Ultrasound Obstet. Gynecol. 1 (1991) 275–278

Transvaginal color Doppler sonography of ovarian masses with pathological correlation

A. C. Fleischer[*†], *W. H. Rogers*[‡], *B. K. Rao*[*], *D. M. Kepple*[*] *and H. W. Jones*[†]

*Section of Diagnostic Sonography, Department of Radiology and Radiological Sciences, †Department of Obstetrics and Gynecology, and ‡Department of Pathology, Vanderbilt University Medical Center, Nashville, Tennessee, USA

Key words: COLOR DOPPLER SONOGRAPHY, TRANSVAGINAL SONOGRAPHY, OVARIAN MASSES

ABSTRACT

This report describes the correlation of pathological findings with transvaginal color Doppler sonography performed preoperatively on 26 ovarian masses. The pulsatility indices of benign lesions (1.9 ± 0.7) were higher than those of malignant ones (0.7 ± 0.2) (p = 0.03). Low pulsatility indices (< 1.0) were found in three relatively vascular benign lesions (one immature teratoma, one cystadenoma containing a dermoid cyst, one endometrioma), causing an overlap between the pulsatility indices of some benign and malignant masses. There appears to be significant potential for discrimination between benign and malignant ovarian masses with transvaginal color Doppler sonography.

INTRODUCTION

Color Doppler sonography affords depiction of blood flow within and around the uterus and ovaries[1–3]. By color encoding of frequency and phase shifts between the incident and returned beams from a moving target, the direction and relative velocity of blood flow can be determined. This technology has only recently been incorporated into a transvaginal probe capable of depicting the blood flow to the uterus and ovaries.

It is the purpose of this study to evaluate the waveforms obtained from benign and malignant ovarian masses using transvaginal color Doppler sonography. The findings on transvaginal color Doppler sonography were correlated with the pathological specimen, with particular attention paid to areas of neovascularity and tumor growth.

METHOD

Patients were referred for transvaginal color Doppler sonography after a pelvic mass was identified on conventional transvaginal sonography. The age range of the patients was 19–82 years of age with a mean of 56 years; 19 of the patients were postmenopausal. Of the seven patients who had normal cycles, four were examined in the follicular phase, three in the luteal phase. Patients signed an informed consent form as approved through the Institutional Review Board.

Examinations were performed using a prototype 5 MHz curvilinear transvaginal probe attached to a Toshiba 270 scanner (Toshiba American Ultrasound, Tustin, CA). The stated intensity for simultaneous use of color and pulsed Doppler modes at 100% output was 72 mW/cm^2 spatial peak temporal average. After the frequency envelope of the waveform was traced manually, the pulsatility index (PI) was calculated automatically using the formula:

$$PI = \frac{\text{systolic peak} - \text{maximum end-diastolic velocity}}{\text{mean maximum velocity}}$$

The adnexal and ovarian vessels were examined and pulsatility indices calculated for each vessel in proximity to the mass. In order to correlate them with the pathological grading, the lowest pulsatility index was taken to be representative of the mass, and vessels closest to the center of the mass were examined carefully for areas of increased diastolic flow. Note was also made of the location of the venous return (central or peripheral). A preoperative diagnosis of benign versus malignant was made based on the gross morphology (presence of papillary excrescences, irregular wall or ascites) depicted on conventional transvaginal sonography[4].

The masses examined were removed surgically 1–2 days after the transvaginal color Doppler sonographic examination. A search was made for areas of abnormal vascularity within tumor both macroscopically and microscopically. Attempts were made to examine areas for neovascularity suggested on transvaginal color Doppler sonography. The size and relative number of vessels as evident on the stained slide were noted.

