IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 21, Issue 1 Ser.7 (January. 2022), PP 27-35
www.iosrjournals.org

Diagnostic Evaluation of Transvaginal Doppler Sonographic Study in Differentiating Benign and Malignant Endometrial Conditions in Postmenopausal Bleeding

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Abstract:
Background*: Endometrial carcinoma is currently the commonest gynaecological malignancy, of which postmenopausal bleeding is the commonest presentation. As of now there is no recommendation for an ideal screening technique in endometrial carcinoma. Hence an efficient non-invasive screening as well as diagnostic tool is the need of the hour as early diagnosis and adequate treatment has been proven to be quite productive in providing good survival benefits.*
Objectives*: Diagnostic evaluation of transvaginal Doppler sonographic study in differentiating benign and malignant endometrial conditions in postmenopausal bleeding.*
Materials & Methods*:50 women above the age of 45 years who presented with postmenopausal bleeding were included in the study. After obtaining detailed clinical history and local examination, all the patients were subjected to transvaginal sonographic study to assess endometrial thickness. Later on, Doppler gate was activated to obtain the endometrial vasculature, specific pattern associated with endometrial pathologies and the different waveform indices (like RI, PI and PSV).*
Results*: Out of the 50 patients who got included in the study, there was a statistically significant difference in the mean endometrial thickness between women with benign and malignant are 9.75 ± 1.16 mm and 15.53 ±3.15 mm respectively (P-value < 0.01). Combining thick endometrium ≥8 mm, RI <0.5 and suspicious endometrial picture (MULTIPLE VESSEL PATTERN) gives the diagnostic values of 80%, 100%, 100%, 95.23%, and 96%, respectively regarding sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy. RI values most corresponding to a malignant histology was observed at a value at or below 0.494 hence the same can be taken as a cut-off value as at this point as both sensitivity and specificity is at 100%. PI values most corresponding to a malignant histology was observed at a value at or below 1.025, same taken as a cut-off value as at this point where sensitivity was 90% and specificity was 70%. PSV which was one other flow parameter that was assessed showed low sensitivity and specificity across different reading levels in truly differentiating a carcinoma.*
Conclusion*: Transvaginal Doppler sonographic study can be used to differentiate endometrial pathologies in postmenopausal bleeding. Vascular patterns can be used in delineating malignant from benign pathologies on the basis of our study. Of the different waveform indices, resistance index (RI) can be used as a measure with high sensitivity and specificity in predicting malignant histologies and has good potential based on this study as a screening tool. Pulsatility Index (PI) rated slightly inferior but promising. Peak Systolic Velocity PSV had poor sensitivity and specificity across different reading levels and cannot be recommended as a good screening tool based on this study results.*
Key Words*: Postmenopausal bleeding, transvaginal Doppler study, endometrial thickness, vascular patterns, RI, PI, PSV.*

Date of Submission: 01-01-2022 Date of Acceptance: 12-01-2022

I. Introduction

Abnormal uterine bleeding in a women's life is always worrisome, but postmenopausal bleeding has to be is of special concern because it can be the only clinical indication of the presence of endometrial carcinoma [1]. Endometrial carcinoma is currently the most frequent gynaecological cancer and postmenopausal bleeding is usually the first and the only symptom. Although postmenopausal bleeding (PMB) is a common complaint [2] accounting for up to 69 per cent of postmenopausal women presenting to the gynaecological outpatient department [3], only 10-15 per cent of them will actually have endometrial carcinoma [4]. Subjecting each and every

one with postmenopausal bleeding to endometrial biopsy is questionable. Hence an appropriate non-invasive diagnostic technique is necessary to screen this age group.

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 transvaginal sonography (TVS) with the measurement of endometrial thickness [4], dilatation and curettage (D&C), hysteroscopy, sonohysterography. Since most of them are invasive, it might be preferable to first use some non-invasive method, such as ultrasound, to identify women at risk who should undergo endometrial biopsy.

Transvaginal ultrasonography (TVS) being a non-invasive procedure and can be used as a screening tool conveniently. TVS allows visualisation of the endo-myometrial interface and the entire cavity. Measurement of endometrial thickness (ET) through transvaginal approach has high negative predictive value and can avoid unnecessary biopsies. According to a study by Dijkhuizen *et al*[5], TVS can prevent around 40 per cent of endometrial biopsies. ET when combined with some morphologic parameters and Doppler velocimetry studies can improve the diagnostic accuracy of TVS in patients with PMB [1].

