Shear Wave Sono-Elastography in Placental Assessment in Preeclampsia: Does it value?

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Abstract

Background: Preeclampsia is a major contributor to maternal and fetal morbidity and mortality. Placenta is considered crucial in its pathogenesis. Shear-wave elastography provides a quantified stiffness map of tissues. Studies concerning placentas of preeclampsia and gestational diabetes mellitus have been reported.

Objectives: evaluate the utility of SWE in assessment of placental function in preeclampsia.

Patients and methods: Study included 60 singleton pregnant women in the 2nd and 3rd trimesters; 30 with preeclampsia, and 30 as controls subjected to ultrasound examination with dedicated SWE of placenta.

Results: Statistically significant difference was found as regard to labor age and birth weight. Placental stiffness as measured by SWE was significantly higher in women with preeclampsia than in healthy controls , measured values ranged from 2.50 to 11.0 kPa (mean =6.23 ± 2.78 kPa) and 4.0 to 13.50 kPa (mean =7.97 ± 2.91 kPa) at central and peripheral placentas respectively at control group, and 7.0 to 35.0 (mean =20.39 ± 10.19 kPa) and 8.50 to 39.80kPa (mean =22.54 ± 10.44kPa) at central and peripheral placentas respectively at preeclampsia group. Good positive correlation was found between placental grading and elasticity values. There was a statistically significant difference as regard to doppler indices with no obvious correlation between shear wave elasticity values and doppler indices. ROC curve analysis revealed cut-off value >8 kPa at central placenta and >11 kPa at peripheral placenta for diagnosis of preeclampsia.

Conclusion: shear-wave elastography is effective non-invasive technique for the assessment of placental elasticity providing good diagnostic performance for detecting preeclampsia.

Keywords: Shear Wave Sono-Elastography; Placental Assessment; Preeclampsia.

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Introduction

Preeclampsia (PE) is a serious hypertensive disorder of pregnancy that contributes significantly to global maternal and perinatal morbidity and mortality with incidence of preterm delivery about 5%–8% and perinatal mortality about 1%–3% of pregnancies, worldwide **(Xiong et al., 2007)**.

Although the exact cause of PE remains unclear, clinical and pathological evidence highlights the placenta as central role in its pathogenesis. As the vital link between mother and fetus, the placenta performs critical functions, including gas exchange, nutrient delivery, removal of fetal waste, hormone production, and immune defense. Any disruption in placental development or function can impair maternal-fetal exchange, ultimately compromising fetal growth and development **(Schoots et al., 2018)**.

The concept of elasticity refers to the mechanical behavior of materials that undergo reversible deformation when subjected to stress**,** Shear wave elastography (SWE) is an advanced, non-invasive ultrasound-based imaging method that measures tissue stiffness quantitatively. This technique utilizes focused acoustic pulses to generate localized tissue displacement, producing shear waves whose propagation speed is analyzed to create a detailed stiffness map of the tissue. **(Elbeblawy et al., 2020; Quibel et al., 2015)**.

Shear wave speed varies depending on tissue stiffness—firmer tissues exhibit faster shear wave propagation and higher Young's modulus values. Currently, SWE is a well-established diagnostic tool for assessing liver, thyroid, breast, and other organ pathologies. Emerging research has also applied this technique to evaluate placental stiffness in conditions such as PE and gestational diabetes mellitus. **(Zhou et al., 2021; Zheng et al., 2020; Han et al., 2020)**.

The objective of this research was to determine the clinical applicability of SWE for examining placental function in PE cases.

Patients and methods

This prospective, observational, matched case-control study was carried out in our department from September 2023 to August 2024, with approval from our institution's Ethics Committee (36264PR810/8/24). Each patient voluntarily provided written consent before study participation.

The Study included 60 singleton pregnant women in the 2nd and 3rd trimesters including 30 patients diagnosed with PE , and other 30 women in normal pregnancy group without any perinatal complications matched for age group and period of gestation (POG) were recruited as control group. These patients had similar ethnic and socio-economic backgrounds.

Exclusion criteria included: posterior placental location, placental abnormalities, inadequate visualization/penetration, hematoma formation, significant calcifications, multiple pregnancies, major fetal anomalies/chromosomal abnormalities, history of pregnancy loss, severe anemia (Hb<6 g/dL), and significant medical/surgical conditions.

All the above pregnant women were referred from obstetric department and diagnosed by two attending physicians. The diagnosis of PE was based on the established criteria from the American College of Obstetricians and Gynecologists (ACOG).(Practice, 2002).

Patients were subjected to relevant history taking with detailed clinical and obstetric data including POG based on last menstrual period or dating obstetric scan, parity, and maternal medical history, clinical examination and ultrasound examination with dedicated SWE of placenta. Postnatal findings such as birth weight, Apgar scores at first and fifth minutes, and short-term medical conditions were collected

Equipment& Imaging technique

All participants (both PE cases and controls) were examined using a Toshiba Aplio 500 ultrasound system equipped with a C5-1 convex abdominal transducer (1-5 MHz). The imaging protocol included sequential B-mode ultrasound, pulsed Doppler assessment, and SWE , all performed by the same board-certified radiologist specializing in obstetric imaging (7 years' experience in obstetric ultrasound, including 3 years of dedicated SWE practice). The operator was blinded to clinical status during SWE measurement.

Fetal biometry, Amniotic fluid index (AFI), placental morphology & echotexture were noted in the two groups. Pulsed doppler was used to measure the Umbilical artery and both uterine arteries blood flow parameters on either two studied groups including RI (resistive index), PI (pulsativity index) and S/D (systolic/diastolic) ratio.

