SONOGRAPHY OF THE OVARY: BENIGN VS. MALIGNANT

INTRODUCTION

Because of the improved resolution with transvaginal sonography, ovarian cysts and/or masses can be delineated with greater confidence than with the transabdominal approach. In addition, detailed tissue characterization is possible and artifacts can be readily excluded. However, the limited field of view with transvaginal sonography permits adequate visualization of only the true pelvis. Transabdominal sonography is still required to gain to overall assessment of large pelvic masses.

The greatest amount of information will be obtained from transvaginal sonography if it is considered an extension of the routine pelvic examination. During real-time scanning, simultaneous pressure with the transvaginal transducer and on the patient's abdomen with the examiner's free hand will optimize visualization of adnexal structures that may be beyond the normal field of view. Pelvic manipulation will also provide information on whether a particular ovarian mass is fixed in the pelvis or mobile. An ultrasound examination not only determines the size of an ovarian mass, but it can also evaluate its architectural pattern, thereby correlating sonomorphology with macroscopic pathologic features of a tumor.

PRE-TEST PROBABILITY

The risk of malignancy once an ovarian mass is detected varies based upon specific historical information. In the general population, the lifetime risk of ovarian cancer is 1.8%[1]. The risk of malignancy increases 12-fold from 20-29 to 60-69 years of age[2]. An ovarian mass in a premenopausal girl or a post-menopausal woman is abnormal. In the reproductive age group, an ovarian mass may be malignant, but it is more likely benign.

A family history of ovarian, breast, or colon cancer would increase the patient's pre-test probability of having a malignancy.

The lifetime risk of ovarian cancer based on family history alone ranges from 6.7% for one first degree relative with disease to 40% for women with an hereditary syndrome[3].

The use of oral contraceptives for greater than 5 years reduces the lifetime risk of ovarian cancer for the general population from 1.6% to 0.8%[4]. Tubal ligation may also reduce the risk of epithelial ovarian cancer[5].

Serum CA-125 in a patient with a pelvic mass may provide additional important information with respect to the likelihood of malignancy. In the postmenopausal age group with a pelvic mass, an elevated CA-125 has a positive predictive value ³ 70% for malignancy[6]. The increased false positive rate in the premenopause, significantly reduces the applicability of this test. By using the initial level and the rate of increase over time, the specificity of a CA-125 value increases without affecting sensitivity[5].

There are 35 sub-types of ovarian tumors. The variability in the macroscopic characteristics of benign and malignant lesions prevents a precise pathologic diagnosis from a detailed sonographic description in

every case. There are few ovarian tumors that have characteristic sonomorphologic findings.

BENIGN CYSTIC TERATOMAS

Benign cystic teratomas or dermoids are the most common ovarian neoplasm in the reproductive age group (Fig. 1). Because of their characteristic findings, Sassone et al[7] correctly diagnosed 23/24 benign cystic teratomas. The diffuse echogenicity of some benign cystic teratomas makes even large tumors (> 6 cm) sometimes difficult to visualize sonographically[8]. A combined pelvic and transvaginal ultrasound examination will improve the accuracy of detecting these masses.

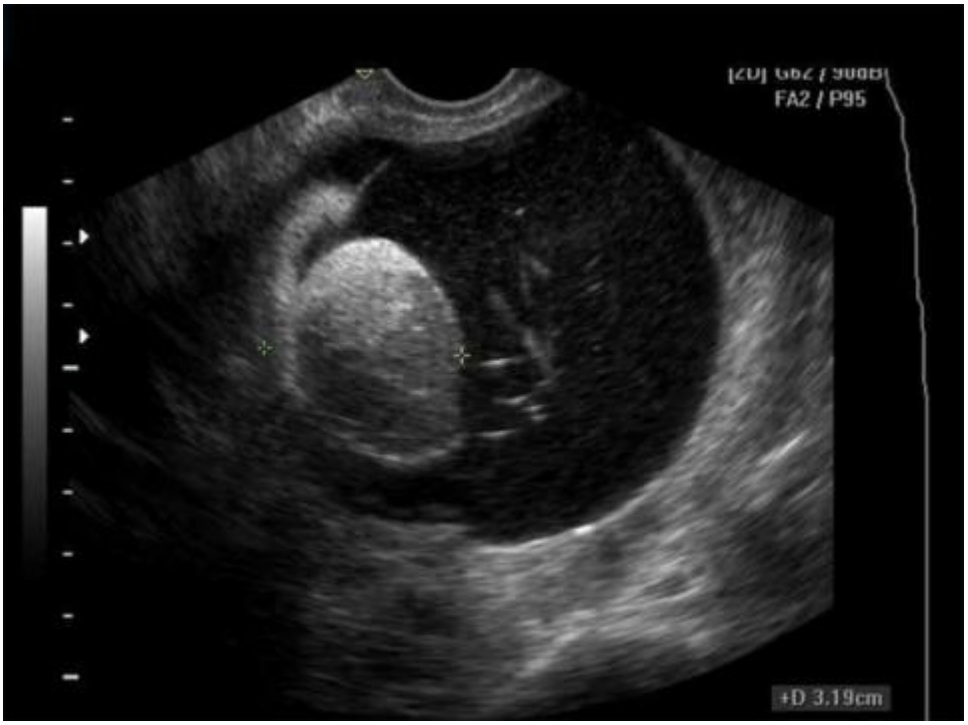

Figure 1 - The echogenic focus (between markers) and speckled debris within the cyst are characteristic of a benign cystic teratoma

The growth rate of benign cystic teratomas in the premenopause is 1.8 mm per year and practically zero in the postmenopause. Because of the know complications of torsion and malignant transformation in larger dermoids, tumors > 6 cm and those with a growth rate > 2 cm per year should be removed[9]. When vascular flow is detected within the central solid component of a presumed dermoid, a struma ovarii containing thyroid tissue should be suspected. Benign cystic teratomas are generally avascular[10]. A sonographic scoring system utilizing morphology and Doppler has a 99.02% sensitivity and 99.75% specificity for detecting benign cystic teratomas[11].