Correspondence: Dr A. C. Fleischer, Dept. of Radiology and Radiological Sciences, Vanderbilt University Medical Center, Nashville, Tennessee 37232-2675, USA

Received 13–9–90
Accepted 15–5–91

RESULTS

Table 1 lists the range of sizes, whether or not malignancy was suspected on transvaginal sonographic morphology and the range and average of pulsatility indices of the various ovarian masses examined. In general, the average pulsatility index of benign ovarian masses (1.9 ± 0.7) was statistically different from malignant or borderline malignant masses (0.7 ± 0.2) ($p = 0.03$). However, there was an overlap in the ranges of the benign and malignant lesions (Table 2). Low (< 1.0) pulsatility indices were found in three relatively vascular benign tumors (one immature teratoma, one cystadenoma containing a dermoid cyst within its wall, one endometrioma). Two masses that were thought to be benign on transvaginal sonography had low pulsatility indices but were proven malignant (one cystadenoma, one germ cell tumor) (Figures 1 and 2). Since the dysgerminoma produced

Table 1 Size and pulsatility indices

Type	*n*	*Size range* (cm)	*Number having sonographic features of malignancy*	*Number malignant*	*Pulsatility index*	
					Range	*Average*
Cystadenoma*	5	10–20	0	1	0.6–2.6	1.9
Hemorrhagic corpus luteum cyst	4	2–9	1	0	1.0–2.4	1.9
Endometrioma	4	5–8	1	0	0.7–4.0	1.7
Dermoid cyst	4	4–6	1	0	2.0–4.0	3.0
Cystadenocarcinoma†	2	12–20	2	2	0.5–0.9	0.7
Torsed ovary	2	4–5	0	0	0	0
Ovarian abscess	2	4–5	0	0	1.0–1.6	1.3
Immature teratoma	1	20	1	0		0.5
Sertoli-Leydig cell tumor	1	20	1	1		0.5
Dysgerminoma†	1	20	1	1		0.4

*Stage I (borderline malignancy); †Stage II (invasive)

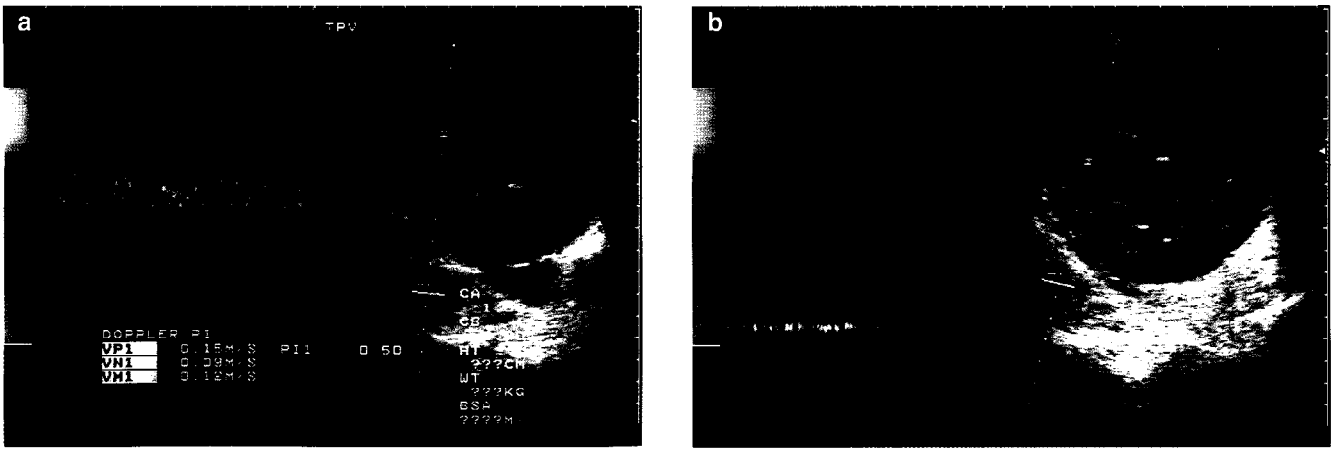

Figure 1 A well-differentiated mucinous cystadenocarcinoma. A transvaginal color Doppler sonogram (a) of a septated cystic mass showing low pulsatility index within a solid area. Same mass (b) showing a central venous plexus

