INTRODUCTION

Ovarian masses present a special diagnostic challenge when imaging findings cannot be categorized into benign or malignant pathology. Ultrasound (US), computed tomography CT, and magnetic resonance imaging are currently used to evaluate ovarian tumors ***(Pierce et al, 2008).***

US is the first- line imaging investigation for suspected adnexal masses helping in detection and characterization of ovarian tumors ***(Pierce et al., 2008).***

An adnexal mass is defined as indeterminate on US when it cannot be confidently placed into either the benign or malignant category ***(Spencer, 2010).***

CT is commonly performed in evaluation of a suspected ovarian malignancy, but it exposes patients to radiation ***(Valentini et al., 2012).***

MRI can be a valuable problem solving tool, an adjunctive modality for evaluating adnexal lesions, useful to give also surgical planning information without radiation exposure ***(Valentini et al., 2012).***

IT is able to identify different types of tissue contained in pelvis masses, distinguishing benign from malignant ovarian tumors, with an overall accuracy of 88%

to 93% ***(Valentini et al., 2012).*** However, the only definitive diagnosis of an ovarian mass is through histology ***(Yeoh et at., 2015).***

Functional imaging techniques are increasingly being used for tumor detection, monitoring of treatment response, and detection of relapsed disease ***(Prakash et al., 2010).***

Recent technical advances allow the use of dynamic and diffusion MR imaging in abdominal and pelvic applications ***(Whittaker et al., 2009).***

Functional imaging by means of dynamic multiphase contrast-enhanced magnetic resonance imaging (DCE-MRI) and diffusion weighted magnetic resonance imaging (DW-MRI) is now part of the standard imaging protocols for evaluation of the female pelvis. DCE-MRI and DW-MRI are important MR imaging techniques which enable the radiologist to move from morphological to functional assessment of diseases of the female pelvis ***(Sala et al., 2010).***

Dynamic contrast enhanced MRI (DCE-MRI) can interrogated the microvascular properties of tissue ***(O'Connor et al., 2007).*** DCE-MRI has the ability to noninvasively characterize tissue vasculature ***(Naggara et al., 2008).*** It can depict the distribution of contrast by measuring variations in vessel and tissue enhancement over

time. Variations in contrast enhancement are associated with specific histopathological features of the tumor ***(Moreno et al., 2012).*** Furthermore it provides additional insight into tumor perfusion and capillary permeability ***(Stomper and Winston, 1997).***

Dynamic contrast-enhanced images are useful for the evaluation of complex adnexal lesions, as they may help differentiate solid components or papillary projections from clots and debris ***(Jeong et al., 2000).*** Moreover, DCE-MRI improves characterization of cystic adnexal lesions and detection of small peritoneal implants in patients with ovarian cancer ***(Sala et al., 2010).***

Diffusion weighted imaging (DWI) technique can help in differentiating malignant from benign ovarian tumors and is useful in detection of peritoneal implants and metastatic lymph nodes in patients with gynecological malignancies ***(Jeong et al., 2000).*** Moreover, Diffusion - weighted imaging provides information about tissue cellularity and integrity of cellular membranes ***(Koh and Padhani, 2006).***

In general, malignant tumors have a higher cellularity than benign tumors; therefore, DWI can assist in differentiating malignant from benign tumors ***(Fujii and Matsusue, 2008).*** DWI is presently used for tumor

detection, tumor characterization, and the evaluation of treatment response in patients with cancer ***(Koh et al, 2007).***

When diffusion-weighted MR imaging is used in gynecologic applications, cancers have shown lower ADC (apparent diffusion coefficient) values. Increasing ADC values is noted in carcinomas responding to radiation therapy, so it can be used as a biomarker for treatment response, and in the evaluation of recurrence and multi focality ***(McVeigh et al., 2008).***

Aim of the Work

The aim of the current study is to evaluate the diagnostic value of dynamic contrast enhanced MRI and diffusion-weighted MR imaging in prediction of the nature of ovarian masses in comparison to the conventional ultrasound.

