Introduction

Diagnostic imaging plays a key role in the management of patients with acute pelvic pain. Diagnostic imaging should therefore be used liberally, especially if surgical treatment might be necessary. In elderly or debilitated patients, the clinical presentations of serious conditions can be muted, so a low threshold for ordering radiography and especially CT should be maintained **(Schwartz, 2008)**.

Because of the availability of powerful computational techniques, new modality techniques such as Multi-Detector Computed-Tomography (MDCT), Magnetic Resonance Imaging (MRI) and others and because of the new techniques of imaging processing (machine vision), the lives of many patients will be saved **(Leondes, 2005)**.

One of the challenging problems of clinical practice is to discerning the cause of acute pelvic pain. Therefore different imaging modalities are appropriate for their evaluation **(Hamm and Forstner, 2007).**

Clinical setting often indicates an obstetric or gynecologic origin of acute pelvic pain, but sometimes, it is not easy to distinguish if the primary cause is related to genitourinary system, the gastrointestinal system or both depending only on the duration of the symptoms and the extension of the disease **(Navallas et al., 2008)**.

Acute Pelvic pain in women due to a gynecologic condition may mimic numerous other conditions such as appendicitis and diverticulitis, resulting in initial evaluation by CT—particularly in the emergency setting. The radiologist should, therefore, be familiar with the spectrum of gynecologic and obstetric pathology that may be present on a CT evaluation of the abdomen and pelvis regardless of the study indication, particularly because CT is often the most readily available imaging modality in the emergency setting on a 24/7 basis **(Navallas et al., 2008).**

During the past 10 years, single-slice helical CT has been steadily replaced by multi-detector row CT (MDCT). Multi-slice MDCT has allowed the acquisition of images of larger volumes in a single breath hold. MDCT provides thinly collimated images with less volume averaging and much greater detail. Some images achieve resolution close to that of a gross pathology specimen **(Siddall and Rubens, 2005).**

Like single-slice CT, MDCT is the modality of choice for patients who cannot undergo MR imaging because of the presence of a pacemaker or a metallic foreign body, such as an aneurysm clip and for patients who are claustrophobic. MDCT is becoming more widely available and less expensive than MR imaging and allows acquisition of an image series in a fraction of the time needed to obtain the multiple sequences of images in a single MR study **(Siddall and Rubens, 2005).**

In the past, inability to resolve abnormalities smaller than 1 cm has been cited as a disadvantage of CT, but resolution is much improved with new MDCT technology and partial-volume averaging is significantly decreased **(Siddall and Rubens, 2005).**

Ultrasound had been claimed to be superior to CT because scanning occurs in both transverse and longitudinal planes; however, two-dimensional and three-dimensional reconstructions are now available with new MDCT technology. Coronal, sagittal and oblique multi-planar reconstructions (MPRs) are performed using the source data obtained in the axial plane and can be used to evaluate the complex female pelvic anatomy **(Siddall and Rubens, 2005).**

In addition to providing a multidimensional survey of pathology, the speed of MDCT reduces motion artifact that complicates interpretation. In fact, CT boasts a more rapid acquisition of images and fewer contraindications and less motion artifact than MR imaging. Speed of scanning also allows the injection of a smaller bolus of intravenous (IV) contrast media to obtain optimal enhancement of anatomy and pathology while maintaining the diagnostic value of the study and preserving kidney function **(Siddall and Rubens, 2005).**

Therefore, the role MDCT in evaluating the acute condition of female pelvis is increasing, providing high accuracy in both diagnosis and confirmation of diagnosis in such cases and improving the rapid treatment and /or emergent surgical interference.

Radiologist's rapid comprehension and translation of the characteristic findings associated with various acute diseases of the female pelvis will surely help to avoid missed diagnosis of many cases and further unnecessary examinations.

Aim of the Work

The purpose of this essay is to highlight the role of multi-detector CT (MDCT) in evaluating the acute conditions of female pelvis.

Chapter I

Anatomy of female pelvis

1. Introduction

The true (lesser) pelvis is separated from the more superior false (greater) pelvis by an oblique plane extending across the pelvic brim from the sacral promontory to the symphysis pubis. The true pelvis of a woman contains the rectum, bladder, pelvic ureters, vagina, uterus and ovaries **(Siddall and Rubens, 2005)**.

