INTRODUCTION

Ovarian cancer remains a major health problem worldwide, with over 225,000 new cases and 140,000 deaths reported annually. Symptoms associated with ovarian cancer are often nonspecific, and the majority of patients continue to present with advanced disease, where the cost of treatment is high and the survival rate is low. Although early stage ovarian cancer is highly curable with conventional treatment, it is estimated that only 15% of patients have their disease confined to the ovary at the time of diagnosis ***(Van et al., 2014).***

The Initial treatment of ovarian cancer consists of cytoreductive surgery and adjuvant chemotherapy. Despite high response after initial treatment, 20-30% of patients with early-stage disease and up to 75% of patients with advanced disease present with recurrence within two years. Early diagnosis of recurrence and exact anatomic localization of metastatic disease are crucial for determination of the best treatment strategy. While the level of CA-125 has been shown to be a sensitive marker for tumor recurrence and levels may rise 3 to 6months before there is clinically apparent disease, it does not provide information concerning the size and distribution of the Lesions ***(Jemal et al., 2009).***

CT and MRI are the most commonly used imaging modalities in patients with suspected recurrent ovarian cancer, but small local recurrence, LN metastasis, small dissemination,

and bone/muscle metastasis are difficult to detect with CT and MRI ***(Von et al., 2004).***

18F-FDG (FDG) PET imaging is a noninvasive diagnostic tool that provides tomographic images and can be used to obtain quantitative parameters concerning the metabolic activity of target tissues ***(Boellaard et al., 2015).***

Integrated PET/CT acquires both metabolic and anatomic imaging data using a single device and provides precise anatomic localization of suspicious areas of increased FDG uptake. PET/CT has been helpful in accurate localization of small areas of increased radiotracer activity that would have been difficult or not possible to localize on PET images alone. PET/CT combines the advantages of the excellent functional information provided by PET and the superb spatial and contrast resolution of CT ***(Von et al., 2004).***

PET/CT with fluorine-18 fluorodeoxyglucose (FDG) has now been widely used for follow-up of various cancer patients. It is recently being used in growing amount for differential diagnosis of malignant/benign tumors, staging and detection of recurrence and evaluation of the treatment efficacy. FDG-PET is useful in detecting recurrent ovarian cancers with high specificity as compared with the serum tumor marker CA-125 level ***(Sari et al., 2012).***

Aim of the Work

The aim of the work is to detect the significance of PET/CT in the early detection of recurrent ovarian tumor.

Chapter One

ANATOMY OF OVARIES

The ovaries are the reproductive organs in female. They are homologous to testes in males. They are both gonads and endocrine glands.

Gross Anatomy:

The ovaries are paired ovoid, almond shaped gonadal structures. The normal ovary varies in size, with measurements up to 5 × 3 × 3 cm. The adult ovary is about 2.5-5 cm long, 1.5-3 cm wide, and 1-2 cm thick. Variation in dimension results from endogenous hormonal production, which varies with age and with each menstrual cycle. 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 **(fig.1)** ***(Sokol et al., 2012).***

The ovaries are suspended between the pelvic wall and the uterus by the infundibulopelvic ligament laterally and the utero-ovarian ligament medially. Inferiorly, the hilar surface of each ovary is attached to the broad ligament by its mesentery (mesovarium), which is dorsal to the mesosalpinx and fallopian tube **(fig 1) (*Sokol et al., 2012)***.