Shear Wave Elastography Protocol

SWE was conducted with participants in the supine position. Ample transmission gel was applied to minimize probe-induced compression artifacts. Patients were instructed to maintain shallow breathing during image acquisition, and measurements were paused during fetal movement to ensure data reliability.The system simultaneously displayed elastograms alongside conventional grayscale B-mode images. For SWE assessments, a standardized electronic measurement box was positioned within homogeneous placental regions, avoiding areas of heterogeneity. The box provided real-time stiffness feedback via a chromatic scale (blue to red), corresponding to shear-wave intensity (kPa), which facilitated precise placement of the region of interest (ROI).

Following image acquisition, the system's software enables placement of a user-adjustable circular ROI within the elastography display window, with selectable diameter parameters for quantitative analysis.Color-saturated images were used to perform calculations. In the present study, the ROI sizes were fixed to 5 mm in all cases. ROI was placed at different parts of the central and peripheral placenta for a total of six measurements each, three including the maternal aspect and other three including the fetal aspect, then the mean of these six measurements at central and peripheral placentas in either studied group was calculated and accepted as the mean placental SWE value. Measurements were deliberately obtained from homogeneous placental regions, excluding vascular structures and areas of tissue heterogeneity. The acquired ROI data were subsequently analyzed statistically.

Statistical analysis

Our data was fed to computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp). Categorical data was represented as numbers and percentages. Chi-square test was applied to compare between two groups. Alternatively, Fisher Exact correction test was applied when more than 20% of the cells have expected count less than 5. For continuous data, they were tested for normality by the Shapiro-Wilk test. Quantitative data were expressed as range (minimum and maximum), mean, standard deviation and median. Student t-test was used to compare two groups for normally distributed quantitative variables while Mann Whitney test was used to compare two groups for not normally distributed quantitative variables. Significance of the obtained results was judged at the 5% level. Receiver operating characteristic (ROC) curve was used to determine optimal cut-off value of placenta elastic modulus to diagnose preeclampsia.

Results

The study included 60 participants, with 30 diagnosed with PE (case group) and 30 cases as controls. The control group age range from 21 to 38 years, with a mean age of 28.67 ± 4.39 years, while the preeclampsia group ranged from 23 to 40 years, with a mean age of 30.33 ± 4.89 years. The mean gestational age at evaluation was 28.43 ± 5.50 weeks (range: 21–36 weeks) for controls and 27.6 ± 4.60 weeks (range: 20–35 weeks) for the preeclampsia group. No significant differences were observed between the groups in terms of age, parity, or gestational age at the time of assessment. (P = 0.573, 0.748 and 0.920 respectively).With assessment of perinatal outcome; at control group age of labor ranged from 38.0 to 40.0 weeks (mean 38.67 ± 0.71 weeks) with birth weight ranging from 2600.0 to 3600.0 grams and no reported preterm labor, while at preeclampsia group age of labor ranged from to 33.0 to 39.0 weeks (mean 37.33 ± 1.69 weeks) and birth weight ranged from 1700.0 to 3400.0 grams, 7 women underwent preterm labor and 17 infants had low weight for age. A significant difference was observed between the two groups regarding the age at delivery and birth weight, with both factors showing a statistically significant association (p< 0.001 for each). (**Table.1)**

Table 1. Comparison of Demographic and Obstetric Characteristics Between the Study Groups .

Variables	Control (n = 30)	Pre-eclampsia (n = 30)	Test of Sig.	p
Age				
20 - 30	22 (73.3%)	20 (66.7%)	χ^2= 0.317	0.573
31 - 40	8 (26.7%)	10 (33.3%)		
Min – Max.	21.0 – 38.0	23.0 – 40.0	t= 1.389	0.170
Mean ± SD.	28.67 ± 4.39	30.33 ± 4.89		
Gestational age (weeks)				
Min – Max.	21.0 – 36.0	20.0 – 35.0	t= 0.119	0.920
Mean ± SD.	28.43 ± 5.50	27.6 ± 4.60		
Parity				
Nullipara (0)	6 (20.0%)	4 (13.3%)	χ^2= 0.582	0.748
Primipara (1)	14 (46.7%)	14 (46.7%)		
Multipara (2+)	10 (33.3%)	12 (40.0%)		
Min – Max.	0.0 – 2.0	0.0 – 3.0	U= 386.000	0.309
Median (IQR)	1.0 (1.0 – 2.0)	1.0 (1.0 – 2.0)		
Age of labor				
Min – Max.	38.0 – 40.0	33.0 – 39.0	t= 3.986*	**<0.001***
Mean ± SD.	38.67 ± 0.71	37.33 ± 1.69		
Preterm labor				
No	30 (100.0%)	23 (76.7%)	χ^2= 7.925*	**^{FE}p= 0.011***
Yes	0 (0.0%)	7 (23.3%)		
Birth Weight (g)				
Low	0 (0.0%)	17 (56.7%)	χ^2= 23.721*	**<0.001***
Normal	30 (100.0%)	13 (43.3%)		
Min – Max.	2600.0 – 3600.0	1700.0 – 3400.0	t= 3.934*	**<0.001***
Mean ± SD.	3043.0 ± 304.0	2661.33 ± 435.7		

IQR: Inter quartile range, SD: Standard deviation, t: Student t-test, U: Mann Whitney test, χ^2: Chi square test,FET:Fisher Exact test, p: p value for comparing between the two studied groups, *: Statistically significant at p ≤ 0.05