2. Pelvic Organs

2.1. The Vagina

The vagina is a fibro-muscular tube lined by non keratinized stratified epithelium. It extends from the vestibule to the uterus. Its anterior wall is 7.5 cm in length and the posterior wall is 9 cm long in average. The rectum and the anal canal are posterior and separated by the upper part by the recto-uterine pouch **(Healy et al., 2005)**.

2.1.1 Vascular Supply

A. Arterial Supply

Arterial supply is derived from the vaginal, uterine, internal pudental and middle rectal branches of the internal iliac arteries **(Healy et al., 2005)**.

B. Venous Drainage

The vaginal veins, one on each side, form from lateral plexuses that connect with uterine, vesical and rectal plexuses. draining into the internal iliac veins **(Healy et al., 2005)**.

2.1.2. Lymphatic Drainage

Vaginal lymphatic vessels link with those of the cervix uteri, rectum and vulva. They form three groups but the regions drained are not sharply demarcated. Upper vessels drain into the internal and external iliac nodes. Intermediate vessels drain into the internal iliac nodes. Vaginal vessels below the hymen, the vulva and perineal skin pass to the superficial inguinal nodes **(Healy et al., 2005).**

2.2. The Uterus

The uterus is a pear-shaped organ that is about the size of an adult fist, approximately 8 cm x 5 cm x 2.5 cm or 9 cm x 6 cm x 4 cm in length, respectively. During menstruation, the uterus enlarges, is more vascular and takes on a more globular shape **(Siddall and Rubens, 2005).**

The fundus or dome of the uterus is superior to the insertion of the fallopian tubes and is covered by peritoneum. The endometrial cavity of the uterus is central, flat, triangular and can contain fluid. The amount of endometrial fluid is dependent upon the time of the menstrual cycle **(Siddall and Rubens, 2005).**

The cervix is the lower one third of the uterus, a cylindrical tube about 2 to 3 cm in length. The inferior aspect of the cervix is surrounded by the vaginal fornix. The cervix is the elliptical or circular in cross-section **(Siddall and Rubens, 2005).**

The cul-de-sac or recto-uterine pouch of Douglas, is a virtual space that is outlined anteriorly by the posterior wall of the uterus, the supra-vaginal cervix and the upper one fourth of the vagina; posteriorly by the rectum and sacrum; superiorly by the small bowel and the recto-uterine ligament and laterally by the sacro-uterine ligaments. A small amount of physiologic low-attenuation free fluid may be seen in the cul-de-sac dependent on the day of the patient's menstrual cycle **(Siddall and Rubens, 2005).**

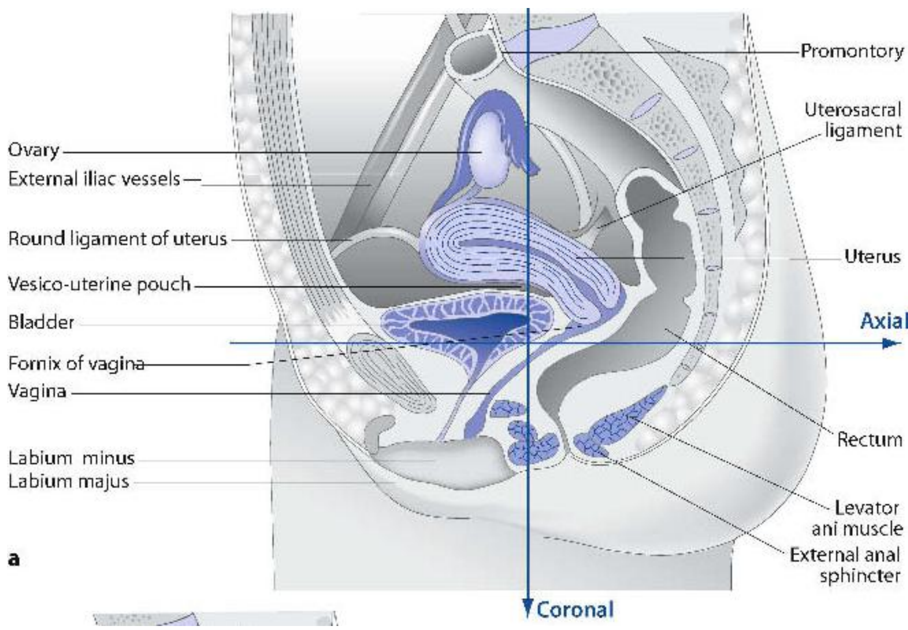


Fig. 1.1: Normal Anatomy of Female Pelvis: mid-sagittal view **(Quoted from Hamm and Forstner, 2007).**

