INTRODUCTION

MRI has extended the usefulness of imaging in evaluation of different disorders associated with female infertility.

The causes of female infertility include ovulatory disorders (i.e., pituitary adenoma and polycystic ovarian syndrome), disorders of the fallopian tubes (i.e., hydrosalpinx and pelvic inflammatory disease), uterine disorders (ie.mullarian duct anomaly, adenomyosis, and leiomyoma), and pelvic endometriosis ***(Imaoka et al., 2003)***.

Although laparoscopy, hysterosalpingography, and transvaginal ultrasonography are the most popular techniques for evaluation of pelvic disorders related to female infertility, MRI is used in a variety of clinical settings. The applications of MRI include visualization of pituitary adenomas, differentiation of mullarian duct anomalies, and accurate noninvasive diagnosis of adenomyosis, leiomyoma, and endometriosis ***(Scarsbrook and Moore, 2003)***.

In addition, MRI helps to predict the outcome of conservative treatment for adenomyosis, leiomyoma and endometriosis and may lead to selection of better treatment plans and management ***(Imaoka et al., 2003)***.

Finally, MRI may serve as an adjunct to diagnostic laparoscopy and hysterosalpingography in patients with hydrosalpinx, peritubal adhesions, or pelvic adhesions related to endometriosis ***(Imaoka et al., 2003).***

AIM OF THE WORK

The aim of this work is to focus on the role of MRI in diagnosing some of the main causes of female infertility.

Chapter (1)

ANATOMY OF THE FEMALE REPRODUCTIVE SYSTEM

The vagina:

The vagina is a thin walled, distensible, fibro-muscular tube that extends from the vestibule of the vulva to the uterus. The walls of the vagina are normally in apposition and flattened in the anteroposterior diameter. Thus the vagina has the appearance of the letter H in cross section ***(Standring, 2005)***.

Anteriorly, the vagina is closely related to the bladder above and the urethra inferiorly. Posteriorly, the superior third of the vagina is related to the rectovaginal pouch (pouch of Douglas), the middle third is related to the ampulla of the rectum and inferiorly it is related to the perineal body, which separates it from the anal canal (Fig. 1). The cervix extends into the upper part of the vagina. The spaces between the cervix and attachment of the vagina are called fornices. The posterior fornix is considerably larger than the anterior fornix; thus the anterior vaginal length is approximately 6 to 9cm in comparison with a posterior vaginal length of 8 to 12cm. The vagina forms an angle of about 90 degrees with the uterus ***(Schneck et al., 1990)*.**

The vagina of reproductive-age women has numerous transverse folds, termed rugae. They help provide accordion-like distensibility. Before puberty the rugae are absent. In the elderly, the vagina becomes narrower and less deep. The wall is less elastic and appears pale and smooth due to loss of rugae ***(Standring, 2005)*.**

The uterus:

The uterus is a thick-walled, hollow, muscular organ located centrally in the female pelvis. Adjacent to the uterus are the urinary bladder anteriorly, the rectum posteriorly, and the broad ligaments laterally (Fig. 1). The uterus is globular and slightly flattened anteriorly; it has the general configuration of an inverted pear ***(Standring, 2005)*.**

In a nulliparous adult the uterus is about 7.5cm long, 5cm wide and 2.5cm thick. The uterus is divided into the fundus, body and cervix. The fundus is dome-shaped and situated above the opening of the fallopian tubes. The body or corpus is the main part of the uterus and provides the endometrium that is necessary for implantation and growth of the foetus. The short area of constriction in the lower uterine segment is termed the isthmus. The body is connected to the cervix at the internal os, where it is narrowest.