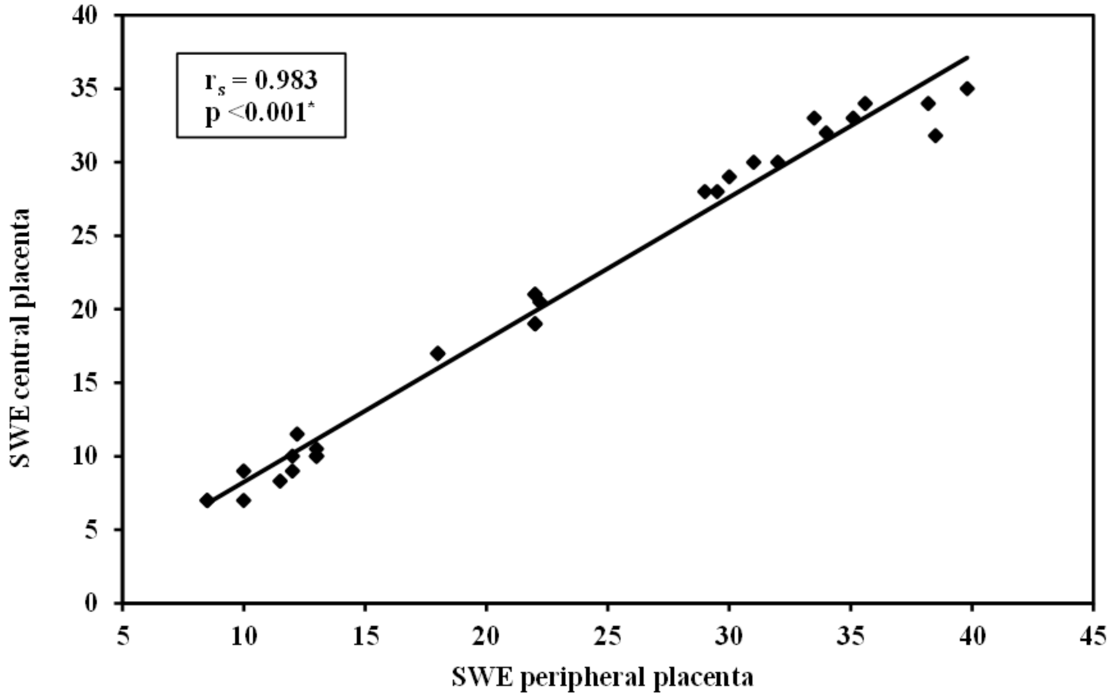
With dedicated placental assessment in both groups, **(Table.2)** As concern to placental ultrasound morphological grading; 20 placentas at control group were reported as grade I, 9 as grade II and only one as grade III, while at PE group 9 were reported as grade I, 11 as grade II and 10 as grade III. The analysis revealed a statistically significant difference in ultrasound placental grading between the two groups (*P* = 0.003). SWE value of the placenta was calculated from the average of the obtained 6 measurements including both fetal and maternal sides at both central and peripheral parts of placenta in both studied groups .The PE group exhibited significantly higher placental elasticity values compared to the controls (p <0.001) where elasticity values at control group ranged from 2.50 to 11.0 kPa (mean =6.23 ± 2.78 kPa) and from 4.0 to 13.50 kPa (mean =7.97 ± 2.91 kPa) at central and peripheral placentas respectively. However, at PE group elasticity values ranged from 7.0 to 35.0 (mean =20.39 ± 10.19 kPa) and from 8.50 to 39.80kPa (mean =22.54 ± 10.44kPa) at central and peripheral placentas respectively with noted higher values at peripheral placenta than central placenta at either groups , also positive correlation was found between central and peripheral placenta elasticity values in preeclampsia group (rs = 0.983, p <0.001). (**Fig. 1A).**

Correlation was done between placental grading and elasticity values of either central and peripheral placentas at PE group, from which we found a positive correlation between placental grading and elasticity values in both central and peripheral parts. **(Fig.1 B,C)**

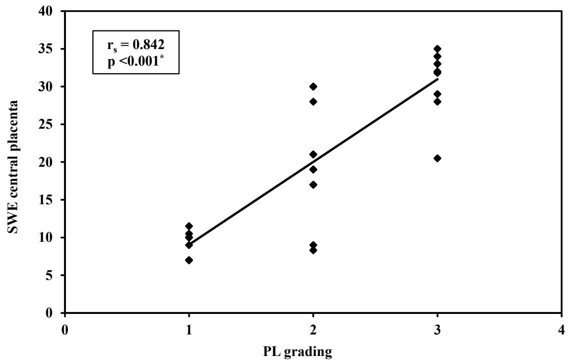
Table 2. Comparison between the two studied groups according to placental morphological ultrasound grading and shear wave elastic elasticity values (elastic modulus in kPa)

Variables	Control (n = 30)	Pre-eclampsia (n = 30)	Test of Sig.	p
PL grading				
I	20(66.7%)	9 (30.0%)	χ^2= 11.736*	0.003*
II	9 (30.0%)	11(36.7%)		
III	1 (3.3%)	10(33.3%)		
Central placenta SWE (Kpa)				
Min – Max.	2.50 – 11.0	7.0 – 35.0	U= 68.500*	<0.001*
Mean ± SD.	6.23 ± 2.78	20.39 ± 10.19		
Median (IQR)	6.0 (3.40 – 8.60)	19.75 (10.0 – 30.0)		
Peripheral placenta SWE (Kpa)				
Min – Max.	4.0 – 13.50	8.50 – 39.80	U= 59.500*	<0.001*
Mean ± SD.	7.97 ± 2.91	22.54 ± 10.44		
Median (IQR)	7.25 (5.10 – 10.0)	22.0(12.20 – 32.0)		