Transvaginal colour Doppler imaging allows the assessment of endometrial vascularisation although some authors have argued that endometrial echotexture may help to differentiate carcinoma from polyps and hyperplasia. In patients with thickened endometrium, a secondary test such as power Doppler could play a role in refining the diagnosis [6,7].

Recently transvaginal colour along with 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. In patients with thickened endometrium, a secondary test such as power Doppler could play a role in refining the diagnosis [6].

II. Materials & Methods

This was a comparative cross-sectional study conducted in the Department of Radiodiagnosis at Jubilee Mission Medical College & Research Institute, Thrissur, Kerala over a period of 18 months starting from January 2019 to July 2020. A total of 50 patients were included who presented with postmenopausal bleeding during the specified period.

Study Design: Cross sectional study.

Study Location: Department of Radiodiagnosis at Jubilee Mission Medical College & Research Institute, Thrissur, Kerala

Study Duration: 18 months (January 2019 to July 2020)

Sample Size: 50 patients.

Sample Size Calculation: Sample size was calculated using sensitivity from a previous publication[8.] Using the formula for the same sample size was calculated as 50 with a confidence interval of 95% and relative allowable error of 10%.

Subjects & Selection Method: According to the calculated sample size, 50 patients who presented to Gynaecology department of Jubilee Mission Medical College & Research Centre, Thrissur with postmenopausal bleeding during the study period who consequently underwent transvaginal Doppler sonographic study along with tissue diagnosis in the form of endometrial biopsy or hysterectomy.

INCLUSION CRITERIA:

1. Natural menopause - defined as 1 year of absence of menstruation in women older than 45 years provided that the amenorrhea was not explained by medication or underlying disease.
2. Postmenopausal bleeding - defined as any vaginal bleeding in a postmenopausal woman, not on any hormone replacement therapy.

EXCLUSION CRITERIA:

1. Hormonal therapy, coagulation disorders, hypothyroidism or hyperthyroidism, liver diseases, evidence of PID, neglected IUD or pessary or any cervical abnormality.

Procedure Methodology:

All females, who presented or referred to the Department of Gynecology, Jubilee Mission Medical college & Research Centre, Thrissur with complaints of postmenopausal bleeding satisfying the inclusion criteria were enrolled in the study. Clinical data was obtained from the patient side. They were subjected to transvaginal Doppler sonographic evaluation in the Department of Radiodiagnosis following which they were subjected to tissue diagnosis through endometrial pipelle biopsy or hysterectomy in subsequent setting. 7.5-MHz endovaginal transducer of MINDRAY (CD 8, V11-3E) or HITACHI-ALOKA ARIETTA (S60, 2210) or G.E (VOLUSON 730 PRO, RIC 5-9H) equipped with colour, power and pulsed Doppler capabilities were used.

Once the vessels are identified the pulsed Doppler sample volume was activated to obtain a flow velocity waveform (FVW). Resistance index (RI), pulsatility index (PI) and peak systolic velocity (PSV - cm/s) were automatically calculated from three consecutive FVWs. Pulsed Doppler evaluated even low flow vessels within the endometrium.

According to power Doppler flow mapping three different vascular patterns were defined likely:[7].

1. Multiple-vessel pattern (Pattern A)
2. Single-vessel pattern (Pattern B)
3. Scattered-vessel pattern (Pattern C)

Thereafter all the cases were referred back to Gynecology department where they underwent Pipelle endometrial sampling or Hysterectomy in the subsequent visits as suggested by the concerned consultants. Tissue diagnosis thus obtained compared with the imaging findings. Appropriate statistical tests were used to assess the data collected and conclusions were drawn.

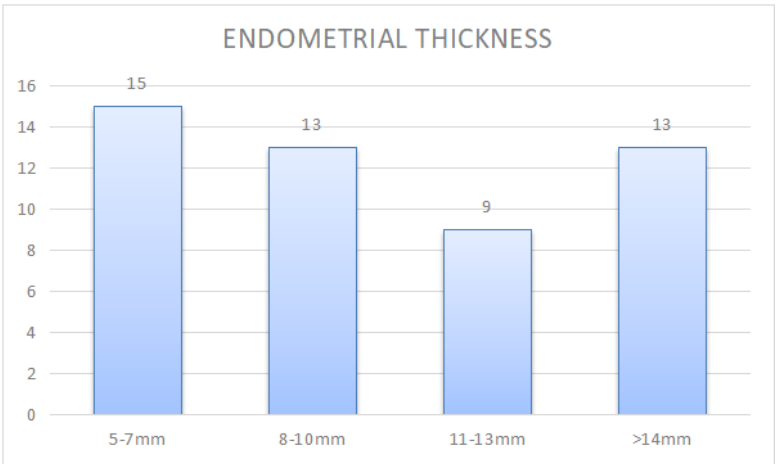
Statistical Analysis:

Diagnostic test evaluation was done using specificity, sensitivity, positive and negative predictive values and percentage analysis. Variables were expressed as mean and standard deviation. Categorical variables were expressed as frequency and percentages. Diagnostic tests were used to find the association between categorical variables. ROC curve was used to derive cut off level with maximum sensitivity and specificity. Data was entered in excel sheet and analysed by using IBM Statistical Package for Social Sciences (SPSS) version 25. The p value <0.05 was considered as statistically significant. Independent sample t-tests were also used.

III. Results

The study population comprised of 50 subjects with post-menopausal bleeding per vaginum. Mean age of study population was 60.58 ± 9.12 D, with minimum age of 49 and maximum of 87. Patient data sets available from history taking and investigations done like ultrasonography, Doppler study and pipelle aspiration or hysterectomy histology are depicted in the following tables and figures.

Endometrial thickening based on initial transvaginal ultrasonography its range and frequencies among subjects are depicted in Table 1 and Graph 1. Endometrial thickening based on Transvaginal sonography was in the range 5-7 mm in 15(30%) subjects, 8-10 mm in 13(26%), 11-13 mm in 9(18%) and >14mm in 13(26%) of subjects respectively.



Graph 1: Distribution of study participants based on Endometrial Thickness.

There was a **statistically significant difference** in the mean endometrial thickness between women with benign and malignant are 9.75 ± 1.16 mm and 15.53 ±3.15 mm respectively
(P-value < 0.01). (Independent sample t-tests was used here).

Taking an endometrial thickness of 8 mm as a cut off value.

		Histology
	Benign	Malignant
< 8mm	15	0
>= 8mm	25	10

Table 1: Frequency of distribution using 8mm as cut off value.

True Positive (TP): 10
False Positive (FP): 25
True Negative (TN): 15
False Negative (FN): 0

Hence, prediction of endometrial malignancy had
Sensitivity = 100%
Specificity = **37.5%**
Positive predictive value = 28.57%
Negative predictive value = 100%
Efficacy = 70%

Taking an endometrial thickness of 8 mm as a cut off value for prediction of endometrial malignancy had 100% sensitivity, 37.5% specificity, 28.57% positive predictive value, 100% negative predictive value, and 70% diagnostic accuracy.

Doppler study detected vascular patterns as described previously and were divided into three categories i.e., single vessel pattern, scattered vessel pattern and multiple vessel pattern in the 50 subjects are shown in Graph 2 and Table 2. Single Vessel pattern was seen in 22 (44%) subjects, Scattered vessel pattern in 20 (40%) and multiple vessel pattern in 8(16%) respectively.

	Frequency	Percent
SINGLE VESSEL PATTERN	22	44.0
SCATTERED VESSEL PATTERN	20	40.0
MULTIPLE VESSEL	8	16.0
Total	50	100.0

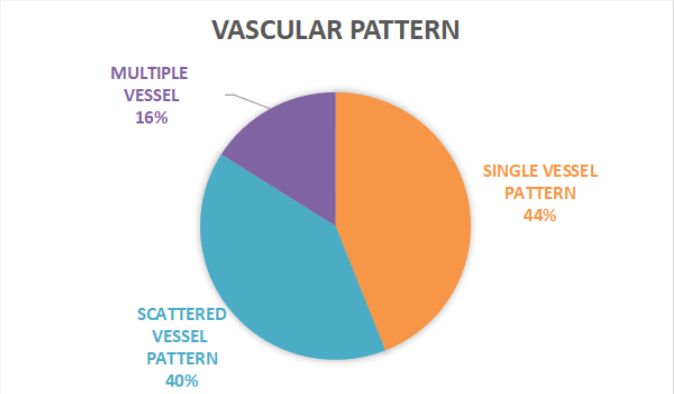


Table 2: Distribution of study participants based on Vascular pattern; Graph 2: Distribution of study participants based on Vascular pattern.