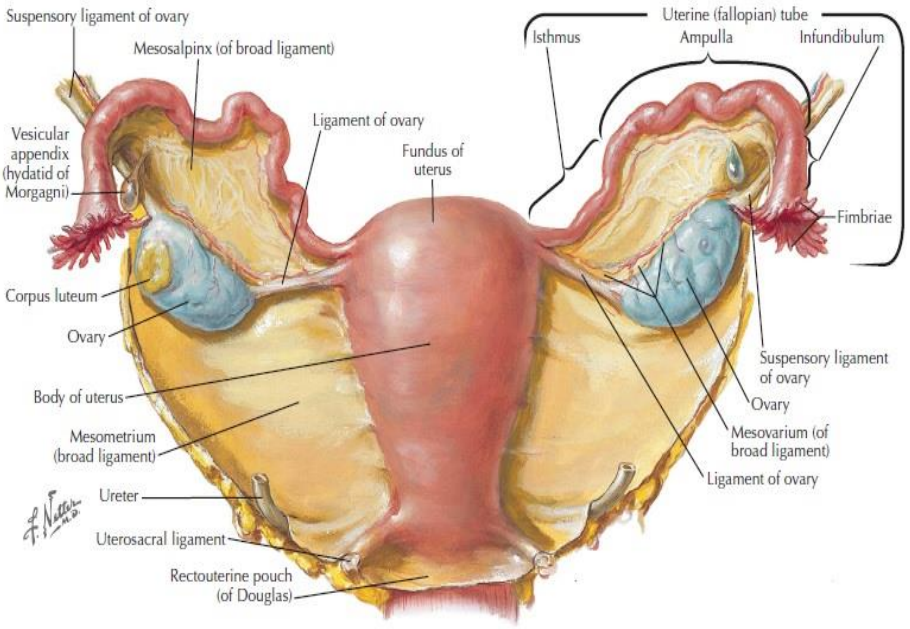


Figure (1): Posterior view of female internal genital organs. **Quoted from *(Cochard et al., 2012).***

Arterial supply of the ovaries

- The ovarian arteries arise from the ventral surface of the abdominal aorta around the level of L2 vertebra just below the origin of the renal arteries.
- They cross over common iliac vessels in close proximity to the ureters, crosses over ureters while superficial to the psoas muscle and runs just lateral to the ureter when entering the pelvis as part of the infundipulopelvic ligament.
- It anastomoses with the uterine artery.
- The artery usually has a tortuous course that is maximum near the level of the ovary **(Fig.2)** ***(Sokol et al., 2012)***.

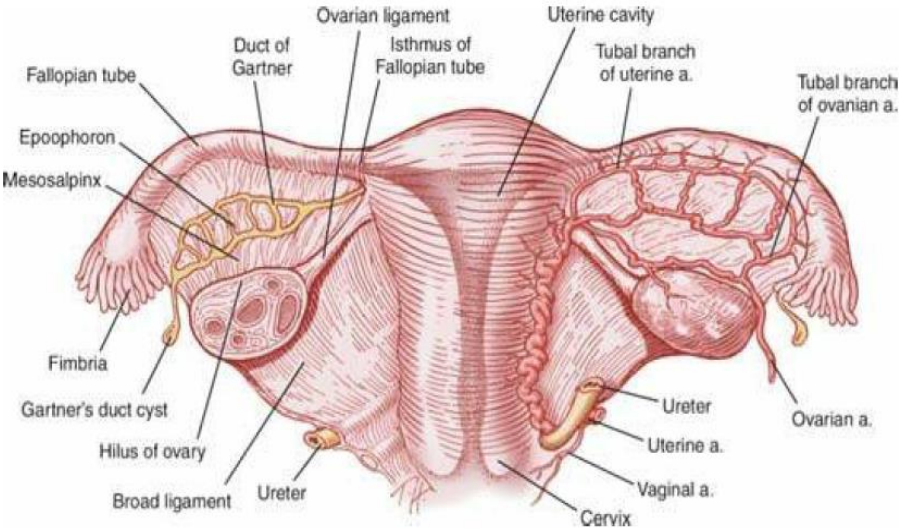


Figure (2): The arterial supply of uterus, fallopian tubes, and ovaries**. Quoted from (*Sokol et al., 2012)***.

Venous drainage of the ovaries

- The ovarian veins leave the hilum of the ovary and form a network 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 vein 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 ***(Sokol et al., 2012)***.

NB: 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 ***(Sokol et al., 2012)***.