The oviducts enter the uterine cavity at the superolateral aspects of the cavity in the areas designated the cornua. In the

majority of women, the long axis of the uterus is both anteverted in respect to the long axis of the vagina and anteflexed in relation to the long axis of the cervix. However, a retroverted uterus is a normal variant found in approximately 25% of women ***(Standring, 2005).***

The uterus has three layers, similar to other hollow abdominal and pelvic organs. The thin, external serosal layer comprises the visceral peritoneum. The peritoneum is firmly attached to the uterus in all areas except anteriorly at the level of the internal os of the cervix. The wide middle muscular layer is composed of three indistinct layers of smooth muscle. The endometrium is a reddish mucous membrane that varies from 1 to 10mm in thickness, depending on hormonal stimulation ***(Hoad et al., 2005).***

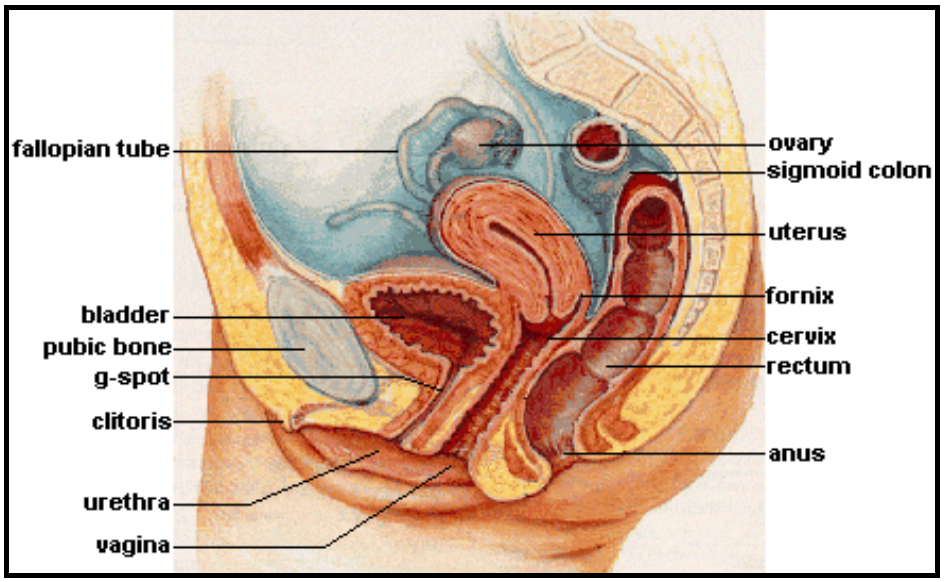

Fig. (1):Sagittal view of the female pelvis ***(Adopted from Netter, 2003).***

The cervix:

The cervix may vary in shape from cylindrical to conical. It consists of predominantly fibrous tissue in contrast to the primarily muscular corpus of the uterus ***(Standring, 2005)***.

The vagina is attached obliquely around the middle of the cervix; this attachment divides the cervix into an upper, supravaginal portion and a lower segment in the vagina called the portio vaginalis (Fig. 2). The supravaginal segment is covered by peritoneum posteriorly and is surrounded by loose, fatty connective tissue—the parametrium—anteriorly and laterally ***(Standring, 2005)***.

The canal of the cervix is fusiform, with the widest diameter in the middle (Fig. 2). The length and width of the endocervical canal varies; it is usually 2.5 to 3cm in length and 7 to 8mm at its widest point. The cervical canal opens into the vagina at the external os of the cervix. In the majority of women the external os is in contact with the posterior vaginal wall. The external os is small and round in nulliparous women. The os is wider and gaping following vaginal delivery ***(Standring, 2005)***.

