Ultrasound Assessment of Acute Female Pelvic Pain of Ovarian Origin: Pictorial Essay and Brief Review

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ABSTRACT

Ultrasound is the initial imaging modality in evaluating ovarian pathology in women in a fertile state, establishing the diagnosis in most cases and without exposing them to large doses of ionizing radiation. In this article, we will describe the imaging findings of the main ovarian pathologies that generate pelvic pain and that are a reason for admission to the emergency room, as well as a brief review of each topic.

KEYWORDS: Ultrasound, Ovary, Pain.

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INTRODUCTION

Pelvic pain in women is a common cause of consultation, generating a considerable number of admissions to the emergency department. Ultrasound is the modality of choice for studying these patients, since it provides timely information to establish the diagnosis and plan treatment, generates detailed information on the anatomy, and eliminates exposure to ionizing radiation. [1, 2] This article describes the main pathologies that generate pelvic pain in women in a fertile state, ultrasound findings, and possible treatments.

ENDOMETRIOMA

Endometriosis is an inflammatory disease associated with pelvic pain and infertility, characterized by ectopic endometrial tissue [3]. Endometriomas are cystic lesions, also known as chocolate cysts, they are the most common manifestation of endometriosis, they cause disabling pain, transvaginal bleeding, and menstrual irregularities [4].

It affects 6 to 10% of women of childbearing age, usually diagnosed at 28 years of age. It is the cause of chronic pain in up to 87% of cases. The most important risk factors are family history of endometriosis, early menarche, short menstrual cycle, heavy menstrual periods, and nulliparity [5].

Infertility, chronic pelvic pain, dysmenorrhea, and dyspareunia are the most common symptoms in patients diagnosed with endometrioma [6]. Imaging studies currently represent the first line for the diagnosis of endometriosis and especially for the characterization of endometrioma; Transvaginal ultrasound (TVUS) [7] has shown a sensitivity of 93% and a specificity of 96% in the diagnosis of endometrioma [8]. Endometrioma will be characterized on ultrasound as unilocular lesions, with increased volume, hyperechoic wall, ground-glass appearance, and the poor signal after applying color Doppler and displacement of healthy ovarian stroma [6]. Another study method that has shown greater sensitivity but also represents an increased economic cost is magnetic resonance imaging with sequences weighted in T1, T2, and DWI. In conclusion, therefore, a combination of physical examination and TVUS provides an accurate assessment for the localization and characterization of endometriotic lesions.
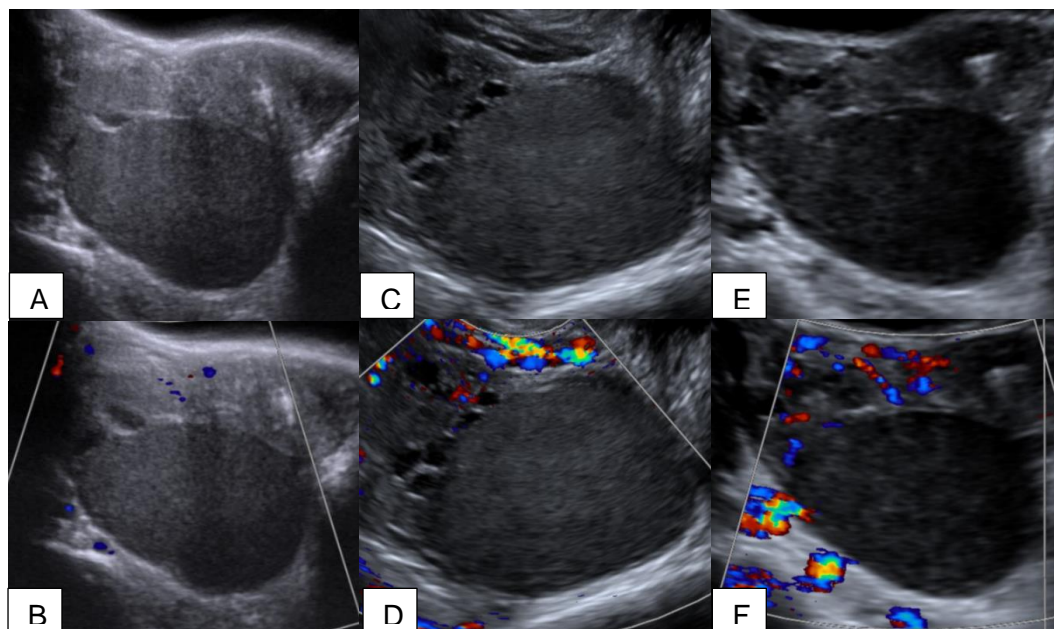
Figure 1. Female patients under 40 years of age who come to the emergency department reporting pelvic pain and transvaginal bleeding. Images A and C show pelvic exploration and image B transvaginal exploration in B mode, (B, D, and F in color Doppler mode); all the images show an ovary with an ovoid morphology image, with a ground-glass appearance, without color Doppler signal and that displaces the ovarian stroma, findings compatible with endometrioma.