ENDOMETRIOMAS

Endometriomas may have several sonomorphologic appearances ranging from an anechoic cyst, a diffusely echogenic cyst to a mass with multiple septations and debris. In general, 95% of endometriomas have diffuse low-level echoes (Fig. 2). Small hyperechoic wall foci in a mass with low-level echoes is also highly suggestive for an endometrioma. These foci are highly echogenic and should not be confused with papillary excrescences. Patel and co-workers[12] have speculated that these echogenic foci within the wall of an endometrioma are secondary to cell breakdown. A final feature of some endometriomas is the presence of septations without nodularity.

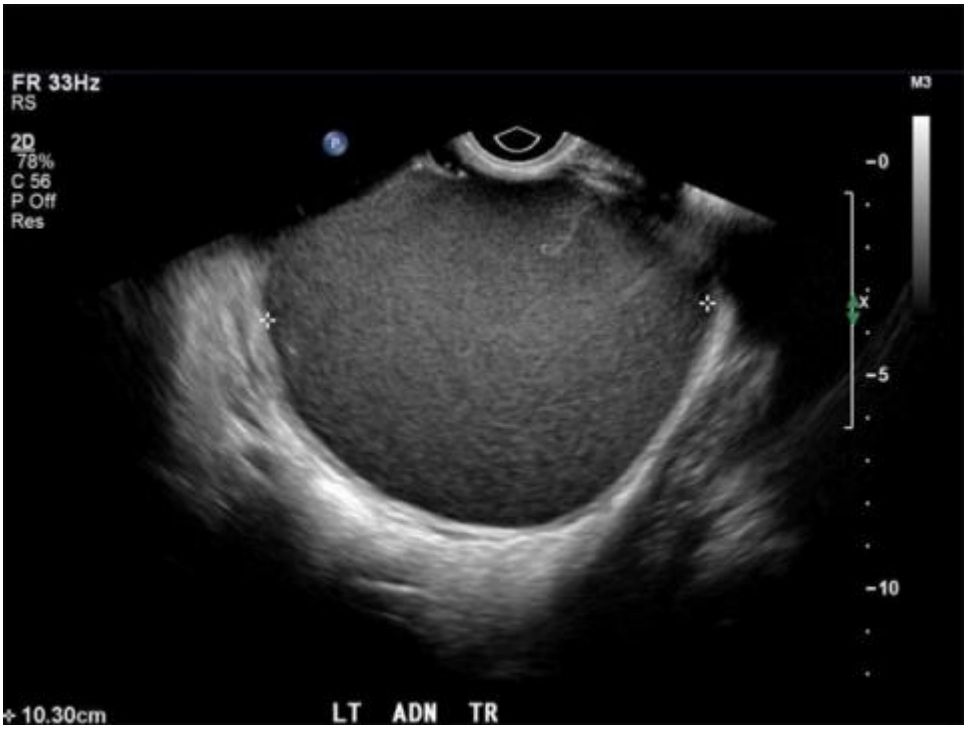

Figure 2 - Cyst containing homogeneous debris consistent with an endometrioma

Acoustic streaming is the movement of fluid within a cyst due to the transfer of energy within the Doppler box to the particles within a cyst. The size of a cyst and its distance from the ultrasound transducer, as well as the viscosity of a cyst determine whether acoustic streaming will be present. Because of their viscosity, endometriomas will only occasionally have acoustic streaming[13].

OVARIAN CRESCENT SIGN

The presence of normal ovarian tissue adjacent to an adnexal mass has been described as the ovarian crescent sign (Fig. 3). In one study of 100 women with adnexal masses, the absence of an ovarian crescent sign had a sensitivity of 96% and a specificity of 76% for the diagnosis of ovarian carcinoma. However, this sign cannot differentiate between benign and borderline tumors. In addition, it is more difficult to document in the postmenopausal age group[14]. Additional studies involving a sufficient number of stage I ovarian cancers will be required to truly test the reliability of this sign.