Combining thick endometrium > 8 mm to suspicious endometrial picture

		Histology
	Benign	Malignant
< 8mm or no Multiple Vessel	40	2
>= 8mm and Multiple Vessel	0	8

Table 3: Frequency of distribution using ≥ 8mm and suspicious endometrial picture.

True Positive (TP): 8
False Positive (FP): 0
True Negative (TN): 40
False Negative (FN): 2

Hence, for prediction of endometrial malignancy had
Sensitivity = 80%
Specificity = 100%
Positive predictive value = 100%
Negative predictive value = 95.23%
Efficacy = 96%

Combining thick endometrium ≥ 8 mm to suspicious endometrial picture (MULTIPLE VESSEL) gives the diagnostic values of the 80%, 100%, 100%, 95.23%, and 96%, respectively regarding sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy.

Resistance Index (RI) was <0.5 in 10 (20%) subjects, 0.5-0.7 in 38 (76%) and >0.7 in 2 (4%) subjects respectively.
Pulsatility Index (PI) was <0.8 in 4 (8%) subjects, 0.8-1.2 in 39 (78%) and >1.2 in 7 (14%) subjects respectively.
Peak systolic velocity (PSV) was <10cm/sec in 31 (62%) subjects, 10-20 cm/sec in 17 (34%) and >20 cm/sec in 2 (4%) subjects respectively.

RI	Frequency	Percent
<0.5	10	20.0
0.5-0.7	38	76.0
>0.7	2	4.0
Total	50	100.0

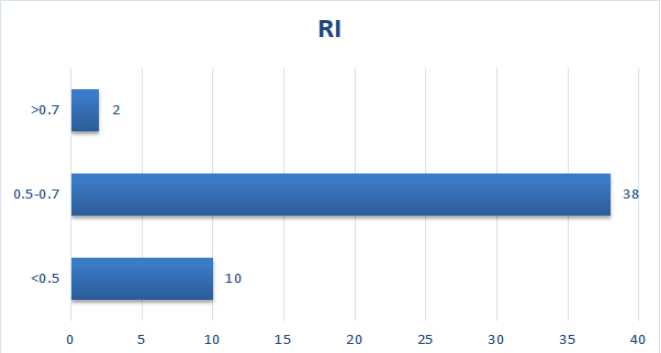


Table 4: Distribution of study participants based on RI; Graph 3: Distribution of study participants based on RI.

Combining thick endometrium > 8 mm, suspicious endometrial picture and RI < 0.5,

	Histology	
	Benign	Malignant
< 8mm or no Multiple Vessel or RI >0.5	40	2
≥ 8mm, Multiple Vessel and RI <0.5	0	8

Table 5: Frequency of distribution using > 8mm, suspicious endometrial picture and RI < 0.5

True positive (TP): 8
False Positive (FP): 0
True Negative (TN): 40
False Negative (FN): 2

Hence, for prediction of endometrial malignancy had
Sensitivity = 80%
Specificity = 100%
Positive predictive value = 100%
Negative predictive value = 95.23%
Efficacy = 96%

Combining thick endometrium ≥8 mm, RI < 0.5 and suspicious endometrial picture (MULTIPLE VESSEL PATTERN) gives the diagnostic values of 80%, 100%, 100%, 95.23%, and 96%, respectively regarding sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy. Accordingly, tables and graphs were plotted with PI and PSV.

Histology types based on Pipelle examination or hysterectomy are depicted in Graph 4/Table 7. Histolgy was benign in 40 (80%) and Malignant in 10 (20%) subjects respectively. Histopathologies belonging to the benign category were Cystic Atrophy, Polyp, Hyperplasia respectively. Few showed a combination of hyperplasia along with polyp formation. Malignant Histology was Carcinoma (Endometroid, Clear Cell, Papillary & Serous) put together.