Anatomy of the Ovaries

The ovary is an ovum- producing reproductive organ. Ovaries in female are homologous to testes in males in that they are both gonads and endocrine glands ***(Lewis et al., 2003).***

Gross anatomy:

The ovaries are ovoid, almond shaped structures that vary considerably in size depending on age, hormonal status, and the stage of menstrual cycle. The adult ovary is about 2.5-5 cm long, 1.5-3 cm wide, and 1-2 cm thick. The ovaries are of grayish-pink color. It lies in a shallow depression, named the ovarian fossa. This fossa is bounded above by the external iliac vessels, in front by the obliterated umbilical artery, and behind by the ureter ***(Faysal et al., 2004).***

In general the ovarian position is influenced by uterine size, ovarian size, degree of filling of urinary bladder, degree of distention of the recto sigmoid colon and the presence of a pelvic mass **fig. (1.1) (*Faysal et al., 2004*).**

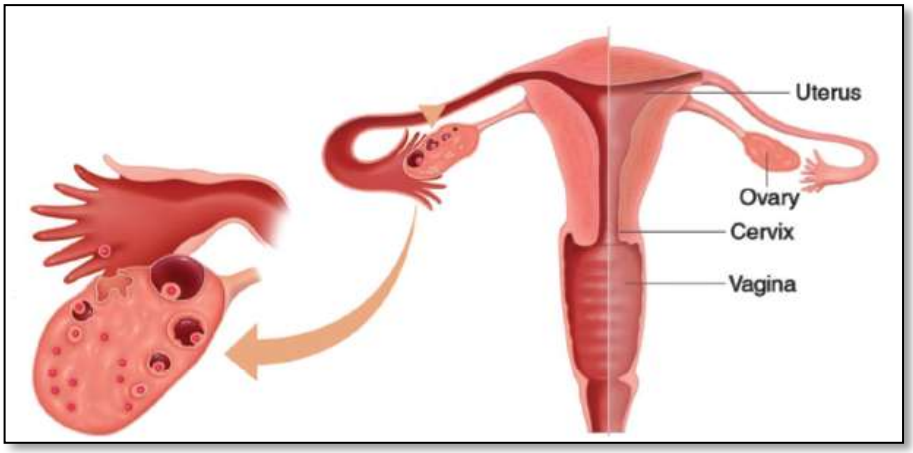

Fig. (1.1): Illustration shows the ovarian fossa
(Faysal et al., 2004).

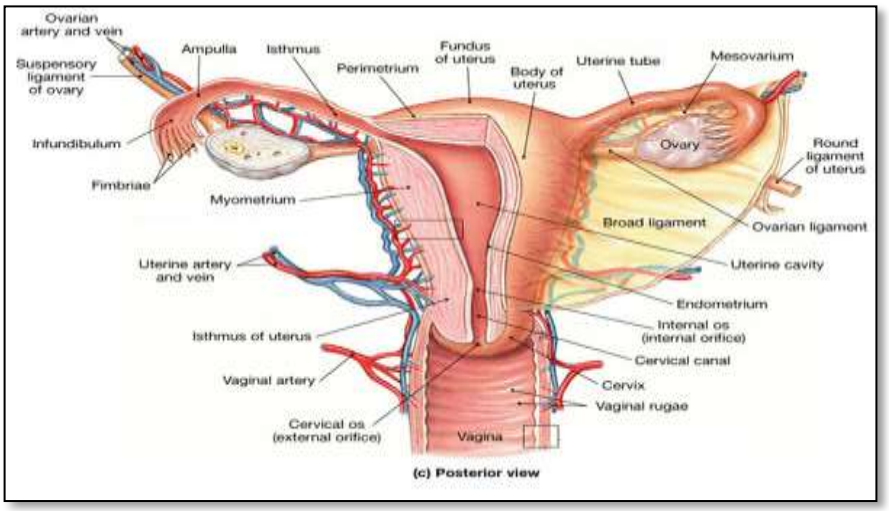

Fig.(1.2): Illustration shows the ovarian anatomy
(Faysal et al., 2004).