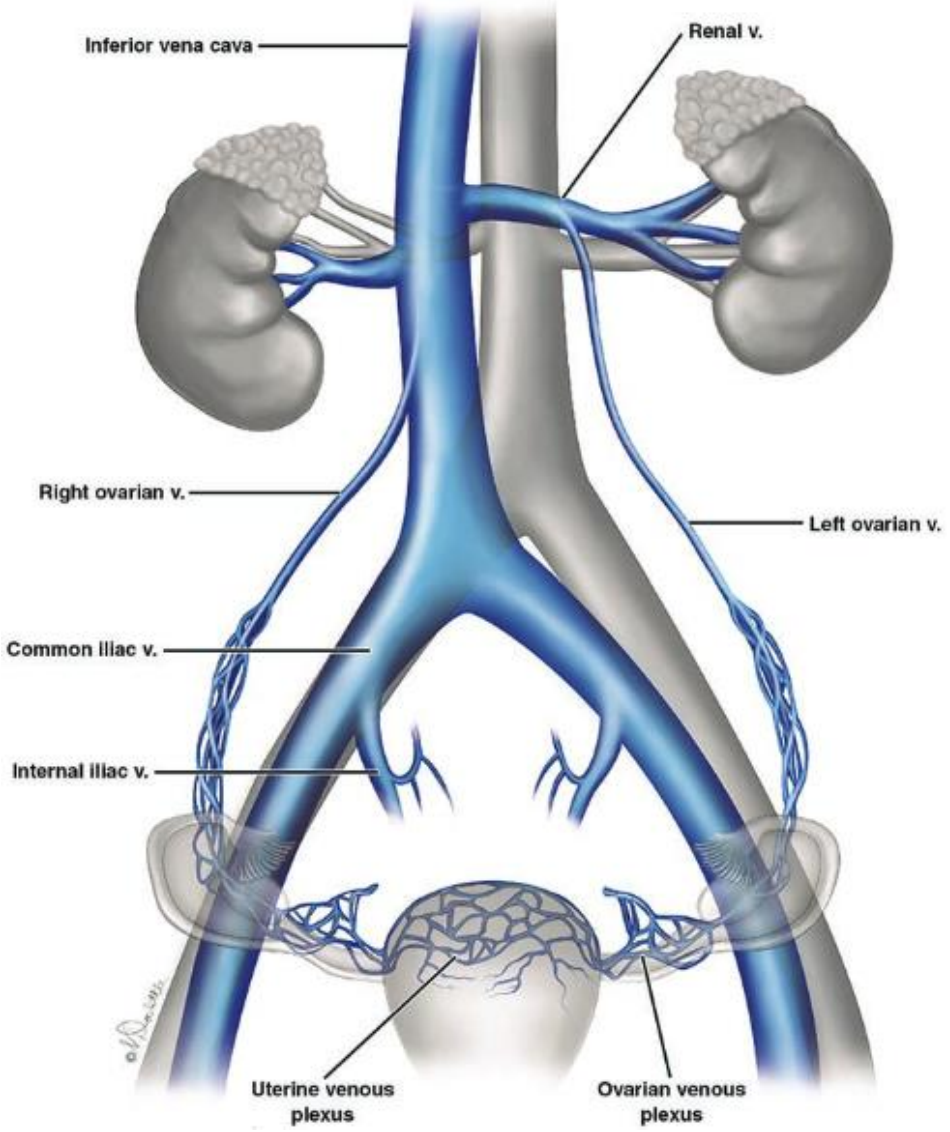


Figure (3): Venous drainage of the ovaries **Quoted from (Knuttinen et al.)**

Lymphatic drainage of the ovaries

Two major and one minor lymphatic drainage pathways from the ovaries were detected. One pathway drained via the proper ligament of the ovaries (ovarian ligament) toward the lymph nodes in the obturator fossa and the internal iliac artery. Another pathway drained the ovaries via the suspensory ligament (infundibulopelvic ligament) toward the para-aortic and paracaval lymph nodes. A third minor pathway drained the ovaries via the round ligament to the inguinal lymph nodes ***(Kleppe et al., 2015).***

Nerve supply of the ovaries

The ovaries, receives its visceral sympathetic innervation from the ovarian plexus, a network of nerve fibers accompanying the ovarian vessels and derived from the aortic and renal plexuses **(*Sokol et al., 2012)***.

