

Role of Transvaginal Color Doppler Ultrasound in the Characterization of Uterine Disease

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This prospective study was carried out during the period from July 2005 to June 2006, to establish the usefulness of transvaginal color Doppler sonography (TV-CDS) in pre-operative discrimination of benign and malignant uterine lesions. A total of 50 patients having uterine masses and enrolled for surgical management were included in this study. The mean age of the patients was 47.46 ± 8.50 years and ranged from 36-65 years. Out of 36 cases diagnosed as benign by TV-CDS, neovascularization was present in 5 cases. Out of 14 cases diagnosed as malignant neovascularization was present in 13 cases. The mean \pm SE pulsatility index (PI) and resistance index (RI) values for benign lesion were 1.33 ± 0.09 and 0.67 ± 0.002 respectively (found in 36/72 % patients). The mean \pm SE PI and RI values for malignant lesions were 0.64 ± 0.05 and 0.41 ± 0.01 , respectively (found in 14/ 28% patients). The mean \pm SE of PSV values in patients diagnosed as benign and malignant uterine lesions were 6.56 ± 0.14 and 20.55 ± 0.47 respectively. These values showed significant difference ($P < 0.001$). After collection of histopathology reports, it was found that 34 patients were diagnosed as benign and 16 patients were diagnosed as malignant. The validity of TV-CDS were studied by calculating sensitivity, specificity, accuracy, PPV and NPV which were 93%, 94%, 87%, 97%, 94%, respectively.

[Dinajpur Med Col J 2015 Jan; 8 (1):28-33]

Key words: Transvaginal, color Doppler, ultrasound, uterus

Introduction

Worldwide cervical carcinoma alone is responsible for about 5% of all cancer deaths in women.¹ It is the common cause of malignancy in our country.² Endometrial carcinoma is the fourth most common cancer in women in United States.³ Leiomyoma of the uterus is the most common

solid pelvic tumors in women present in 20-25% of women aged >35 years.¹ Adenomyosis is another benign condition. It occurs in approximately 15-20% of uteri. Endometrial hyperplasia though benign, deserves special attention because of its relationship with endometrial carcinoma.¹

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The diagnostic aids for assessing uterine tumours are cervical biopsy, endometrial curettage, laparoscopy, hysteroscopy and ultrasonogram including transvaginal ultrasonogram. Transvaginal color Doppler ultrasonography (TV-CDS) is the safest diagnostic method. It can reduce potential risk and save economic cost. A properly conducted transvaginal ultrasonography with color Doppler will allow survey of the body and the cervix of uterus and evaluate both structural and blood flow related events. Vaginal probe ultrasonography transducers are of higher frequency and closer proximity to structures being studied. This results in excellent near field resolution with high degree of magnification, thus yielding a type of sonomicroscopy. This transvaginal ultrasound Color Doppler has become very quick, simple, painless, less expensive and accurate method of investigation. It is also easy for the patients who can not fill the bladder and are obese.

K. Hata et al. in 1991 and Kurjak et al. in 1993 has successfully discriminated cervical carcinoma and endometrial carcinoma from the normal uterus and myoma by transvaginal color Doppler ultrasonography.^{3,6}

Methods

The prospective study was carried out on purposively selected 50 patients based on selection criteria. The patients were aged 30-70 years, admitted in the Gynaecology units of Bangladesh Institute of Research and Rehabilitation of Endocrine and Metabolic Disorders (BIRDEM). Dhaka Medical College Hospital (DMCH) & Bangabandhu Sheikh Mujib Medical University Hospital (BSMMUH) requiring operative intervention for their clinical and imaging diagnosis (perabdominal ultrasonography) of uterine tumours and referred to the Radiology and Imaging department of BIRDM for pre-

operative discrimination of tumors by TV-CDS.