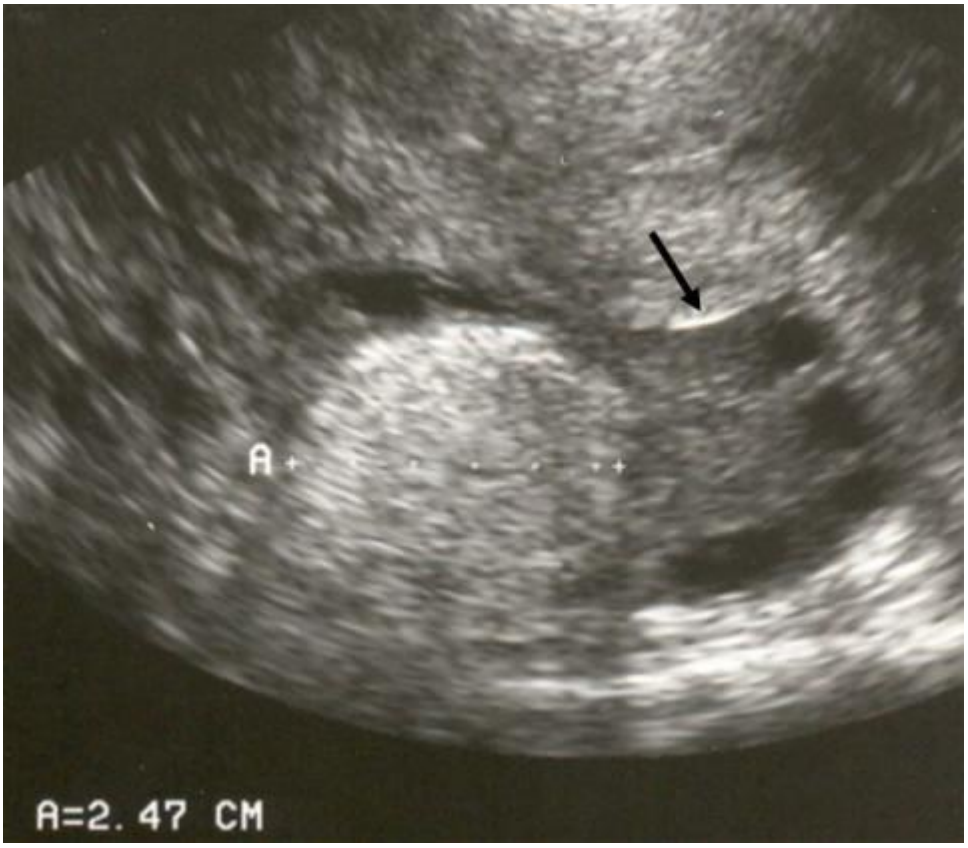

Figure 3 - Crescent sign. There is normal ovarian tissue adjacent to a benign cystic teratoma (between markers)

Specific sonographic parameters have been evaluated in an attempt to reliably distinguish between benign and malignant ovarian tumors. The addition of color Doppler (see below) helps to decrease the false positive rate of a morphologic evaluation of an ovarian mass. The most important sonographic criteria utilized to distinguish benign from malignant lesions are discussed in the following paragraphs.

OVARIAN VOLUME OR SIZE

The risk of malignancy increases with tumor size, regardless of morphology[15,16]. However, the incorporation of tumor size does not improve the accuracy of the morphologic criteria outlined below and is, therefore, not included in most of the more recent studies of ovarian masses[17]. Ovarian lesions³ 10 cm are difficult to assess morphologically, do not decrease in size with observation and should, therefore, be removed. For ovarian masses less than 5 cm, sonomorphology and Doppler assessment are most efficacious. With masses between 5 cm and 10 cm determining a course of action should be individualized. The patient's age, history, symptoms, adequacy of the ultrasound examination, and possibly observational over 6 to 8 weeks should be considered.

SIMPLE THIN WALLED CYSTS

The risk of malignancy generally increases with patient age and the size of a simple cyst. Because of the limited number of patients in any single study, the prevalence of ovarian malignancy for a specific size simple cyst varies (Fig. 4). Osmers et al[18] reported an overall risk of malignancy and of tumors of low-malignant potential of 0.3% and 0.5%, respectively for simple ovarian cysts. It must be emphasized that there were only two malignancies and three tumors of low malignant potential in this study. As a result, the prevalence given may have a wide confidence interval. Ekerhovd et al[19] found that 3/413 simple cysts (0.7%) were borderline or malignant in premenopausal women; 4/247 cysts (1.6%) were borderline or malignant in postmenopausal women. There were no borderline or malignant ovarian tumors with a cyst

size < 7.5 cm. There appears to be a general consensus that the likelihood of a malignancy with a simple ovarian cyst of < 4 cm is remote. As a cyst increases in size, the risk of missing a papillary excrescence that would increase the risk of malignancy by 3 to 6-fold also increases. Hence, the presence or absence of papillary excrescences may explain the differences noted in the above reports.

