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ORIGINAL ARTICLE

Added Value of Transvaginal Real-Time Shear Wave Elastography in the Diagnosis of Endometrial and Sub-endometrial Lesions

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ABSTRACT

Background: Endometrial and sub-endometrial lesions are a common cause of abnormal uterine bleeding. Ultrasound is a reliable diagnostic tool for those lesions, but not all patients exhibit definite changes in ultrasound, making additional techniques necessary. Elastography, such as shear wave elastography (SWE), can assess the mechanical properties of the endometrial lesions and provides a quantitative measure of tissue stiffness and so aids in differentiating different pathologies. Our study aimed to determine the added value of SWE in diagnosis of different endometrial and sub-endometrial lesions.

Methods: Thirty-six female patients presented with abnormal uterine bleeding (AUB) with pathologically proven endometrial and sub-endometrial pathologies were included in this prospective study and assessed with transvaginal SWE. The mean elasticity values (E mean) in Kilopascals (KPa), and the ratio of the mean elasticity of the lesion to the mean myometrial elasticity (E/M ratio) were calculated in variable lesions.

Results: There was a statistically significant difference in the E mean ($P < 0.001$) as well as the E/M ratio of different endometrial and sub-endometrial lesions ($P < 0.001$). E mean value in endometrial carcinoma (EC) was 39.79 ± 3.65, endometrial hyperplasia (EH) was 24.24 ± 1.52, and endometrial polyp was 15.74 ± 2.71. While that of submucosal fibroid was 59.36 ± 12.84 and adenomyoma (AM) was 52.15 ± 4.44. In the analysis of the subgroups, the E/M ratio of uterine polyp (0.36 ± 0.07) was statistically significantly lower than other subgroups ($P <0.01$), while submucosal leiomyoma (1.8 ± 0.27) and focal adenomyoma (1.37 ± 0.07) had significantly higher values than other subgroups ($P < 0.01$).

Conclusions: Shear wave elastography is an effective additional method in differentiating between benign and malignant endometrial and sub-endometrial lesions when combined with conventional ultrasonography.

Keywords: Shear wave elastography; Endometrial lesions; Sub-endometrial lesions; E mean; E/M ratio

INTRODUCTION

Premenopausal women with AUB constitute a large proportion of gynaecologic consultations, often resulting in a variety of diagnostic tests being ordered. The most common pathologies in premenopausal women associated with AUB are submucous fibroids, endometrial polyps, and endometrial hyperplasia [1]. They often pose a diagnostic challenge to radiologists and gynecologists due to the non-specific clinical presentation and appearance on initial imaging evaluation. The accurate diagnosis of these conditions may result in surgical or medical treatment being directed at the specific pathology and may avoid the need for major surgery [2].

According to current guidelines, transvaginal ultrasound (TVS) should be the first-line imaging modality in premenopausal patients with abnormal uterine bleeding. Saline infusion sono-hysterography and diagnostic hysteroscopy should be used in differential diagnosis and characterization of intrauterine lesions [3].

However, sono-hysterography is more expensive and time-consuming than classic TVS (including elastography), requires the use of catheters, and is an invasive procedure (even though minimally), thus carries the risk of complications (pain, infection). Moreover, during sono-hysterography, pedunculated fibroids may mimic polyps, while broad-based polyps may appear as fibroid-like ones. These drawbacks justify the search for new diagnostic approaches for distinguishing intrauterine lesions [4].

Elastography is somehow a new non-invasive ultrasound method that evaluates tissue's mechanical stiffness based on Hooke's law. Hooke's law describes the behaviour of an elastic spring subjected to a force, F, longitudinally, either in traction or compression. Hooke's law states that an elastic body undergoes a deformation that is directly proportional to the force applied to it. This law is valid, of course, within certain limits, beyond which the body loses the capacity to return to its original shape (elastic behavior) and becomes permanently deformed (plastic behavior) [5].

This technique may be able to provide an extra pattern for endometrial and sub-endometrial pathologies' characterization, and widen the scope of traditional sonographic investigations [6]. Each diagnostic imaging procedure has its own advantages along with disadvantages, and no imaging examination is enough to accurately diagnose the disease. As a result, SWE should not replace conventional transvaginal ultrasound but should be an addition to it [7].

Shear wave elastography displaces tissue using dynamic, acoustic forces generated by the ultrasound system and is less user-dependent than strain imaging. The shear wave velocity can qualitatively and quantitatively estimate tissue stiffness [8].

Our study aimed to determine the added value of shear wave elastography (SWE) in the diagnosis of different endometrial and sub-endometrial lesions.

