INTRODUCTION

Leiomyomas (fibroids) of the uterus are the most common gynecologic masses, but relatively few become symptomatic while endometrial carcinoma is a disease of menopausal or postmenopausal women, with a peak incidence at age 60 years and it has became more common than cervical carcinoma in situ as the latter became easily detected by screening ***(Outwater, 2003)***.

Over the past two decades, magnetic resonance (MR) imaging (MRI) has proven to be a valuable diagnostic tool in oncology. Rapid improvements in MRI techniques have resulted in MR images with excellent spatial resolution and soft tissue contrast, which contribute to the differentiation of suspected tumors ***(Vermoolen et al., 2012)***.

However, using conventional MRI sequences, difficulty in differentiating benign from malignant lesions may arise when malignant and benign lesions share certain morphologic and contrast-enhancement characteristics. In these cases, diffusion-weighted MR imaging (DWI) might be of value in tumor assessment, as it has the ability to provide tissue contrast based on molecular diffusion ***(Vermoolen et al., 2012)***.

Recent technical advances in diffusion-weighted imaging (DWI) greatly enhanced the clinical value of magnetic resonance imaging (MRI) of the body. DWI can provide

excellent tissue contrast based on molecular diffusion and may be able to demonstrate malignant tumors ***(Namimoto et al., 2009)***.

DWI involves the acquisition of a magnetic resonance signal related to random thermal motion (Brownian motion) or the “diffusion” of water protons in tissue. The signal obtained with DWI is a measure of the net displacement of water molecules, e.g., the water path length in the extracellular, intracellular and intravascular spaces ***(Türkbey et al., 2011)***.

Restricted diffusion in biological tissues is inversely proportional to tissue cellularity and the integrity of cell membranes, and it can be quantified with apparent diffusion coefficient (ADC) measurements ***(Türkbey et al., 2011)***.

DWI can be assessed in two ways, qualitatively, by visual assessment of signal intensity, and quantitatively, by measurement of the ADC value which quantifies water proton motion ***(Vermoolen et al., 2012)***.

The ADC value can theoretically be usedto characterize tissues, as the degree of diffusion is correlated to cellular density and extracellular space volume. Malignant tumors are reported to have a high cellular density and low extracellular space volume, which is associated with impeded water proton diffusion and low ADC values. In contrast, various benign lesions are characterized by an increased amount of

extracellular matrix with minimal increase of cellular density, which may result in higher ADCs ***(Vermoolen et al., 2012)***.

Depending on the microarchitecture, either restricted or increased diffusion can occur in malignant tumors. For instance, diffusion is restricted in cellular portions of the tumor, but it may be increased in necrotic portions. Other causes of enhanced diffusion include increased water content arising from intratumoral edema and cystic tumor components ***(Türkbey et al., 2011)***.

Although initially used to evaluate neurological diseases, the applications of DWI have been extended to oncologic imaging throughout the body made possible by improvements in MRI hardware and new sequences. The use of DWI as a complement to conventional MRI methods has led to improvements in the detection and characterization of tumors, treatment response monitoring, and detection of recurrence in oncology patients ***(Türkbey et al., 2011)***.

AIM OF THE WORK

The aim of this work is to highlight the role of diffusion-weighted MR in the imaging of uterine tumors.

GROSS AND CROSS SECTIONAL ANATOMY OF THE UTERUS

A) Gross Anatomy of the Uterus

The female pelvic cavity contains the urinary bladder anteriorly, the female internal genitalia and the rectum posteriorly. The term adnexae (adjacent parts) refer to the ovaries, uterine tubes, and ligaments of the uterus ***(Patrick, 2005)***.

The non-pregnant uterus is situated in the pelvic cavity between the bladder anteriorly and the rectum posteriorly. The entire posterior wall of the uterus is covered by serosa, that is, visceral peritoneum. The lower portion of this peritoneum forms the anterior boundary of the recto-uterine cul-de-sac, or Douglas pouch. Only the upper portion of the anterior wall of the uterus is so covered. The peritoneum in this area reflects forward onto the bladder dome to create the vesico-uterine pouch. The lower portion of the anterior uterine wall is united to the posterior wall of the bladder by a well-defined loose layer of connective tissue. This is the vesico-uterine space ***(Cunningham et al., 2010)***.