Before TV-CDS were performed, abdomen were scanned to confirm the previous findings. The procedure was carefully explained to the patient, a verbal consent was obtained and any question the patient might had was answered. Then the transvaginal Doppler sonography was performed. Presence or absence of neovascularization, resistance index (RI) and pulsatility index (PI), peak systolic velocity (PSV) of the uterine tumors were determined for discrimination of benign and malignant tumors pre-operatively. The patients were operated by gynaecologists. The collected histopathological reports were compared with TV-CDS diagnosis. All these information were collected in pre-designed structured data collection sheets.

The patients who were unmarried, extremes of age, refused transvaginal color Doppler scanning, vaginal bleeding other than uterine cause, have pelvic pathology other than uterine tumors (such as pelvic inflammatory disease, discharging or infected vaginal canal), history of intake of hormone (i.e. tamoxifen, hormone replacement therapy) were excluded .

The demographic out come variables studied were age of the patients, clinical history and menstrual history. TV-CDS variables were neovascularization, RI, PI and PSV. The newly formed capillary blood vessels from pre-existing microvessels are obligatory event of malignant humors. But neovascularization is absent in benign tumors.⁶ According to the study done by Ivanov et al. 2004, uterine tumors were considered malignant in the present study, when PI and RI values were < 1 and < 0.5 respectively.⁸

Ultrasound examination of the patients was performed by using 3.5 to 5 MHz probe for transabdominal examination.

For the validity of the study outcome sensitivity, specificity, positive and negative predictive values of the transvaginal color Doppler sonography were calculated after confirmation of diagnosis by histopathological examination. For significance of difference unpaired 't' test and 'Z' test of proportion were done. A 'P' value <0.05 was considered significant.

Results

The age range of patients was 36-65 years. The mean ages were 42.63 ± 3.20 and 55.75 ± 2.38 years for benign and malignant uterine tumors respectively. The most common symptoms associated with uterine tumors were menorrhagia (50%), dysmenorrhea (38%) and lump in the lower abdomen (32%), respectively.

Neovascularization is a characteristic feature in malignant tumors. Among 36 patients having benign uterine tumors diagnosed by TV-CDS, neovascularization was present in 5 patients. Among 14 malignant patients neovascularization was present in 13 patients.

Mean PI \pm SE of benign and malignant uterine tumors were 1.33 ± 0.09 and 0.64 ± 0.05 respectively and the PI ranges were 1.14 -1.51 for benign and 0.60 -0.66 for malignant uterine tumors. The result is shown in, Table-I and Fig-3.

Out of 36 benign cases, mean RI was 0.67 ± 0.002 , ranging from 0.64-0.69. Similarly, the mean RI of 14 malignant cases was 0.41 ± 0.01 ranging from 0.33-0.48. The result is shown in Table-II.

Out of 36 benign cases, the mean PSV was 6.56 ± 0.14 cm/sec ranging from 5.72 - 7.40

cm/sec. Out of 14 malignant cases, the mean PSV $20.55 \pm .47$ ranging from 18.78 - 24.04 cm/sec (Fig-1,2). Based on RI, PI indexes and PSV, 72% were found benign and 28 % were malignant (Table-III).

Of total patients, histopathologically 34 (68%) were diagnosed as benign and 16 (32%) were diagnosed as malignant, indicating that the results are almost correlating with TV-CDS. The sensitivity of TV-CDS was 93%, specificity 94%, PPV 87%, NPV 97% and accuracy 94%.