METHODS

1. Study type and population:

A single-center prospective cross-sectional study that was conducted at a tertiary hospital and included all the consecutive female patients with abnormal uterine bleeding that may be related to a focal or diffuse endometrial or sub-endometrial irregularity on primary transabdominal or TVS referred from gynecological outpatient clinic to the department of radiodiagnosis for transvaginal SWE and were subjected after that to histopathological correlation of the excised lesion or the biopsy. During the period from September 2023 to March 2024, in addition to the transvaginal SWE data, the variables collected included the patients' demographics, medical history, and clinical characteristics. Patients who receive estrogen replacement therapy (ERT)/radiotherapy or chemotherapy (n=9), patients who had a curettage (D&C), patients with an IUD for endometrial pathology (n=2), as well as virgin females (n=3), cases where pathological reports were not accessible (n=7), pregnant females, and suboptimal SWE images or maps were excluded from our study. Finally, 36 patients were enrolled in the study, their ages ranged from 20 to 75 years, with a mean age of 42.81 ± 11.45 years. The study has been carried out in accordance with the code of ethics of the World Medical Association (Declaration of Helsinki): Ethical Principles for Medical Research Involving Human Subjects. Approval was obtained from our institutional review board (IRB) (IRB #10742/30-4-2023), and the patient's informed consent was taken. All patients were subjected to transvaginal SWE in addition to histopathological examinations of the excised mass or the biopsy.

2-Transvaginal ultrasound and SWE:

The imaging study for the research consisted of transvaginal ultrasonography and SWE, which were performed using a Toshiba Canon Aplio 500 ultrasound machine (made in Japan) with a multifrequency 3.5-8.8 MHz transvaginal probe. The patients laid supine in lithotomy position and a protective condom was covering the transvaginal probe. The examination was performed by a radiologist with 5 years of experience.

First, Gray scale ultrasound (B-Mode) examination was performed in sagittal and axial planes to evaluate the uterine endometrium and myometrium with paying special attention to each. Observation of whether the endometrium had a focal mass or widespread thickening. After that, Color Doppler imaging was done to evaluate the mass's vascularity.

After ensuring the endometrial pathology of interest was perfectly prepared, the pathological lesion of endometrium or sub-endometrium was examined with SWE.

3-SWE examination:

In shear wave elastography, the transducer was kept stationary with light pressure and a generous amount of coupling gel during the acquisition of each SWE sonogram, using B-mode to ensure the

endometrial or sub-endometrial pathology of interest. After freezing the elastography image, a circle was drawn around the region of interest (ROI) (3-5 mm) within the elastography window in both lesion and normal myometrial to assess the tissue stiffness of the lesion and measure the E/M ratio. We took care to adjust the ROI to the maximum homogeneous and thick tissue to avoid the ROI bias. To optimize the width of ROI, the same ROI size was handled to both lesion and normal myometrium. Three random measurements were performed, and the mean value was used as the final value. In the present study, tissue elasticity was measured in kPa of the spectrum scale, which guided the placement of the ROI cursor. Each pixel in the SWE image represented the tissue stiffness as a semi-transparent color map with a range of dark blue to red (0–180 kPa), signifying a low to high shear modulus (stiffness). This color map's level of homogeneity was observed for different endometrial or sub-endometrial pathologies. Next, the standard regions of interest (ROI) were utilized to produce the quantitative evaluation of tissue stiffness of diseases (Q-box).

Images with speckling or an empty Q-box were not included. Within the ROI, the system yielded the mean (E mean). The mean elasticity value of normal myometrium was also calculated to obtain the E/M ratio. Overall, the imaging study was conducted with meticulous attention to detail to ensure results obtained accuracy.

Image Analysis

The elastography box is a color map that overlays B-mode ultrasound image. The blue color indicates that the lesion is less stiff, while the red color indicates high stiffness of the lesion.

SWE images were interpreted by two experienced women imaging radiologists, each with 10 years' experience, blinded to the histopathological data. They were asked to comment in each case on homogeneity of color map (homogenous or heterogenous), E mean of the lesion, and E/M ratio. All obtained data were correlated to the histopathological data to assess the added value of transvaginal SWE in the diagnosis of different endometrial and sub-endometrial lesions.

Histopathology Analysis

Every patient had additional histopathology assessment, either hyseterectomy, endometrial biopsy, or hysteroscopic biopsy. The definitive histological diagnosis was regarded as the gold standard.

STATISTICAL ANALYSIS

Statistical analysis was done by SPSS version 28 (IBM Co., Armonk, NY, USA). Quantitative data were presented as mean and standard deviation (SD), analysed by one-way ANOVA (F) test with post hoc test (Tukey). Shapiro test was used to detect normality of the data and the data was normally distributed. Categorical data were presented as frequency and percentage. ROC curve analysis was used to estimate the diagnostic performance of every SWE cut-off value to select the best one based on Youden index. A two-tailed P value < 0.05 was considered statistically significant.

