Role of Combining Colour Doppler and Grey Scale Ultrasound in Characterizing Adnexal Masses

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Abstract

Objective: To evaluate the adnexal masses with conventional gray scale and color Doppler flow imaging and to assess their diagnostic reliability to differentiate benign and malignant adnexal masses.

Materials and methods: We evaluated 30 patients with adnexal mass. Morphological characterization of the mass was done using Sassone score. Color Doppler parameters noted down in each patient and Caruso vascular score was also used. The results were compared with surgical/ pathological and/or follow up scans.

Results: Using sonomorphological score (Sassone) overall reliability of differentiating adnexal masses had sensitivity of 91.7% and specificity of 77.7%. Using Caruso score alone we had sensitivity of 83.3% and specificity of 88.9%. Using Sassone and Caruso score together we had sensitivity of 90.9% and specificity of 93.3%.

Conclusion: In evaluation of adnexal masses combining both sonomorphological and color Doppler scores which gave higher specificity and positive predictive value (PPV) than using individual score alone.

Keywords: Adnexal mass, Sonomorphological, Vascular score, Malignant, Benign

Introduction

The diagnosis of adnexal masses is a common clinical problem. Most adnexal masses are due to benign conditions. Determination of a degree of suspicion for malignancy in an adnexal mass is the most critical step after identification of the mass and has a profound effect on patient survival.

Adnexa consists of fallopian tubes, ovaries, broad ligament and structures within the broad ligament that are developed from the embryonic nests (1).

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The differential diagnosis of adnexal masses varies from functional cysts to benign tumors to malignant tumors of various pelvic organs. Most common cause of adnexal mass is that ovarian origin, so it's important to know normal size of ovary before labeling an mass (Table 1).

Table 1: Normal volume of ovaries in relation to age

Age	Ovarian volume
< 3 months	< 3.6 CC.
4- 12 months	< 2.7 CC.
2nd year	< 1.7 CC.
Menarch	< 8 CC.
Adult menstruating female	As large as 22 CC
Postmenopausal ovary	mean = 1.2 CC- 5.8 CC. (8 CC is the upper limit)

Surgery is often required solely to exclude the possibility of malignancy and about 1/3rd of tumors operated upon for suspected ovarian cancer turn out to be benign (2). So it's important to know the nature of tumor before surgery especially in young and unmarried (3).

An adnexal mass may be benign or malignant; it is the risk of malignancy that propels us for early, accurate and prompt diagnosis to lessen the mortality and morbidity. An adnexal mass often involves ovary because of the propensity of the ovary for the neoplasm, fewer neoplasms occur in the fallopian tube, though it is commonly involved in inflammatory process (1).

The overlap in ultrasonographic features of benign and malignant pelvic masses, however, has led to further research on complementary techniques (4). The increased metabolism demand of neoplastic tissue requires the formation of new tumor vessels. Arteries in malignancies typically are randomly arranged and lack the muscle layer and have increased permeability (Figure 1). Increased vascularity and arteriovenuous shunting is responsible for decreased peripheral blood flow resistance resulting in absent dicrotic notch, increased diastolic flow and increased peak blood velocities as compared to benign lesions (5).