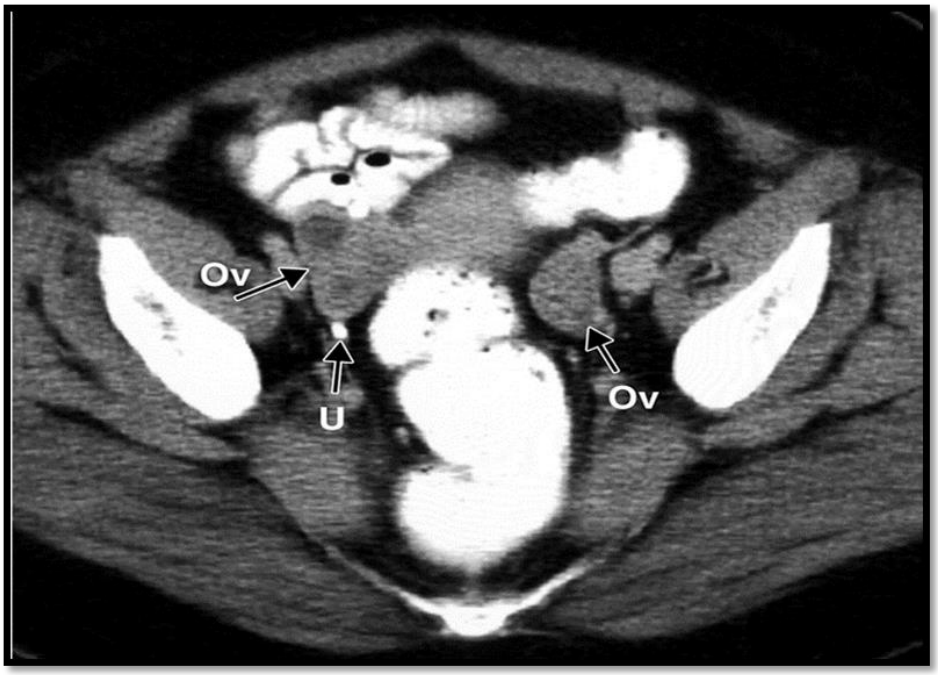
Other sympathetic input may originate from the superior and inferior hypogastric plexuses. The parasympathetic fibers are provided by the inferior hypogastric plexus which includes parasympathetic fibers arising from the pelvic splanchnic nerves (S2 to S4) ***(Sokol et al., 2012).***

Normal CT anatomy of ovaries

The CT recognition of the ovaries is facilitated by knowledge of the morphologic features and the relationship of

the ovary to the ureter, the course of the ovarian vein and artery, and the ligamentous attachments of the ovaries.

Morphologic Features



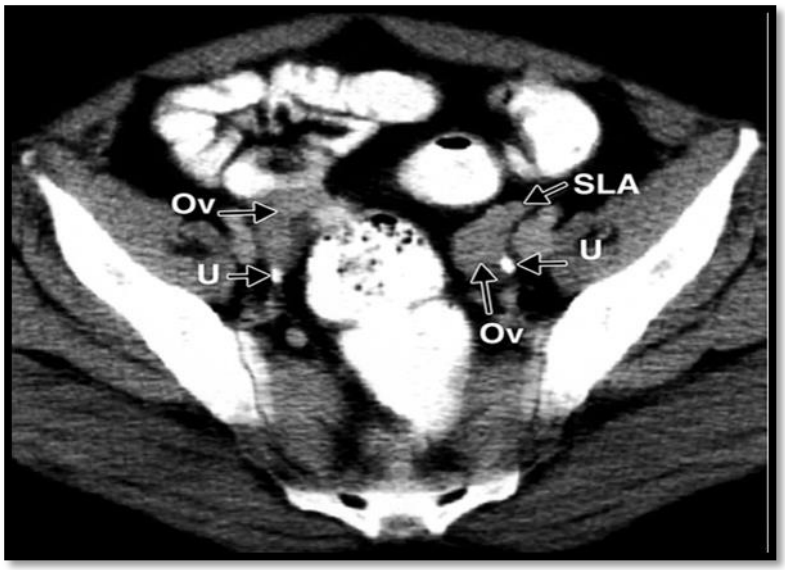
OV: Ovary **U:** Ureter

Figure (4): CT morphological features of ovary **Quoted from *(Cahill et al., 2005).***

On CT the uterus is seen as a round structure of soft-tissue density lying on or behind the bladder. Oral contrast helps to differentiate loops of bowel, which lie on and around it. Intravenous contrast improves contrast between the uterus and surrounding structures, and enhancement may be seen in the myometrium and endometrium, especially mid-cycle non-enhancing fluid may also be seen in the uterine cavity during

the secretory phase of the cycle. Enhancing vessels may be seen on either side of the lower uterus. The ovaries may usually be identified as small round structures of soft-tissue density, occasionally with small cysts **(fig 5)** ***(Ryan et al., 2011).***

