ROLE OF TRANSVAGINAL ULTRASONOGRAPHY AND COLOUR DOPPLER IN THE EVALUATION OF POSTMENOPAUSAL BLEEDING

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KEYWORDS
Transvaginal ultrasound; Postmenopausal bleeding; Endometrial carcinoma

Abstract Aim of the work: The aim of this study is to evaluate the role of transvaginal ultrasonography and colour Doppler in postmenopausal bleeding.

Patients and methods: In the study fifty female patients with their age ranging between 45 and 80 years were subjected to transvaginal US examination and transvaginal colour and pulsed Doppler examination.

Results: All the malignant cases and 94.7% of the benign cases had endometrial thickness P 5 mm, however 90% of the control group with the remaining of the benign cases (5.2%) had endometrial thickness < 5 mm. The mean uterine artery RI and PI were lower in cases with PMB than in control cases and in cases with malignant causes than benign causes. The mean spiral artery RI & PI were lower in cases with benign than in cases with malignant causes of PMB.

Conclusion: In conclusion, transvaginal colour Doppler as a noninvasive method has a significant place in the diagnostic procedures for evaluation of PMB. Transvaginal colour Doppler can help in differentiating benign from malignant endometrial changes.

1. Introduction

Abnormal uterine bleeding at any age in women’s life is disruptive and worrisome, but postmenopausal bleeding is of special concern because it is the only common clinical indication of the presence of endometrial carcinoma (1). Postmenopausal bleeding (PMB) can be defined as uterine bleeding occurring at least one year after menopause, its incidence can be as high as 10% (2). The differential diagnosis of postmenopausal bleeding is wide, and includes, endometrial hyperplasia, endometrial polyp, endometrial carcinoma, cervical cancer and uterine leiomyosarcoma (3). It is estimated that...
10–15% of patients who present with postmenopausal bleeding end up having endometrial cancer (4). Several different approaches have been proved to be clinically useful screening methods for early detection of endometrial abnormality in women with irregular uterine bleeding. These include dilatation and curettage (D&C), hysteroscopy, sonohysterography and transvaginal sonography (TVS) with the measurement of endometrial thickness (1). Recently transvaginal colour and pulsed Doppler ultrasound has increased the reliability of ultrasonographic diagnosis of women with certain endometrial pathologies. It is able to detect subtle changes in the endometrium and it has been observed that endometrial thickness 5 mm is usually associated with normal morphology (5). In patients with thickened endometrium, a secondary test such as power Doppler could play a role in refining the diagnosis (6). Doppler velocimetric study of the uterine artery offers a simple, noninvasive and valuable method in screening women with postmenopausal bleeding. Transvaginal colour Doppler imaging allows the assessment of endometrial vascularization (7). A good correlation has been found between the uterine artery flow velocity waveform and the histopathological diagnosis in women with PMB (8). It is recommended to take 5 mm endometrial thickness and 0.85 uterine artery RI as a cut-off value to detect endometrial pathology (9). Colour Doppler sonography has a role in assessment of endometrial polyps by detection of pedicle artery reaching the central part of the endometrium (10).

2. Patients and methods

2.1. Patients

This prospective study was conducted according to the guidelines of the ethics committee of our university and was approved by our institutional review board. All females gave us a written informed consent. This prospective study was done between December 2013 and April 2014 including 50 females with the age range from 45 to 80 years old, complaining of postmenopausal bleeding, and 10 control females with the same age range.

2.2. Methods

Transvaginal US was carried out using 6 MHz transvaginal transducer. All women were examined transvaginally in the lithotomy position, with an empty bladder. First, the conventional grey-scale US examination of the uterus was performed. Transverse and longitudinal sections of the endometrium were obtained and maximal endometrial thickness in the sagittal plane was measured (double layer). Malignancy was suspected if there was an irregular endometrial/myometrial junction, or an inhomogeneous endometrial texture. After completion of grey-scale US, power Doppler US was carried out. The endometrial and subendometrial areas were magnified and blood vessels were observed. Only blood vessels that were within 5 mm from the endometrial edge were included. Endometrial thickness of 5 mm and PI < 1 were used as cutoff points for endometrial thickness and blood flow respectively. The uterine artery was examined and the PI, and RI were measured. Clinical and ultrasound data were compared with the final histological diagnosis of the endometrium, which was obtained by D&C or hysteroscopic resection or by hysterectomy.

3. Statistical analysis

Statistical analyses were performed using the SPSS software package version 16.0 (statistical package for social science TM) and P < 0.05 was considered to be statistically significant. The sensitivity and specificity for each protocol were compared in order to evaluate the reliability of each of them and when they are combined.