IQR: Inter quartile range, SD: Standard deviation, t: Student t-test, U: Mann Whitney test , χ^2: Chi square test, p: p value for comparing between the two studied groups, *: Statistically significant at p ≤ 0.05



(A)



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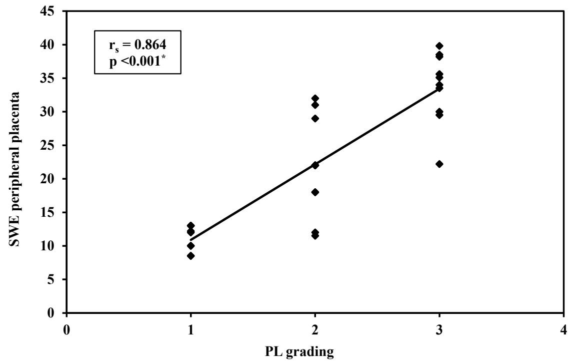


(C)

Fig.1. (A): Figure 4: Correlation between central and peripheral placenta SWE values in preeclampsia group, (B): Correlation between PL grading and central placenta SWE values in pre-eclampsia, (C): Correlation between PL grading and peripheral placenta SWE values in pre-eclampsia

As regard to Doppler assessment: umbilical artery resistance indices in either studied groups were reported in the 16 patient whose gestational age at time of evaluation exceeded 28 weeks ranging from 0.45 to 0.71 and from 0.63 to 0.79 at control and PE groups respectively .And as concern to uterine artery Doppler ; diastolic notch was present in 17 out of the 30 PE patients (56.6 %), bilateral in 10 patient and unilateral at 7 patients , and none at the healthy controls with mean uterine artery pulsativity indices ranging from 0.64 to 1.30 and from 0.83 to 1.73 at control and PE groups respectively . There were a statistically significant difference between both studied groups as regard to measured umbilical artery resistive index and uterine artery pulsitivity index being significantly higher in PE group than relevant indices in the control group (p =0.003* and <0.001). **(Table.3)**

Table 3. Comparative Analysis of Doppler Indices Between Study Groups

Variables	Control	Pre-eclampsia	Test of Sig.	p
Umbilical artery RI (n=16)				
Min – Max.	0.45 – 0.71	0.63 – 0.79	t= 3.345*	0.003*
Mean ± SD.	0.63 ± 0.09	0.72 ± 0.05		
Median (IQR)	0.67 (0.56 – 0.70)	0.72 (0.67 – 0.76)		
Mean uterine artery PI (n = 30)				
Min – Max.	0.64 – 1.30	0.83 – 1.73	t= 3.843*	<0.001*
Mean ± SD.	1.02 ± 0.17	1.25 ± 0.26		
Median (IQR)	0.98 (0.90 – 1.20)	1.30 (0.97 – 1.45)		

RI : Resistive index, PI: Pulsitivity index, IQR: Inter quartile range, SD: Standard deviation, t: Student t-test, U: Mann Whitney test, χ^2: Chi square test, p: p value for comparing between the two studied groups, *: Statistically significant at $p \leq 0.05$

No significant correlation was observed between placental shear wave elasticity values (both central and peripheral) and umbilical artery resistive index or uterine artery pulsatility index.(**Table.4).**

Table 4. Correlation between central and peripheral placenta elasticity values and doppler indices

Variables	Central Placenta		Peripheral Placenta	
	r_s	P	r_s	P
Umbilical artery RI	0.298	0.262	0.295	0.267
Mean uterine artery PI	0.022	0.908	0.004	0.981

RI : Resistive index, PI: Pulsitivity index, r_s: Spearman coefficient, *: Statistically significant at $p \leq 0.05$

ROC curve analysis demonstrated that placental SWE provides excellent diagnostic performance for PE. The highest diagnostic accuracy was achieved using mean elasticity values from both central and peripheral placental regions.

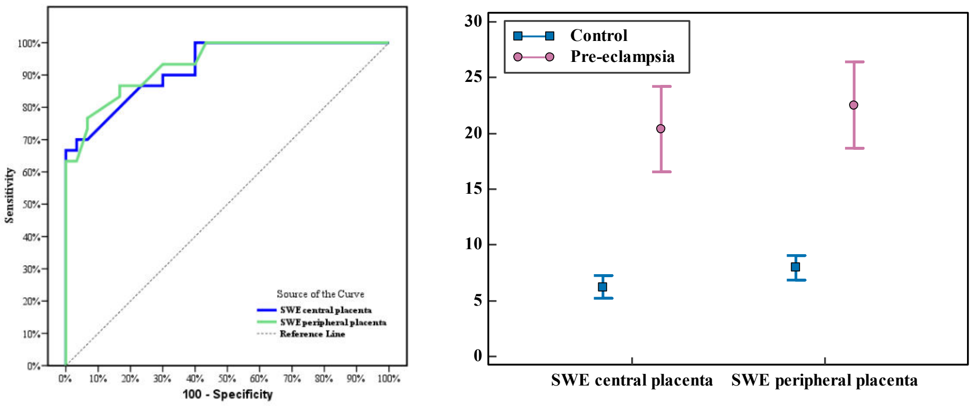
For central placental measurements, the optimal cutoff was >8 kPa (AUC: 0.924; 95% CI: 0.862–0.986), yielding 90% sensitivity, 70% specificity, 75% PPV, and 87.5% NPV.