RESULTS

The study consisted of 36 female patients with AUB who were referred for transvaginal ultrasound and SWE. The mean age was 42.81 ± 11.45 years (range between 20 and 75 years). More than two thirds of patients (69.4%) were premenopausal (**Error! Reference source not found.**).

As shown in **Error! Reference source not found.**, endometrial and sub-endometrial lesions were classified by transvaginal SWE as endometrial carcinoma (30.6%), polyp (25%), hyperplasia (19.4%), submucosal fibroid (13.9%), and adenomyosis (11.1%).

We noticed that EC showed variable homogeneity, with 45.4% of cases showed heterogeneous color maps, while 85.7% of the patients with hyperplasia showed a homogeneous color map, and 100% of endometrial polyps showed a homogenous color map. We noticed that submucosal leiomyomas and focal adenomyomas were notable for high intralesional variability in the elasticity. This is also reflected in the form of heterogeneous color maps in which submucosal leiomyomas showed marked heterogeneity in 80% of the cases and 75% of focal adenomyomas also showed a heterogeneous color map as in Table 3.

There was a statistically significant difference regarding E mean of the studied lesions (P<0.001), as the values of fibroid and adenomyosis were significantly higher than those of endometrial pathologies (polyps, EH & EC), the value of carcinoma was significantly higher than that of hyperplasia and both were significantly higher than that of polyp. Also, there was a significant difference among the studied lesions regarding E/M ratio (P<0.001) as the ratio of fibroid was significantly higher than that of endometrial lesions (polyps, EH and EC), E/M ratio of carcinoma and hyperplasia were significantly lower than that of

adenomyosis, and all three were significantly higher than that of polyp (Table 4).

E mean and E/M ratio had a significant diagnostic ability for detecting EC as in (Table 5).

The cut-off value of E mean for differentiation between benign and malignant endometrial lesions (34.2 kPa), E mean > 34.2 indicates the endometrial lesion is mostly malignant and showed sensitivity (SN) of 90%, specificity (SP) of 94.12%, positive predictive value (PPV) of 90% and negative predictive value (NPV) of 94.1% (AUC=0.941, P<0.001).

The cut-off value of E/M ratio for differentiation between benign and malignant endometrial lesions (0.6), E/M ration > 0.6 is more in favor of EC and showed sensitivity of 100%, specificity of 82.94%, PPV of 85.6% and NPV of 100% (AUC=0.809, P<0.001).

Table 1: Baseline characteristics of the studied patients with AUB (n=36)

		Total patients (n=36)
Age (years)	**Mean ± SD**	42.81 ± 11.45
	Range	20 – 75
Menopausal status	**Premenopausal**	25 (69.4%)
	Postmenopausal	11 (30.6%)

Data are presented as frequency (%) unless otherwise mentioned.

Table 2: Transvaginal SWE diagnosis of the studied patients (n=36)

	N	**%**
Carcinoma	11	30.6
Polyp	9	25.0
Hyperplasia	7	19.4
Fibroid	5	13.9
Adenomyosis	4	11.1

Table 3: Qualitative assessment of lesions by color map among the studied patients (n=36)

Group	**Homogenous**	**%**	**Heterogenous**	**%**
Endometrial polyp (n=9)	9	100%	0	0 %
Endometrial hyperplasia (n=7)	6	85.7%	1	14.3%
Endometrial carcinoma (n=11)	6	54.6%	5	45.4%
Fibroid (n=5)	1	20 %	4	80%
Adenomyoma (n=4)	1	25%	3	75 %

Table 4: Shear wave elastography values of the studied lesions

	Carcinoma (n=11)	**Polyp (n=9)**	**Hyperplasia (n=7)**	**Fibroid (n=5)**	**Adenomyosis (n=4)**
Mean value (of lesion)	39.79 ± 3.65 [a]	15.74 ± 2.71 [b]	24.24 ± 1.52 [c]	59.36 ± 12.84 [d]	52.15 ± 4.44 [d]
	34.2 - 44.2	11.5 - 19.1	22.5 - 26.4	46 - 78.7	48.2 - 58.5
Endometrial/ Myometrial ratio	0.78 ± 0.1 [a]	0.36 ± 0.07 [b]	0.69 ± 0.07 [a]	1.8 ± 0.27 [c]	1.37 ± 0.07 [d]
	0.62 - 1.02	0.29 - 0.5	0.59 - 0.8	1.48 - 2.1	1.29 - 1.45

Data are presented as mean ± SD and range, *: Statistically significant as P value<0.05, Different lower-case letters indicate significant difference in pairwise comparison.