HISTOLOGICAL TYPE	Frequency	Percent
BENIGN	40	80.0
MALIGNANT	10	20.0
Total	50	100.0

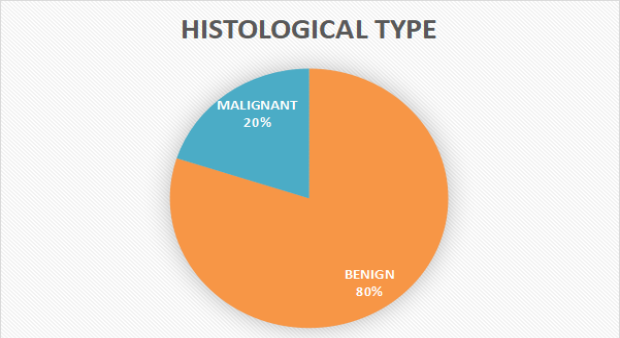


Table 6: Distribution of study participants based on Histological type; Graph 4: Distribution of study participants based on histological type

	Cystic Atrophy (n%)	Polyp (n%)	Hyperplasia (n%)	Adenocarcinoma (n%)	TOTAL
Single Vessel Pattern	3 (42.8)	17 (80.9)	0	2 (20)	22
Scattered Vessel	4 (57.2)	1 (19.1)	15 (100)	0	20
Multiple Vessel	0	0	0	8 (80)	8
Total	7	18	15	10	50

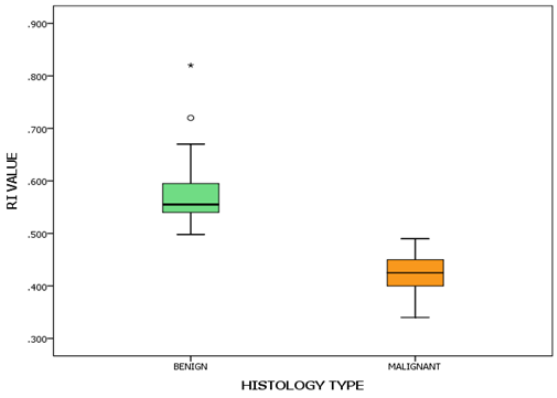
Table 7: The crosstable depicting histpathology (5 histologies) against vascular pattern (divided to 3 categories)

The power Doppler vascular patterns of the 50 patients were as follows: 8 cases showed multiple vessel pattern (16%) and all of them were diagnosed by histopathology as adenocarcinoma.
20 cases showed scattered vessel pattern (40%) and 15 of them were diagnosed by histopathology as hyperplasia, 3 of them showed polyp along with hyperplasia.
22 cases showed single vessel pattern (44%) and 17 of them were diagnosed by histopathology as polyp. 2 cases turned out to be malignancy arising from polyp (squamous cell carcinoma).

	Cystic Atrophy	Polyp	Hyperplasia	Carcinoma
RI (Mean±SD)	0.557 ± 0.031	0.578 ± 0.042	0.559 ± 0.084	0.423 ± 0.044
PI (Mean±SD)	1.157 ± 0.076	1.137 ± 0.093	1.110 ± 0.051	1.025 ± 0.078
PSV (Mean±SD)	9.871 ± 3.889	8.928 ± 5.594	8.192 ± 4.448	10.350 ± 5.068

Table 9: Mean ± standard deviation of Flow parameters like RI, PI and PSV across the four histologies.

Sensitivity and Specifity and Youden's Index (Sensitivity+ Specificity-1) was calculated for each of the flow parameter under study across varying measurements recorded across the 50 subjects.
RI values most corresponding to a malignant histology was observed at a value at or below 0.494. RI value of 0.494 can be taken as a cut-off value as at this point as both Sensitivity and Specificity is at 100%.
If an ROC curve is plotted Area under the Curve would be 1. An RI value above 0.494 is denoting a benign lesion.



Graph 5: Box and Whisker plot based on histology type.

Coordinates of the Curve for RI			
Benign if Greater Than or Equal To	Sensitivity	1 - Specificity	Youden Index
0.465	1	0.2	0.8
0.485	1	0.1	0.9
0.494	1	0	1
0.499	0.975	0	0.975
0.51	0.925	0	0.925

Table 10: Coordinates of the Curve for RI.

Denotes the distribution of RI value among benign and malignant.