Ligaments:

Utero-Ovarian Ligament

The utero -ovarian ligament (proper ligament of the ovary) is a cordlike structure invested with the posterior layer of the broad ligament. It consists of smooth muscle and connective tissue. The ovarian ligament extends from the lower ovarian pole to the lateral uterine wall. It is located between the mesosalpinx and the mesovarium fig (1.2) ***(Dooms et al., 1986).***

Infundibulo-pelvic Ligament

The Infundibulo-pelvic ligament (suspensory ligament of the ovary) is a fan-shaped band of fibromuscular visceral connective tissue containing arteries, veins, lymphatics, and visceral nerves extending from the upper ovarian pole to the lateral pelvic wall. This ligament passes from the abdominal cavity into the pelvic cavity at the level of the pelvic brim, superficial to the bifurcation of the common iliac artery, just lateral to where the ureter passes over the bifurcation of the common iliac vessels ***(Ascher et al., 1997).***

Mesovarium

The mesovarium is a short peritoneal fold from the posterior surface of the broad ligament to the anterior ovarian wall. It facilitates the passage of ovarian vessels

and nerves into the ovarian hila. The mesovarium, the infundibulo pelvic ligament, and the utero-ovarian ligament together support the ovary in its position along the pelvic sidewall ***(Doherty et al., 2000).***

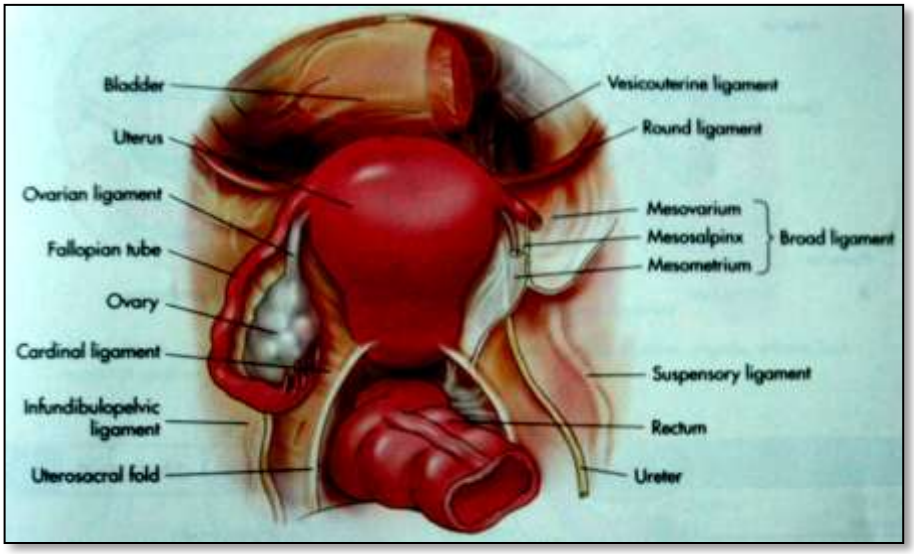

Fig. (1.3): Ovarian ligaments ***(Faysal et al., 2004).***

Microscopic anatomy:

The ovaries are covered on the outside by a layer of simple cuboidal epithelium called germinal (ovarian) epithelium. This is actually the visceral peritoneum that envelops the ovaries. Underneath this layer, there is a dense connective tissue capsule, the tunica albuginea. The substance of the ovaries is distinctly divided into an outer cortex and an inner medulla. The cortex appears more dense and granular due to the presence of numerous ovarian follicles in various stages of development. Each of

the follicles contains an oocyte, a female germ cell. The medulla is loose connective tissue with abundant blood vessels, lymphatic vessels, and nerve fibers. Vesicular ovarian follicles (Graafian follicles) are follicles containing the ova. Immediately beneath the superficial covering is a layer of stroma, in which are a large number of minute vesicles, of uniform size, about 0.25 mm in diameter. These are the follicles in their earliest condition and the layer where they are found has been termed the cortical layer. They are especially numerous in the ovary of the young child, after puberty, and during the whole of the child-bearing period. Large and mature follicles are also found in the cortical layer in small numbers, and also corpora lutea the remains of follicles which have burst and are undergoing atrophy and absorption **fig(1.4)** ***(William et al., 2006).***