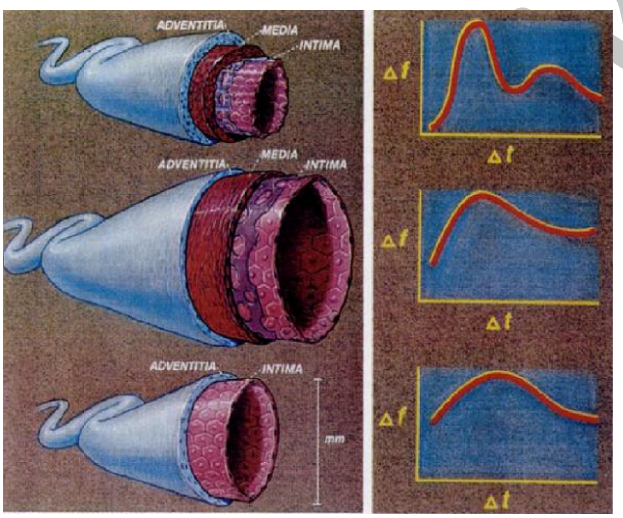

Figure 1. Diagram shows a normal arteriole (top) with muscular media, a vasodilated normal arteriole (middle), and a tumor vessel with paucity of media (bottom) and the shape of typical waveforms from these vessels. The typical waveform from a normal arteriole (top) has high pulsatility (i.e., the difference between systolic and diastolic peaks) and a notch during the diastolic portion of the waveform. The waveform from a tumor vessel (bottom) has relatively low pulsatility and lacks a notch during diastole.[12]

Materials and methods

The ultrasonographic examination was performed during the follicular proliferative phase of the menstrual cycle in premenopausal women. All patients were subjected to sonomorphological evaluation followed by blood flow analysis using color and pulsed spectral Doppler sonography. The examination was performed with Philips Envisor whole body color MC-15601 Doppler machine with multi-frequency transducers. All patients had transabdominal sonography of the pelvis with 2-5 MHz curved transducer and transvaginal examination with wide band 5-7.5 MHz intracavitary transducer. Evaluation was limited to transabdominal sonography of the pelvis in virgins and for large masses which exceed the maximum field of view of the transvaginal transducer. Morphological characterization of the mass was done using Sassone score (Table 2) based upon the visualization of inner wall structure, wall thickness, septae and solid part echogenicity and classified as low and high risk masses. Color Doppler study including blood flow, vessel localization, (Resistivity index) RI, (Pulsatility index) PI, (Peak systolic velocity) PSV and presence and absence of dicrotic notch was be noted down in each patient. The vascular score as described by Caruso et al (Table 3) was also used for further characterization of the mass. Depending upon the gray scale and color Doppler sonography classification of the adnexal mass was done.

The results were compared with surgical/laparoscopic/ FNAC & histopathological findings and/or follow up scan.

Results

On the basis of the morphological score (Sassone) of adnexal mass on gray-scale sonography (Figure 2), 14 of the 18 benign masses were characterized prospectively as suggestive of benignity, and 11 of the 12 malignant masses were characterized as suggestive of malignant. These finding had sensitivity of 91.7%, specificity of 77.7%, PPV of 73.3%, NPV 93.3% and accuracy of 93.3%.

Using vessel localization as Color Doppler sonography criteria, peripheral vessels were seen in 9/18 benign masses and 1/12 malignant mass, peripheral + septal vessels seen in 7/18 benign masses and 1/12 malignant masses. Peripheral + septal + central vessels seen in 5/12malignant masses

Table 2: Criteria used in SASSONE SCORE for sonomorphological characterization (7)

Usg Finiding	1	2	3	4	5
Inner Wall Structure	Smooth	Irregularity <3mm	Papillarities >3mm	Not Applicable, Mostly Solid	-
Septae	No Septa	Thin <3mm	Thick >3mm	-	-
Wall Thickness	Thin <3mm	Thick >3mm	Not Applicable,Mostly Solid	-	-
Echogenicity	Sonolucent	Low Echogenicity	Low Echogenicity With Echogenic Core	Mixed Echogenicity	High Echogenicity

Table 3: Criteria used in CARUSO SCORE for sonomorphological characterization (11)

Criteria		Score
Vessels	Absent	0
	Present	1
Vessels location	Peripheral	0
	Septal	1
	Central	2
Arrangement of vessels	Regular	0
	Random	2
Waveform pattern	Sharp with diastolic notch	0
	Smooth without diastolic notch	2
Lowest ri	>0.43	0
	<0.43	2