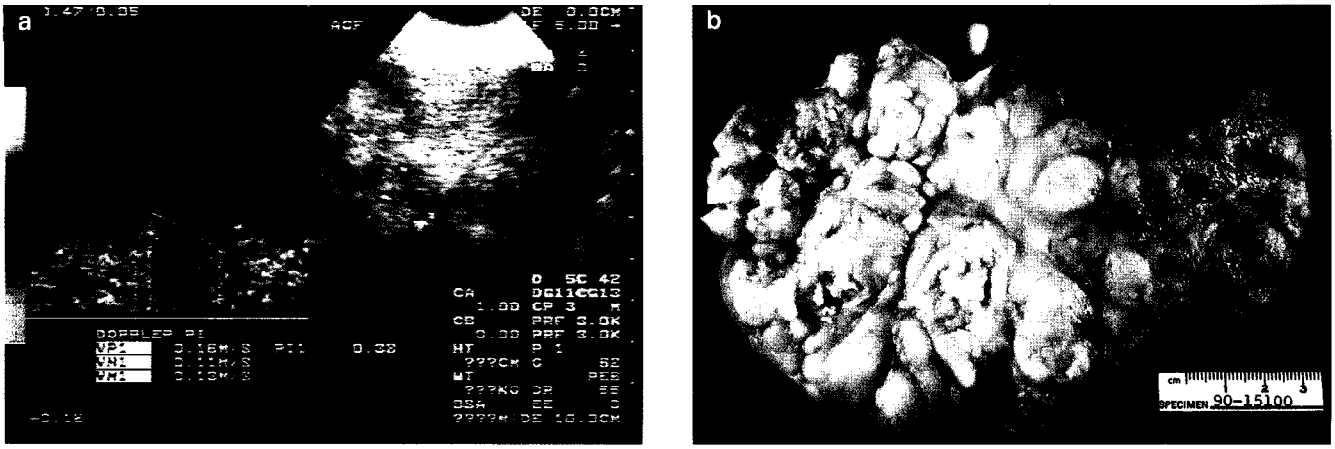

Figure 2 Dysgerminoma with capsular invasion. Transvaginal color Doppler sonogram (a) of a solid mass with low pulsatility indices. β-hCG and lactate dehydrogenase serum levels were elevated. Sectioned specimen (b) showing vessels and an area of capsular invasion

β-human chorionic gonadotropin (β-hCG) and the Sertoli-Leydig tumor was associated with amenorrhea, they were considered endocrinologically active. Four lesions demonstrated central venous flow: one endometrioma with extensive peripheral vascularity, one immature teratoma (Figure 3), one cystadenocarcinoma (Figure 1b), and one Sertoli-Leydig cell tumor (Figure 4). Two benign lesions, a dermoid and a cystadenoma, showed no detectable flow. A 4-cm diverticular abscess with a pulsatility index of 0.4 was misdiagnosed as an ovarian lesion in one elderly patient. One large (20 cm) septated mass had low pulsatility indices (0.7) but at pathological examination was found to represent a serous cystadenoma with mucinous elements containing a dermoid cyst within its wall.

The sensitivity of transvaginal color Doppler sonography for benign masses was 90%, specificity 83%, accuracy 92%, positive predictive value 95%, and negative predictive value 71%. For malignant masses, the sensitivity was 100%, specificity 83%, accuracy 100%, positive predictive value 73%, and negative predictive value 100%.

DISCUSSION

Recent reports have investigated the role of transvaginal color Doppler sonography as a means of differentiating between benign and malignant ovarian masses[1-3].