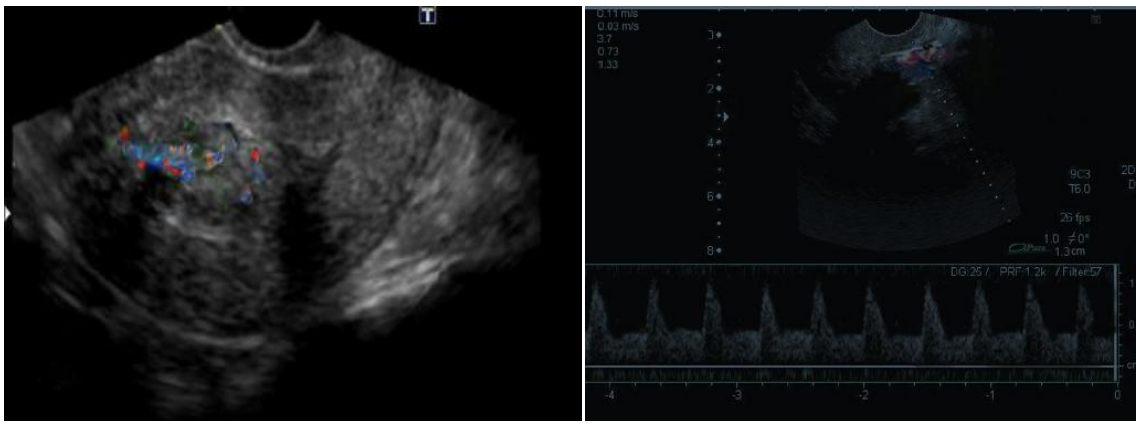
Sensitivity, Specifity and Youden's Index(Sensitivity+ Specificity-1) was calculated for each of the flow parameter under study across varying measurements recorded.
Accordingly, PI values most corresponding to a malignant histology was observed at a value at or below 1.025. PI value of 1.025 can be taken as a cut-off value as at this point where Sensitivity was 90% and Specificity was 70%.

A PI value below 1.025 is more likely denoting a Benign lesion. If an ROC curve is plotted Area Under the Curve would be 0.849.

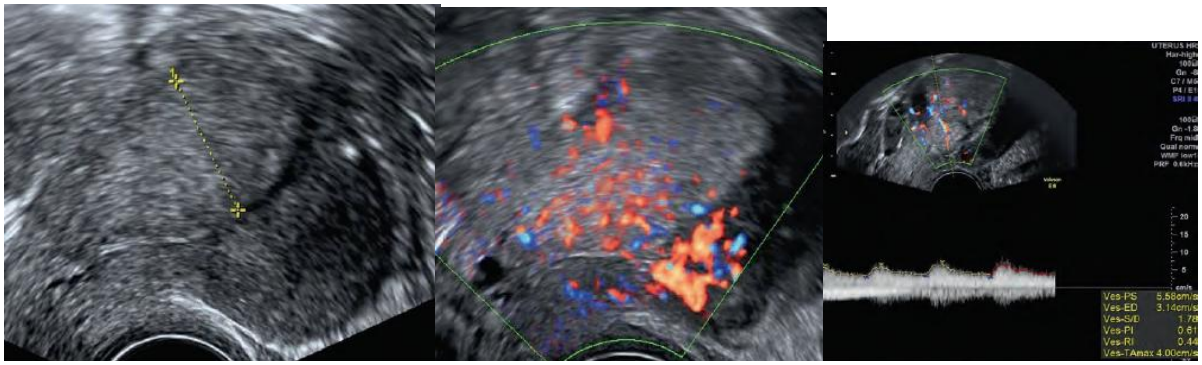
PSV which was one other flow parameter that was assessed showed low sensitivity and specificity across different reading level in truly differentiating a carcinoma. Area Under the Curve was 0.417 when an ROC was plotted.

PSV value of 10 if taken as a cut -off value as at this point Sensitivity is 37.5% and Specificity is 60%.

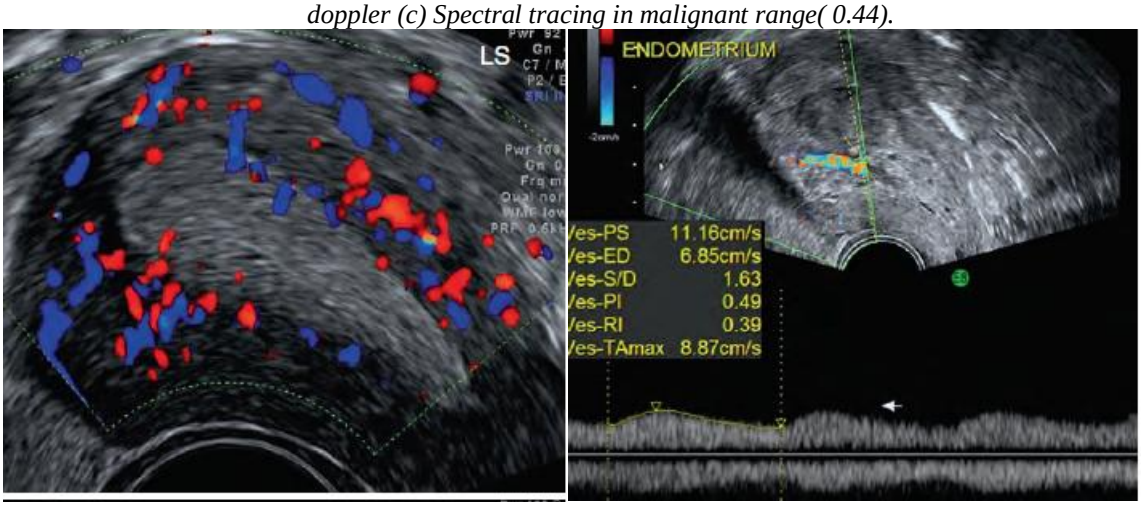
Results points us to the observation that Resistance index can be used as a measure with high sensitivity and Specificity in predicting malignant histologies and has good potential based on this study as a screening tool. Pulsatility Index rated slightly inferior but promising. Peak Systolic Velocity (PSV) had poor sensitivity and specificity across different reading levels and cannot be recommended as a good screening tool based on this study results.