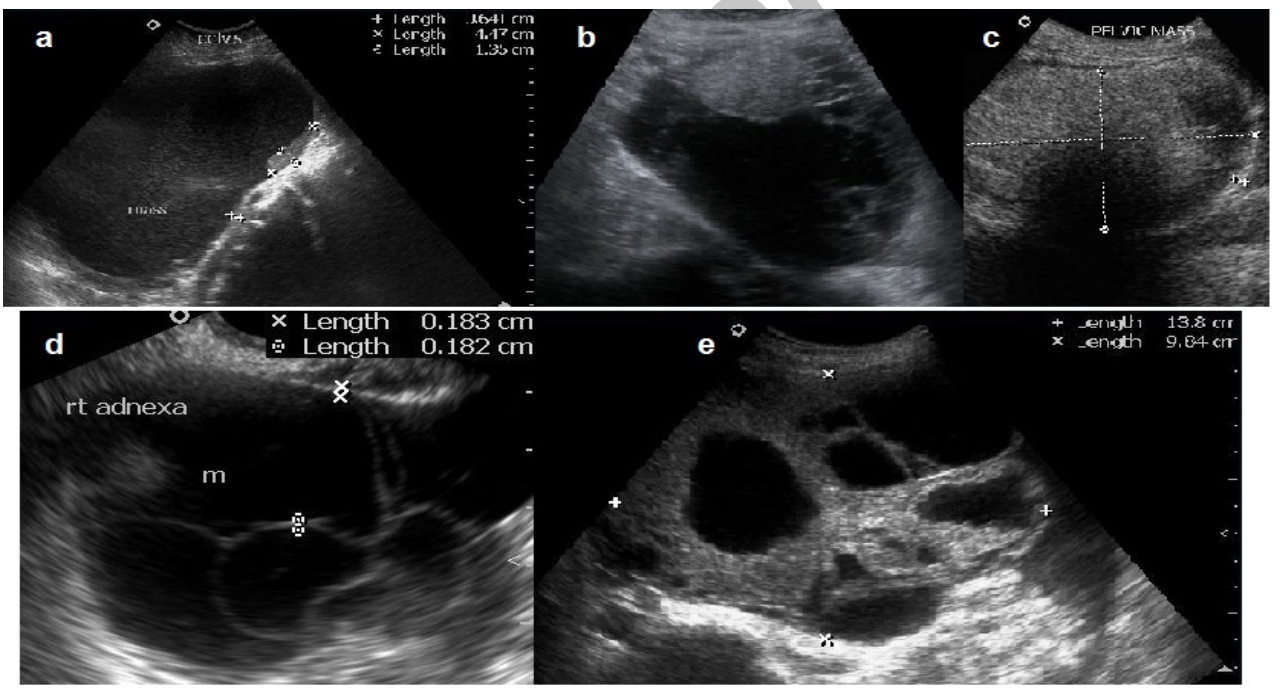

Figure 2. Adnexal mass with cyst with peripheral nodule (a), mixed echogenicity (b) and highly echogenic (c). Different masses showing thin septae (d) and thick septae (e).

and 0/18 benign masses. Peripheral + central seen in 2/18 benign masses and 5/12 malignant masses (Figure 3).

Using spectral indices (RI, PI, PSV AND DICROTIC NOTCH) in for characterization of mass (Figure 4), Low RI (≤0.4) were seen in 5/12 malignant masses and none of the benign mass. High RI (>0.4) seen in 7/12 malignant masses and 18/18 benign masses has sensitivity of 41.7%, specificity of 100%, PPV of 100%, NPV 72% and accuracy of 76.7%. Low PI (≤1) were seen in 9/12malignant masses and 7/18 of the benign mass. High PI (>1)