Table 5: Diagnostic performance of shear wave elastography values for differentiation between benign and malignant endometrial lesions

	Cut-off	Sensitivity	Specificity	PPV	NPV	AUC	P value
Mean value (of lesion)	>34.2	90	94.12	90	94.1	0.941	**<0.001***
Endometrial/ Myometrial ratio	>0.6	100	82.94	85.6	100	0.809	**<0.001***

*: Statistically significant as P value<0.05, PPV: Positive predictive value, NPV: Negative predictive value, AUC: Area under the curve

Table 6: Diagnostic performance of US for assessment of different lesions

	Sensitivity	Specificity	PPV	NPV	Accuracy
For carcinoma	90	92.31	81.82	96	91.67
For polyp	90	100	100	96.3	97.22
For hyperplasia	71.43	93.1	71.43	93.1	88.89
For fibroid	100	96.88	80	100	97.22
For adenomyosis	80	100	100	96.88	97.22

PPV: Positive predictive value, NPV: Negative predictive value

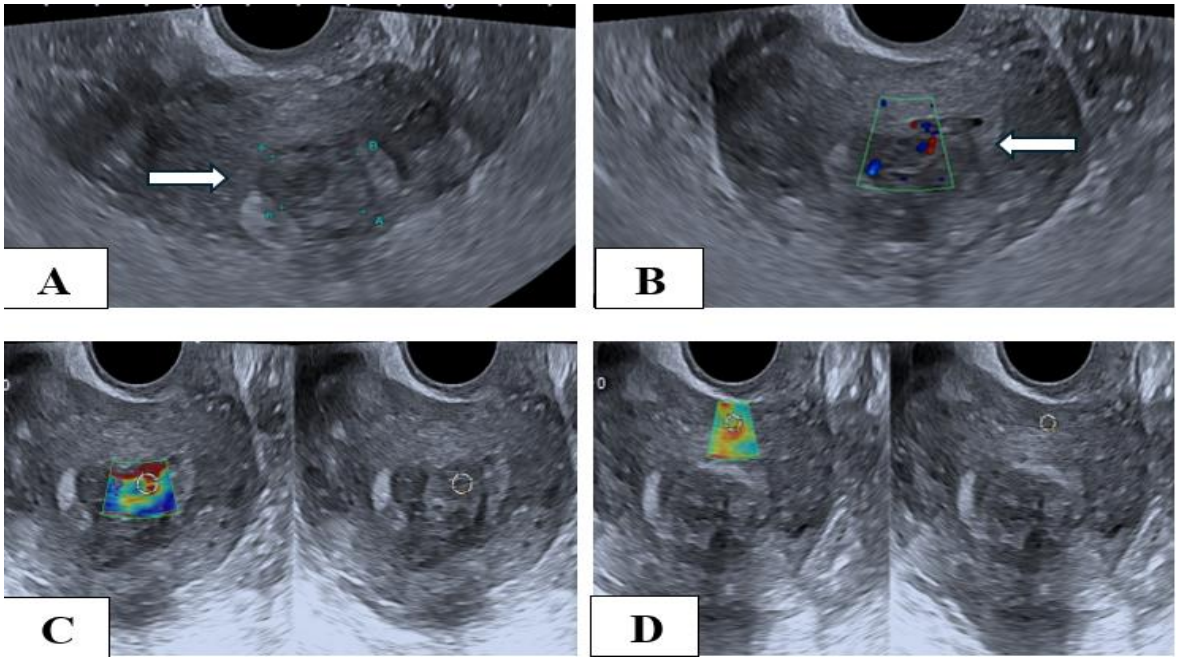

Figure (1): Submucosal Fibroid in a Thirty -five premenopausal Female patient presented by vaginal bleeding for 9 months. (A) Longitudinal B-mode TVS: shows small well defined heterogenous submucosal lesions largest measures 21x19 mm. (B) Colour doppler study shows central and peripheral vascularity. (C) SWE of the lesion reveals heterogenous color map with the E mean of the lesion =64.1 Kpa. (D) SWE of normal myometrium reveals the E mean of normal myometrium=49.6 Kpa. E/M ratio= 1.3