Endometrium is thickened.Power Doppler showing feeding vascular pedicle. Spectral tracing showed RI of 0.67 suggestive of endometrial polyp. On tissue diagnosis confirmed the finding.



Case of endometrial adenocarcinoma showing(a) thickened endometrium (b)Multiple tortuous vessels on power doppler (c) Spectral tracing in malignant range(0.44).



Case of Endometrial hyperplasia showing scattered vessel on power Doppler. Spectral tracing showed RI in equivocal range. On histopathology it turned out to be hyperplasia with atypia.

IV. Discussion

Endometrial carcinoma is second commonest only to carcinoma breast worldwide in females and has a very high five-year mortality rate all stages put together. When diagnosed at an early stage, adequate treatment has been proven to be quite productive in providing good survival benefits. These points to the requirement of a good screening technique to pick these subjects from high-risk population.

As of now there is no recommendation for an ideal screening technique in carcinoma endometrium. In routine practice carcinoma endometrium is picked up by using histology using D&C or Pippele aspirations. Although all these techniques can give morphological or histopathologic patterns suggestive of carcinoma, none of them has the virtues of a very good screening tool like high sensitivity, high specificity, non-invasive nature or convenience of execution put together.

Transvaginal ultrasonographic study with measurement of endometrial thickness is found to be one of the most significant and non-invasive screening tool till date[9]. Smith-Bindman *et al*. in his meta-analysis showed that using endometrial thickness cut off values ≥ 5mm false negative rates in post-menopausal bleeding is as low as 4%[9]. Recently combining transvaginal colour and pulsed Doppler study with endometrial thickness has increased the reliability [10].

In our study we have taken a sample size of 50 women who presented with postmenopausal bleeding. Majority of patients (40%) were having a period of amenorrhoea ranging between 6-10 years. 12 subjects (24%) had <6 yrs of amenorrhoea before developing post-menopausal bleeding per vaginum and 18 (36%) had >10yrs of amenorrhoea respectively.

Out of the 50 study subjects, 3 (6%) had no offsprings, 38 (76%) had <3 kids and 9 (18%) had >3 kids. 2 among the 3 nulliparous subjects turned out to be malignancy on histopathology which is in agreement with the literature which suggests nulliparity as a strong predictor of endometrial malignancy.

Among the 50 patients that we studied the mean for endometrial thickness measured by transvaginal scan in cases of cystic atrophy, polyp, hyperplasia, and adenocarcinoma was 7.91 ± 1.13 mm, 9.38 ± 1.09 mm, 10.74 ± 0.87 mm, and 15.53 ± 1.41 mm respectively. A cut off value of ≥ 8mm in prediction of endometrial carcinoma showed 80% sensitivity, 100% of specificity, 100% of positive predictive value, 95.23% of negative predictive value and 96% of efficacy.

As described earlier endometrial blood flow can be evaluated non – invasively using colour and power Doppler ultrasound. Power Doppler is superior and sensitive to colour Doppler imaging in detecting low velocity blood flow and hence improving the visualisation of small vessels. Our results indicate that the use of vascular patterns by power Doppler imaging in defining endometrial conditions of postmenopausal age group is useful in distinguishing between endometrial malignancy from other benign conditions like polyps and hyperplasia. Out of the 50 patients, 8 patients showed multiple vessel pattern and all of them turned out to be adenocarcinoma on histopathology (80%). 2 other cases which demonstrated single vessel pattern on power Doppler turned out to be polyp with malignant transformation (20%). This is almost in agreement with Epstein et al. [11]who detected power Doppler signals in all cases of malignancy (16 out of 16).

