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Doppler Index for Prediction of Benign and Malignant Ovarian Tumour

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ABSTRACT

Objective To determine the sensitivity and specificity of pulsatility index (PI) and resistance index (RI) by colour Doppler ultrasound for prediction of benign and malignant ovarian tumour.

Design Cross sectional descriptive analysis.

Methods A total of 181 non-pregnant women scheduled for elective surgery due to ovarian tumour at Chiang Mai University Hospital between February 1995 and October 1996 were recruited to the study. All underwent colour Doppler ultrasound to determine the PI and RI by the same examiner on the day before operation. Nine were excluded because of pathological diagnosis of non-ovarian tumour. The remaining 172 women were analyzed.

Results The appropriate cut-off point value for PI and RI were 1.0 and 0.5, giving the sensitivity of 93.5% and 80.4% and the specificity of 91.3% and 93.7% respectively.

Conclusion PI and RI by colour Doppler ultrasound have high sensitivity and specificity and may be a useful clinical tool in the preoperative evaluation of ovarian masses.

Key words : colour Doppler ultrasound, malignant ovarian tumour

Differentiation of benign from malignant adnexal masses represents one of the most challenging problems in gynaecologic practice. Several diagnostic methods have been introduced to this purpose such as serum CA 125 tumour marker. Ultrasound was admitted in clinical use since late 1970's and several attempts have been made in order to objectively define the sonographic criteria predicting malignancy and benignity.[1,2]

Colour Doppler ultrasound has been proposed as a possible new technique for early diagnosis of ovarian carcinoma for several years.[3,4] Some reports showed the superiority of this technique in screening ovarian cancer,[5,6] others reported the ability in differentiating benign from malignant tumours preoperatively.[7-9] However, more data are needed, especially for

Thai populations which may be different in pathophysiology of the tumours, in order to actually define the benefits and limitations of this interesting acquisition.

The purpose of the present study was to determine the sensitivity and specificity of pulsatility index(PI) and resistance index(RI) for prediction of benign and malignant ovarian tumour.

Materials and Methods

Between February 1995 and October 1996, 181 patients were admitted at Chiang Mai University Hospital for surgery because of the detection of an adnexal mass either by pelvic examination or ultrasonography elsewhere or both.

All sonographic examinations were performed on the day before surgery by the same examiner who had no clinical information of the patients. The women were examined with either real time sector 5 MHz transvaginal probe or 3.5 MHz transabdominal probe connected to an Aloka model SSD 680 EX. After thorough conventional examination, colour Doppler blood flow analysis was performed.

Conventional ultrasound parameters for defining the nature of the masses were those proposed by Sassone et al.[2] On the colour Doppler ultrasonogram, the sampling point on the line of the pulsed Doppler beam was positioned where the coloured dots within the tumour revealed the presence of vessels and these positions were followed those proposed by Kurjak et al.[10] When no blood flow was detectable within the tumour, a signal was recorded by the adnexal branch of the ovarian artery or uterine artery.

Both pulsatility index (PI) and resistance index (RI) were calculated. The value of each artery was calculated from a curve fitted to the average waveform over three cardiac cycles.

The formulas used for PI and RI were PI = (S-D)/mean and RI = (S-D)/S respectively, when S is the peak Doppler frequency shift and D is the minimum. Signals from various areas within the tumour were determined but the lowest PI and RI were considered for data analysis.

In the present study, after surgery the histopathological diagnoses were recorded and grouped into benign and malignant (which included borderline malignancy) for data analysis.

The sensitivity and specificity of various cut-off levels of PI and RI were calculated and the proper PI and RI for differentiating the tumours were determined by receiver operator characteristic curve (ROC curve).

Results

Between February 1995 and October 1996, 181 patients initially diagnosed as ovarian tumours were recruited to undergo colour Doppler ultrasound examinations. Nine were excluded because of pathological diagnoses of non-ovarian tumour including subserous myoma, hydrosalpinx, etc. The remaining 172 cases were analyzed.