For peripheral placental measurements, the best diagnostic threshold was >11 kPa (AUC: 0.934; 95% CI: 0.877–0.991), with 86.67% sensitivity, 83.33% specificity, 83.9% PPV, and 86.2% NPV. (**Fig. 2 and Table. 5).**

Table 5. Diagnostic Accuracy of Placental Shear Wave Elastography in Preeclampsia: Central and Peripheral Comparisons

Variables	AUC	p	95% C.I	Cut off	Sensitivity	Specificity	PPV	NPV
Central placenta SWE	0.924	**<0.001***	0.862 – 0.986	>8	90.0	70.0	75.0	87.5
Peripheral placenta SWE	0.934	**<0.001***	0.877 – 0.991	>11	86.67	83.33	83.9	86.2

AUC: Area Under a Curve, p value: Probability value, CI: Confidence Interval, NPV: Negative predictive value, PPV: Positive predictive value, *: Statistically significant at $p \leq 0.05$.



(A) (B)

Fig. 2. (A): Correlation between placental grading and peripheral placenta elasticity values in pre-eclampsia group, (B): Confidence interval of mean SWE values of central and peripheral placenta at preeclampsia and control group

In concern to safety consideration, In our study The TI (thermal index) of the device program mode used ranged from 0.1 to 0.3 and MI (mechanical index) ranged from 0.9 to 1.3 in either studied groups.

Case presentation

Case 1: 29 W 2 D normal control pregnant woman. (**Fig.3).**

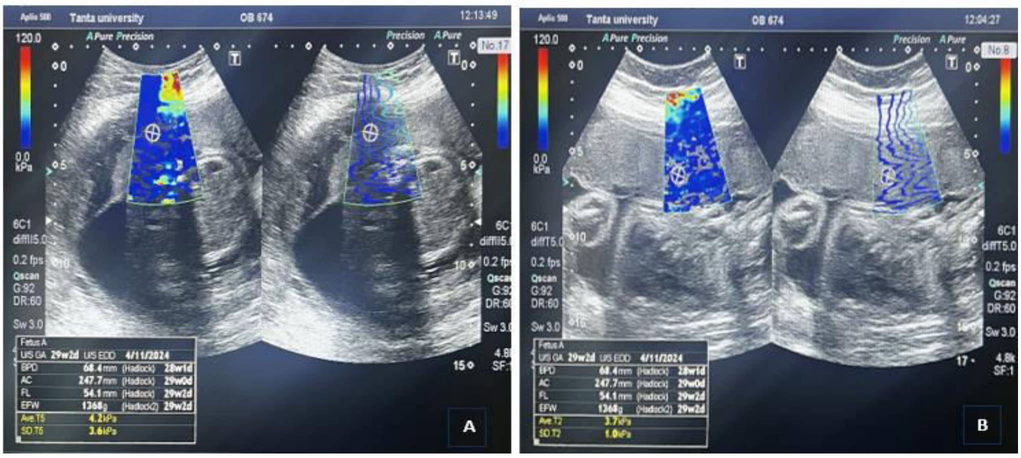


Fig. 3. (A,B): Two shear wave sono-elastographic images of anteriorly located placenta of with placental elastic modulus at peripheral and central placenta measuring 4.2 KPa and 3.7 KPa respectively

Case 2: 28W 1 D pregnant woman diagnosed with preeclampsia. (**Fig. 4).**

Case 3: 32W 6 D another pregnant woman diagnosed with preeclampsia. (**Fig.5).**

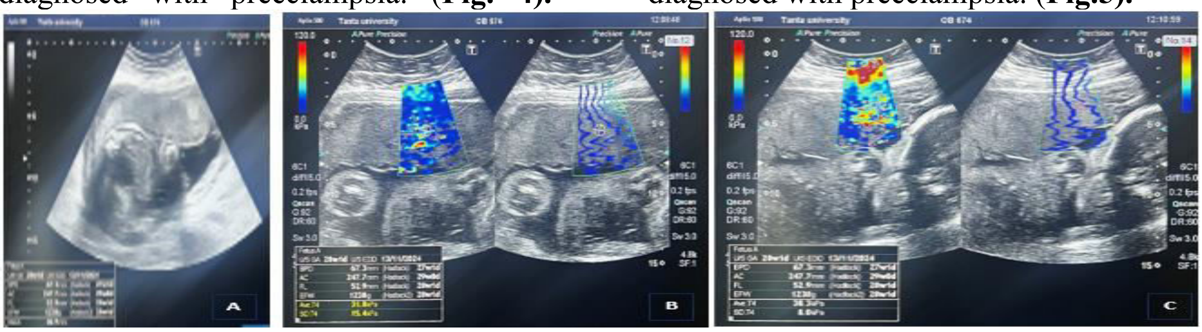


Fig. 4. (A): 2D grey scale ultrasound image showing anteriorly located placenta with grade II placental maturity and thickness 37 mm. (B)(C) Two shear wave sono-elastographic images of central and peripheral placenta with placental elastic modulus measuring 31.8 KPa and 38.3 KPa respectively