OVARIAN TORSION

Ovarian torsion occurs when an ovary is twisted on the supporting ligaments, when the fallopian tube is twisted with the ovary it is called adnexal torsion; the main risk factor is an ovarian mass greater than 5 cm in diameter [9]. In the pediatric age, it is an idiopathic and rare event, most torsions occur in the reproductive age of women, between 20 to 40 years of age. [10] It is a surgical emergency, being the most frequent gynecological emergency. [11]

It is important to perform an adequate clinical history and physical examination, looking for a recent adnexal mass, recurrent abdominal pain, and low-grade fever; Likewise, we must request laboratories that include serum human chorionic

Gonadotropin, hematocrit, white blood cell count, an electrolyte panel [12]. Diagnosis is made by having a strong clinical suspicion with the use of laboratory data and image findings [13]. Finally, the diagnosis is confirmed on surgical evaluation [14]; laparoscopic surgery is considered the best

approach and treatment. The most accurate imaging study to help us suspect adnexal torsion in pediatric and adolescent patients is the pelvic ultrasound with Doppler, however, transvaginal ultrasound (TVUS) is the most used in the adult population [11].

The most characteristic ultrasound finding is an enlarged ovary, which may be solid, heterogeneous, or echogenic; It is important to compare the size of both ovaries, we can find specific signs such as the presence of multiple follicles in the periphery of a unilaterally enlarged edematous ovary. Another sign that helps us suspect is the twisted vascular pedicle which can be seen as a round hyperechoic structure with multiple concentric hypoechoic stripes on TVUS images [15]. Another sign that helps us suspect is the whirlpool sign by color Doppler, which occurs due to torsion of the vessels [11].
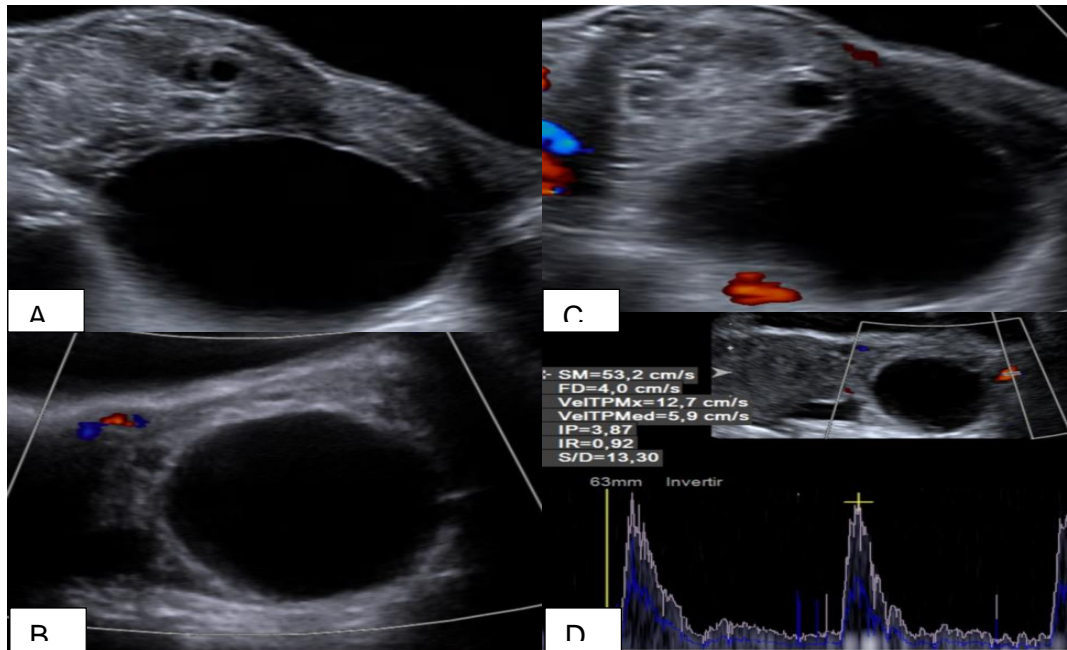
Figure 2. 22-year-old patient presenting to the emergency department complaining of sudden, disabling pelvic pain. Images A and B show B-mode ultrasound examination, where a hyperechoic ovary is observed, with a peripheral displacement of the follicles and an image of round morphology, with a thin wall and liquid content compatible with a cyst. After the application of color Doppler (image C), an absence of venous flow is observed, only showing little arterial flow demonstrated by spectral Doppler mode (image D), findings compatible with ovarian torsion and confirmed after performing an exploratory laparotomy in the operating room.