2.2.1. Uterine Ligaments (Fig. 1.2):

The broad ligament, a two-layer structure continuous with the peritoneum contains the paired fallopian tubes, ovaries, uterine/ovarian vessels and the parametrium and connects the uterus to the pelvic sidewall **(Siddall and Rubens, 2005).**

The round ligament, a fibro muscular b and of tissue that originates at the uterine horn and passes through the inguinal canal, is thought to maintain the uterus in an anteverted position. **(Yitta et al., 2009)**

The utero-sacral ligaments originates laterally at the level of the internal os of the cervix and pass downwards along the sides of the rectum extending to the third and fourth bones of the sacrum **(Skandalakis; 2004).**

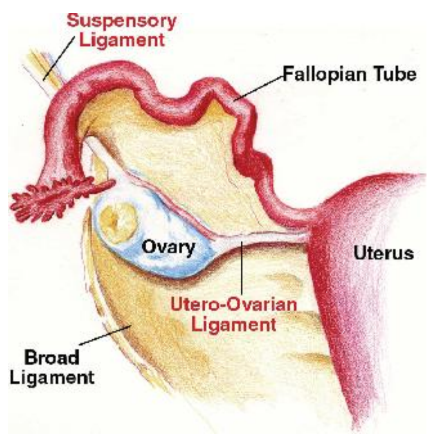


Fig.1.2: Posterior view shows the broad ligament and ovarian attachments with the fallopian tube separated from the ovary **(Quoted from Saksouk and Johnson, 2004).**

2.2.2. Vascular supply (Fig. 1.3):

A. Arterial supply

The uterine artery supplies the uterus and gives off superior and inferior branches to the cervix, fallopian tubes and upper vagina. Anatomically, the uterine artery arises from the anterior branch of the internal iliac artery and crosses the ureter as it enters the bladder **(Siddall and Rubens, 2005).**

B. Venous drainage

The venous drainage of the uterus is via the uterine veins, which extend laterally in the broad ligament and drain into the internal iliac veins **(Healy et al., 2005).**

2.2.3. Lymphatic drainage (Fig. 1.3):

A rich lymphatic network is present under the peritoneum, especially at the posterior uterine wall; the lymphatic vessels form a peculiar and complicated network. The lymphatic of the utero-tubal area drains to the superficial inguinal lymph nodes. The upper part of the uterus (the fundus and part of the uterine body) drains into the para-aortic lymph nodes. The lower part of the body of the uterus drains into the external iliac nodes. The cervical lymph nodes drain into the internal and external iliac lymph nodes as well as the sacral nodes **(Skandalakis; 2004).**

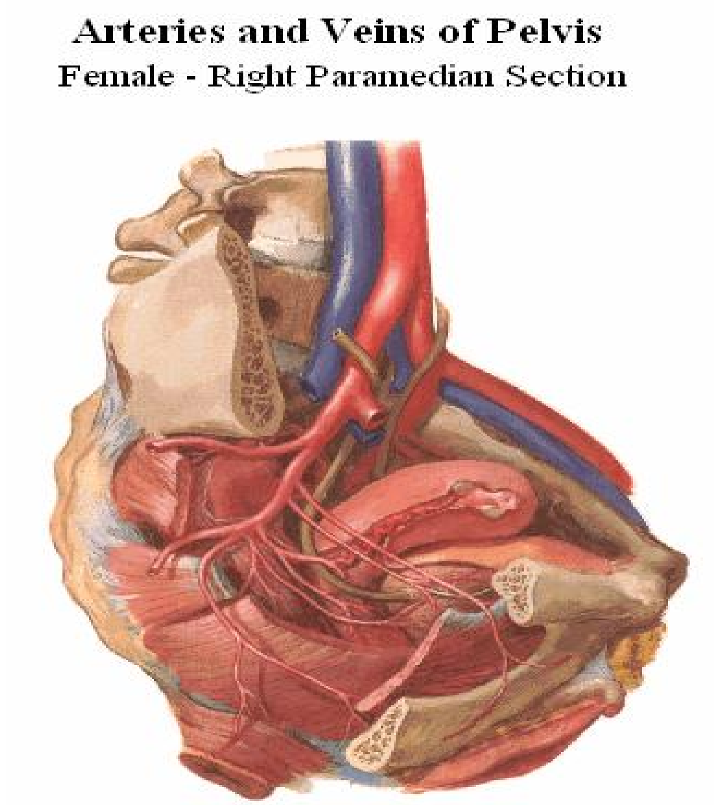


Fig. 1.3: Normal blood supply and venous drainage of the female pelvis **(Quoted from Netter, 1997).**