The mucous membrane of the endocervical canal of nulliparous women is arranged in longitudinal folds, called plicae palmatae, with secondary bran-ching folds, the arbor

vitae. These folds, disappear following vaginal delivery ***(Standring, 2005)*.**

The oviducts:

The paired uterine tubes, more commonly referred to as the fallopian tubes or oviducts, extend outward from the superolateral portion of the uterus and end by curling around the ovary (Fig. 2). The tubes are contained in a free edge of the superior portion of the broad ligament. The mesentery of the tubes, the mesosalpinx, contains the blood supply and nerves. The uterine tubes connect the cornua of the uterine cavity and the peritoneal cavity ***(Standring, 2005)*.**

The oviducts are between 10 and 14cm in length. Each tube is divided into four anatomic sections. The uterine intramural, or interstitial segment is surroun-ded by myometrium. The isthmic segment begins as the tube exits the uterus. This segment is narrow, and straight. The ampullary segment is wider and more tortuous in its course than other segments. Fertilization normally occurs in the ampullary portion of the tube. The infundibulum is the distal trumpet-shaped portion of the oviduct. From 20 to 25 irregular finger-like projections, termed fimbriae, surround the abdominal ostia of the tube. One of the largest fimbriae is attached to the ovary, the fimbria ovarica ***(Standring, 2005)*.**

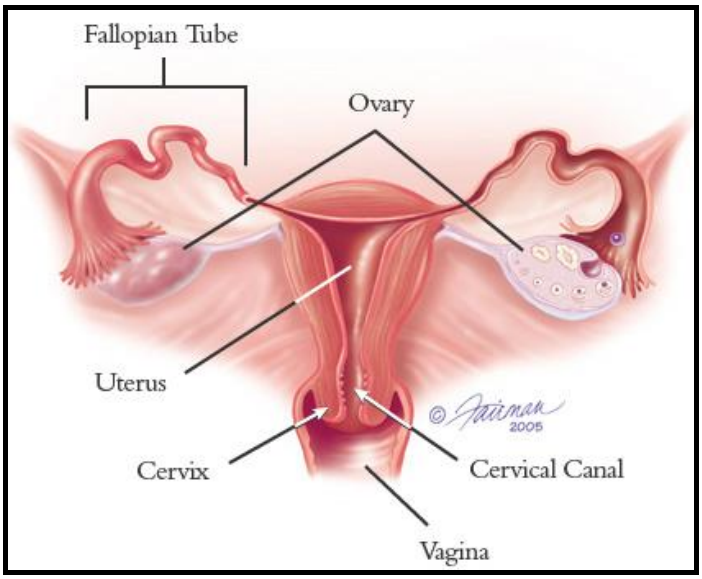

Fig. (2): Coronal view of the female reproductive system ***(Adopted from Netter, 2003)*.**

Ligamentous support:

The broad ligament:

Is formed by two layers of peritoneum, which surround the uterus and extend laterally to the pelvic sidewall (Fig. 3). The fallopian tube, round ligament, ovarian ligament, uterine and ovarian vessels, nerves, lymphatics, mesonephric remnants, a portion of the ureter and loose connective tissue and fat known as the parametrium are found between the two leaves of the broad ligament. At the superior free edge, the broad ligament encircles the fallopian tube. At the inferior aspect of the broad ligament is the ureter ***(Foshager et al., 1994)*.**