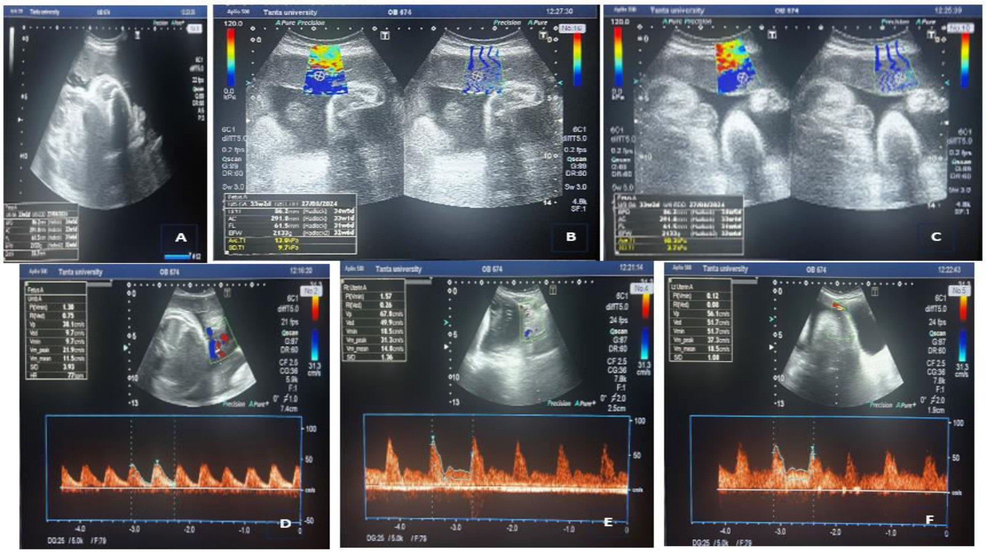


Fig.5. (A) 2D grey scale ultrasound image showing anteriorly located placenta with grade II placental maturity and thickness 33.7 mm (B)(C): shear wave sono-elastographic images at fetal side of peripheral placenta with placental elastic modulus measuring 13 KPa and 10.2 KPa respectively. (D) umbilical artery doppler with = RI 0.75. (E)(F) Right and left uterine arteries doppler showing persistent notching in either sides with RI 0.26 and 0.08, PI 1.57 and 0.12 respectively

Discussion

SWE is an emerging and promising technique for placental assessment. This method utilizes acoustic radiation force to induce transient tissue deformation within a region of interest (ROI), while ultrasound tracks the dynamic tissue response. SWE provides quantitative stiffness measurements, expressed either as shear wave velocity (m/s) or as shear modulus (kilopascals, kPa), offering objective evaluation of tissue elasticity**. (Khanal et al., 2019; Sarvazyan et al., 1995)**.

It can be applied at the same session using the same device for fetal anomaly scanning and Dopple . Moreover, this noninvasive application has important advantage of being operator independent as dynamic compression is not needed , however SWE is essentially based on acoustic radiation force impulses **(Sebag et al., 2010; Marcy et al., 2012; Arda et al., 2011)**.

In our study, at control group mean shear wave elasticity values was 6.23 ± 2.78 kPa (range 2.50 to 11.0 kPa) at central placenta and 7.97 ± 2.91 kPa (range 4.0 to 13.50 kPa) at peripheral placenta. These results are matching with those of **Li et al. (2012)** who reported 7.60 ± 1.71 kPa and 7.84 ± 1.68 kPa as average elastic modulus values at placental edge and central placenta respectively in normal pregnant women as well as results of **Cimsit (2015)** where mean elasticity values were 6.67 kPa and 6.64 kPa at central placenta and placental edge respectively with overall mean value of 7.01 kPa.

However our results were relatively higher compared those of **Khanal et al. (2019)** in their study where placental mean SWE value for controls was 3.3829 ± 0.83325. Those could be attributed to demographic variations such as race, age in addition to different measurement techniques which could possibly play a role in this variation.

We found that shear wave elasticity values were significantly higher either in central and peripheral placentas at PE patients compared to controls, keeping with the results of **kilic et al. (2015)** in their study as well as **Sirinoglu et al. (2021)** results.

Cimsit (2015) as well while investigating placental SWE in normal pregnancies and others complicated with PE found a higher overall mean SWE values in those complicated with PE than controls. Consistent with our findings, **Yan et al. (2022)** observed significantly elevated placental Young's modulus values in both gestational hypertension and preeclampsia groups compared to controls. This increased tissue stiffness likely reflects pathological changes characteristic of PE including systemic inflammation and impaired fetal-maternal circulation secondary to atherosis, placental infarction, and abnormal trophoblastic hyperplasia**. (Nelson et al., 2014)**. We also noted higher values at peripheral placenta than central placenta at both groups. **Spiliopoulos et al. (2020)** as well found the placental periphery was significantly stiffer than the placental core in PE patients but no such difference was found them at control group. Although **Meena et al. (2022**) reported significantly higher elasticity values in the central versus peripheral placenta among PE cases ($p < 0.05$), no such regional variation was observed in normal pregnancies . In addition, **Cimsit (2015)** did not find statistically significant difference in the SWE values between the placental center and edges in both groups

Regarding placental grading , we reported a statistically significant difference between the two studied groups with higher grades seen at PE group than controls , these results are matching with those of **Garain et al. (2024)**. **Grannum et al. (1979)** also substantiated association of early placental maturation with maternal hypertension. Moreover, we investigated the relation between placental grading and elasticity values at preeclampsia groups, and thus reported a good positive correlation between the two in both central and peripheral parts.

Doppler assessment revealed significantly elevated parameters in the PE group compared to controls ($p < 0.05$), consistent with reports by **El Gebally et al. (2023) and Yan (2022),** who similarly demonstrated altered umbilical artery hemodynamics in preeclampsia. Notably, Yan (2022) found no correlation between placental Young's modulus and umbilical artery flow indices, aligning with our observation that central/peripheral placental shear wave elasticity values showed no significant association with umbilical artery resistive index (RI) or uterine artery pulsatility index (PI). Also, we reported diastolic notch in 17 / 30 (56.6 %) PE patients, bilateral in 10 patient and unilateral at 7 patients and none of the healthy controls matching with **Cimsit (2015)** results in their study and being in line with other reported results in similar studies **(At, 2004; Yu et al., 2008)**.