HEMORRHAGIC OVARIAN CYST

An ovarian cyst rupture is a physiological event during the ovarian cycle, particularly on days 20 and 26, and usually involves the follicle or the corpus luteum; If the cystic lesion is less than 25 mm in diameter, it is called a "follicle" and when it is greater than this amount, a "cyst". It is common to see it in early pregnancy, thrombophilias, or in anticoagulant treatment [16].

A pertinent clinical history should be made, asking for the last date of her menstruation; the patient may have tenderness and cramping in the lower abdomen or pelvic region; however, on certain occasions, she may have hypovolemia. Therefore, the approach for these patients requires a bimanual examination to assess the size and tenderness of the cyst, along with a complete blood panel and a pregnancy test to rule out ectopic pregnancy. The first line of diagnosis in the face of high suspicion is ultrasound. Hemorrhagic cysts change in the visualization of the ultrasound depending on the stage in which they are found, thanks to the blood [16, 17].

Sonographic features of hemorrhagic ovarian cysts ranged from an anechoic mass, a low-attenuating hypoechoic mass, to moderately cystic with thick walls and septa. It is a common ultrasound finding, it is particularly characterized by a cystic mass from an ovary; it has a reticular pattern with internal echoes that are fibrin strands. The set of fibrin strands, absence of septa, and smooth wall tell us that it has great sensitivity and specificity for a hemorrhagic ovarian cyst. These findings are commonly known as lace-like, also known as a fishnet, cobweb, or spiderweb appearance. Transvaginal ultrasound has shown better diagnostic results than abdominal ultrasound, thanks to its proximity to the pelvic organs [18, 19, 20]. This pathology can be treated with analgesia and observation, however, any predisposing factor must be taken into account. Observation is made by pelvic ultrasound in 4 to 6 weeks to check for a resolution. However, there may be an indication for surgical intervention in the event of a large amount of peritoneal fluid on transvaginal ultrasound, hemodynamic instability, and severe pain [16, 17].
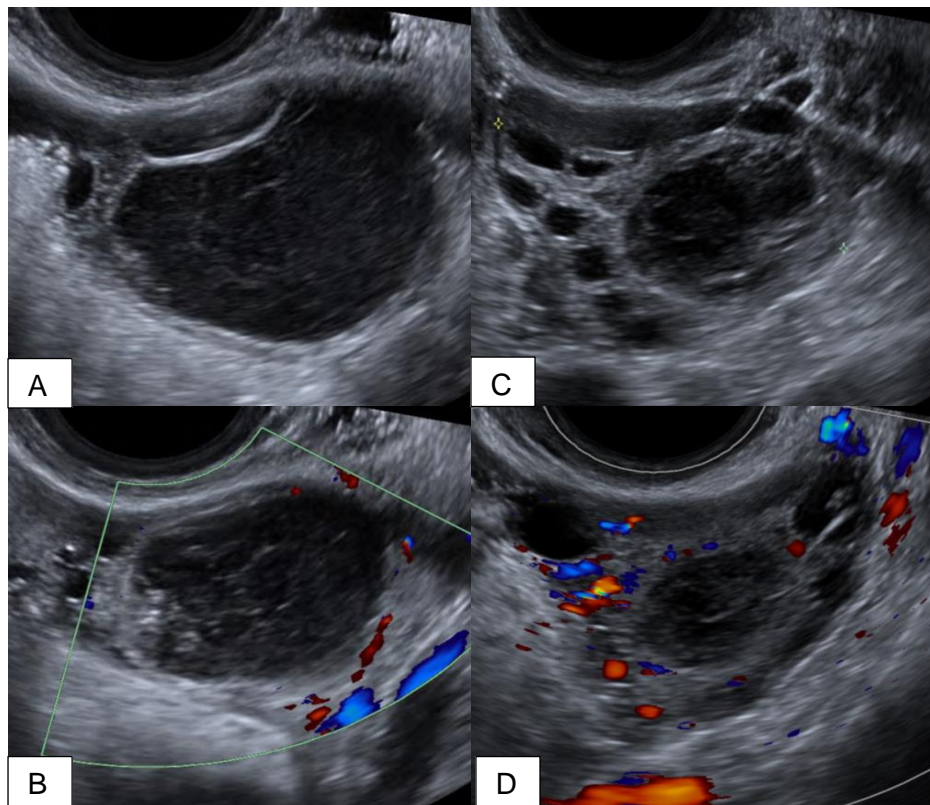
Figure 3. Female patients between 19 and 30 years of age, presented to the emergency department reporting pelvic pain for hours of evolution. Images A and C show a B-mode transvaginal ultrasound, where an ovoid morphology image is identified, hypoechogenic and heterogeneous, with an internal reticular pattern; same that after the application of color Doppler (image B and D respectively) show an absence of flow, findings compatible with hemorrhagic ovarian cyst.