Table I: Comparison of mean pulsatility index (PI) in between patients diagnosed as Benign and Malignant by TV-CDS

Type of Tumor Diagnosed by TV-CDS	Number	Pulsatility Index (PI)		
		Mean \pm SE	Range	95%CL
Benign	36	1.33 ± 0.09	1.14-1.51	1.35-1.31
Malignant	14	$0.64 \pm 0.05^{***}$	0.60-0.66	0.73-0.55

*** P < 0.001 in unpaired t test (highly significant)
CL = Confidence Limit

Table II: Comparison of mean resistance index (RI) in between patients diagnosed as Benign and Malignant by TV-CDS

Type of Tumor Diagnosed by TV-CDS	Number	Resistance Index (RI)		
		Mean \pm SE	Range	95%CL
Benign	36	0.67 ± 0.002	0.64-0.69	0.673-0.667
Malignant	14	$0.41 \pm 0.01^{***}$	0.33-0.48	0.42-0.39

*** P < 0.001 in unpaired t test (highly significant)
CL = Confidence Limit

Table III: Distribution of patients according to TV-CD findings

TV-CD feature	Benign		Malignant	
	Frequency	%	Frequency	%
Presence of neovascularization	5	10	13	26
Resistance index	36	72	14	28
Pulsatility index	36	72	14	28
Peak systolic velocity	36	72	14	28

Chi square test: $P < .001$

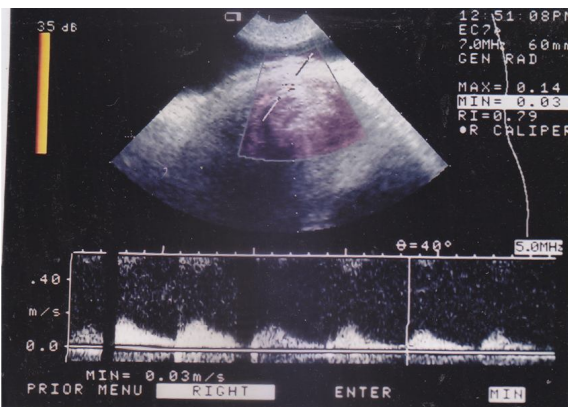


Figure 1. Benign uterine tumor with resistance index (RI) value 0.79 and Peak Systolic Velocity (PSV) 0.03m/sec based on TV CDS findings

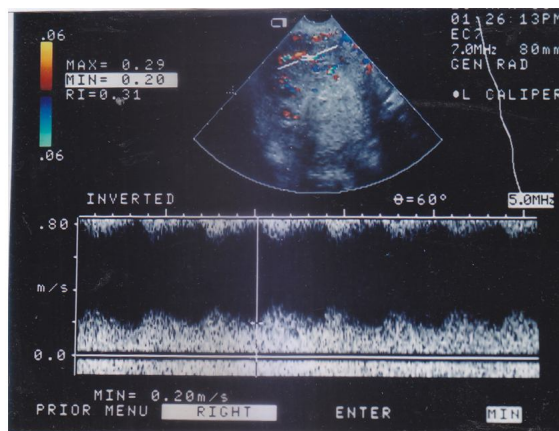


Figure 2. Malignant uterine tumor with Resistance Index (RI) value 0.31 and Peak

Systolic Velocity (PSV) 20cm/sec based on TV-CDS finding

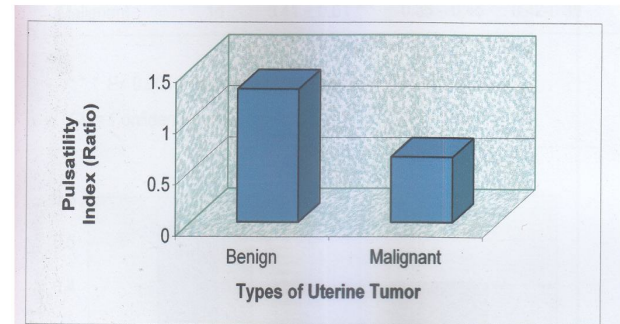


Figure 3. Bar diagram showing Comparison between Mean Pulsatility Index (PI) in patients diagnosed as Benign and Malignant by TV-CDS

Discussion

The present study findings were compared and discussed with previously published relevant studies.