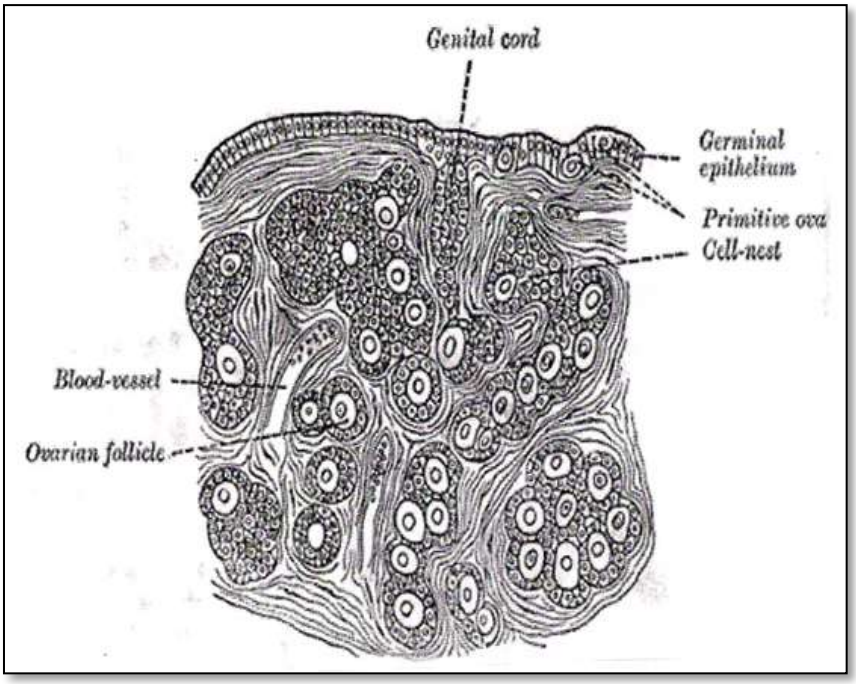

Fig. (1.4): Illustration shows the structure of the ovary ***(William et al., 2006).***

Embryology:

- The ovary is composed of four main components, each with different embryologic origins: surface epithelium, stroma, germ cells, and sex cord.
- Coelomic epithelium forms the ovarian surface epithelium.
- Subcoelomic mesoderm forms the ovarian stroma.
- Primordial germ cells migrate from the yolk sac endoderm to the developing ovary.

- Invaginations of coelomic epithelium in the superficial ovarian cortex form the sex cords (pregranulosa cells) ***(Schneck et al., 1999).***

Arterial supply of the ovaries

- The ovarian arteries arise from the abdominal aorta around the level of L 2 vertebra.
- They descend along the posterior abdominal wall, courses caudally and laterally ventral to the psoas major
- It anastomoses with the uterine artery.
- The artery usually has a tortuous course that is maximum near the level of the ovary ***(Faysal et al., 2004).***

Venous drainage of the ovaries: :

- The ovarian veins leave the hilum of the ovary and form a net work of vessels, called the pampiniform plexus in the broad ligament near the ovary and uterine tube.
- This plexus of veins communicates with the uterine plexus of veins.
- Each ovarian veins arises from the pampiniform plexus and leave the pelvis minor with the ovarian artery.
- The right ovarian veins ascends to the IVC below the level of renal vessels, whereas the left ovarian vein drains into the left renal vein ***(Faysal et al., 2004).***

The ovarian artery and vein are medial to the ureter near the level of the lower renal poles, cross obliquely anterior to ureter at about the middle to lower lumbar region, and lateral to the ureter in the lower abdomen and pelvis **fig(1.5)** ***(Faysal et al., 2004).***