Histopathological examinations revealed 126 benign tumours, 10 borderline and 36 malignant tumours. Table 1 summarizes the types of ovarian tumours in this study.

Blood flow velocity waveforms within the tumour were detected in all cases of the malignant group and in 76 of 126 cases of the benign one. In the remaining 50 patients, blood flow was detected only in either the ovarian artery or adnexal branch of the uterine artery. The sites of detected vessels are summarized in Table 2.

The mean PI value of tumour arteries was 1.710 (SD = 0.684) in benign and 0.662 (SD = 0.193) in malignant tumours. When malignant and

Table 1. Histopathological diagnoses of the ovarian tumours

	Histopathologic diagnosis	number
Malignant	Serous cystadenocarcinoma	12
	Endometrioid carcinoma	11
	Mucinous cystadenocarcinoma	6
	Endodermal sinus tumour	1
	Mixed germ cell carcinoma	1
	Immature teratoma	1
	Metastatic carcinoma	4
Borderline	Mucinous	8
	Serous	2
Benign	Endometrioma	35
	Mature teratoma	29
	Mucinous cystadenoma	27
	Serous cystadenoma	10
	Follicular cyst	8
	Corpus luteal cyst	7
	Adenofibroma	3
	Tuboovarian abscess	2
	Parovarian cyst	1
	Thecofibroma	1
	Struma ovarii	1
	Sclerosing stromal tumour	1
	Brenner tumour	1
	Total	172

Table 2. Sites of artery and histopathologic reports

Sites of artery	no.	benign (%)	borderline (%)	malignant (%)
centre	28	9 (32.1)	3 (10.7)	16 (57.1)
periphery	16	9 (56.3)	0	7 (43.7)
in the septum	34	29 (85.3)	2 (5.9)	3 (8.8)
in papillae	37	27 (72.9)	2 (5.5)	8 (21.6)
pericystic	7	2 (28.6)	3 (42.8)	2 (28.6)
adnexal branch of uterine or ovarian artery	50	50 (100.0)	0	0
Total	172	126	10	36

Table 3. Sensitivity and specificity of pulsatility index (PI)

Pulsatility index	0.5	0.6	0.7	0.8	0.9	1.0	1.5
Sensitivity	17.4	37.0	45.7	65.2	82.6	93.5	97.8
Specificity	99.2	97.6	94.4	92.1	91.3	91.3	58.7

Table 4. Sensitivity and specificity of resistance index (RI)

Resistance index	0.3	0.4	0.5	0.6	0.7
Sensitivity	8.7	50.0	80.4	95.7	100.0
Specificity	100.0	97.6	93.7	88.9	67.5

borderline tumours were considered together, their mean PI was 0.713 (SD = 0.229).

The mean RI values were 0.755 (SD = 0.149) and 0.380 (SD = 0.072) for benign and malignant tumours respectively. The mean RI was 0.415 (SD = 0.096) if malignant and borderline tumours were considered together.

At various cut-off levels of PI and RI when combined malignant and borderline in the same group, the sensitivity and specificity are presented in Table 3 and 4 respectively.

Sensitivity and false positive rate (1-specificity) in detecting risk of malignancy at various cut-off points were calculated. Receiver operating characteristic (ROC) curve for both pulsatility index (PI) and resistance index (RI) were constructed as shown in Figure 1. Based on the ROC curve, PI of 1.0 and RI of 0.5 were the

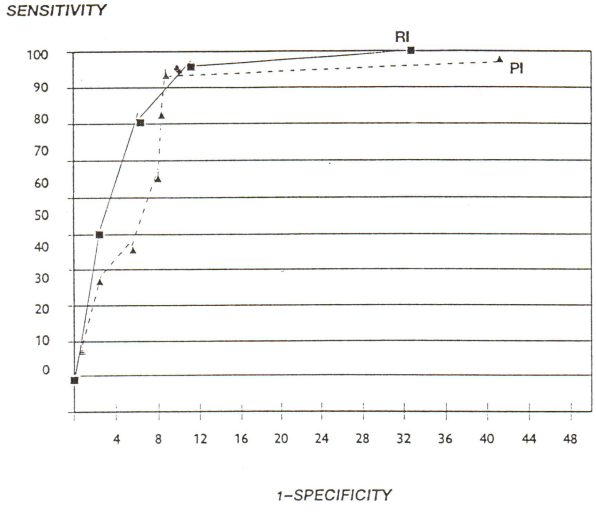

Fig. 1. Receiver operating characteristic curve of PI and RI.

most appropriate cut-off points for detecting malignant ovarian tumour, giving sensitivity of 93.5%, 80.4% and specificity of 91.3%, 93.7% respectively.