The uterus is a hollow, thick-walled, extra peritoneal and flattened pear-shaped muscular organ (Fig.1). The long axis of the uterus forms a right angle with the long axis of the vagina

tilting the uterus forwards "anteverted position" ***(Anderson and Gendary, 1996)***.

The shape, weight, and dimensions of the uterus vary according to parity and estrogen stimulation. In the adults, non-pregnant woman, the adult nulliparous uterus measures approximately 7 cm in length and 5cm in width at the fundus and weights 30 gm to 40 gm, whereas in parous women it averages 80g or more ***(Marlene et al., 2008)***.

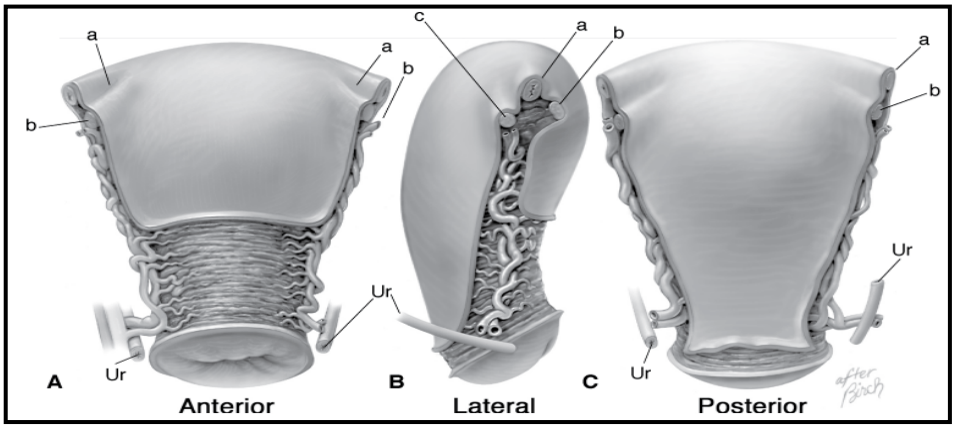

Figure (1): (A) anterior **(B)** right lateral **(C)** posterior views of the uterus of an adult woman (a=oviduct, b=round ligament, c=ovarian ligament, ur=ureter) ***(Quoted from Cunningham et al., 2010)***.

The uterus consists of two major but unequal parts: an upper triangular portion - the body or corpus, and a lower, cylindrical portion - the cervix, which projects into the vagina. The isthmus is that portion of the uterus between the internal cervical os and the endometrial cavity. The fundus is the

convex upper segment between the points of insertion of the fallopian tubes. The bulk of the body of the uterus, but not the cervix, is composed of muscle.

The inner surfaces of the anterior and posterior walls lie almost in contact, and the cavity between these walls forms a mere slit, the fundus and cervix are approximately equal in length, but in multiparous women, the cervix is only a little more than a third of the total length ***(Cunningham et al., 2010)***.

During the reproductive years, the length of the body is twice that of the cervix. The average linear dimensions of a nulli gravid uterus are: 7.7cm in length “from the cervix to the fundus”, 4.7cm in width in between the two cornuae and 2.9cm in depth ***(Anderson and Gendary, 1996)***.

In primiparous, the uterus averages 8.6cm in length, 5.0cm in width and 3.5cm in depth, while the multiparous uterus averages 9.4cm in length, 5.8cm in width and 4.2cm in depth, while postmenopausal uteri become smaller in size ***(Anderson and Gendary, 1996)***.

The uterine wall is composed of three main layers, from its lumen outwards these are the endometrium (mucosa), myometrium (smooth muscle layer) and perimetrium (serosa) or adventitia depending on region. The myometrium is far the largest component (Fig. 2) ***(Salem and Wilson, 2005)***.

The endometrial cavity is triangular in shape having a thickness of approximately 7mm to 12 mm in females during the reproductive age ***(Anderson and Gendary, 1996)***.