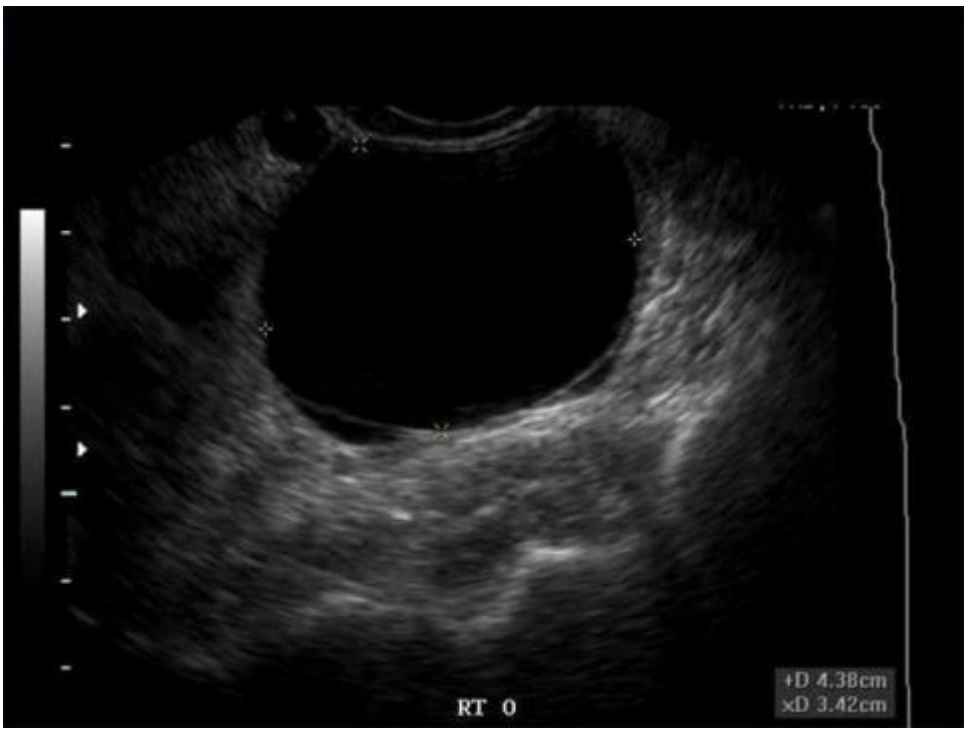

Figure 4 - 4.4 x 3.4 cm clear ovarian cyst

Modesitt and co-workers[20] screened 15,106 asymptomatic women over the age of 50; 18% had a unilocular ovarian cyst and 1.2% had a mean diameter > 6 cm to 10 cm. There were no cases of ovarian carcinoma in the latter study. The risk of malignancy in this study was, therefore, < 0.1% with a 95% confidence interval.

Sixty-nine percent of cystic ovarian tumors in the premenopause resolve within 3 months. The size of an ovarian follicle is between 15 and 25 mm (Fig. 5). However, even between 30 and 40 mm, 68.2% of simple cysts were found to be functional[11].

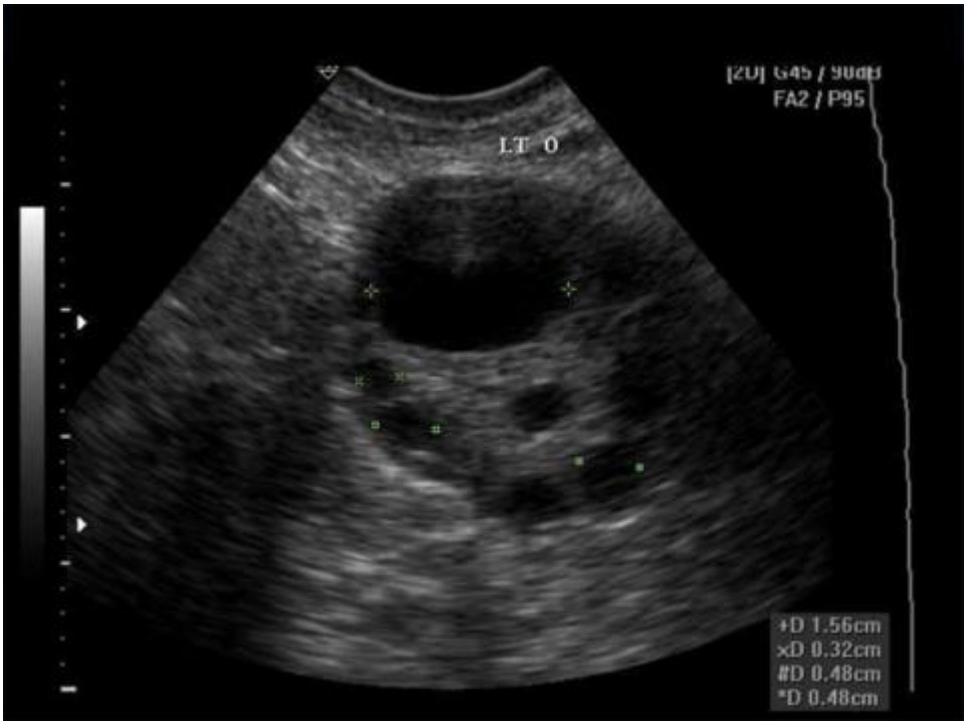

Figure 5 - 1.56 cm dominant follicle

LOCULATED CYST

The loculation of an ovarian cyst increases the risk of malignancy (Fig. 6)[21,22]. The presence of papillary excrescences can help to differentiate a mucinous cyst adenoma from a mucinous cyst adenocarcinoma[23]. As the number of mucinous tumors increases in a series, the sensitivity and specificity for the detection of malignancy decreases[17].