2.2.4. Innervations

The uterus has no somatic innervation, only visceral innervation from sympathetic and parasympathetic sources. The parasympathetic efferent nerve supply originates from the second, third and fourth sacral segments of the spinal cord **(Skandalakis; 2004).**

2.3. The Uterine Tubes

The fallopian tubes extend from the posterior aspect of the uterus at the junction of the body and fundus and course along the superior aspect of the broad ligament to the ovaries (Fig. 1.4) **(Yitta et al., 2009).**

The tube is subdivided into four parts the infundibulum, the ampulla, the ismuth and the intramural part **(Lioyid; 2001).**

The oviduct is 1 to 5 mm in diameter at the isthmus and up to 1 cm in diameter at the ampulla **(Siddall and Rubens, 2005).**

2.3.1. Vascular supply

A. Arterial supply

The blood supply to the uterine tubes is derived from ovarian and uterine stems, the lateral third of the tube is supplied by the ovarian artery, which continues in the meso-salpinx to anastomose with branches from the uterine artery. The branches from the uterine artery supply the medial two thirds of the tube **(Healy et al., 2005).**

B. Venous Drainage

The venous drainage for the lateral two thirds of the uterine tube is via the pampiniform plexus to the ovarian veins. Which open into inferior vena cava on the right side and the renal vein on the left side. The medial third of the tube drains via the plexus to the internal iliac vein **(Healy et al., 2005).**

2.3.2. Innervations

The tubes are innervated by the sympathetic and parasympathetic systems, through the ovarian and inferior hypogastric plexuses. Pain sensation from the oviduct is transmitted back to T11, T12 and L1 levels of the spinal cord and corresponding dermatomes **(Skandalakis; 2004).**