## OVARIAN ECTOPIC PREGNANCY (OEP)

Ectopic pregnancy refers to an embryo that does not implant or develop in the uterine cavity. However, there are different kinds of ectopic pregnancies, the primary ovarian pregnancy as its name mentions the foundation arises in the ovary [21]. Within ectopic pregnancies (EP), ovarian pregnancy (OP) is rare, having an incidence of 1/7000-40,000 live births and 0.5-3% of ectopic pregnancies; an estimated 75% resolve in the first trimester and are commonly misdiagnosed as corpus luteum hemorrhage [23]. Its etiology is still uncertain, but risk factors are known that may contribute, such as a previous PE, pelvic inflammatory disease (PID), and endometriosis [23]. It is extremely common (91%) that within OPs the sac ruptures and ends during the first trimester. The usual clinical picture is abdominal pain, vaginal bleeding, adnexal mass, irregular menstruation, and shock [24].

In 1878, Spiegelberg suggested the following diagnostic criteria: 1) the fallopian tube on the affected side must be intact, 2) the gestational sac must occupy the same position as the ovary, 3) the ovary must be connected to the uterus by the uterine ligament. -ovarian and 4) the ovarian tissue must be located in the wall of the gestational sac. In 2002 Sergent et al. Suggested the following as new diagnostic criteria to

add to those of the Spiegelberg study: 1) serum ß-hCG level ≥1,000 IU/L and uterine emptiness on vaginal ultrasound, 2) ovarian involvement confirmed by surgical exploration, with bleeding, visualization of chorionic villi or presence of an atypical ovarian cyst, 3) normal tubes, and 4) undetectable serum ß-hCG after ovarian treatment [24].