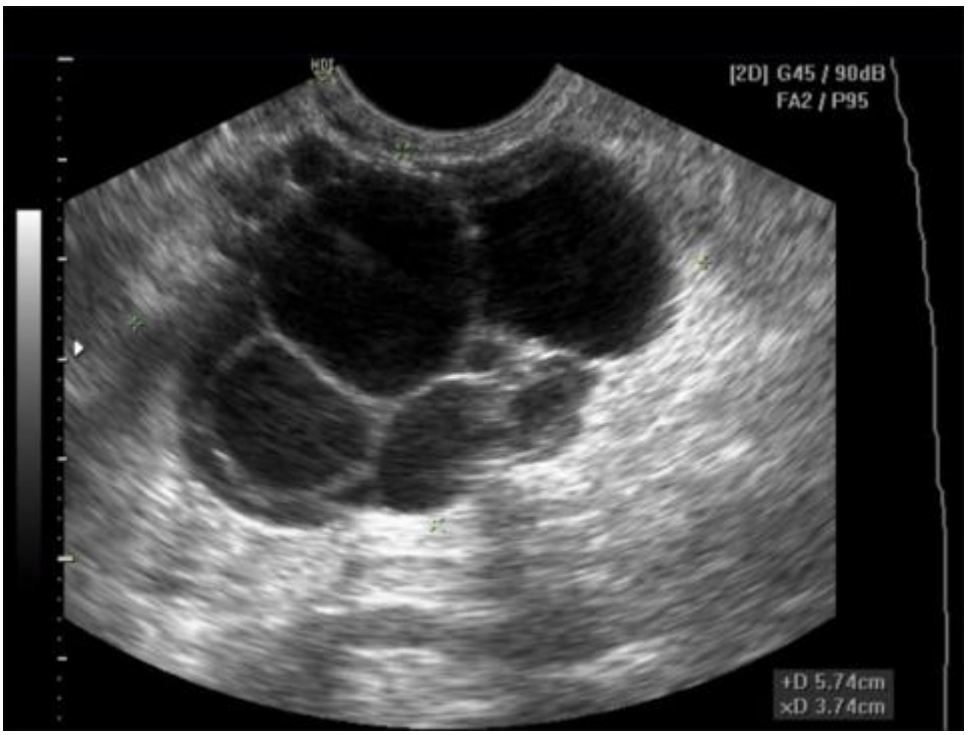

Figure 6 - Multiloculated ovarian cyst

SOLID ADNEXAL MASSES

When a solid adnexal mass is detected sonographically, a pedunculated leiomyoma must be excluded[24]. Color Doppler can be utilized in an attempt to find the stalk between the uterus and the adnexal mass. A

partial list of solid ovarian tumors (Fig. 7) is outlined in Table I. An ovarian fibrothecoma has a homogeneous echo pattern and marked posterior acoustic shadowing without any internal calcifications. A diffusely hypoechoic ovarian mass without posterior echo enhancement suggests a thecoma[25]. Ovarian steroid cell tumors have a different echogenicity from the surrounding ovary[26]. While the majority of granulosa cell tumors (Fig. 8) have cystic components, some are isoechoic to the uterus[27]. Brenner tumors are also solid, hypoechoic and with good through transmission of sound. They are architecturally similar to fibromas/thecomas[24]. Dysgerminomas are malignant germ cell tumors; sonographically, they are solid and multiloculated. Color Doppler reveals vascular flow along the septations of dysgerminomas[28].

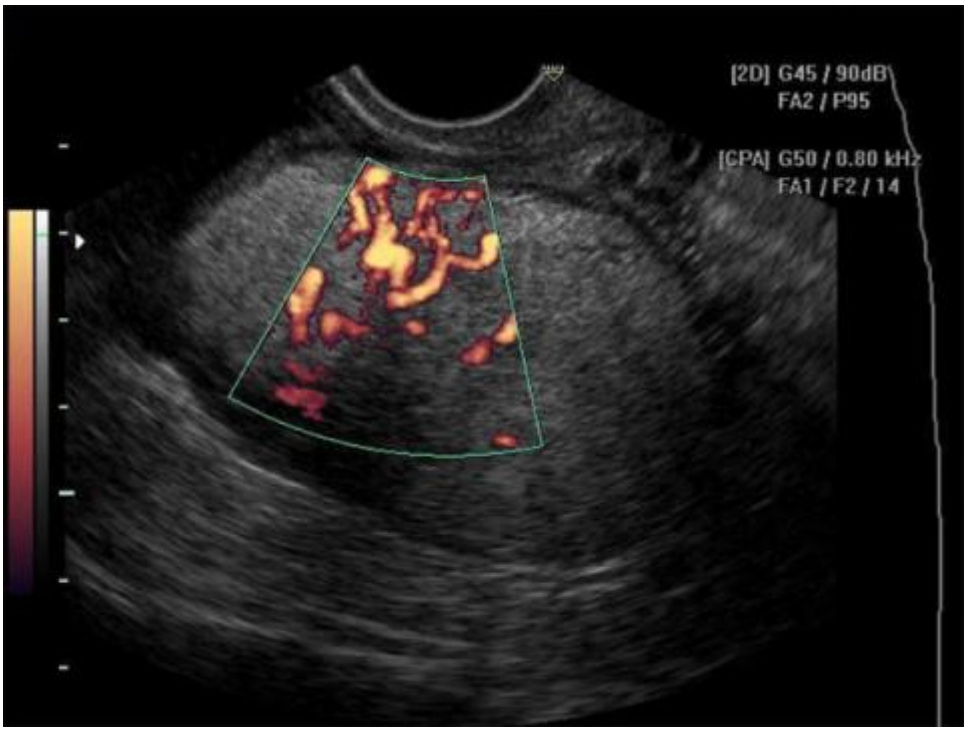

Figure 7 - Solid ovarian tumor

Table I. Solid Ovarian Tumors.
• Fibroma • Thecoma • Granulosa cell tumors • Brenner tumors • Dysgerminomas • Sertoli-leydig tumor • Sclerosing stromal tumor • Fibrosarcoma