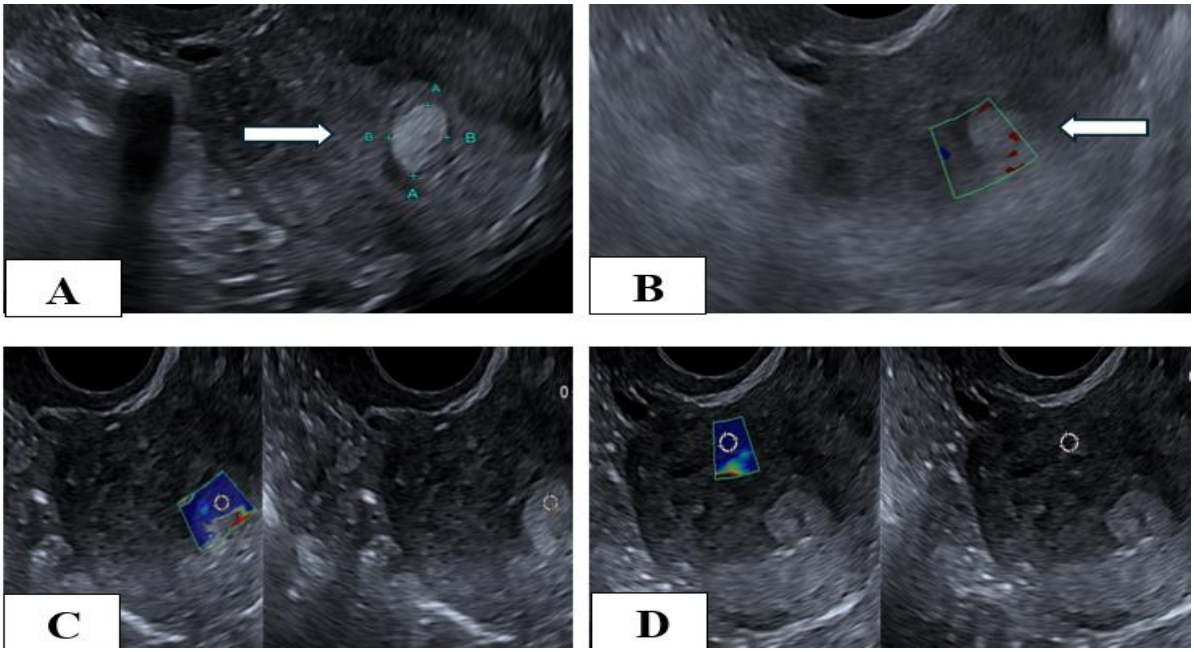

Figure (2): Endometrial polyp in a Thirty -nine premenopausal Female patient presented by bleeding for 2 months. (A) Longitudinal B mode TVS: Uterus show small well defined oval shaped homogenous isoechoic endometrial lesion measures 9.9X5.3 mm. (B) Colour Doppler study: show central feeding vessel. (C) SWE: homogenous colour map with the E mean of the lesion = =12.5 Kpa. (D) SWE: the E mean of normal myometrium =46 Kpa. E/ M ratio=0.27.