Associated perinatal outcome was also assessed and PE group witnessed 7 woman undergoing preterm labor and 17 infants with low weight for age with statistically significant difference were found between them and controls as regard to age of labor and birth weight . **El Gebally (2023)** also in their results documented a highly statistically significant decrease in the birth weight and birth age among preeclampsia patients than the control group.

Comparable findings were reported by **Khan et al. (2021)** study where birth weights were lower in preeclamptic cases compared to normal instances.

ROC curve analysis identified optimal diagnostic cutoffs for PE using placental shear wave elastography. For central placental measurements, a cutoff of >8 kPa demonstrated excellent diagnostic accuracy (AUC 0.924, 95% CI 0.862–0.986), with 90% sensitivity, 70% specificity, 75% PPV, and 87.5% NPV. Peripheral placental measurements showed even greater discriminative power at >11 kPa (AUC 0.934, 95% CI 0.877–0.991), with 86.67% sensitivity, 83.33%

specificity, 83.9% PPV, and 86.2% NPV**.**These values were comparable to those of **Sirinoglu (2021)** who proposed a mean SWE value above 7.43 kPa to predict PE with very high sensitivity and specificity as well as **Kılıç (2015)** he chose 7.35 kPa as the most predictive cut-off value to diagnose preeclampsia basing on central placenta median elasticity values.

However, higher values was proposed by **El Gebally (2023)** which were 18.47 Kpa for central placenta and 14.39 Kpa for peripheral placenta.

Safety considerations remain paramount when applying SWE in pregnancy. While studies by **Li (2012), Kılıç (2015), and Cimsit (2015)** report elevated thermal indices compared to conventional ultrasound, **Herman and Harris (2002)** demonstrated that the transient temperature increases induced by acoustic radiation force impulse (ARFI) pulses remain within FDA-approved safety thresholds. This suggests that when properly administered, SWE may maintain an acceptable safety profile for obstetric use. **Sugitani et al. (2013)** as well did not report thermal harmful effects while investigating ARFI biological effects on placental tissue. Even if, meticulous consideration was given to the safety issue. In our study TI of the device program mode used ranged from 0.1 to 0.3 and MI ranged from 0.9 to 1.3 in either studied groups, ensured within the safety range recommended by the American Ultrasonic Medical Association (Ti ≤ 0.7, MI ≤ 1.9) for obstetric ultrasound examination **(Shiina et al., 2015)**. Moreover, we didn't evaluate Interobserver variability in our study to avoid repeated examinations of the same fetus and not to prolong scan time. We also excluded posteriorly located placentas to avoid passing of ARFI wave-path through the fetus.

Our study had limitations such as small sample number so, findings may not accurately reflect the general population. This came out of our concern to solely assess SWE of isolated preeclampsia placentas, where we excluded other maternal medical and surgical diseases, multiple gestations as well as other inert placental anomalies as detailed that possibility may alter SWE results .Moreover, posteriorly located placentas are not evaluated which represents a considerable percentage for better penetration and more accurate assessment. also, All findings were reported by a single observer who was not blinded to the SWE, conventional ultrasound and Doppler findings making them susceptible to observer bias. one more limitation was that body mass indices of study subjects weren't obtained, and hence Potential confounding effects of maternal obesity and abdominal wall thickness on placental elasticity measurements were not assessed, which may influence measurement accuracy. We also did not investigate the relation between placental SWE and severity of preeclampsia.

Conclusion

We came to a conclusion that SWE is effective non-invasive technique for the assessment of placental elasticity providing good diagnostic performance for detecting preeclampsia.

Therefore, further studies are considered on larger scale to assess role SWE in early detection, even prediction of PE , disease severity and progression as well as possible pathological changes of intervention with pharmacological medications on placental elasticity.

References

- **Arda K, Ciledag N, Aktas E, Aribas B K , Köse, K. (2011).** Quantitative assessment of normal soft-tissue elasticity using shear-wave ultrasound elastography. American journal of roentgenology, 197 (3): 32-36
- **At, P. (2004).** The role of uterine artery Doppler in predicting adverse pregnancy outcome. Best Pract Res Clin Obstet Gynaecol, 18: 383-396
- **Cimsit C, Yoldemir T , Akpinar I N. (2015).** Shear wave elastography in placental dysfunction: comparison of

elasticity values in normal and preeclamptic pregnancies in the second trimester. Journal of medical ultrasound, 34 (1): 51-91