4. Results

Comparison between the endometrial thickness cutoff (5 mm) in the control group and the group with postmenopausal bleeding whether benign or malignant is shown in Table 1. This table shows that all the malignant cases and 94.7% of the benign cases had endometrial thickness 5 mm, however 90% of the control group with the remaining of the benign cases (5.2%) had endometrial thickness <5 mm.

This table shows that the mean uterine artery RI and PI were lower in cases with PMB than in control cases and in cases with malignant causes than benign causes (Table 2).

This table shows that the mean spiral artery RI and PI were lower in cases with malignant than in cases with malignant causes of PMB (Table 3).

This table shows that the mean uterine artery RI, PI and spiral artery RI, PI were lower in malignant cases with malignant than in cases with malignant causes of PMB (Table 4).

Table 1  Comparison between the endometrial thickness cutoff between both groups of the study.

| Endometrial thickness | Pt. with PMB | |
|-----------------------|--------------|
|                       | Benign       | Malignant     | PM control group |
|                       | No.         | %             | No.         | %             | No.  | %  |
| ≥5 mm                 | 36           | 94.7          | 12           | 100           | 1    | 10 |
| <5 mm                 | 2            | 5.3           | 0            | 0             | 9    | 90 |
| Total                 | 38           | 100           | 12           | 100           | 10   | 100|
| Benign and malignant P value | Benign and control | Malignant and control | 0.001 | 0.001 |

P < 0.05 was considered to be statistically significant.
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dence for endometrial malignancy (11). Doppler analysis of
of endometrial pathologies but it is a nonspecific clinical evi-
is the most convenient, noninvasive method for the diagnosis
were control (postmenopausal females not complaining of
malignancy as a cause of PMB. This study has been conducted
(12). The present
point of sampling of the uterine artery. There was a significant
occurring within and around the tumour tissue distal to the
nancy is thought to be a reflection of the neovascularization (1). Svetlana et al. (14) stated that the
study of the uterine artery also allows the assessment of endo-
metrial vascularization (1). Svetlana et al. (14) stated that the
level (RI < 0.61) has a positive predictive value in the detec-
tion of endometrial pathological changes. They also stated that
in majority of patients with endometrial cancer the PI values
were less than 1.1 in the group of patients with benign endome-
trial changes, and values of this hemodynamic parameters were
higher than 2.0.

In our study, the results obtained by TVCD were through studying the RI and PI of the uterine arteries. There was a signif-
ificant difference in RI of the uterine arteries in benign and malignant groups, measured by Doppler US between the two
groups, with a tendency towards a lower RI in the malignant
group, the best cutoff value for RI of uterine artery is 0.50,
(0.50 or less predict malignancy). There was also a significant
difference in PI of the uterine arteries in benign and malignant
groups, with a tendency towards a lower RI in the malignant
group; the best cutoff value is 0.50, measured by Doppler US between the two
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groups, with a tendency towards a lower RI in the malignant
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difference in PI of the uterine arteries in benign and malignant
groups, with a tendency towards a lower RI in the malignant
group; the best cutoff value is 0.50, measured by Doppler US between the two
groups with a tendency

Kucur et al. (15) found that there was a significant correla-
tion between spiral artery RI and PI and different endometrial

5. Discussion

The measurement of endometrial thickness by transvaginal US
is the most convenient, noninvasive method for the diagnosis
of endometrial pathologies but it is a nonspecific clinical evi-
dence for endometrial malignancy (11). Doppler analysis of
uterine and myometrial arteries could be used in differentia-
tion between benign and malignant uterine findings (11). Using
the transvaginal approach, the accuracy of measurement is
increased because of the small distance between the probe
and the vessels under investigation and better identification
of smaller vessels due to better resolution (12). The present
study aimed at making a correlation between results obtained
by TVUS with colour Doppler of uterine and spiral arteries
(myometrial vessels) and endometrial histopathological find-
ings in a trial to disclose the helpful role of TVCD for detecting
malignancy as a cause of PMB. This study has been conducted
on 60 females, 50 of them complaining of PMB, the other 10
were control (postmenopausal females not complaining of
bleeding), 38 cases were diagnosed as benign endometrial
lesion and 12 were diagnosed as malignant endometrial lesion
by histopathology. As regards the results of TVUS in the pre-
sent study, 5 mm is the cutoff point of endometrial thickness for
differentiating malignant from benign cases. There was a sta-
tistically significant difference in endometrial thickness mea-
sured by TVUS between the two groups with a tendency
wards a thicker endometrium in the malignant group.