Table 2 Pulsatility indices of benign vs. malignant ovarian masses

	n	*Mean ± SD*	*Range*
Benign	21	1.9 ± 0.7	0.6–2.8
Malignant	5	0.7 ± 0.2	0.3–1.0

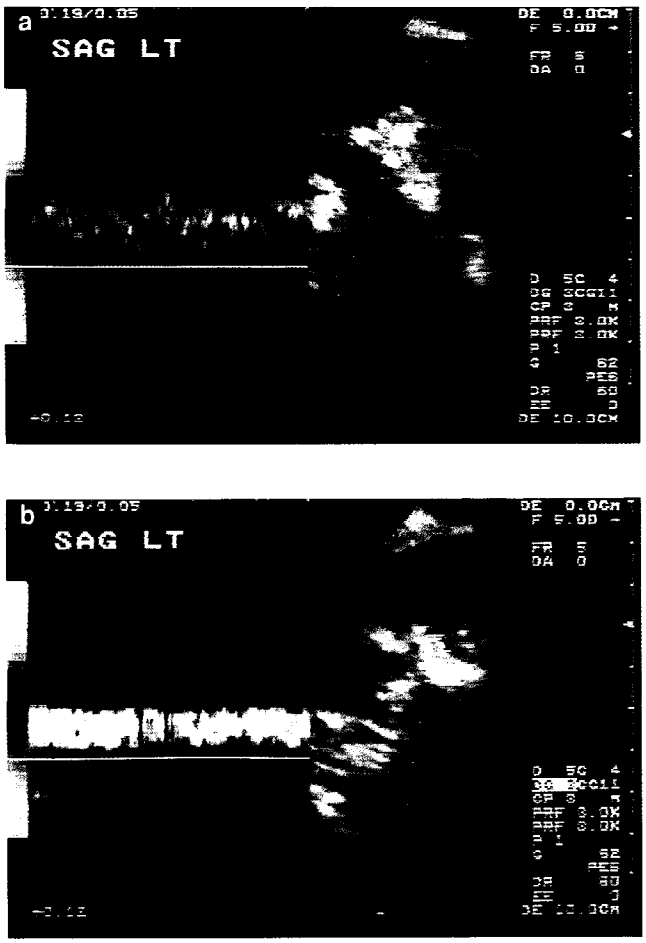

Figure 3 Immature teratoma. Transvaginal color Doppler sonogram (a,b) showing abnormal arterial (a) and venous (b) flow within solid portion of this complex mass. Sectioned specimen (c) showing solid area and papillary projections

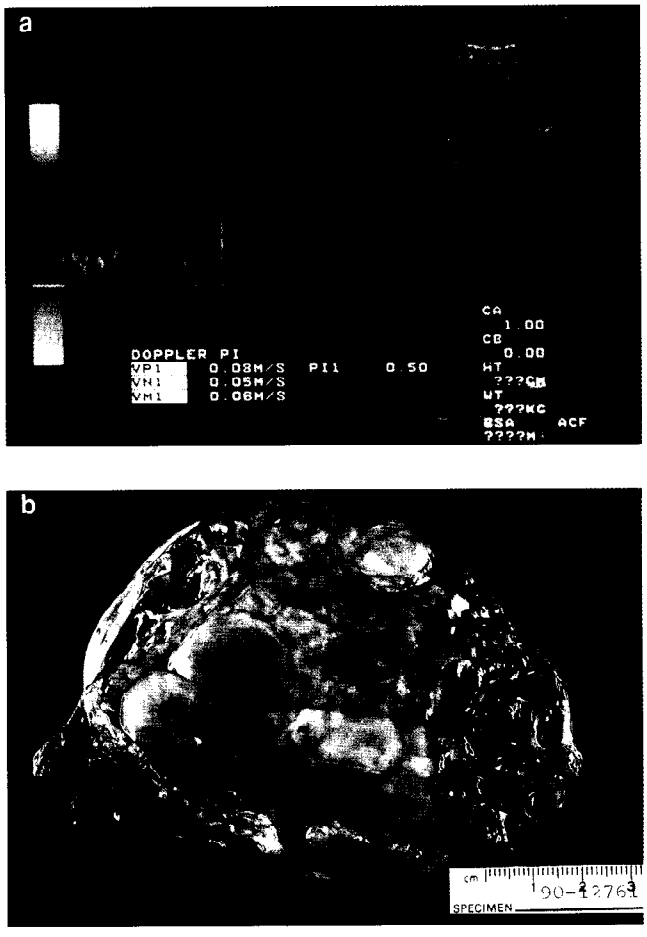

Figure 4 Sertoli-Leydig cell tumor. Transvaginal color Doppler sonogram (a) of a complex, septated mass in an amenorrheic virilized teenager. Sectioned specimen (b) of Sertoli-Leydig tumor showing solid area which contained tumor-like vessels