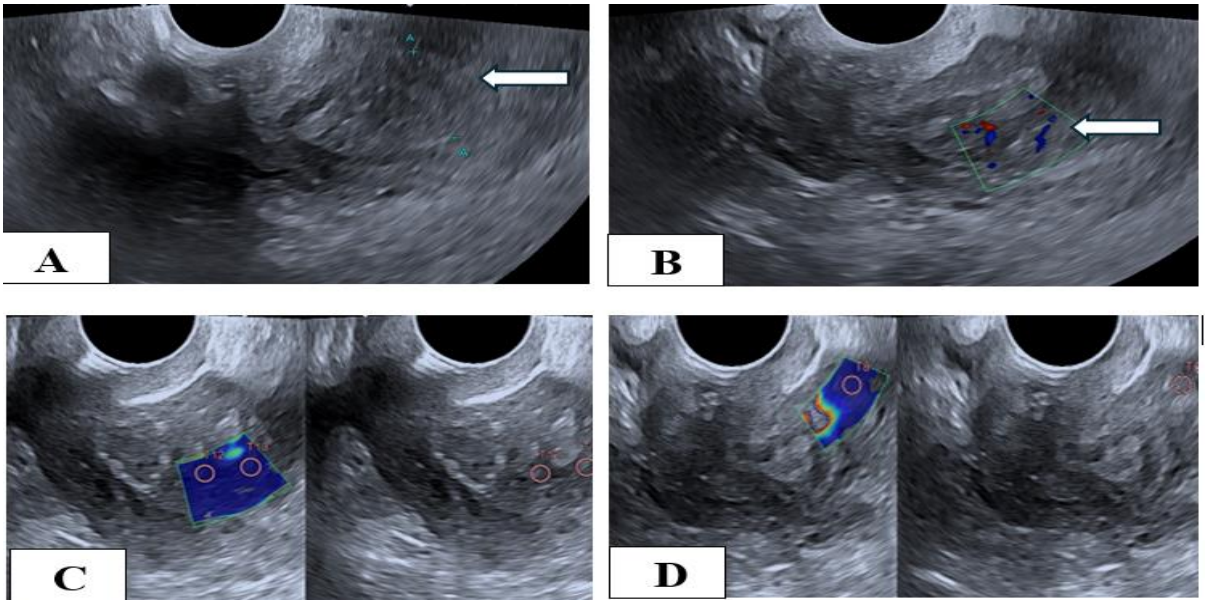

Figure (3): Endometrial hyperplasia in a Fifty -five years old Female patient presented by post-menopausal bleeding for few months and increased the last 2 weeks. (A) B-mode TVS (sagittal plane): homogenously thickened Endometrium, measures about 20.6 mm, intact endo-myometrial junction. (B) Colour doppler study: shows mild central vascularity. (C) SWE: homogenous colour map with the E mean of the lesion = 31.7 Kpa. (D) SWE: The E mean of normal myometrium =55.4 Kpa., E/M ratio=0.57.

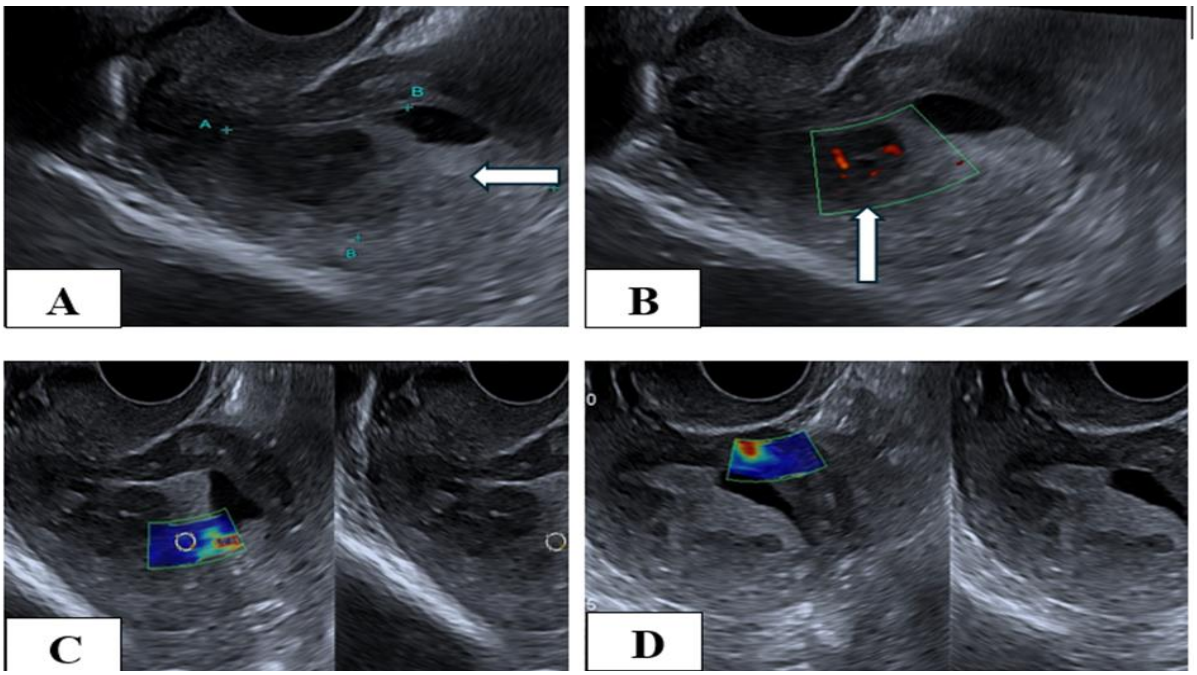

Figure (4): Endometrial carcinoma in a Fifty -four years old Female patient presented by Postmenopausal bleeding for 7 months. (A) Longitudinal B-mode TVS shows: heterogenous endometrial lesion measuring about 54.4 x31 mm, indistinct endo-myometrial junction and area of cystic degeneration. (B) Colour doppler study: show minimal central vascularity. (C) SWE: heterogenous color map with the E mean of the lesion = 43 Kpa. (D) SWE: the E mean of normal myometrium =55.4 Kpa. E/ M ratio=0.77.

DISSCUSSION

Because of their non-specific clinical presentation and features on primary imaging assessment, endometrial diseases pose a diagnostic challenge to radiologists and gynecologists. The primary examination of choice is TVS, but the results are non-specific and can include endometrial heterogeneity, diffuse thickening, or localized lesion [9].

In our study, 69.4% of patients were premenopausal, while the rest (30.6%) were postmenopausal. This agrees with Wozniak et al. [10] and Latif et al. [11] studies in which 75% & 74% of patients were premenopausal and 25% & 24% were postmenopausal. But this is in contrast with Ma et al. [7], who found that 59% were postmenopausal and 41% were premenopausal state.