The use of transvaginal ultrasound (TVS) and the detection of human chorionic gonadotropin (hCG) in serum have provided an early diagnosis of PD. Currently, TVS has become the gold standard for diagnosing PE, thanks to its early detection during the natural history, especially before tubal rupture, which has helped carry out non-surgical management [25, 26]. Ultrasound findings during the first trimester are; inhomogeneous mass or spot sign in the adnexal region; mass with a hyperechoic ring around the gestational sac or bagel sign; gestational sac containing a fetal pole with cardiac activity; gestational sac containing a fetal pole without cardiac activity. If it is not diagnosed in time, it can be dangerous, leading to the rupture of the ectopic gestational sac that finally causes hemoperitoneum. The treatment will be surgical, with laparoscopic surgery being the treatment of choice [24, 25].
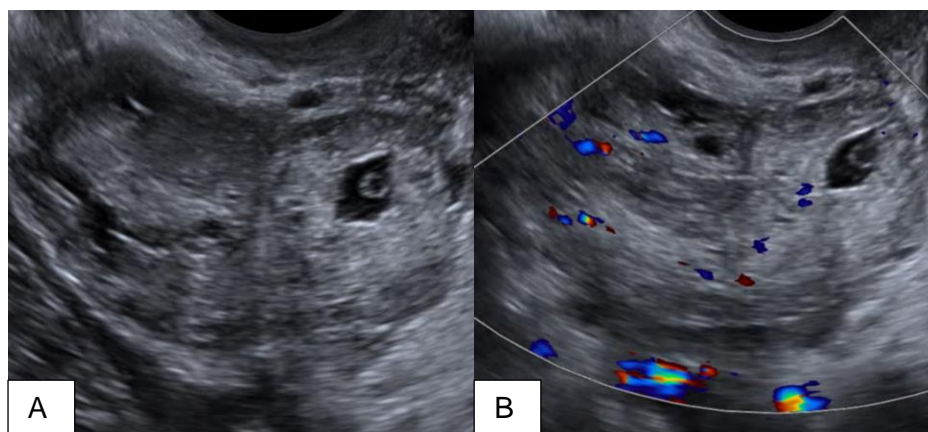
Figure 4. A 34-year-old patient with a positive pregnancy test comes to the emergency department complaining of pelvic pain. Transvaginal ultrasound is performed (images A and B) where an image with ring morphology is identified, dependent on the right ovary and which shows a gestational sac inside, with no evidence of cardiac activity; findings consistent with ovarian ectopic pregnancy.

FOLLICLES RUPTURE

During the menstrual cycle, four different types of follicles are seen in the ovaries: primordial, primary, secondary, and tertiary, also known as an antral follicles. However, before follicular rupture, only one follicle will be dominantly present. Currently, ultrasound has been a very important tool to monitor the process of ovarian stimulation [25]. There are different ultrasound parameters, such as the antral follicles count (AFC), mean follicular diameter, follicle growth rate, and dominant thickness of the follicular wall, it also helps us to confirm multi follicular ovary, which is important to detect ovarian hyperstimulation syndrome [28]. One of the best markers to predict poor ovarian response and exaggerated Response is the AFC [29]. Antral follicles are detected from 2 mm; when they measure 2-10 mm they are recruitable follicles; with dimensions > 10 mm they are called dominant follicles [30]. An AFC < 5-7 tells us about a small number of retrieved oocytes and a reduced pregnancy rate, while the interpretation of an AFC ≥ 20 is an exaggerated ovarian response, which in turn is related to a higher risk of suffering from the syndrome of ovarian hyperstimulation. Currently, 3D ultrasound technology has provided major advantages over 2D technology, which was previously used, becoming the new standard in clinical practice [29]. They have provided automatic sensors of the follicular diameter, the data is stored and can be analyzed in detail later, in turn, it can be reconstructed in any plane, reducing the influence of the operator in the interpretation and objectivity of the scan. Follicular rupture can be a frequent cause of consultation in the emergency department and is the reason for ultrasonographic exploration. Within the findings we found follicles with a diameter of generally 25 mm, thin-walled, with heterogeneous and mobile content inside, after the application of color Doppler, it can show circumferential peripheral flow [30].
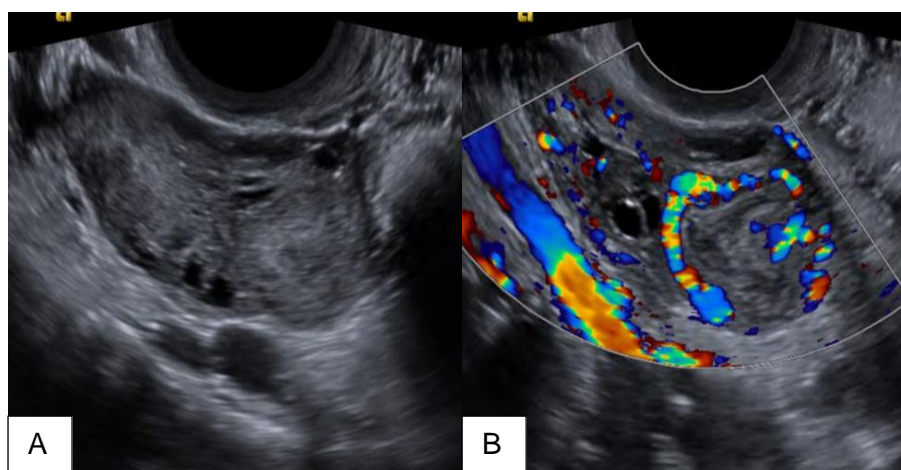