Relationship to the Ureter

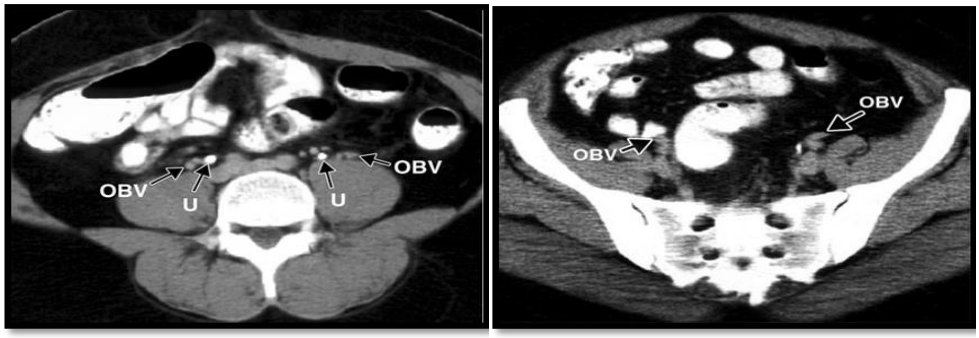


Ov: Ovary **U:** Ureter **SLA:** Suspensory ligament attachment

Figure (5): Relationship to ureter **Quoted from** ***(Cahill et al., 2005)***

The ovary in its typical location at the ovarian fossa is usually anterior or anteromedial to the pelvic ureter (**Fig.6**) ***(Cahill et al., 2005).***

Tracking the Ovarian Vein to the Ovarian Region

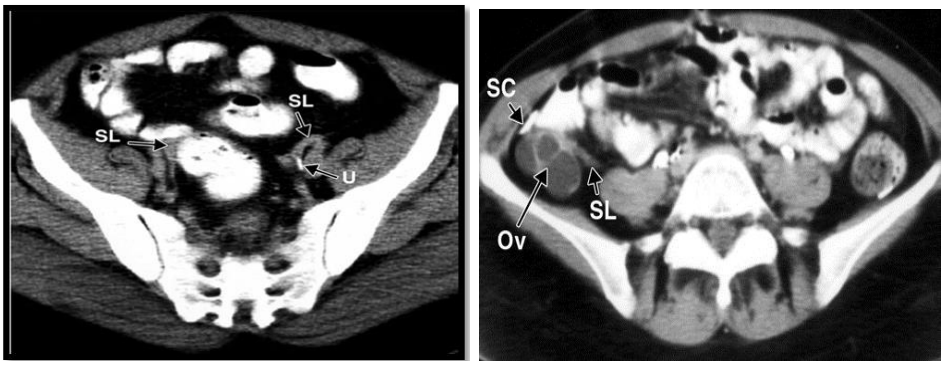


OBV: Ovarian blood vessel **U:** Ureter

Figure (6): Tracking the ovarian vein to ovarian region **Quoted from *(Cahill et al., 2005).***

The ovarian vein can be readily identified with CT and followed, along the anterior surface of the psoas major muscle, to the true pelvis and often may be visualized to the level of the suspensory ligament in the immediate vicinity of the ovary. The ovarian artery is smaller and less confidently or consistently identifiable with CT than the vein (**Fig.7**) ***(Cahill et al., 2005).***

Suspensory Ligament Leading to the Ovary



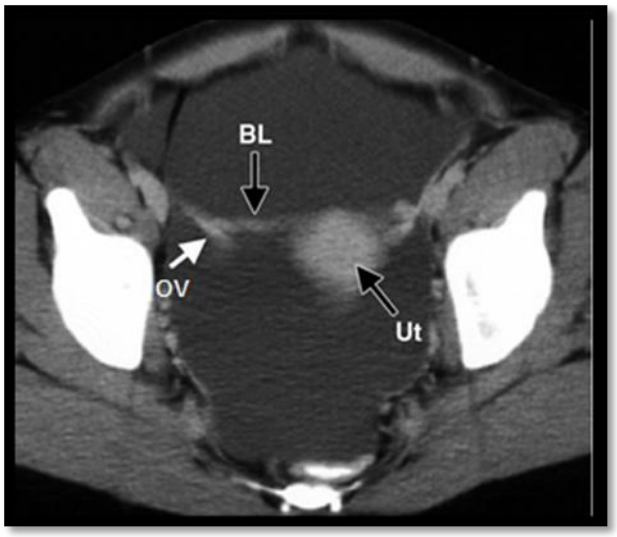
SL: Suspensory ligament **U:** Ureter **Ov:** ovary **SC:** surgical Clip

Figure (7): Suspensory ligament leading to the ovary **Quoted from *(Cahill et al., 2005).***

The suspensory ligament leads to the ovary, to which it is attached, and is a good anatomic landmark for localizing the ovary, The suspensory ligament transmits the ovarian artery and vein and may be depicted with CT, in continuity with the ovarian vessels, as a short and narrow fan-shaped soft-tissue band that widens as it approaches the ovary and is slightly thick at its ovarian attachment or as a linear band slightly thicker than the ovarian vein leading into it. This depicted ligamentous band is actually a summation of the peritoneal fold and the enclosed ovarian vessels, nerves, and fibromuscular fibers ***(Cahill et al., 2005).***