In our study, the most common lesion was endometrial carcinoma for 11 patients (30.6%), and the least common lesion was adenomyosis (11.1%). Our results were in agreement with Vora et al. [2], who stated that the most common lesion examined was of a malignant nature (38.3%) and the least common lesion was adenomyosis (9.5%). While our results were in contrast to Elsayed et al. [12], who found the most common lesion was endometrial polyp (30.3%) and increased endometrial thickness (30.3%), followed by submucous leiomyoma (24.3%), then the least common lesion was intrauterine septum (15.1%).

Upon qualitative analysis of the elastography using color maps, we discovered that endometrial cancer displayed varying degrees of homogeneity, with 45.4% of cases showed heterogeneous maps and 85.7% of patients with EH showed homogeneous maps, and 100% of endometrial polyps showed homogenous colour map. This is in line with Vora et al. [2], who discovered that while 100% of patients with endometrial hyperplasia displayed a homogenous map, 35.7% of cases of endometrial cancer showed heterogeneous color maps. The pleomorphism and necrotic alterations that may be present in carcinoma might be used to illustrate this shift in color map.

With the development of ultrasound technology, improving the accuracy of the early diagnosis of EC has become a research hotspot. Studies have shown that the hardness of endometrial lesions is closely related to their biological characteristics, and elastography can directly analyze the hardness of tissues, which provides a new idea for the differential diagnosis of benign and malignant endometrial lesions.

Our study stated that values of endometrial carcinoma were higher than those of endometrial hyperplasia, and both were statistically significantly higher than those of endometrial polyp, indicating that shear wave elastography mean values of malignant endometrial lesions are higher than those of benign endometrial lesions.

The E mean of EC appears to be in the range of 34.2 Kpa to 44.2 Kpa, while E mean in individuals with benign lesions were in the range of 11.5-19.1 in endometrial polyps and 22.5 to 26.4 Kpa in endometrial hyperplasia. So, these results agreed with Ma et al. [7], who stated that the range mean value of shear wave elasticity in EC and AEH (21.36 -55.56KPa) was significantly higher than the benign group (9.94 – 25.98KPa).

Also, our results were in line with Du et al. [13], using shear wave elastography, showed E mean values to be significantly lower in benign tissue with a range of 15.68–21.20 Kpa compared to a range of 38.46 Kpa–49.36 Kpa.

Guler et al. [14], the E mean was statistically significantly higher in group III (malignant endometrial lesions) when compared to group I (normal endometrium) and group II (benign endometrial lesions). We found some overlap may occur between atypical endometrial hyperplasia and endometrial carcinoma. The pleomorphism and necrotic alterations that may be observed in cancer provide an explanation for this. The elasticity characteristics of these two groups did not differ statistically significantly based on a quantitative analysis. And this was similar to Vora et al. [2] results.

Thus, it may be suggested that EC pathologically experiences a range of increasing cellular pleomorphism, with an increase in nuclear atypia in the earlier stage while in the later stage increase in a solid component. As a result, elastography may not show an apparent variance between the elasticity values of hyperplastic endometrium and cancer in its early stages. The elasticity of both groups was less than that of the myometrium.

Marshall et al. [15] stated that all studies performed on women with increased endometrial thickness or endometrial lesions found statistically significant differences between the stiffness of endometrial carcinoma and benign endometrial lesions when using elastography.

Although submucosal fibroid is a benign pathology, our study stated that the E mean values of SWE as well as the E/M ratio of it are significantly higher than other benign lesions and also higher than malignant lesions due to its nature (fibrosis).

In our study, we recorded that the E/M ration was statistically significantly higher in sub-endometrial lesions (1.8+- 0.27 in fibroid and 1.37+- 0.07 in adenomyosis.) than endometrial lesions and statistically significantly higher in malignant endometrial carcinoma (0.78+\- 0.1) than that of benign endometrial lesions (E\M ratio of polyp & endometrial hyperplasia is 0.36+\-0.07 and 0.69+\-0.07 respectively). This is in line with the findings of Vora et al. [2], who indicated that endometrial cancer and hyperplasia differed statistically significantly from submucosal leiomyoma and adenomyoma separately in terms of their elasticity values. Also, our study agreed with Zhang et al. [16] and Acar et al. [17] studies, which demonstrated that the mean values of SWE were higher in leiomyoma and adenomyoma than in normal myometrium.