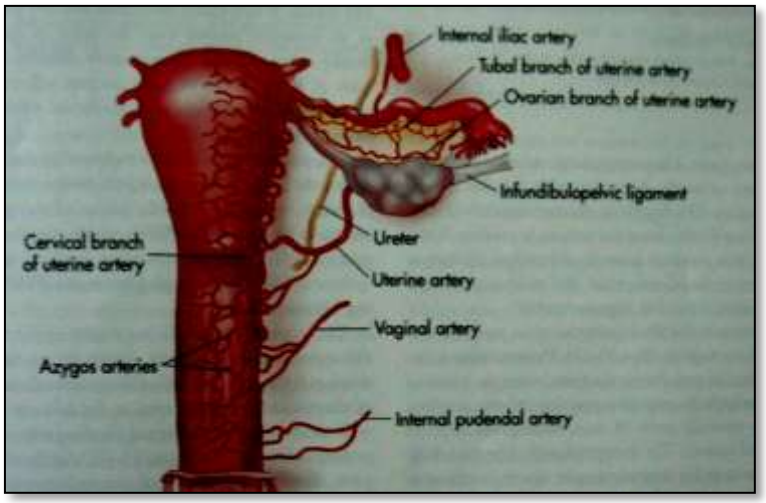

Fig. (1.5): Illustration shows the ovarian blood supply ***(Faysal et al., 2004).***

Lymphatic drainage of the ovaries

The ovarian lymphatics ascend with the ovarian vessels drain almost exclusively into to the para-aortic lymph nodes, close to the origin of the ovarian arteries ***(Reynolds et al., 2006).***

Other small branches drain via the broad ligament to the external, internal, and common iliac groups of nodes ***(Livengood et al., 2006).***

Innervation of the ovaries

- The ovary receives its visceral sympathetic innervation from the aorto-renal plexus.
- Other sympathetic input may originate from the superior and inferior hypogastric plexuses.
- The parasympathetic fibers are provided by the inferior hypogastric plexus ***(Faysal et al., 2004).***

Radiographic features of the normal ovary:

1. Ultrasound:

- Ovaries are on either side of the uterus on transverse images and they may lie in the pouch of Douglas-The volume of the normal ovary is 3cm x2 cm x 2cm ***(Ryan et al., 2011).***
- Normal ovary may contain small anechoic follicles in premenopausal. In late phase of menstrual cycle a small amount of fluid may be seen in the pouch of Douglas ***(Ryan et al., 2011).***
- Homogenous echotexture with a central echogenic medulla fig (1.6) ***(Saksouk et al., 2004).***

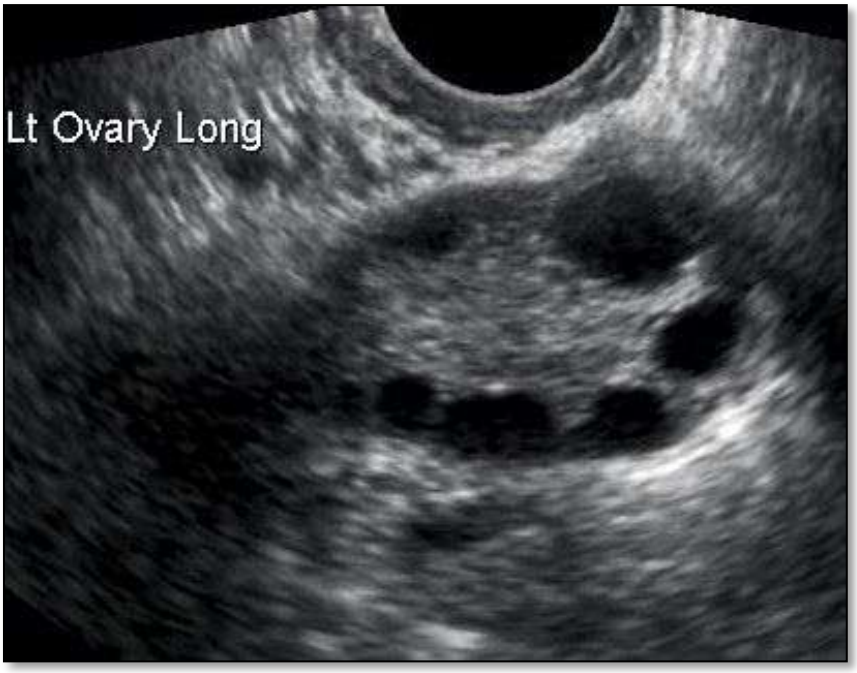

Fig. (1.6): Normal transvaginal ovary demonstration normal peripheral follicles ***(Garel et al., 2001).***

2. MRI:

- Ovaries are isointense (they are of inter-mediate intensity on T1WI).On T2WI the ovaries are isointense but the follicles show high signal on T2WI fig. (1.7) ***(Ryan et al., 2011).***