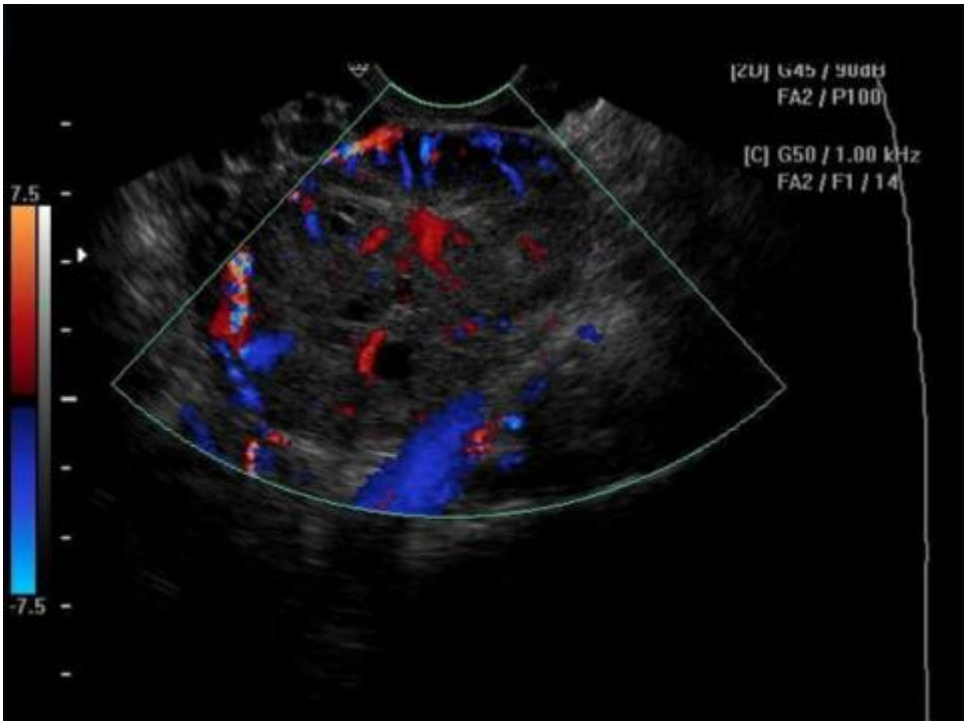

Figure 8 - Central vascular flow is present within this granulosa cell tumor

PAPILLARY EXCRESCENCES

Papillary excrescences are localized overgrowths of the epithelial lining of a cyst (Fig. 9). The more papillary excrescences, the greater the likelihood of malignancy[29]. Papillary excrescences that do not protrude³ 3 mm into the cyst cavity are not strongly associated with malignancy[15,30]. Papillary excrescences must be distinguished from focal punctate calcifications in an otherwise normal appearing ovary (Fig. 10). The latter areas have been found to represent superficial inclusion cysts and associated psammomatous calcifications[31]. When tumors were evaluated macroscopically at the time of surgery, papillary excrescences was the finding most frequently associated with malignancy[32].

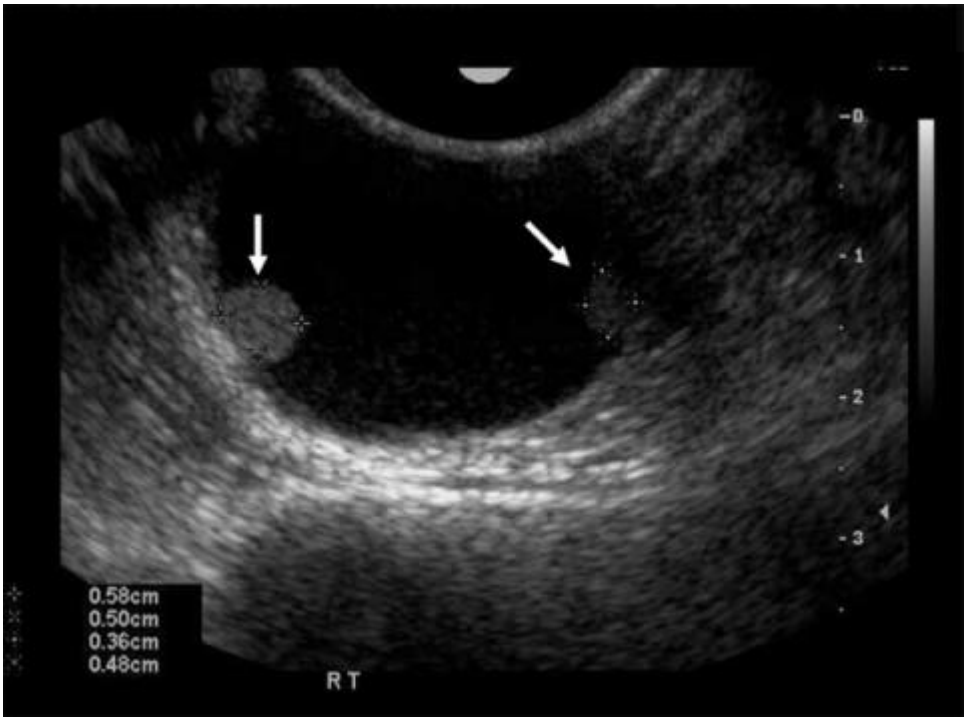

Figure 9 - Ovarian malignancy containing two papillary excrescences

(arrows)