Regarding focal endometrial and sub-endometrial lesions, there may be some conflict in the ultrasound feature of endometrial polyps, submucosal fibroid, and focal adenomyoma. Our results revealed that both the shear wave E mean and E\M ratio were statistically significantly lower in endometrial inflammatory polyps (15.7 ±2.71 and 0.36+\- 0.07) compared to the sub-endometrial benign focal lesions (P<0.001). E mean and E\M ratio of fibroid was 59.36+- 12.84 and 1.8+- 0.27 and adenomyosis 52.15+- 4.44 and 1.37+-0.07 (p value <0.001) suggesting that compared to the normal myometrium, both lesions are stiffer. These results were consistent with Wozniak et al. [10] and Vora et al. [2], who stated that the E mean of inflammatory polyp was12.25 ± 6.13 Kpa Vs that of fibroid 56.81±39.12Kpa).

This finding suggests that endometrial polyps are quite softer than other endometrial and sub-endometrial diseases. High intralesional variability in elasticity was seen in submucosal leiomyomas and localized adenomyomas.

We found that E mean cut-off value of shear wave elasticity 34.2 to differentiate malignant from benign endometrial lesions showed 90% sensitivity, 94.12 % specificity, 90% PPV, and 94.1% NPV.

E/M ratio cut-off value 0.6 to differentiate malignant from benign endometrial lesions showed sensitivity of 100%, specificity 82.9%, PPV 85.6% and NPV 100%.

Guler et al. [14] revealed that by analysis of the ROC curve according to shear wave ratio to differentiate between malignant lesions and benign

lesions showed that the sensitivity, specificity, PPV, and NPV of the cut-off value for the E-mean of 13 Kpa were 96.15%, 100%, and 96.3%, respectively. This quite difference in E mean cut-off value may be due to the higher number of cases with EH in our study (19.4%) than in Guler's study, that represent only (6%) of cases, and EH showed higher E mean than polyp and lower than EC, this may explain the difference between our E mean cut-off value (34 Kpa) and Guler's study (13 Kpa).

Our results revealed that sensitivity and specificity of SWE for diagnosis of endometrial polyps were 90% and 100 %, this agreed to some extent with Wozniak [10], who stated that the sensitivity and specificity in endometrial polyp cases were 85.7% and 77.7%, respectively. The difference in specificity between our results and Wozniak's result may be related to the histological composition of endometrial polyps (vascular, glandular, fibromuscular & connective tissue) and if it was associated with metaplasia, hyperplastic or atrophic polyps.

The sensitivity and specificity of SWE for diagnosis of EC in our study were 90% and 92.31% which agreed with Bian et al. [18], who revealed that he pooled sensitivity, and specificity of SWE for the diagnosis of EC were 91% and 90% respectively.

These results were consistent with the potentially high diagnostic accuracy of SWE for EC, suggesting that SWE may be a good tool for the differential diagnosis of benign and malignant endometrial tumours and could predict the prognosis of patients with EC.

We found that sensitivity (SN), specificity (SP), PPV, and NPV of submucosal fibroid were 100%, 96.88%, 80%, and 100%, while Wozniak (10) stated that the SN, SP, NPV, and PPV for SWE in determining submucosal uterine fibroids were 87.5% and 75%, respectively.

In our study, sensitivity and specificity of adenomyosis were 80 % and 100%. This is in line with Gorgulu et al. [19], Liu et al. [20], Steolonga et al. [21], and Frank et al. [22] studies.

According to Ragab et al. [23], SWE is an accurate tool for identifying this gynaecological problem. The sensitivity is 93%, the specificity is 91%, the positive likelihood ratio is 10.6, and the negative likelihood ratio is 0.08. Our findings are consistent with those of Acar et al. [16], who discovered that uterine adenomyosis was identified with SN, SP, PPV, and NPP of 89.7%, 92.9%, 97.2%, and 76.5%, respectively.

Vora et al. [2] also did a study to evaluate the role of SWE in characterizing various uterine diseases (endometrial polyp, leiomyoma, and uterine adenomyoma). They found that SWE is a possible supplementation to ultrasound that can be used to identify such lesions. Elastography imaging of the endometrium offers the opportunity to diagnose endometrial pathology, fibroid, and adenomyosis without invasive tissue sampling procedures in females with abnormal uterine bleeding. SWE not only obtains quantitative indicators, but also may serve as a potential means to assess tissue stiffness and so, improve the diagnostic accuracy of different endometrial and sub-endometrial lesions.

Limitations of our study and Future Perspectives

The relatively small sample size and single-centre design of the study may restrict the applicability of the findings, indicating the necessity for bigger, multi-centre investigations to confirm and build upon these results.

CONCLUSIONS

Transvaginal shear wave elastography is an effective additional method for differentiating between benign and malignant endometrial lesions when combined with conventional ultrasonography. This technique can not only obtain quantitative indicators, but also provide new information about the elastic hardness of tissue, and so, improve the diagnostic accuracy of different endometrial and sub-endometrial lesions and also has the potential to reduce the use of endometrial biopsies by determining the nature of tissue.

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