- **El Gebally A M W, Elsammak A A, Refaat M M, Abd Ellatif O E E. (2023).** Study of Use of Shear Wave Elastography in Placental Dysfunction by Comparison of Elasticity Values in Normal and Pre-eclamptic Pregnancies. The Egyptian Journal of Hospital Medicine, 90 (2): 2345-2352
- **Elbeblawy Y M , Eshaq A M M. (2020).** Strain and shear wave ultrasound elastography in evaluation of chronic inflammatory disorders of major salivary glands. Dentomaxillofacial Radiology, 49 (3): 20-90
- **Garain P, Barman S C, Mandal P, Patra K K , Madhwani K P. (2024).** Comparative study on ultrasonic placental grading among normotensive pregnancy and pregnancy-induced hypertension and its correlation with fetal outcome. Asian Journal of Medical Sciences, 15 (2): 133-140
- **Grannum P A, Berkowitz R L , Hobbins J C. (1979).** The ultrasonic changes in the maturing placenta and their relation to fetal pulmonic maturity. Am J Obstet Gynecol, 133 (8): 915-22
- **Han D Y, Sohn Y M, Seo M, Yun S J, Park W S, Jeon, S H, et al. (2020).** Shear-wave elastography in thyroid ultrasound: Can be a predictor of extrathyroidal extension and cervical lymph node metastasis in papillary thyroid carcinoma? Medicine (Baltimore), 99 (52): 23-65
- **Herman B A , Harris G R. (2002).** Models and regulatory considerations for transient temperature rise during diagnostic ultrasound pulses. Ultrasound in medicine & biology, 28 (9): 1217-1224
- **Khan A, Mubarik S, Nabi G, Fan C , Wang S. (2021).** Effect of preeclampsia and premature rupture of membrane on neonatal birth weight and length by gestational age: A retrospective study in China. Journal of Research in Medical Sciences, 26 (1): 38
- **Khanal U P, Chaudhary R , Ghanshyam G. (2019).** Placental elastography in intrauterine growth restriction: a case–control study. Journal of clinical research Radiology, 2 (2): 1-7
- **Kılıç F, Kayadibi Y, Yüksel M A, Adaletli İ, Ustabaşıoğlu F E, Öncül M, et al. (2015).** Shear wave elastography of placenta: in vivo quantitation of placental elasticity in preeclampsia. Diagnostic and Interventional Radiology, 21 (3): 22-27
- **Li W J, Wei Z T, Yan R L , Zhang Y L. (2012).** Detection of placenta elasticity modulus by quantitative real-time shear wave imaging. Clinical and Experimental Obstetrics & Gynecology, 39 (4): 70-73
- **Marcy P Y, Thariat J , Lacout A. (2012).** Should we catch the train of shear-wave elastography? American journal of roentgenology, 198 (6): 624-626
- **Meena R, Malik A, Jain S , Batra A. (2022).** Placental elastography in second trimester preeclampsia prediction: A prospective study. Ultrasound, 30 (3): 228-235
- **Nelson D B, Ziadie M S, McIntire D D, Rogers B B , Leveno, K J. (2014).** Placental pathology suggesting that preeclampsia is more than one disease. American journal of roentgenology, 210 (1): 66-78
- **Practice A C o O. (2002).** ACOG practice bulletin. Diagnosis and management of preeclampsia and eclampsia. Number 33, January 2002. Obstetrics and gynaecology, 99 (1): 59-67
- **Quibel T, Deloison B, Chammings F, Chalouhi G E, Siauve N, Alison M, et al. (2015).** Placental elastography in a murine intrauterine growth restriction

model. Prenatal diagnosis, 35 (11): 6-11

- **Sarvazyan A, Skovoroda A, Emelianov S, Fowlkes J, Pipe J, Adler R, et al. (1995).** Biophysical bases of elasticity imaging. Acoustical imaging: 223-240
- **Schoots M H, Gordijn S J, Scherjon S A, van Goor H & Hillebrands J L. (2018).** Oxidative stress in placental pathology. Placenta, 69: 153-161
- **Sebag F, Vaillant-Lombard J, Berbis J, Griset V, Henry J F, Petit P, et al. (2010).** Shear wave elastography: a new ultrasound imaging mode for the differential diagnosis of benign and malignant thyroid nodules. Journal of Clinical Endocrinology & Metabolism, 95 (12): 81-89
- **Shiina T, Nightingale K R, Palmeri M L, Hall T J, Bamber J C, Barr R G, et al. (2015).** WFUMB guidelines and recommendations for clinical use of ultrasound elastography: Part 1: basic principles and terminology. Ultrasound Med Biol, 41 (5): 1126-47
- **Sirinoglu H A, Uysal G, Nazik H, Cingillioglu B, Genc S , Pekin O, et al. (2021).** Efficacy of shear wave elastography in predicting preeclampsia in the first trimester. Revista da Associação Médica Brasileira, 67 (11): 1558-1563
- **Spiliopoulos M, Kuo C-Y, Eranki A, Jacobs M, Rossi C T, Iqbal S N, et al. (2020).** Characterizing placental stiffness using ultrasound shear-wave elastography in healthy and preeclamptic pregnancies. Archives of gynecology and obstetrics, 302: 1103-1112
- **Sugitani M, Fujita Y, Yumoto Y, Fukushima K, Takeuchi T, Shimokawa M, et al. (2013).** A new method for measurement of placental elasticity: acoustic radiation force impulse imaging. Placenta, 34 (11): 1009-1013
- **Xiong X, Buekens P, Pridjian G , Fraser W D. (2007).** Pregnancy-induced hypertension and perinatal mortality. Journal of reproductive medicine, 52 (5): 40-62
- **Yan Z, Huang X, Zhao Y , Zhang B. (2022).** Clinical study of ultrasonic shear wave elastography in assessing placental function in patients with hypertensive disorders of pregnancy during late pregnancy. Available at SSRN 4137654: 20-40
- **Yu C, Khouri O, Onwudiwe N, Spiliopoulos Y , Nicolaides K. (2008).** Prediction of pre-eclampsia by uterine artery Doppler imaging: relationship to gestational age at delivery and small-for-gestational age. Ultrasound in Obstetrics and Gynecology: The Official Journal of the International Society of Ultrasound in Obstetrics and Gynecology, 31 (3): 310-313
- **Zheng X, Huang Y, Liu Y, Wang Y, Mao R, Li F, et al. (2020).** Shear-Wave Elastography of the Breast: Added Value of a Quality Map in Diagnosis and Prediction of the Biological Characteristics of Breast Cancer. Korean Journal of Radiology, 21 (2): 172-180
- **Zhou X, Rao J, Wu X, Deng R , Ma Y. (2021).** Comparison of 2-D Shear Wave Elastography and Point Shear Wave Elastography for Assessing Liver Fibrosis. Ultrasound in Medicine and Biology, 47 (3): 408-427.