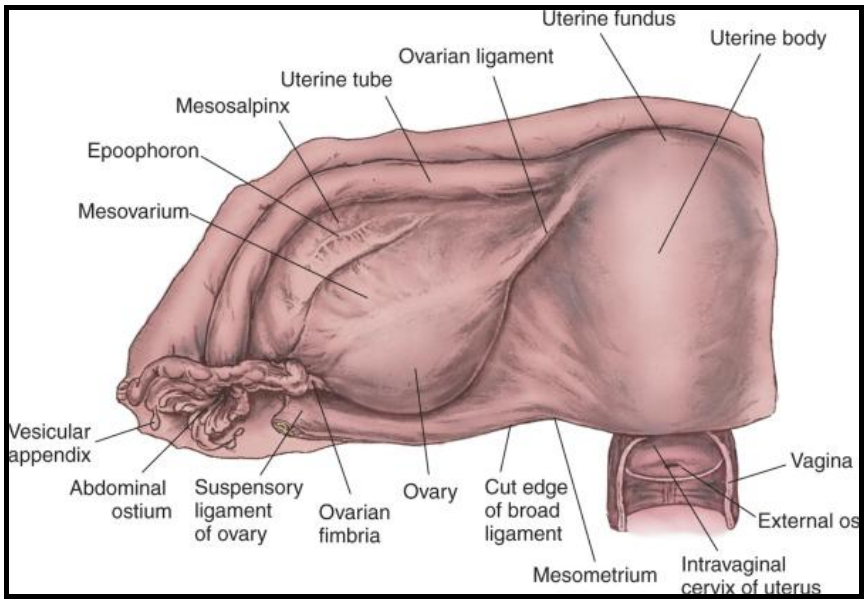

Fig. (3): The posterior aspect of the broad ligament-spread out to demonstrate the ovary ***(Adopted from Standring, 2005)***.

The cardinal (transverse cervical) ligament:

Extends from the cervix and upper vagina to merge with the fascia of the obturator internus muscle. It forms the base of the broad ligament and is the primary ligamentous support of the uterus and upper vagina. The uterine artery traverses the superior aspect of the cardinal ligament. The normal cardinal ligament has a wide variation in shape, contour and thickness; it is usually seen on axial imaging as a triangular structure with the apex tapering towards the pelvic sidewall ***(Foshager and Walsh, 1994)***.

The uterosacral ligament:

Extends posteriorly from the lateral aspect of the cervix

and vagina to the anterior body of the sacrum at the second or third sacral vertebra, and fuses medially with the cardinal ligaments ***(Foshager and Walsh, 1994)*.**

The ovaries:

Each one is approximately the size and config-uration of a large almond. During the reproductive years, ovaries measure approximately 1.5cm×2.5cm×4cm. As the woman ages, the ovaries become smaller and firmer in consistency ***(Standring, 2005).***

The ovary in nulliparous women rests in a depression of peritoneum named the ovarian fossa. Immediately adjacent to the ovarian fossa are the external iliac vessels, the ureter, and the obturator vessels and nerves ***(Standring, 2005).***

Three prominent ligaments determine the anatomic mobility of the ovary. The posterior portion of the broad ligament forms the mesovarium, which attaches to the anterior border of the ovary. The mesovarium contains the arterial anastomotic branches of the ovarian and uterine arteries, a plexus of veins, and the lateral end of the ovarian ligament. The ovarian ligament is a narrow, short, fibrous band that extends from the lower pole of the ovary to the uterus. The infundibular pelvic ligament, or suspensory ligament of the ovary, forms the superior and lateral aspect of the broad

ligament. This ligament contains the ovarian artery, ovarian veins, and accompanying nerves. It attaches the upper pole of the ovary to the lateral pelvic wall ***(Standring, 2005)*.**

Blood supply:

Arterial:

The vagina:

The vaginal artery originates either directly from the uterine artery or as a branch of the internal iliac artery arising posterior to the origin of the uterine and inferior vesical arteries. The vaginal arteries may be multiple arteries on each side of the pelvis. There is an anastomosis with the cervical branch of the uterine artery to form the azygos arteries. Branches of the internal pudendal, inferior vesical, and middle hemorrhoidal arteries also contribute to the interconnecting network and the longitudinal azygos arteries ***(Thompson et al., 1999)*.**

The uterus:

The paired uterine arteries are branches from the anterior trunk of the internal iliac artery. The uterine artery runs medially above the cardinal ligament within the base of the broad ligament to provide the primary blood supply to the uterus. The artery crosses anterior to the pelvic ureter to reach the cervix and divides into a large uterine branch and asmaller

cervicovaginal branch. Both of these branches are tortuous and form extensive vascular networks lateral to the uterus and vagina. At the superior level of the uterus, the uterine artery trifurcates, giving branches to the fallopian tube, the uterine fundus and the ovary (Fig. 4). In addition, the ovaries receive a direct blood supply from the ovarian arteries, which arise from the aorta just below the origin of the renal arteries ***(Foshager and Walsh, 1994)***.