Figure 5. An 18-year-old female patient comes to the emergency department complaining of disabling pelvic pain. In the ultrasonographic examination, an image of ovoid morphology, a diameter of 20 mm, with a thin wall, heterogeneous content, and peripheral color Doppler signal, findings highly suggestive of a ruptured follicle, is identified.

OVARIAN HYPERSTIMULATION SYNDROME

Ovarian hyperstimulation syndrome (OHSS) is a serious but rare event and is associated with ovarian stimulation by assisted reproductive technology (ART) treatment [31]. It can be seen by ovarian enlargement, a high concentration of sex steroids, and accumulation of extravascular exudate [32]. It can occur in 3 to 10% of patients with ART cycles and has a 20% incidence in women with risk factors [33]. OHS is triggered by arteriolar vasodilation and increased capillary permeability caused by stimulation of vascular endothelial growth factor (VEGF) by human chorionic gonadotropin, which facilitates a shift of intravascular fluid to the extravascular space. It is a self-limited situation in non-pregnant patients, however, pregnant patients may persist with symptoms until the end of the first trimester [33]. The most frequent symptoms are mild abdominal distension, abdominal ascites, thromboembolic events, oliguria, electrolyte imbalances, and hypotension, which finally culminate in death [35]. OHSS is classified according to its severity: mild, moderate, severe, critical; also according to