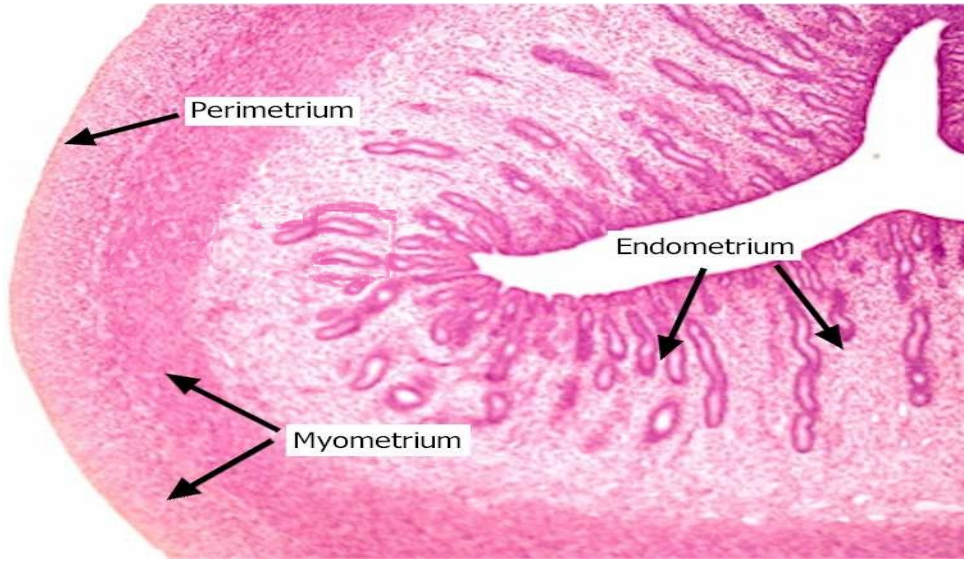

Figure (2): An illustration showing the histological axial anatomy of the uterus ***(Quoted from Peungjesada et al., 2009)***.

Support of the Uterus:

The uterus is continuous with a number of ligaments (Fig. 3), some of these are true ligaments in that they have a fibrous composition and supply support to the uterus. Some ligaments provide no support to the uterus, and others only consist of folds of peritoneum ***(Healy et al., 2005)***.

The main support of the uterus and cervix is provided by the interaction between the levatorani muscles and the connective tissue. The connective tissue that attaches lateral to the uterus is called parametria ***(Marlene, 2008)***.

It consists of the cardinal ligament and uterosacral ligament ***(Marlene, 2008)***.

1) <u>The cardinal Ligaments:</u>

In addition termed transverse cervical ligaments or Mackenrodt ligaments consist primarily of perivascular connective tissue. They attach to the posterolateralpelvic walls vessels supplying the uterus and vagina ***(Marlene, 2008)***.

2) <u>The Uterosacral Ligaments:</u>

Attach to a broad area of the sacrum posteriorly and form the lateral boundaries of the posterior cul-de-sac of Douglas they consist primarily of smooth muscle and contain some of the pelvic autonomic nerves. The parametric continues down along the vagina as the paracolpium ***(Marlene, 2008)***.

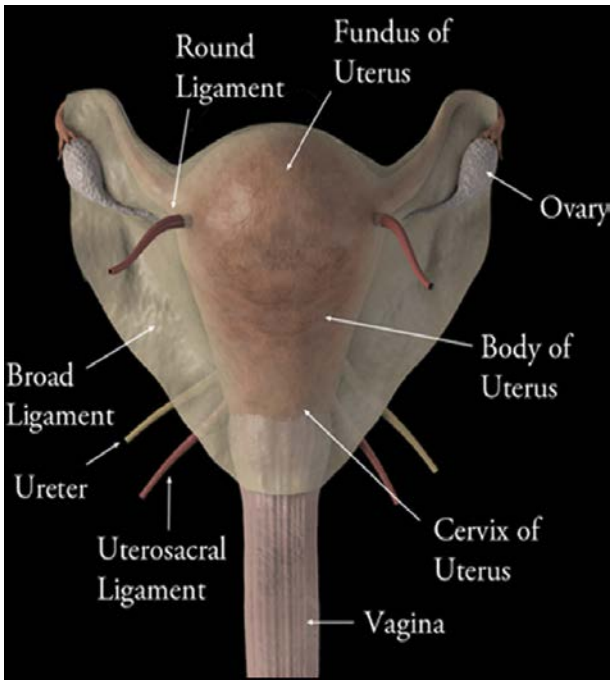

Figure (3): An illustration showing the normal anatomy of the uterus and the supporting ligaments ***(Quoted from Peungjesada et al., 2009)***.