In the pelvis, the ovarian artery enters the broad ligament via the suspensory ligament of the ovary, and provides branches to the ovary through the mesovarium ***(Foshager and Walsh, 1994)***.

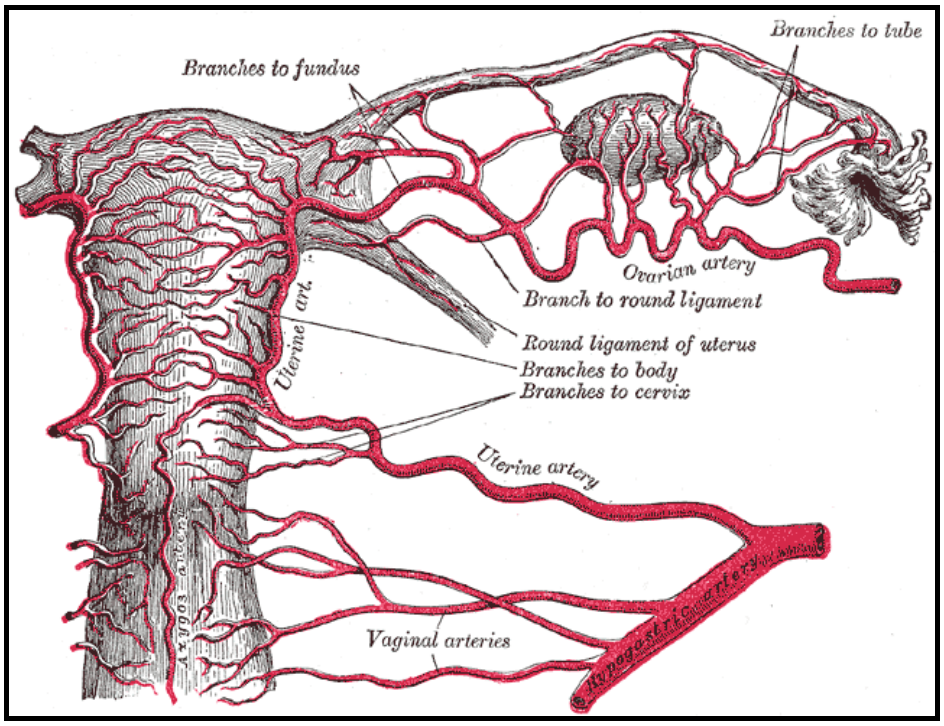

Fig. (4): Arterial supply of the uterus ***(Adopted from Standring, 2005).***

Venous drainage:

The vagina:

Below the pelvic floor the principal venous drainage occurs via the pudendal veins. The vaginal, uterine, and vesical veins, as well as those around the rectosigmoid, all provide venous drainage of the venous plexuses surrounding the middle and upper vagina ***(Standring, 2005).***

Uterus and ovaries:

Venous drainage of the uterus, cervix, upper vagina and ovaries is via an extensive venous plexus within the

parametrium. This plexus finally forms veins that parallel the arterial blood supply. The left ovarian is the only exception, draining into the left renal vein instead of the inferior vena cava ***(Foshager and Walsh, 1994).***

Lymphatic drainage:

The vagina:

In general the primary lymphatic drainage of the upper third of the vagina is to the external iliac nodes, the middle third of the vagina drains to the common and internal iliac nodes, and the lower third has a complex and variable distribution, including the common iliac, superficial inguinal, and perirectal nodes ***(Standring, 2005).***

Uterus:

The majority of lymphatics from the fundus and the body of the uterus go to the aortic, lumbar, and pelvic nodes surrounding the iliac vessels, especially the internal iliac nodes ***(Standring, 2005).***

Cervix:

The principal regional lymph nodes are the obturator, common iliac, internal iliac, external iliac, and visceral nodes of the parametria