the moment, early or late. An elevated antimüllerian hormone (AMH) (>3.4 ng/mL) or an elevated antral follicle count (AFC) (>24) are highly specific and sensitive to potential OHSS [35]. The use of ultrasound and hormonal evaluation have been used to monitor controlled ovarian stimulation (COS), which requires information to medical personnel on when to cancel cycles if there is no adequate ovarian response; when is the appropriate time to trigger final follicular maturation, and helps in assessing the risk of OHSS [36]. In turn, we can predict that patients are likely to develop OHSS by visualizing ≥25 follicles, estradiol on the day of onset >3500 pg/mL, or ≥24 oocytes retrieved [35]. Dopamine agonists can be used to prevent the incidence of OHSS when hCG is used for many days. However, the mainstay of treatment in OHSS is fluid replacement and prophylactic anticoagulation, and paracentesis is recommended for large amounts of ascites [31]. Identification of risk factors in patients before treatment for planning ovarian stimulation cycles is routinely recommended [33]
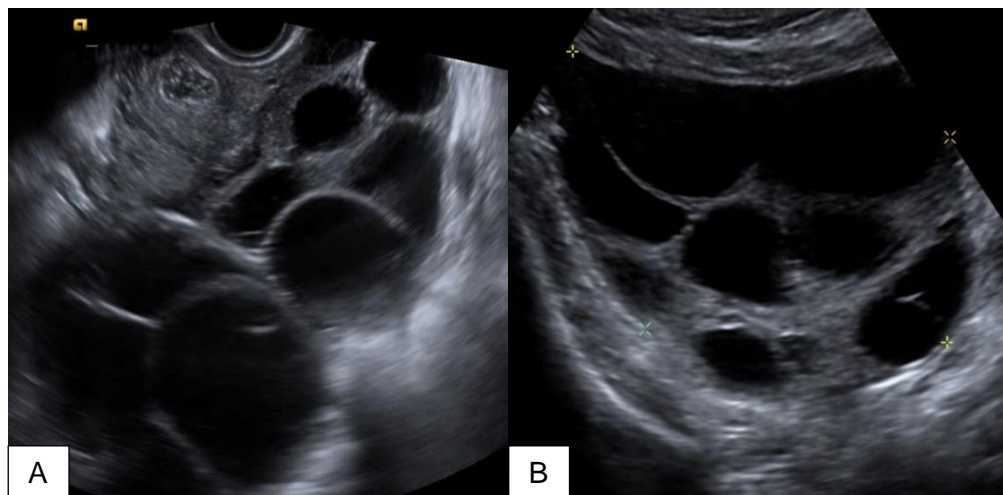
Figure 6. A 36-year-old female patient with a history of ovarian stimulation treatment came to the emergency department reporting pelvic pain. Transvaginal ultrasound is performed observing both ovaries (image A and B) with increased dimensions, as well as multiple follicles of multifocal and bilateral distribution, compatible findings are ovarian hyperstimulation syndrome.
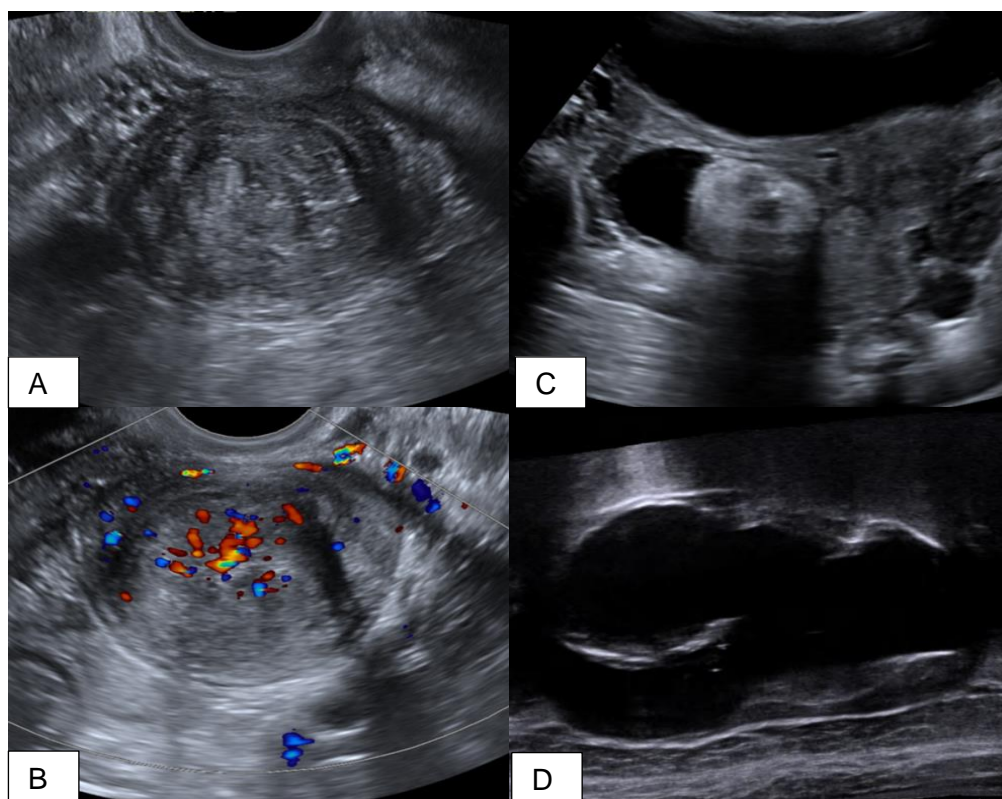
TERATOMA

