Color Flow and Doppler Velocimetry Indices in Benign and Malignant Pelvic Tumors

Shipra Kunwar, K. Saxena, M. L. Bhatt, Tamkin Khan

Departments of Obstetrics & Gynaecology and Radiodiagnosis, J. N. Medical College, A.M.U., Aligarh – 202 002

Summary

This prospective study was undertaken to evaluate the utility of color flow mapping (CFM) and Doppler studies in differentiating between benign and malignant pelvic tumors. A total of 60 patients with pelvic tumors (ovarian, 30; uterine, 22; cervical, 4; choriocarcinoma, 4) were evaluated with color flow for neovascularization and Doppler for resistane index (R1) and pulsatility index (P1). The results were correlated with histology and cytology. Neovascularization was present in 75% of malignant and 11.1% of benign ovarian tumors and in all the cases of endometrial carcinoma, cervical carcinoma and choriocarcinoma. The sensitivity, specificity, positive and negative predictive value for malignant tumors were 88%, 80%, 75.8 and 92.3% respectively. Velocity indices R1 and P1 were significantly lower in malignant tumors. It was concluded that CFM and Doppler velocity indices can help distinguish between benign and malignant pelvic tumors.

Introduction

Color flow mapping and pulsed Doppler flow velocimetry are emerging as a useful diagnostic technique in differentiating benign and of malignant pelvic tumors. Morphological scoring system with transabominal and transvaginal sconography has high sensitivity but the specificity and positive predictive values are low (Weiner et al, 1992). Since all the malignant tumors have significant neovascularization, its demonstration by color flow and aetired velocity indices by pulsed Doppler may increase the diagnostic accuracy. A few studies in malignant ovarian tumors (Hata et al, 1992; Kurjak et al, 1993; Timor and Lerner, 1993), endometrial malignancy (Bourne et al, 1991), cervical malignancy and choriocarcinoma (Shekhar, 1999) have reported higher specificity and positive predictive value with color Doppler studies in comparison to conventional sonography. The present study was undertaken to evaluate the role of color flow imaging and pulsed Doppler waveform indices in differentiating malignant and benign pelvic tumors.

Material & Methods

The present study included admitted patients of pelvic tumors. A total of 60 patients presenting with ovarian, uterine, cervical malignancy and choriocarcinoma were evaluated with thorough history and physical examination.

Besides routine investigations all the patients were subjected to gray scale ultrasonography, Doppler evaluation and color flow studies by color Doppler unit with 3.5 mH3 transducer, color flow imaging was used to identify arterial flow within the mass and pulsed Doppler parameters were optimized for detection of low Doppler signals and shifts. Areas of neovascularization were identified in tumor mass. The following velocity indices were measured.

$$\text{Resistance Index} = \frac{\text{Peak systolic velocity} - \text{End diastolic velocity}}{\text{Peak systolic velocity}}$$

$$\text{Pulsatility Index} = \frac{\text{Peak systolic velocity} - \text{End diastolic velocity}}{\text{Mean velocity}}$$

All the patients underwent surgical procedure of either laparotomy or biopsy and findings were confirmed on histology or cytology.

Results

The present study included 60 patients of pelvic tumors. The mean age was 38.6 years (32-55 yrs). The distribution of cases is shown in Table – I. The presence of neovascularization in pelvic tumors is shown in Table – II. It was present in 75% of malignant and 11.1% of benign ovarian tumors. All the 5 cases of endometrial carcinoma showed neovascularization while fibroid and endometrial hyperplasia showed neovascularization in 33.3% and 20% cases respectively. It was present in all 4 cases of cervical carcinoma and choriocarcinoma. Pulsed Doppler waveform velocity indices are shown in Table III. Mean RI in malignant ovarian tumor was 0.44 as compared to 0.67 in benign tumors, in uterine pathology lowest RI of 0.60 was observed in endometrial carcinoma while RI of 0.71 in fibroid and 1.16 in endometrial hyperplasia were noted. The RI in cervical malignancy and choriocarcinoma were 0.74 and 0.57 respectively.

Table – I
Distribution of benign and malignant tumors.

Pathlogy	No.	Benign	Malignant
Ovarian	30	18	12
Uterine	22	17	5
Cervical	4	0	4
Choriocarcinoma	4	0	4

Mean PI was 0.7 in malignant and 1.2 in benign ovarian tumors. Lowest PI of 0.91 was noted in endometrial carcinoma. Mean PI in cervical carcinoma and choriocarcinoma were 1.01 respectively.

Discussion

Color flow mapping and pulsed Doppler indices are new diagnostic tools in the diagnosis of benign and malignant tumors.