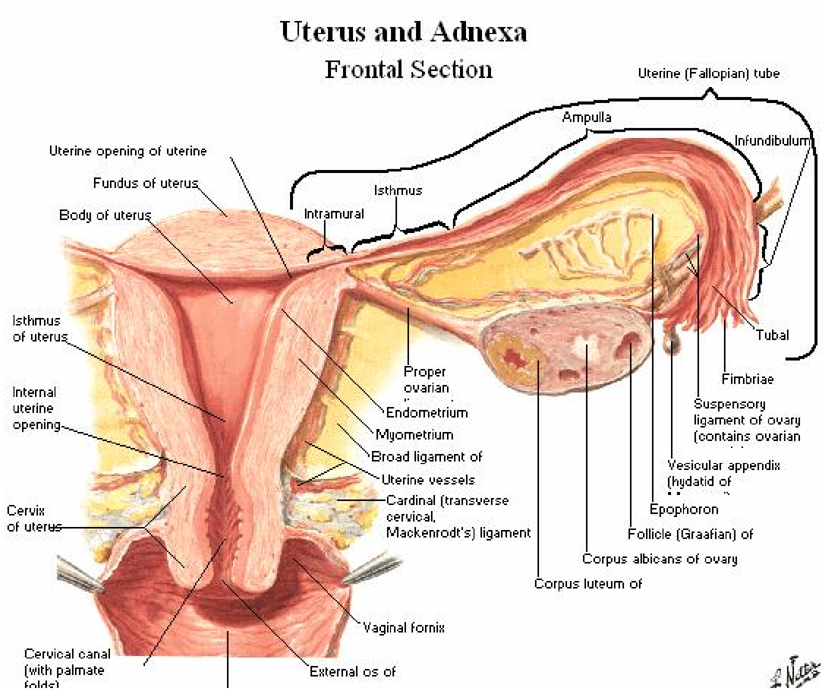


Fig.1.4: Uterus and adnexa frontal view **(Quoted from Netter; 1997).**

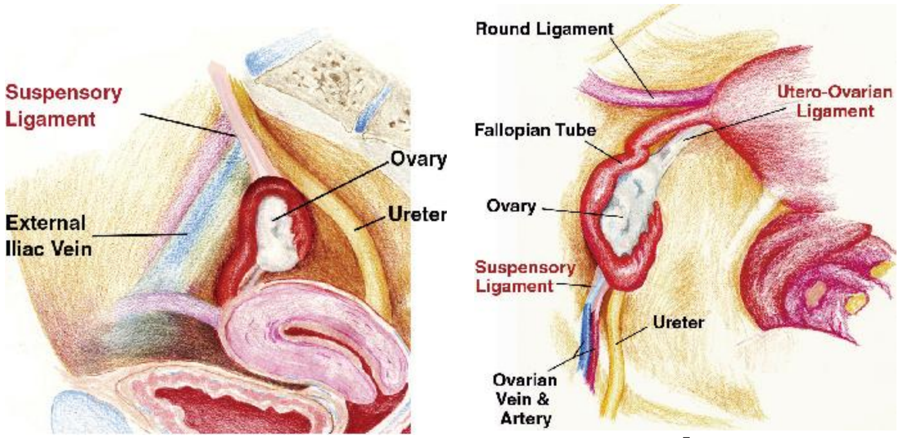
2.4. The Ovaries

The ovaries are paired, oval or almond-shaped and seen on either side of the uterus. The position of the ovaries within the pelvis is variable and is affected by uterine size and orientation, bladder or distal colon distention, the presence of pelvic fluid or a pelvic mass and by ovarian shape and size. In a woman of reproductive age, the average volume of the ovary is 11 cm3 and is up to 4 cm on the long axis **(Siddall and Rubens, 2005).**

The suspensory or infundibulo-pelvic ligament (Fig.1.5a.) is a peritoneal fold that extends from the superolateral aspect of the ovary to the pelvic sidewall and carries the ovarian vessels. The suspensory ligament is contiguous with the peritoneum covering external iliac vessels and psoas muscle and posterolateral pelvic sidewall **(Siddall and Rubens, 2005).**

The ovary is suspended by the mesovarium, a double peritoneal fold, which attaches to the upper and posterior broad ligament and carries the ovarian vessels from the suspensory ligament to the ovarian hilum **(Siddall and Rubens, 2005).**

The ovarian ligament connects the lower pole of the ovary to the uterus and carries the ovarian branches of the uterine artery (Fig. 1.5 b.) **(Siddall and Rubens, 2005).**



a. **b.**

Fig. 1.5: a. Illustration shows the suspensory ligament anchoring the ovary to the posterolateral wall of the pelvis. b. View from above shows the left ovary and its attachments within the true pelvis. (This view simulates the appearance of the right hemi-pelvis at cross-sectional imaging.) The utero-ovarian ligament extends between the ovary and uterine cornu. The suspensory ligament transmits the ovarian vein and artery near the pelvic brim **(Quoted from Saksouk and Johnson, 2004).**

2.4.1. The Vascular Supply (Fig. 1.6):

A. Arterial Supply

The ovarian arteries arise from either side of the aorta inferior to the takeoff of the renal arteries. Each ovarian artery courses medial to the ureter at level of lower renal poles, crosses anterior to the ureter at the mid-lower lumbar level and then courses lateral to the ureter in the pelvis **(Siddall and Rubens, 2005).**

B. Venous Drainage

The multiple ovarian veins form a plexus (pampiniform plexus) that is located in the area of the mesovarium and infundibulo-pelvic ligament. The plexus coalesces to form two veins that are adjacent to the ovarian artery. The two veins then unite to form a single vein that empties into the inferior vena cava on the right side and on the left side empties into the left renal vein **(Skandalakis; 2004).**

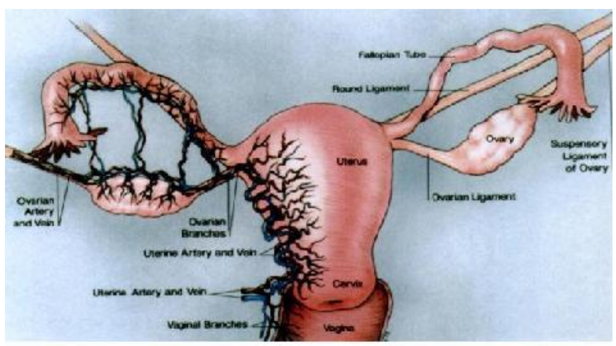


Fig. 1.6: Normal blood supply and venous drainage of the uterus and ovaries **(Quoted from Netter 1997).**