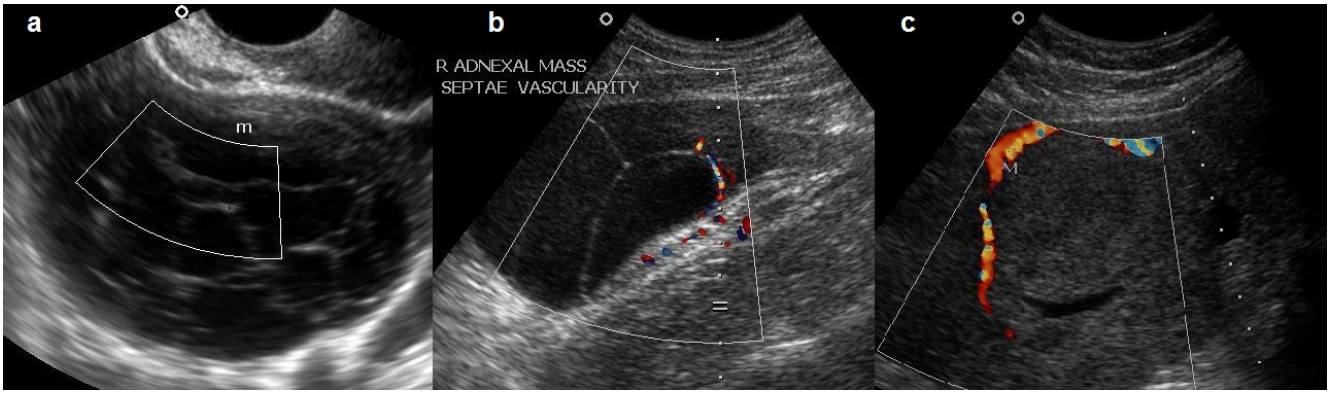

Figure 3: (a) No vascularity in septae of hemorhagic cyst. (b) Vascularity in the thin septa. (c) Random vessel in solid mass.

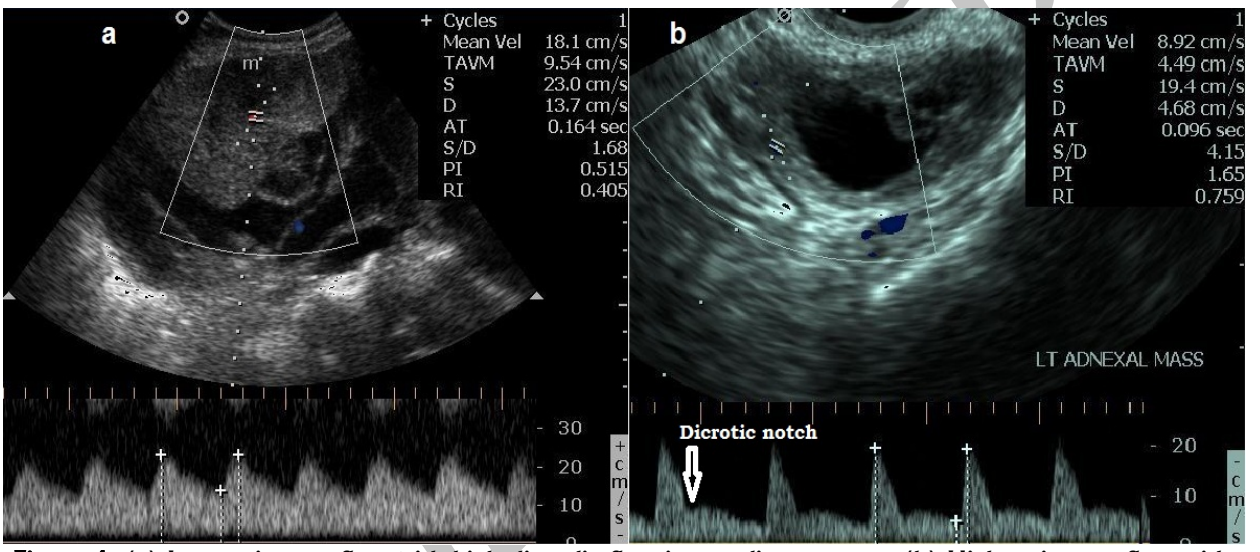

Figure 4: (a) Low resistance flow with high diastolic flow in a malignant mass. (b) High resistance flow with diastolic notch in benign mass.

seen in 3/12 malignant masses and 11/18 benign masses had sensitivity of 75%, specificity of 61.1%, PPV of 56.6%, NPV 78.6% and accuracy of 66.7%. Low PSV (<15cm/sec) were seen in 8/12 malignant masses and 15/18 of the benign mass. High PSV (≥15cm/sec) seen in 4/12 malignant masses and 3/18 benign masses had sensitivity of 33%, specificity of 83.3%, PPV of 57.1%, NPV 65.2% and accuracy of 63.3%. Dicrotic notch seen in 11/18 benign masses and 1/12 malignant mass, absent dicrotic notch seen in 7/18 benign masses and 11/12 malignant masses had sensitivity of 91.7%, specificity of 61.1%, PPV of 61.1%, NPV 91.7% and accuracy of 73.3%.