Color flow imaging seeks to detect blood flow in small vessels that form in neoplastic tissue termed as neovascularization. In our study neovascularization was significantly higher in malignant tumors. The sensitivity and specificity for malignant tumors were 88% and 80% respectively and specificity further increased to 86.9% when cases of fibroid were excluded. The diagnostic accuracy was high with a positive predictive value of 75.8% and negative predictive value of 90.32%. Our observations are comparable to those of Kurjak et al (1993) and Kumar et al (1999).

Doppler velocity indices including resistance index and pulsatility index were significantly lower in malignant tumors in comparison to benign ovarian tumors. Weiner et al (1992) and Carter et al (1994) have also reported lower resistance and pulsatility indices and high peak systolic velocity. Angiogenesis is an obligatory early event in tumourogenesis. Since these are abnormal vessels formed at a rapid pace, they lack muscular layer leading to a significantly low flow impedance, therefore, a low RI and PI and high PSV is recorded. Since fibroids have high vascularity at the periphery RI in fibroids ranged from 0.3 to 0.84 (mean 0.61). Rajan (1999) also showed low RI (mean 0.410) in fibroids. Therefore, fibroids although benign may show decreased RI Endometrial hyperplasia however could

Table – II
Neovascularization in benign and malignant pelvic tumors.

Pathology	No	Present	Absent	% cases with Neovascularization
Ovarian				
Benign	18	2	16	11.1
Malignant	12	9	3	75.0
Uterine				
Fibroid	12	4	8	33.3
Endometrial hyperplasia	5	1	4	20.0
Endometrial Carcinoma	5	5	0	100.0
Cervical				
Malignant	4	4	0	100.0
Benign				
Choriocarcinoma				

Table III
Pulsed Doppler velocity indices in benign and malignant pelvic tumors.

Pathology	Resistance Index		Pulsatility Index		Peak systolic velocity (Cm/sec)	
	Range	Mean	Range	Mean	Range	Mean
Ovarian (30)						
Benign (18)	0.4 – 0.82	0.67	0.6 - 2.25	1.2	11 70	22.5
Malignant (12)	0.2 – 0.8	0.44	0.29 – 1.73	0.7	21 – 32	27.8
Uterine (22)						
Fibroid (12)	0.34 – 0.84	0.71	0.4 – 1.56	1.05	13 54	32.11
Endometrial Hyperplasia (5)	0.79 – 1.3	1.16	0.92 – 1.88	1.19	23 - 40	33.0
Endometrial Carcinoma(5)	0.5 – 0.8	0.60	0.75 – 1.25	0.91	17 - 27	30.2
Cervical						
Malignant (4)	0.6 – 0.89	0.74	0.90 – 2.29	1.05	22 – 35	29.6
Benign (0)						
Choriocarcinoma (4)	0.2 – 0.83	0.57	0.5 – 1.81	1.01	25 - 118	52.5

be differentiated from endometrial carcinoma on velocity indices. Significanlty lower R1 and P1 were recorded in endometrial carcinoma. Our results are comparable to those of Bourne et al (1991) and Kupesic et al (1993).

Doppler velocity indices were significantly lower in cervical carcinoma. Shekhar (1999) found significantly lower R1 and P1 in carcinoma cervix in comparison to healthy women.

All cases of choriocarcinoma in our study showed low impedance high velocity flow which is characteristic of a malignant pathology. The typical hot areas described earlier (Shekhar, 1999) were seen in all the cases.

Conclusions

Hence, we conclude that color Doppler and pulsed Doppler velocity wave from indices may be utilized as an important diagnostic tool in differential diagnosis of benign and malignant pelvic tumors with high sensitivity and specificity. The presence of neovascularization on color Doppler and low waveform indices like R1 and P1 and high PSV can help distinguish between benign and malignant pelvic tumors.

References

1. Bourne TH, Campbell S and Patrick Sleer C V. Gynaecologic Oncology. 40253; 1991.
2. Carter JR, Lau M, Saltzman AK, Hartenback FM Jour. Ultrasound Med. 13:835; 1994.
3. Hata K, Hata T and Manable A. Obstet GYnaecology. 90; 922; 1992.
4. Kumar CA, Chew S, Wong YC. Indo-Singapore obstet & Gynaecology ultrasound course 163, 1999.
5. Kupesic US, Shalan h, Kurjak A. Euro. Jour. Obstet Gynaecology, 49:46; 1993.
6. Kurjak A, Maiden P, Sanja K and Slanko T : Gyn. Oncology, 50: 3; 1993.
7. Rajan R. Indo-Singapore ultrasound course in Obstet and Gynaecology. 97; 1999.
8. Shekhar KD. Indo-Singapore Obstet & Gynaecology Ultrasound course, 102;1999.
9. Timor TIE, Lerner JP. Amer J. Obstet Gynaecology. 168 : 909; 1993
10. Weiner Z, Isreal T and Beck D : Obstet. Gynaecology. 79; 159; 1992.