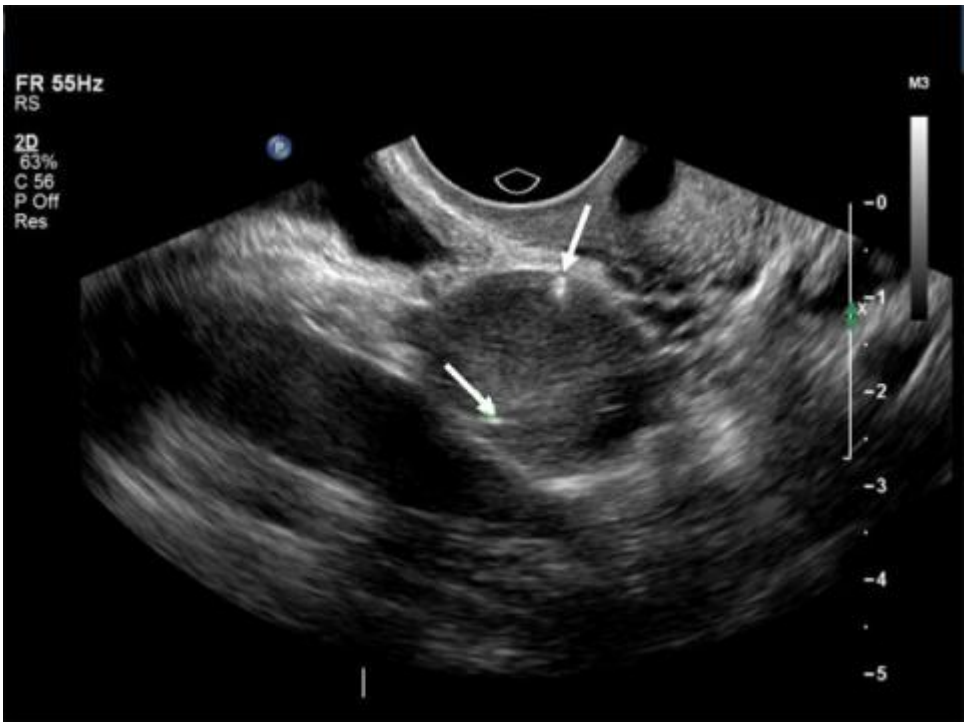

Figure 10 - Echogenic foci (arrow) on the periphery of the ovary

FOCAL SOLID AREAS

Focal solid areas within an ovarian cyst are much larger and, therefore, sonographically distinct from papillary excrescences. Focal solid areas also increase the likelihood of malignancy (Fig. 11)[7,15,18,22,33].

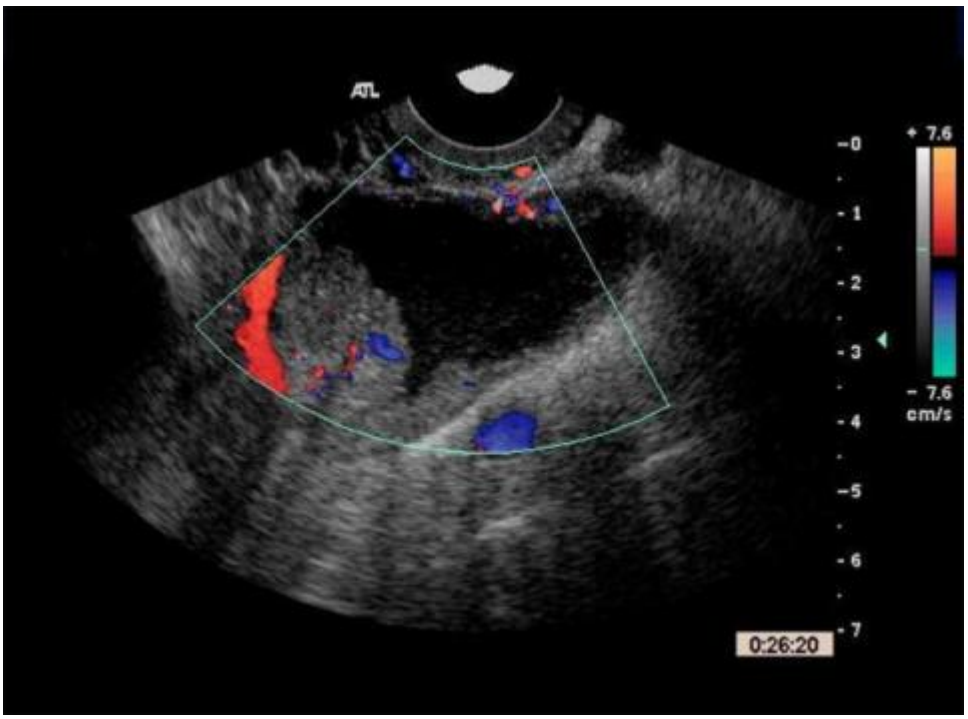

Figure 11 - Solid component within an ovarian malignancy with internal vascular flow

TINCTURE OF TIME

If there are not any obvious stigmata of malignancy and the size of the lesion does not mandate surgery,

a follow up ultrasound examination in 6-8 weeks will reduce the false positive rate of sonomorphology. Occasionally, hemorrhagic ovarian cysts (Fig. 12) will have a complex appearance that almost completely resolves in the interval between examinations. From 76%[34] to 94%[35] of functional ovarian cysts in women of reproductive age resolve in 5 to 10 weeks. Even in postmenopausal women 29% of simple ovarian cysts will disappear[36].

