaki Y, Nishida M, et al: Ovarian dysgerminoma: MR and CT appearance. J Comput Assist Tomogr 1994; 18:443-448.
25. Ferrozzi F, Tognini G, Bova D, et al: Non Hodgkin lymphomas of the ovaries: MR findings. J Comput Assist Tomogr 2000; 24:416-420.
26. national cancer institute : vaginal cancer treatment PDQ : stages of vaginal cancer 2013.
27. David Sutton.Textbook of Radiology and imaging .7 th edition Elsevier Science LTD32003.
28. Norries HJ,Jenson RD .Relative frequency of ovarian neoplasm in chlder andadolscents Cancer
29. Worthington JLBalfe DM ,MR imaging radiology.
30. Ash Saini,Robert Diana et.alCharacterization of adnexal masses with MRI.AJR2005
31. Ahju Sahadev,Philippe Van Trappen et.all Characterization of adnexal mass lesion with MRI imaging AJR 2002:1297.
32. Andreottic RF ,Zusmer NR,Sheldon JJ et.al.Ultrasound and magnetic resonance imaging of pelvic masses.Sug Gynecol Obster 166:327,1988
33. Carol M.Rumack ,Diagnostic ultrasound 3 rd edition 527-57
34. Grays anatomy .Anatomical basis of clinical practice 39 th edition 2005.
35. Grainger and Allison ,Diagnostic Radiology A.textbook of medical iaging ,Edition - 4,2201-2222.
36. Charles BHiggns, Hedvig Hricak,Clyde A.Helms Magnetic Resonance Imaging of body III edition p3-24.
37. Funt SA,Hann LE .Detection and characterization of adnexal masses using ultrasound :A practical review .Int J womens Health2-14 .
38. Guerra A,Cunha T.M Felix A, Magnetic Resonance evaluation of adnexal masses 2006:49(6)
39. Caroline R.Magnetic Resonance Imaging in gynaecology disease .Topics in Magnetic Resonance Iamging 2003:14:267-268.
40. Pretorius ES, Outwater EK, Hunt JL, Siegelman ES. Magnetic resonance imaging of the ovary. Topics in Magnetic Resonance Imaging. 2001;12(2):131–46. [PubMed] [Google Scholar]
41. Ascher S, Susan M, Takahama Jha J, Reena C. Staging of gynecologic malignancies. Topics in Magnetic Resonance Imaging. 2001;12(2):105–29. [PubMed] [Google Scholar]
42. McLeary M, Kjellin IB, Kirk SR. Magnetic resonance imaging of the pediatric female pelvis: a pictorial essay. Journal of Women's Imaging. 2001;3(1):38–44. [Google Scholar]
43. Troiano B, Robert N. Magnetic resonance imaging of mullerian duct anomalies of the uterus. Topics in Magnetic Resonance Imaging in Gynecologic Disease. 2003;14(4):269–79. [PubMed] [Google Scholar]
44. Pretorius ES, Outwater EK, Hunt JL, Siegelman ES. Magnetic resonance imaging of the ovary. Topics in Magnetic Resonance Imaging. 2001;12(2):131–46. [PubMed] [Google Scholar]
45. Ascher S, Susan M, Takahama Jha J, Reena C. Staging of gynecologic malignancies. Topics in Magnetic Resonance Imaging. 2001;12(2):105–29. [PubMed] [Google Scholar]
46. Halmin JD, Pettersson H, Fitzsimmons J, Morgan LS. MR imaging of uterine leiomyomas and their complications. J Comput Assist Tomogr. 1985;9:902–07. [PubMed] [Google Scholar]
47. Bristow RE. Endometrial cancer. Curr Opin Oncol. 1999;11:388–93. [PubMed] [Google Scholar]
48. Rose PG. Endometrial carcinoma. N Engl J Med. 1996;335:640–49. [PubMed] [Google Scholar]
49. Reinhold C, McCarthy S, Bret P, Mehio A, Atri M, Zakarian R, et al. Diffuse adenomyosis: comparison of endovaginal US and MR imaging with histopathologic correlation. Radiology. 1996;199(1):151–58. [PubMed] [Google Scholar]
50. Reinhold C, Gallix BP, Ascher SM. Semelka Rc, Ascher SM, Reinhold C., editors. Uterus and cervix. MRI of the abdomen and pelvis: a text atlas, New York. 1997:585–660. [Google Scholar]