The diagnostic performance of power Doppler for detecting malignancy was: Sensitivity 80%; specificity 100%; positive predictive value 100%; negative predictive value 95.2%. These results were superior to those found by Alcazar et al.[7] who reported sensitivity, specificity, positive predictive value and negative predictive values of 78.8%, 100%, 100% and 89% respectively.

In the present study, single vessel pattern suggestive of endometrial polyp was detected in 22 patients (44%). 94.4% of polyps on histopathology had the corresponding vascular pattern. Amit et al. [103] also reported the same pattern in case of endometrial polyp on conventional colour Doppler imaging. Taking tissue diagnosis as gold standard, the diagnostic performance of power Doppler for detecting endometrial polyp was: Sensitivity 80.9%; specificity 82.7%; positive predictive value 77.2%; negative predictive value 85.7%. These results were inferior to those found by Alcazar et al.[17] , who reported sensitivity, specificity, positive predictive value and negative predictive value as 89.2%, 87%, 82.5%, and 92.2% respectively.

Power Doppler signals were found in 20 patients of endometrial hyperplasia in our study. The vascular pattern was scattered type. Out of these, 12 cases were hyperplasia on histopathology and 3 cases had polyp formation along with hyperplasia (40%). Diagnostic performance of power Doppler for detecting endometrial hyperplasia was: Sensitivity 100%; specificity 85.7%; positive predictive value 75%; and negative predictive value 100%.

Regarding velocimetric studies, we found that malignant endometrium had much low RI (0.423 ± 0.044) and high PSV (10.350 ± 5.068) than other causes of postmenopausal bleeding. Even though 2 patients with single vessel pattern on sonography became malignant on histopathology, their corresponding RI and PI were still in the malignant range. Thus, giving a suspicion of an underlying malignant pathology.

Alcazar et al.[12] had assessed and correlated malignant blood flow as detected using power Doppler imaging with tumour histopathology. In our study we have reported a much higher RI (0.578 ± 0.042) for endometrial polyps than in cases with endometrial carcinoma (0.423 ± 0.044), this is similar to the study done

by Kupesic and Kurjak [13] who reported RI of more than 0.45 for polyps. In cases with endometrial hyperplasia, we again reported a higher RI (0.559 ± 0.084) than endometrial malignancy. This is also in agreement with Kupesic and Kurjak who reported RI of 0.55 in endometrial hyperplasia.

Sensitivity and specifity and Youden's Index (sensitivity+ specificity-1) was calculated for each of the flow parameter under our study across varying measurements recorded across the 50 subjects. RI values most corresponding to a malignant histology was observed at a value at or below 0.494. Thus, RI value of 0.494 can be taken as a cut-off value as at this point as both Sensitivity and Specificity is at 100%. An RI value above 0.494 is denoting a Benign lesion. If an ROC curve is plotted Area Under the Curve would be 1. Accuracy of a diagnostic test is measured by area under a ROC curve. An area of 1 represents a perfect test.

Likewise, PI values most corresponding to a malignant histology was observed at a value at or below 1.025. PI value of 1.025 can be taken as a cut-off value as at this point where Sensitivity was 90% & and Specificity was 70%. A PI value below 1.025 is more likely denoting a benign lesion. If an ROC curve is plotted Area under the curve would be 0.849.

In case of PSV which was one other flow parameter that was assessed, showed low sensitivity and specificity across different reading level in truly differentiating a carcinoma. Thus, being a less accurate diagnostic test.

V. Conclusion

Transvaginal Doppler as a noninvasive test can be used as a screening tool in patients with postmenopausal bleeding who are not on any hormone replacement therapies or tamoxifen. The vascular pattern and waveform indices, especially RI in such women are of great help in discriminating carcinoma from benign causes.It can be used as a promising tool in screening asymptomatic women of postmenopausal age group with risk factors of endometrial carcinoma

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Dr.Varsha Venugopal Nair, et. al. "Diagnostic Evaluation of Transvaginal Doppler Sonographic Study in Differentiating Benign and Malignant Endometrial Conditions In Postmenopausal Bleeding." *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)*, 21(01), 2022, pp. 27-35.