Ovarian teratomas are the most common germ cell tumor (GCT) [37], they are composed of both mature and immature tissue, derived from the three layers of germ cells: ectoderm, mesoderm, and endoderm [38]. Its main presentations are mature teratoma (MT), immature teratoma (IT), and monodermal [39]. MT is the most common, accounting for 69% of all GCTs, and is seen mostly in women of reproductive age, being the most common benign ovarian tumor in patients <20 years of age. Its are the second in frequency, representing 10% of GGTs. Although they are benign, they tend to be more aggressive and recur, constituting 42% of malignant GGTs. However, monodermal teratoma is the least common of the above [39]. There are no specific tumor markers, but elevated carbohydrate 125 (CA 125) and carbohydrate 19-9 (CA 19-9), as well as alpha-

fetoprotein, have been seen in immature teratomas. Most are asymptomatic and it is very common for them to be diagnosed incidentally in imaging studies [39]. MT contains at least two germ layer tissues, is usually cystic with a diameter of 5-10 cm in diameter, and diagnosis is made by detecting images associated with fat or calcifications [40]. Typical ultrasound findings are: echogenic tubercle with cystic echo; Computed tomography (CT) findings are: fat intralesional (measured in HU), Tooth\calcifications, Rokitansky nodule, Tuft\Hairs, Fat-fluid level; Magnetic resonance imaging (MRI) resolution: fat intralesional, fat saturation T1W technique, chemical shift artifact analysis, gradient-echo imaging [38]. TIs contain tissues from all three germ layers [38], and irregular solid components with thick calcifications, small fat foci, and hemorrhagic foci are found in CT and MRI [40]. Monodermal teratoma, unlike the previous ones, does not

show fat in the ovarian stroma [39], derived exclusively from a germ line, appearing as a lobulated and hypervascular cystic mass. On MR imaging findings, a stained glass appearance is seen; multiple locules with variable signal intensities on both T1 and T2 [40].

Figure 7. Patients with a diagnosis of teratoma. In image A we observe a transvaginal ultrasound, where at the level of the right ovary we identify a solid, ovoid morphology image with a diameter of 10 cm, with multiple hyperechoic images that generate posterior acoustic shadowing, as well as centrally located cystic-like areas. After applying color Doppler (image B) with increased central flow signal, findings were compatible with mature teratoma. In images C and D we observe an ovary with a central cystic area, as well as thick hyperechoic walls, the histopathological study was compatible with an immature teratoma.

DISCUSSION

Pelvic pain in women is a common cause of consultation and the ultrasound is the modality of choice for studying these patients [1, 2]. Endometriomas are cystic lesions and they are the most common manifestation of endometriosis, they cause disabling pain, transvaginal bleeding, and menstrual irregularities. It affects 6 to 10% of women of childbearing age, usually diagnosed at 28 years of age [4]. Ovarian torsion occurs when an ovary is twisted on the supporting ligaments, in the pediatric age, it is an idiopathic and rare event, most torsions occur in the reproductive age of women, between 20 to 40 years of age [9]. An ovarian cyst rupture is a physiological event during the ovarian cycle, particularly on days 20 and 26, a pertinent clinical history should be made, asking for the last date of her menstruation; the patient may have tenderness and cramping in the lower abdomen or pelvic region; however, on certain occasions, she may have hypovolemia [16, 17]. OP is rare, having an incidence of 1/7000-40,000 live births and 0.5-3% of ectopic pregnancies; an estimated 75% resolve in the first trimester and are commonly misdiagnosed as corpus luteum hemorrhage [23]. The use of ultrasound and hormonal evaluation have been used to monitor controlled ovarian stimulation (COS), which requires information to medical personnel on when to cancel cycles if there is no adequate ovarian response; when is the appropriate time to trigger final follicular maturation, and helps in assessing the risk of OHSS [36]. Teratomas are the most common germ cell tumor, typical ultrasound findings are: echogenic tubercle with cystic echo; Computed tomography findings are: fat intralesional tooth\calcifications, Rokitansky nodule, Tuft\Hairs, Fat-fluid level; magnetic resonance imaging (MRI) resolution: fat intralesional, fat saturation T1W technique, chemical shift artifact analysis, gradient-echo imaging [37, 38].

CONCLUSIONS

Acute pelvic pain is a common cause of admission to the emergency department; generally, a good physical examination, clinical history and laboratory studies will provide us with an important diagnostic suspicion, these factors associated with targeted imaging studies will provide an accurate diagnosis. Ultrasound continues to be the first-line study modality for the evaluation of these pathologies,

since it does not emit radiation, generates low cost and in expert hands can provide accurate diagnoses.

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