In our experience, the suspensory ligament is more commonly identifiable with CT than the other ovarian ligamentous attachments, and recognizing it is facilitated by tracking the ovarian blood vessels caudally to the adnexa. When visualized on axial CT scans, the suspensory ligament usually extends from the ovary along the direction of the external or common iliac vessels (**Fig.8**) **(*Cahill et al., 2005*).**

Relationship to the Broad Ligament

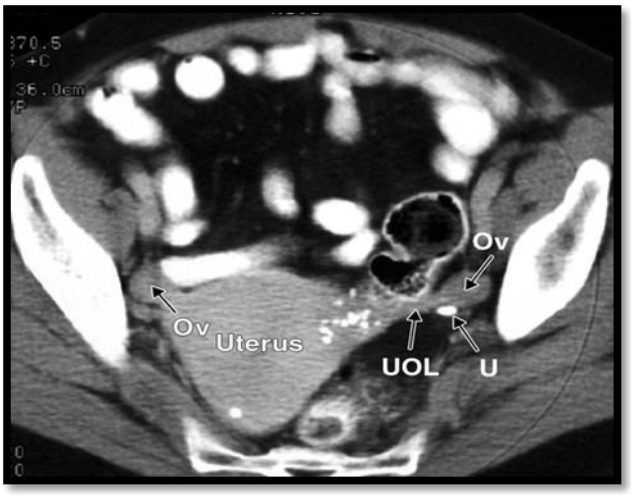


BL: Broad ligament **Ut:** Uterus **OV:** ovary

Figure (8): Ovaries relationship to broad ligament. ***Quoted from (Cahill et al., 2005).***

The broad ligament and the mesovarium are usually not obvious at CT unless surrounded by a large amount of ascites. In this setting, the ovaries can be seen suspended from the posterior surface of the broad ligament (**Fig.9**) ***(Cahill et al., 2005).***

Utero-ovarian Ligament



OV: Ovary **UOL:** Utero-ovarian ligament **U:** Ureter

Figure (9): Utero-ovarian ligament ***Quoted from (Cahill et al., 2005).***

The utero-ovarian ligament may occasionally be visualized with CT. It is depicted as a short and narrow soft-tissue band extending between the uterus and ovary (**Fig.10**) ***(Cahill et al., 2005).***

Normal PET/CT ovaries uptake

Knowledge of benign FDG uptake of the ovaries and uterus is important for daily practice of nuclear medicine radiologists. Increased uptake in the ovaries or uterus indicates a pathologic or neoplastic process in postmenopausal patients. In premenopausal women, increased ovarian or endometrial uptake can be functional or malignant ***(Liu, 2009).***

In general, normal postmenopausal ovaries have no visible FDG uptake.

In contrast, in premenopausal women focal FDG uptake is often identified in the normal ovaries with SUV range about 2.6 to 5.2 usually around the time of ovulation and during the early luteal phase of the menstrual cycle, therefore, information about the patient's menstrual status is crucial for interpretation. Physiologic FDG uptake may also be detected in postmenopausal females on hormonal therapy ***(Liu, 2009).***

There were scattered case reports about focal uptake of normal ovulating ovaries, ovarian torsion and hemorrhage as well as corpus luteal cysts (fig 10) ***(Liu, 2009).***

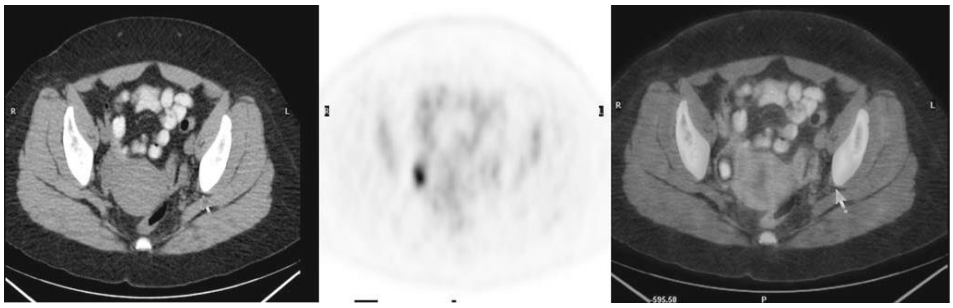


Figure (10): PET/CT images shows ovarian corpus luteum cyst uptake **Quoted from *(Liu, 2009).***