3) Other Uterine Ligaments:

- **The broad ligament:**

It is formed of double layered peritoneum that encloses the fallopian tubes in its upper part and extends from the sides of the uterus to the pelvic side walls and floor ***(Ryan et al., 2004)***.

Within the upper portion of these two layers lie the fallopian tubes and the ovarian and round ligaments. Each of them has its separate mesentery, called the mesosalpinx, mesovarium, and mesoteresrespectively. At the lateral border of the fallopian tube and the ovary, the broad ligament ends where the infundibulopelvic ligament blends with the pelvic lower portion of the broad ligaments ***(Marlene et al., 2008)***.

- **The round ligaments:**

They are smooth muscle extensions of the uterine corpus and represent the homologue of the gubernaculums testis. They arise from the lateral aspect of the corpus just below and anterior to the origin of the fallopian tubes. They extend laterally to the pelvic sidewall. They enter the retroperitoneal space and pass lateral to the inferior epigastric vessels before entering the inguinal canal to terminate in the subcutaneous

tissue of the inguinal canal to terminate in the subcutaneous tissue of the labia majora. They do not contribute to uterine support they receive their blood supply from a small branch of the uterine or ovarian artery known as **Sampson's artery** ***(Marlene, 2008)***.

4) Other uterine support:

It includes the bladder and the muscles of the pelvic floor ***(Ryanet al., 2004)***.

- **The uterine tubes:**

The uterine (fallopian) tubes lie in the free edge of the broad ligament. They open into the uterine cornuae. They are described as having four parts as follows:

- The uterine part.
- The isthmus.
- The ampulla.
- The infundibulum ***(Ryan et al., 2004)***

Blood Supply of the Uterus and Uterine Tubes (Fig. 4):

- **Arterial supply:** Is via the uterine artery may originate directly from the internal iliac artery as an independent branch, or it may have a common origin with the internal pudendal or vaginal artery.The uterine artery approaches the uterus in the uterine isthmus. In this area, the uterine artery courses over the

ureter and provides a small branch to this structure. Several uterine branches over course along the side of the artery and are variably found over or under the ureter ***(Marlene, 2008)***.

The uterine artery then divides into a larger ascending and a smaller descending branch that course along the side of the uterus and cervix. These vessels connect on the lateral border of the uterus and form an anastomotic arterial arcade that supplies the uterine walls ***(Marlene, 2008)***.

- **Venous drainage**: is via a venous plexus in the base of the broad ligament to the internal iliac vein (Fig. 4) ***(Ryan et al., 2004)***.