51. McCarthy S, Haricak H. The uterus and vagina. In: Higgins CB, Hricak H, Helms CA, editors. Magnetic resonance imaging of the body. 3rd ed. New

York, NY: Lippincott_Raven; 1997. pp. 761–814. [Google Scholar]
52. Szklaruk J, Tamm EP, Choi H, Varavithya V. MR imaging of common and uncommon large pelvic masses. Radiographics. 2003;23:403–24. [PubMed] [Google Scholar]
53. Dwivedi A, Jain S, Shukla RC, Jain M, Srivastava A, Verma A, et al. MRI is a state of art imaging modality in characterization of indeterminate adnexal masses. J Biomedical Science and Engineering. 2013;(6):309–13. [Google Scholar]
54. Sohaib SA, Sahdev A, Troppen PV, Jacobs IJ, Reznek RH. Characterization of adnexal mass lesions on MRI. American Journalism Review. 2003;180:1297–304. [PubMed] [Google Scholar]
55. Andrade Neto F, Palma-Dias R, Costa FS. Ultrasonography of adnexal masses: imaging findings. Radiol Bras. 2011;44(1):59–67. [Google Scholar]
56. Siedman JD, Russell P, Kurman RJ. Surface epithelial tumours of ovary. In: Kurman RJ, editor. Blaustein's pathology of female genital tract. 5th ed. New York: Springer Verlag; 2002. pp. 791–904. [Google Scholar]
57. Shaaban AM, Rezvani M, Elsayes KM, Baskin H, Mourad A, Foster BR, et al. Ovarian malignant germ cell tumours: cellular classification and clinical and imaging features. Radiographics. 2014;34(3):777–801. [PubMed] [Google Scholar]
58. Caruso PA, Marsh MR, Minkowitz S, Karten G. An intense clinicopathologic study of 305 teratomas of the ovary. Cancer. 1971;27:343–48. [PubMed] [Google Scholar]
59. Outwater E, Siegelman E, Hunt J. Ovarian teratomas: tumour types and imaging characteristics. RadioGraphics. 2001;21(2):475–90. [PubMed] [Google Scholar]
60. Kido A, Togashi K, Konishi I. Dermoid cysts of the ovary with malignant transformation: MR appearance. AJR Am J Roentgenol. 1999;172:445– [PubMed] [Google Scholar]
61. Yamashita Y, Baba T, Baba Y, Nishimura R, Ikeda S, Takahashi M, et al. Dynamic contrast-enhanced MR imaging of uterine cervical cancer: pharmacokinetic analysis with histopathologic correlation and its importance in predicting the outcome of radiation therapy. Radiology. 2000;216(3):803–09. [PubMed] [Google Scholar]
62. Guinet C, Ghossain MA, Buy JN, Malbec L, Hugol D, Truc JB, et al. Mature cystic teratomas of the ovary: CT and MR findings. Eur J Radiol. 1995;20:137–43. [PubMed] [Google Scholar].
63. Norris HJ, Jensen RD. Relative frequency of ovarian neoplasms in children and adolescents. Cancer 1972;30:713–719.
64. Worthington JL, Balfe DM, Lee JK, et al. Uterine neoplasms: MR imaging. Radiology 1986;159:725–730.
65. Parazzini F, LaVecchia C, Negri E, et al. Reproductive factors and risk of endometrial cancer. Am J Obstet Gynecol 1991;64:522–527.
66. Hacker NF, Berek JS. Surgical staging. In: Surwit E, Alberts D, eds. Cervix cancer. Boston: Martinus Nijhoff, 1987:43–57.
67. Sohaib SA et al. The role of MRI and ultrasound in patients with adnexal masses. Clinical Radiology 2005;60;340-348.
68. Ash Saini, Robert Diana et al. characterization of adnexal masses with MRI. AJR 2005;vol184no3;1004-1009
69. Adusumilli S, Hussain H. K. et al., MRI of sonologically indeterminate adnexal masses. AJR 2006;vol187no3;732-740
70. Hedvig Hricak et al., complex adnexal masses: detection and characterization with MRI imaging. RSNA 2000;214;39-46.
71. Pratiksha Yadav et al., Magnetic resonance imaging in the evaluation of female pelvis.