Discussion

Differentiation of benign from malignant tumours might be achieved by several methods such as clinical signs and symptoms,[11,12] serum CA 125,[13] sonography.[1,2] Conventional ultrasound parameters for the differentiation of malignant from benign tumours are based merely on morphological features. The introduction of colour Doppler ultrasound might allow a step forward from morphological to functional evaluation of the masses. The theoretical background comes from the observation that the new tumour vessels that grew as a result of angiogenesis differ from the normal vessels with respect to cellular composition, basement membrane structure and permeability. As a result, the haemodynamics of these vessels are changed.[4]

Considering angiogenesis as a neoplastic marker for malignancy, colour Doppler ultrasound allowing a better insight in the biological behavior of the tumour, the early diagnosis of cancer could become possible by detecting neovascularization in the tumour.[3-9,15]

In previous studies, some authors suggested the existence of clear cut-off points of PI and RI of benign and malignant tumours ; Kurjak et al[6] reported only one false positive and two false negative results in a screening programme involving 624 benign ovarian tumours and 56 malignant tumours by using a cut-off value of RI 0.4. Sengoku et al[16] reported sensitivity and specificity of 81.3% and 91.7% respectively when the cut-off value of PI 1.5 were used. Timor-Tritsch et al[17] reported the RI value of 0.4 had sensitivity 93.8% and specificity 98.7% which was different from the study of Zanetta et al[15] (RI 0.56).

In this study 60% of benign and 100% of malignant including borderline tumours had detectable arterial blood flow in the tumours using a colour Doppler unit. This information may enable us to conclude that tumour without detectable blood flow is very unlikely to be malignant. Our cut-off PI value of 1.0, giving the sensitivity and specificity of 93.5% and 91.3% respectively, was different from the study of Sengoku et al[16] but was consistent with the data reported by Weiner et al.[9] Considering RI value of 0.5 as the cut-off point, the sensitivity and specificity were 80.4% and 93.7% respectively, slightly different from the studies of Timor-Tritsch et al[17] and Zanetta et al[15] in which RI value were 0.4 and 0.56 respectively.

The scanning approach (transabdominal or transvaginal) and frequency of the probes might partially explain inconsistent results reported previously by different authors.[15] In this study, we firstly used transabdominal probe, if the vessel signal was unable to be visualized or the tumours confined in the deep pelvis, the transvaginal probe were performed.

Although there are different opinions about cut-off values, all authors agree that recognition of angiogenesis as a reference point for malignant changes within the ovary has proved to be a highly sensitive parameter. Given that neovascularization is an obligate event in malignant change, this recognition may enable us to observe the earliest stages in ovarian oncogenesis.

The bias in this study might have existed. This was due to the fact that Doppler evaluation of the tumour was not a blind method as the examiner had known the morphology of the tumour from conventional sonographic images. Therefore, the nature of the mass could have

been anticipated. Consequently, the signs of neovascularization in tumours considered benign by conventional ultrasound might be missed by insufficient evaluation of the vascularity, whereas the tumours with suspicion of malignancy would be examined more thoroughly until the expected lowest PI and RI were found. However, we tried to examine all arterial signals to find out the lowest ones in each case to reduce the bias described.

In the future, research should be directed to compare colour Doppler ultrasound with conventional sonographic findings and other screening methods for detecting ovarian malignancy. Because of low incidence of ovarian cancer, one can initiate this ovarian malignancy screening programme in high-risk population so that the efficacy of this method can be evaluated.

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