Uterine mass was uncommon before age of 30 years.⁷ Benign lesions were common in age range of 35-45 years. Commoner age group for cervical carcinoma was 45-55 years and for endometrial carcinoma it was 60-70 years.^{4,7} These observations were also reflected in the present study, where most of the patients were in age range of 36-65 years. No patient was found before the age of 36 years, possibly because at younger age patients were usually not advised for hysterectomy.

The most common presenting symptoms to patients in the present study were menorrhagia (50%), dysmenorrhea (38%) and lump in the lower abdomen (32%). Similar observations regarding the clinical presentations were also made by Bhatla et al. (1998) and Hylton et al (2001).^{4,7}

Neovascularization was present in 5 cases diagnosed as benign by TV-CDS. Among them 3 were diagnosed as patients of

adenomyosis on histopathology. The result is closely supported by a study done by Cheng et al. (1999). They showed that 87% patients of adenomyosis had randomly scattered vessels or intratumoral signals. This flow pattern of adenomyosis was also supported by Bhatla et al. (1998) and Hylton et al. (2001).^{4,7,11} Neovascularization was also present in other two benign cases. This change was possibly due to some associated inflammatory conditions.^{12,13}

Out of 14 patients diagnosed as malignant lesions by TV-CDS, 13 showed intratumoral and peritumoral increased flow. Neovascularization was not detected in only 1 patient. In this case newly formed vessels were probably too small and velocity and volume of flow were below the limit of the equipment's resolution power. Hata et al. (1991) have made identical observations.⁶

In the present study, The mean PI and RI values for benign lesion were 1.33 ± 0.09 and 0.67 ± 0.002 respectively (found in 36/72 % patients). The mean PI and RI values for malignant lesions were 0.64 ± 0.05 and 0.41 ± 0.01 respectively (found in 14 /28% patients). These values showed significant difference ($P < 0.001$).

Hata et al. (1991) observed the mean RI value to be 0.679 ± 0.131 for uterine fibroid. It was 0.510 ± 0.097 for cervical carcinoma and 0.535 ± 0.158 for endometrial carcinoma.⁶ Kupesic et al. (1993) & Sawicki et al. (2005) showed a significantly lower ($P < 0.05$) resistance index (RI 0.37 ± 0.07 & 0.38 ± 0.09) in cases of endometrial cancer than in patients with benign uterine lesion (0.54 ± 0.9).^{9,14}

In the present study mean PSV was 6.56 ± 0.14 cm/sec for lesions diagnosed as benign and 20.55 ± 0.47 cm/sec for those diagnosed as malignant. The difference was statistically significant ($P < 0.001$). The idea of the present

study was supported by a study done by Kurjak et al (1993) & Sawicki et al. (2005).^{3,9}

After collection of histopathology reports, in the present study, it was found that 34 patients were diagnosed as benign. Among them 23 were patients of fibroid, 3 were adenomyosis and 8 were endometrial hyperplasia.

Sixteen patients were diagnosed as malignant by tissue diagnosis. Among them 10 were patients of endometrial carcinoma and 6 were patients of cervical carcinoma. When compared with histopathological examination, in the present study the sensitivity, specificity, PPV, NPV and accuracy of TV-CDS was 93%, 94 %, 87%, 97% and 94%. The sensitivity and specificity observed in the present study were in close agreement with Alcazar et al. (2004 & 2008) and Sawicki et al.^{9,15,16}

Kurjak et al (1995) showed that transvaginal color Doppler sonography offers 90.91% sensitivity, 99.82%, specificity, 71.43 % PPV, 99.96% NPV in predicting benign and malignant uterine tumors.³

Conclusion

From the results of the present findings as well as the findings obtained by a number of investigators, it is conceivable that transvaginal color Doppler is an accurate diagnostic imaging modality for pre-operative characterization and discrimination of benign and malignant uterine tumors. TV-CDS would result in a significant reduction of the use of invasive diagnostic modalities with considerable saving of both risks and economic costs. So, it is expected that this method will be used in routine clinical examinations to rule out and / or diagnose a uterine malignancy.

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