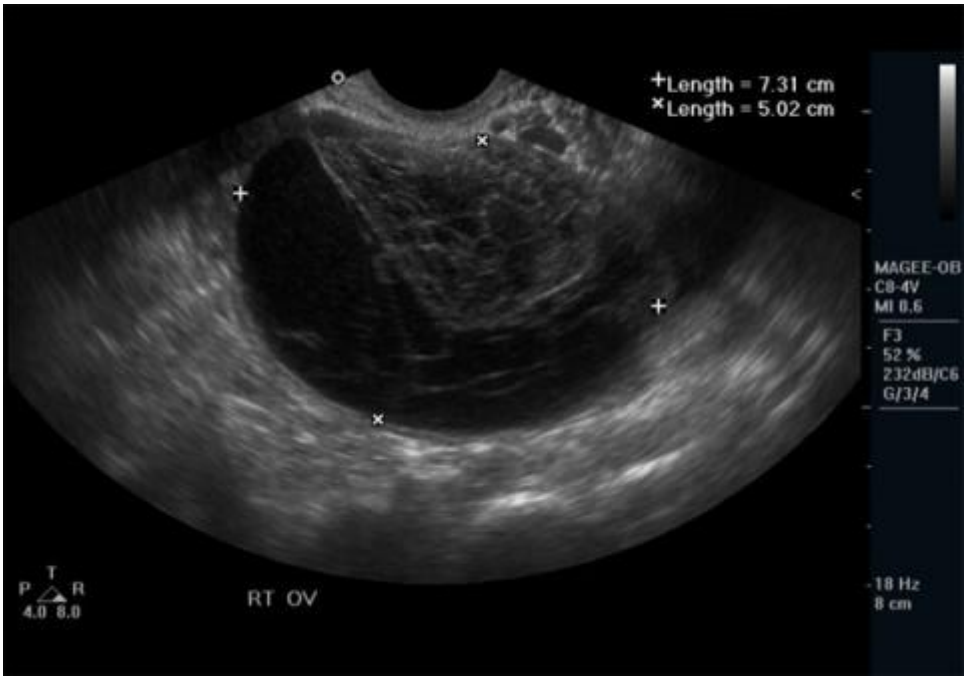

Figure 12 - 7.3 x 5.0 cm cyst with a dependent "ground-glass" component consistent with a hemorrhagic cyst

PRESENCE OR ABSENCE OF CUL-DE-SAC FLUID

Transvaginal sonography will consistently detect 8 ml of cul-de-sac fluid. A post-menopausal patient has between 1.2 ± 1.9 ml[37] and 5.5 ± 7.8 ml[38] of cul-de-sac fluid. Hence, a moderate amount of cul-de-sac fluid in a post-menopausal patient should increase the index of suspicion for an ovarian malignancy or liver disease. Unfortunately, this sign is usually only present with advanced ovarian carcinoma[39].

COLOR DOPPLER

Color Doppler has been used in attempt to reduce the false positive rate of ovarian morphology. Although the initial reports were quite promising, subsequent studies have had conflicting results. The utilization of color Doppler has evolved from the quantitative to the qualitative. Hence, rather than utilizing a specific RI or PI cut-off for benign and malignant[40,41], the presence or absence of vascular flow into specific regions of a mass are evaluated. In the latter instance, central vascular flow within the mass, flow within a papillary excrescence or flow along septations (Fig. 13) would be considered indicators of malignancy, while peripheral flow is more indicative of a benign process[42,43]. Hence, with a unilocular cyst, Doppler flow would not improve the diagnostic accuracy of morphology. It has not yet been determined if three-dimensional power Doppler will further improve the accuracy of the qualitative assessment of ovarian masses[42].

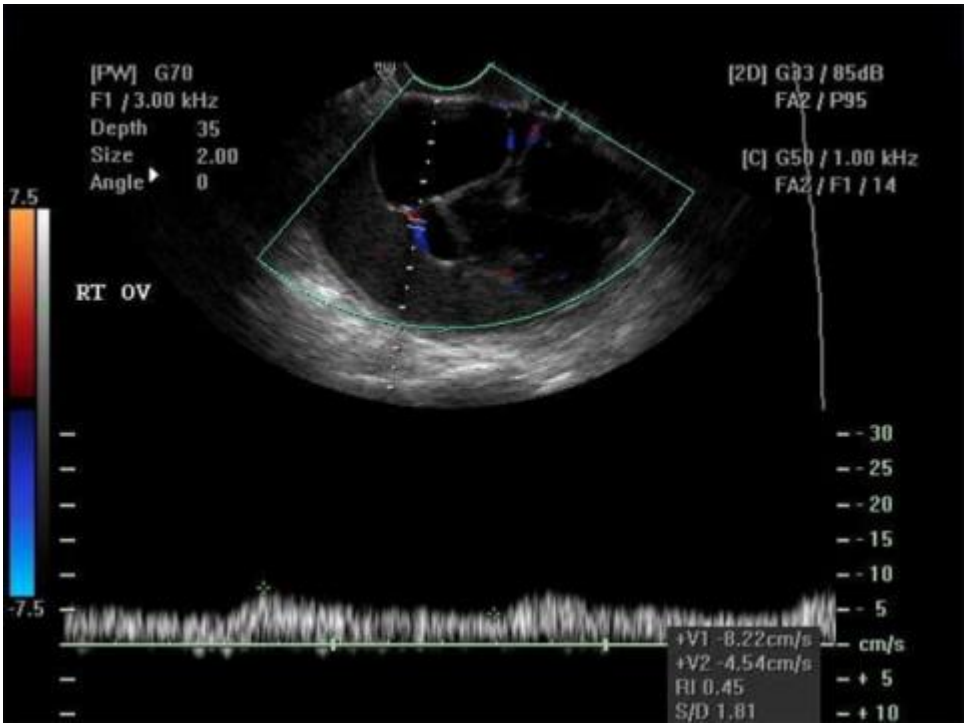

Figure 13 - Vascular flow on a dividing septation in an ovarian malignancy

CONCLUSIONS

Ultrasound is most reliable predicting that an ovarian lesion is benign; it is less accurate in detecting malignancy[44,45]. The data presented indicates that sonographic morphology can provide a significant amount of information concerning the risk of malignancy of an ovarian tumor. The most consistent sonographic signs of malignancy appears to be the presence of papillary excrescences > 3 mm along the internal wall of an ovarian mass[32,46] and the presence of a solid component[21]. From a morphologic standpoint, benign cystic teratomas produce the most false positive diagnoses of malignancy. By excluding benign cystic teratomas from evaluation based upon their distinct morphology, all of the scoring systems that attempt to distinguish benign from malignant ovarian masses are improved[22]. Pattern recognition of the specific criteria outlined above has been shown to be as effective as the multiple scoring systems that have been proposed[15]. The ability of ovarian morphology to distinguish between a benign and malignant ovarian mass ranges between 65% and 94%[17].

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