Develioglu et al. (9) who had studied 97 postmenopausal
women presented by PMB stated that the endometrial thick-
ness of 9.6 mm is the cutoff value for diagnosing endometrial
carcinoma. In a study performed by Jacobs et al. (13) to assess
the sensitivity of TVUS screening for endometrial cancer in
postmenopausal women, they found that the endometrial
thickness of 5 mm is the cutoff value in endometrial carcinoma with
sensitivity of 77.1% and specificity of 85.8%. The studied
groups included in that study were 96 patients with PMB.

TVCD imaging is a simple, noninvasive and valuable
method in screening women with PMB. Doppler velocimetric
study of the uterine artery also allows the assessment of endo-
metrial vascularization (1). Svetlana et al. (14) stated that the
low value of hemodynamic parameters at the uterine arteries
level (RI < 0.61) has a positive predictive value in the detec-
tion of endometrial pathological changes. They also stated that
in majority of patients with endometrial cancer the PI values
were less than 1.1 in the group of patients with benign endome-
trial changes, and values of this hemodynamic parameters were
higher than 2.0.

In our study, the results obtained by TVCD were through studying the RI and PI of the uterine arteries. There was a sig-
ificant difference in RI of the uterine arteries in benign and malignant
groups, measured by Doppler US between the two
groups, with a tendency towards a lower RI in the malignant
group, the best cutoff value for RI of uterine artery is 0.50,
(0.50 or less predict malignancy). There was also a significant
difference in PI of the uterine arteries in benign and malignant
groups, with a tendency towards a lower PI in the malignant
group; the best cutoff value is 0.64. Colour Doppler studies
of the uterine arteries in the present study showed that the
RI is lower in cases of malignancy compared to those with
benign lesions. The decrease in RI values in cases of malign-
ancy is thought to be a reflection of the neovascularization
 occurring within and around the tumour tissue distal to the
point of sampling of the uterine artery. There was a significant
correlation between left and right uterine artery measurements
so either can be used for screening.

Kucur et al. (15) found that there was a significant correla-
tion between spiral artery RI and PI and different endometrial

### Table 2 Comparison of uterine artery RI and PI between cases with PMB PM control groups.

<table>
<thead>
<tr>
<th>Doppler indices</th>
<th>Pt. with PMB</th>
<th>PM control group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Benign</td>
<td>Malignant</td>
</tr>
<tr>
<td>RI</td>
<td>0.57–0.82</td>
<td>0.47–0.52</td>
</tr>
<tr>
<td>Mean</td>
<td>0.73</td>
<td>0.50</td>
</tr>
<tr>
<td>P value</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>PI</td>
<td>0.80–1.60</td>
<td>0.80–1.60</td>
</tr>
<tr>
<td>Mean</td>
<td>1.19</td>
<td>1.19</td>
</tr>
<tr>
<td>P value</td>
<td>0.99</td>
<td>2.16</td>
</tr>
<tr>
<td>Total</td>
<td>38</td>
<td>12</td>
</tr>
</tbody>
</table>

### Table 3 Comparison of spiral artery RI and PI between cases with benign and malignant causes of PMB.

<table>
<thead>
<tr>
<th>Doppler indices</th>
<th>Benign causes</th>
<th>Malignant causes</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>RI</td>
<td>0.54–0.73</td>
<td>0.42–0.48</td>
<td>0.059</td>
</tr>
<tr>
<td>Mean</td>
<td>0.61</td>
<td>0.45</td>
<td></td>
</tr>
<tr>
<td>PI</td>
<td>0.77–1.33</td>
<td>0.52–0.56</td>
<td>0.001</td>
</tr>
<tr>
<td>Mean</td>
<td>0.96</td>
<td>0.54</td>
<td></td>
</tr>
</tbody>
</table>

### Table 4 Comparison of uterine artery RI, PI and spiral artery RI, PI between cases with benign and malignant causes of PMB.