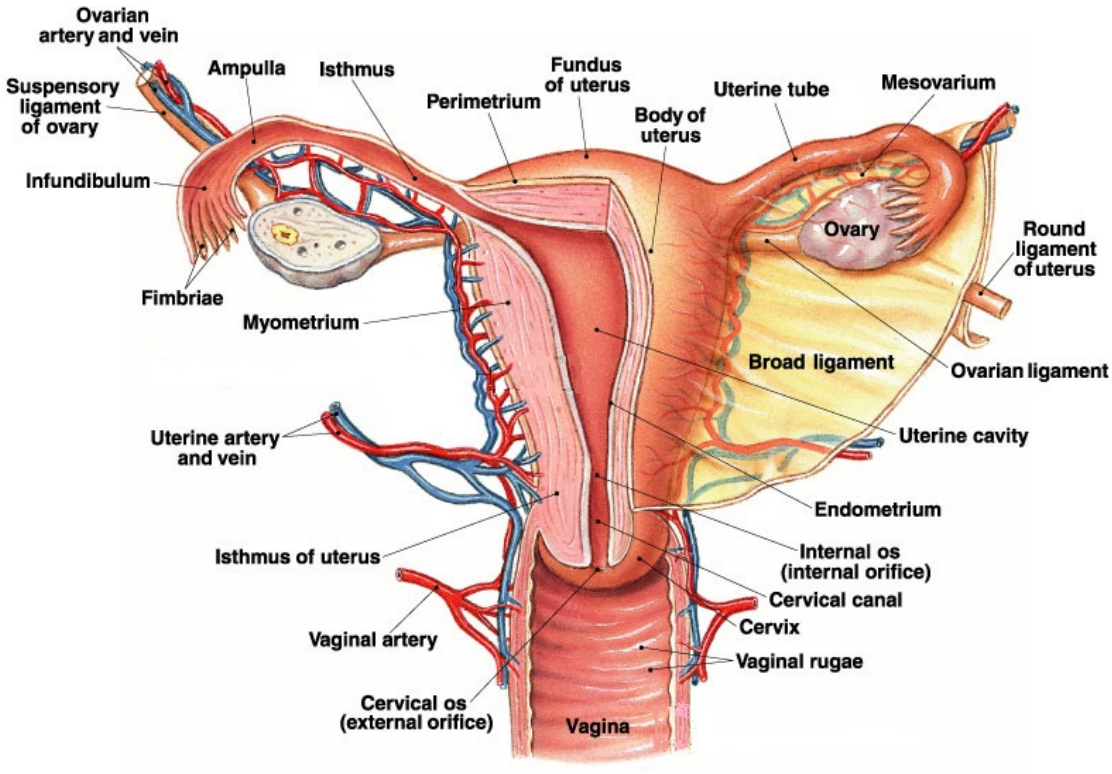

Figure (4): Uterus and fallopian tubes: coronal section showing the uterine blood supply ***(Quoted from Ryan et al., 2004)***.

Lymph Drainage:

The fundus drains along ovarian vessels to para-aortic nodes. The body drains to nodes around the external iliac vessels and occasionally via the round ligament to inguinal nodes. The cervix drains to external and internal iliac nodes and posteriorly to sacral nodes (Fig. 5) ***(Ryan et al., 2004)***.

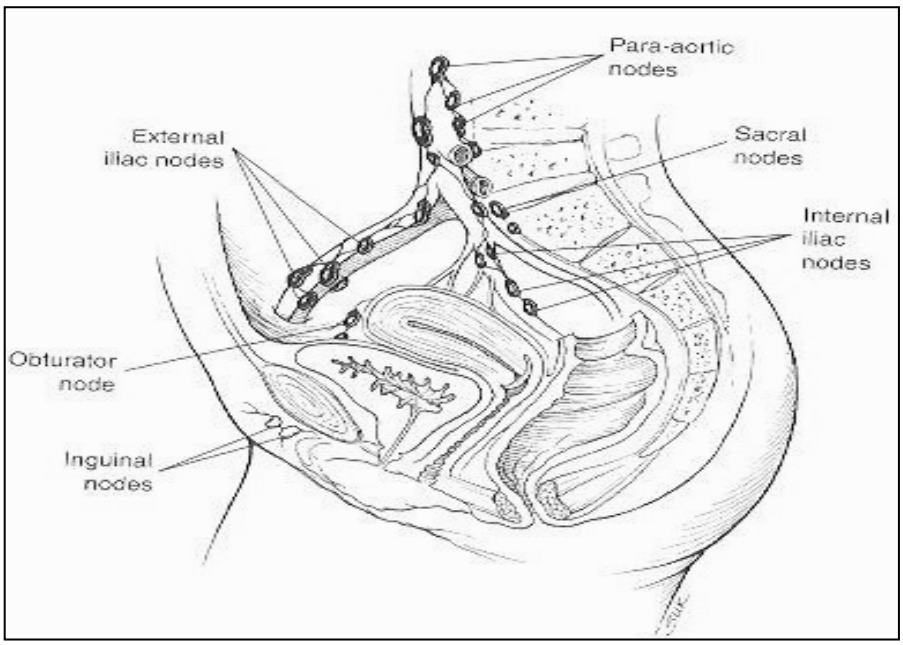

Figure (5): An illustration showing lymphatic drainage ***(Quoted from Perez et al., 2004)***.

➢ Gross anatomy of the cervix:

The cervix is the most inferior part of the uterus, and it is divided from the muscular corpus by a fibro muscular junction, the internal os. The cervix projects through the vagina, means that there is an upper supra vaginal portion and a lower vaginal