Although the number of proven ovarian malignancies in each of these studies is small, there seems to be a difference in the pulsatility and resistance indices in benign versus malignant masses. Additional studies will be needed to assess the actual sensitivity and specificity of these indices as well as reasons for any overlap. The two cases of ovarian torsion detected by transvaginal color Doppler sonography also demonstrate the potential for definitive diagnosis of this condition.

Detection of malignancy by transvaginal color Doppler sonography is based on recognition of arterial flow, which has an abnormally high amount during diastole. This abnormal diastolic flow is thought to be the result of a relative paucity of the muscular coating in tumor neovascular vessels, allowing for increased diastolic flow combined with arteriovenous shunting that occurs in larger (over 5-cm) tumors[5].

As our results indicate, there seems to be a difference in the pulsatility index in benign versus malignant ovarian masses. The five ovarian malignancies in this series demonstrated very low (less than 1.0) pulsatility indices. It is felt that this technique is of particular help in distinguishing benign from malignant ovarian masses that have features on transvaginal sonography that suggest malignancy, such as irregular walls or echogenic internal material.

Problems with this determination with transvaginal color Doppler sonography, however, are exemplified by the overlap in the pulsatility index between some relatively vascular tumors such as the immature teratoma, the cystadenoma containing a dermoid cyst, and an endometrioma and those masses that were truly malignant. Other problems with transvaginal color Doppler sonography include a lack of uniformity of the pulsatility indices in different areas of the tumor and some inflammatory processes that may be associated with increased diastolic flow. Clearly, our experience indicates that areas of lowest pulsatility index corresponded to areas of histological abnormality. This was exemplified by a case of a cystadenoma whose borderline malignant components were identified by abnormal vascularity shown by transvaginal color Doppler sonography. The lowest pulsatility indices in our series were demonstrated in a dysgerminoma that had invaded the ovarian capsule and a Sertoli-Leydig tumor that was associated with amenorrhea, both of which could be considered endocrinologically active.

In summary, our results indicate that there is significant potential for distinguishing between benign and malignant ovarian tumors using transvaginal color Doppler sonography. From this initial experience, it seems that the main use of transvaginal color Doppler sonography is in identification of malignant ovarian tissue in those masses that do not demonstrate definitive morphological features of malignancy. Conversely, transvaginal color Doppler sonography can be used to confirm benignancy in a sonographically complex mass.

REFERENCES

1. Bourne, T., Campbell, S., Steer, C., Whitehead, M. I. and Collins, W. P. (1989). Transvaginal colour flow imaging: a possible new screening technique for ovarian cancer. *Br. Med. J.*, **299**, 1367
2. Kurjak, A., Zalud, I., Jurkovic, D., Alfirevic, A. and Miljan, M. (1989). Transvaginal color Doppler for the assessment of pelvic circulation. *Acta Obstet. Gynecol. Scand.*, **68**, 131
3. Fleischer, A. C., Kepple, D. M. and Rao, B. K (1990). Transvaginal color Doppler sonography: preliminary experience. *Dynamic Cardiovascular Imaging*, **3**, 52
4. Fleischer, A. C., Gordon, A. N. and Entman, S. S. (1989). Transabdominal and transvaginal sonography of pelvic masses. *Ultrasound Med. Biol.*, **15**, 529
5. Folkman, J., Watson, K., Ingber, D. and Hanahan, D. (1989). Induction of angiogenesis during the transition from hyperplasia to neoplasia. *Nature (London)*, **339**, 58