<table>
<thead>
<tr>
<th>Causes of PMB</th>
<th>Uterine artery</th>
<th>Spiral artery</th>
<th>Uterine artery</th>
<th>Spiral artery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endometrial carcinoma</td>
<td>0.47–0.52 (0.50)</td>
<td>0.42–0.48 (0.45)</td>
<td>0.55–0.79 (0.67)</td>
<td>0.52–0.56 (0.54)</td>
</tr>
<tr>
<td>P value</td>
<td>0.255</td>
<td></td>
<td>0.025</td>
<td></td>
</tr>
<tr>
<td>Endometrial hyperplasia</td>
<td>0.61–0.82 (0.77)</td>
<td>0.57–0.73 (0.63)</td>
<td>0.98–1.60 (1.31)</td>
<td>0.83–1.33 (1.01)</td>
</tr>
<tr>
<td>P value</td>
<td>0.033</td>
<td></td>
<td>0.016</td>
<td></td>
</tr>
<tr>
<td>Uterine fibroid</td>
<td>0.57–0.75 (0.66)</td>
<td>0.54–0.70 (0.60)</td>
<td>0.80–0.83 (0.81)</td>
<td>0.60–0.82 (0.77)</td>
</tr>
<tr>
<td>P value</td>
<td>0.297</td>
<td></td>
<td>0.571</td>
<td></td>
</tr>
</tbody>
</table>
Fig. 1  (a) Transvaginal ultrasound examination found regular, thick and heterogeneous endometrium, measured about 1.2 cm; (b) Colour Doppler examination of the endometrium revealed increased endometrial vascularity and pulsed Doppler examination of spiral arteries showed its blood flow velocity waveform with RI = 0.59, PI = 0.63; (c) Doppler examination of uterine artery showed its blood flow velocity waveform with RI = 0.61, PI = 0.83. The patient underwent D and C and histopathological study confirming the diagnosis of endometrial hyperplasia with atypia.
Fig. 2  (a) Transvaginal ultrasound examination found a well defined, inhomogenous myometrial focal mass lesion measured about $23 \times 21$ mm with regular, thick endometrium, measured about 7 mm; (b) Colour Doppler examination of the uterus showed vasculature around the lesion and pulsed Doppler examination of spiral arteries showed blood flow velocity waveform with $RI = 0.54$, $PI = 0.77$; (c) Doppler examination of uterine artery showed its blood flow velocity waveform with $RI = 0.57$, and $PI = 80$ patient underwent hysterectomy and histopathological study of the lesion confirms the diagnosis of uterine fibroid.
histologies, in patients with endometrial cancer spiral artery PI was found to be lower and significantly lower than other groups in endometrial cancer, hyperplasia, submucous fibroid, and endometrial polyp. Spiral artery RI was also lower in endometrial polyp, hyperplasia and fibroid groups.

In our study, there was a significant difference in RI of the spiral arteries for both benign (Figs. 1, 2 and 5) and malignant groups measured by Doppler US with a tendency towards a lower RI in the malignant group (Figs. 3 and 4); the best cutoff value for RI of spiral arteries is 0.45. There was also a significant difference in PI of the spiral arteries for both benign and malignant and the malignant group with tendency towards a lower RI in the malignant group, and the best cutoff value for PI of spiral arteries is 0.45.

The difference between the results of the present study and those reported by the different authors previously mentioned, might be attributed to many variables that can influence the Doppler measurements such as variation in the angle of insonation of the Doppler beam which cannot be standardized or precisely determined, type of Doppler beam used, machine resolution, the sample sizing ability, quality of produced image, and the patient cooperation during the examination.

In agreement with our results, colour Doppler is a useful tool for identifying the presence of uterine cancer, as it determines
the type of angiogenesis. High resistance in the sub-and intraendometrial vessels measured by resistive and/or pulsatility indices indicates benign pathology, while low resistance demonstrates possible malignant pathology (3).

Furthermore, from our study, we conclude that, the combination of both TVUS and Doppler examination of the endometrium and the uterine arteries can contribute to a correct pathology of endometrial malignancy in women with

Fig. 4  (a) Transvaginal ultrasound examination of the uterus showed grossly thickened heterogeneous endometrium with myometrial infiltration, and endometrial thickness measured about 35 mm; (b) Doppler examination of the uterus showed increased vascularity of the lesion and pulsed Doppler examination of spiral arteries showed its blood flow velocity waveform with high diastolic flow, its $RI = 0.47$. (c) Doppler examination of uterine artery showed its blood flow velocity waveform with high diastolic flow, $RI = 0.50$, and $PI 0.55$. The patient underwent hysterectomy and histopathological study of the lesion confirms the diagnosis of endometrial carcinoma.
postmenopausal bleeding and endometrium $\geq 5$ mm. The greater the colour content of the endometrium, the greater the risk of endometrial malignancy.

6. Conclusion

In conclusion, transvaginal colour Doppler as a noninvasive method has a significant place in the diagnostic procedures for evaluation of PMB. Transvaginal colour Doppler can help in differentiating benign from malignant endometrial changes.

Conflict of interest

None declared.
References