Where as on the basis of vascular scoring (Caruso) we had 16 of the 18 benign masses were characterized prospectively as suggestive of benignity, and 10 of the 12 malignant masses were characterized as suggestive of malignant and this had sensitivity of 83.3%, specificity of 88.9%, PPV of 83.3%, NPV 88.9% and accuracy of 86.6%.

Using Sassone score alone for sonomorphological characterization of adnexal mass into benign and malignant masses, we had sensitivity of 91.7%,specificity of 77.7%, PPV of 73.3%, NPV 93.3% and accuracy of 93.3%. Using color Doppler score (Caurso) alone for characterization of adnexal mass into benign and malignant masses, we had sensitivity of 83.3%, specificity of 88.9%, PPV of 83.3%, NPV 88.9% and accuracy of 86.6%. While using both score together we had sensitivity of 90.9%, specificity of 93.3%, PPV of 90.9%, NPV 93.3% and accuracy of 92.3%. 4 cases were having indeterminate combined score (sonomorphological and color Doppler) out of which 3 were benign and one turned out to be malignant adnexal mass. 4 cases benign on both sonomorphological and color Doppler scoring were

rescanned after 2-3 menstrual cycles and they either regressed completely or showed significant decrease in size and were labeled as benign. Out of 4 of the cases having indeterminate features on combined US/CD scoring, 1 turned out to be malignant (malignant surface epithelial tumor), and 3 were benign (1 endometrioma, 1 dermoid and 1 follicular cyst).

Increased vascularity was seen in 91.7% of malignant masses. Among the vessel arrangement, 66.7% of malignant masses had random vessel arrangement. Among vessel localization septal and central vascularity is considered as predictor of malignancy in an adnexal mass, 91.7% of malignant adnexal masses had either septal flow or septal and central flow. Using both Sassone and Caruso score together we had sensitivity of 90.9%, specificity of 93.3%, PPV of 90.9%, NPV 93.3% and accuracy of 92.3%. 4 cases had indeterminate combined score out of which 3 were benign and one proved to be malignant.

Discussion

As with cervical and endometrial cancer the prognosis of ovarian cancer remains poor, with a 45% 5-year survival rate. However mortality rates differ depending on age and the stage at which tumor is detected. Currently, the most used methods for discriminating between malignant and benign adnexal masses are physical examination, serum tumor markers, and gray scale and color Doppler ultrasonography (6).

In the past using ultrasound for characterizing adnexal masses has been limited due to lack of explicit criteria for evaluation (7). Although gray-scale sonography is sensitive in detecting ovarian carcinoma, its reliability has not been sufficient to obviate more invasive procedures, such as laparoscopy and laparotomy. Color Doppler imaging and spectral Doppler imaging have been investigated as possible means of improving the specificity of gray-scale sonography in differentiating benign from malignant masses (8).

Low velocity, high impedance waveforms are usually noted in early part of menstrual cycle (follicular phase). Luteal phase coincides with the extrusion of the mature egg and formation of corpus luteal cyst, which demonstrates a ring of vascularity (ring of fire) with marked increase in PSV and EDV, which relates to the neovascularisation (9). Similarly in cases of malignancy there is neovascularisation which leads to low RI, PI and high PSVs.

It would seem reasonable that the combined and simultaneous use of several different parameters, all of them independent predictors of malignancy, would offer better diagnostic performance than a single technique (10). Our results confirm that notion which is better than considering the individual score (Table 4).

Table4: Results

Criterion	Sonomorphology	Color doppler	Combined sonomorpholgy and color doppler
Sensitivity (%)	91.7	83.3	90.9
Specificity (%)	77.7	88.9	93.3
Ppv (%)	73.3	83.3	90.9
Npv (%)	93.3	88.9	93.3
Accuracy (%)	93.3	86.6	92.3

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