

Original Research Article

COMPARISON OF SHEAR WAVE ELASTOGRAPHY OF PLACENTA IN NORMAL AND PRE-ECLAMPTIC PREGNANT WOMEN IN SECOND AND THIRD TRIMESTER

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Received : 29/06/2026
Received in revised form : 23/07/2026
Accepted : 06/08/2026

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DOI: 10.70034/ijmedph.2026.3.946

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (3); 6140-6143

ABSTRACT

Background: Pre-eclampsia is associated with abnormal placentation and increased fetomaternal morbidity. Placental shear wave elastography is a non-invasive imaging technique that evaluates placental stiffness and may help in differentiating normal and pre-eclamptic pregnancies during the second and third trimester. The objective is to compare placental elastography values between normal and pre-eclamptic pregnancies, determine normal placental ARFI values, evaluate the diagnostic utility of placental SWE/ARFI, and identify a potential cut-off value predictive of pre-eclampsia in pregnancy.

Materials and Methods: A prospective comparative study was conducted on 100 pregnant women comprising 50 normotensive and 50 pre-eclamptic cases. Placental SWE/ARFI measurements were obtained using transabdominal ultrasonography, and maternal as well as perinatal outcomes were assessed until delivery.

Results: Placental SWE/ARFI values were significantly higher in pre-eclamptic pregnancies across all placental regions ($p < 0.001$). Pre-eclamptic women also demonstrated higher rates of maternal complications, LSCS, preterm delivery, IUGR, reduced birth weight, and low APGAR scores.

Conclusion: Placental SWE/ARFI elastography is a reliable non-invasive modality for assessing placental stiffness and differentiating pre-eclamptic from normal pregnancies. Increased placental stiffness showed significant association with adverse maternal and perinatal outcomes.

Keywords: Pre-eclampsia, Placenta, Shear Wave Elastography, ARFI, Placental Stiffness, Pregnancy, Ultrasonography, Perinatal Outcome.

INTRODUCTION

The placenta is an essential organ of pregnancy because it supports fetal growth by helping in oxygen transfer, nutrition, waste removal and hormonal regulation. Normal placental development depends on proper trophoblastic invasion and adequate uteroplacental blood flow, which are necessary for healthy fetal and maternal outcomes.^[1] Pre-eclampsia is a pregnancy-specific hypertensive disorder usually occurring after 20 weeks of gestation and is associated with maternal hypertension, proteinuria or organ dysfunction. It remains an important cause of maternal and perinatal morbidity, especially when placental circulation is affected.^[2] In pre-eclampsia,

abnormal placentation and reduced blood flow can lead to placental ischemia, fibrosis, infarction and altered tissue structure, which may influence fetal growth and neonatal outcome.^[3,4]

Routine evaluation of pre-eclampsia is mainly based on clinical findings, blood pressure measurement, urine protein estimation, biochemical tests and fetal assessment. However, these methods may not directly measure structural changes in the placenta. Ultrasound elastography is a newer imaging technique that assesses tissue stiffness non-invasively.^[5] Shear wave elastography measures the speed of shear waves passing through tissue and gives a quantitative value of tissue elasticity or stiffness.^[6] Therefore, it may help in identifying

placental changes that are not clearly visible on routine ultrasound. Previous studies have shown that placental elasticity differs between normal and pre-eclamptic pregnancies, with pre-eclamptic placentas generally showing higher stiffness values.^[7,8] Similar findings have also been reported using strain elastography and acoustic radiation force impulse elastography in pregnancies complicated by placental dysfunction.^[9,10]

MATERIALS AND METHODS

Study Design: Prospective comparative study

Study Period: November 2023 to March 2025

Study Place: Department of Radiodiagnosis, Maharishi Markandeshwar Institute of Medical Sciences and Research Institute, Ambala, Haryana

Sample Size: Total of 100 patients (50 normotensives and 50 pre-eclamptic) with anterior placenta in pregnant women in second and third trimester were included in this study.

Selection Criteria

Inclusion Criteria

- 15 – 40 weeks of gestation age women with anterior placenta.
- Willingness to participate in study.

Exclusion Criteria

Those not willing to participate in study.

- Placental anomalies, insufficient placental adherence or penetration, misdevelopment and complications including hematoma and gross calcifications.
- Other fetal anomalies and obstetric pathologies such as diabetes, polyhydramnios, hydrops fetalis, single umbilical artery.
- Posterior placental presentation.
- Women with severe anemia (Hb < 6gm/dl) or miscarriage history.
- Multiple gestation.

Method: Detailed history, consent, and PCPNDT documentation were obtained before transabdominal ultrasound using PHILIPS EPIQ 7G. Placental ARFI shear wave elastography measurements were taken from different placental regions, and patients were followed till delivery for perinatal outcome assessment.

Data management and analysis: Data were coded in MS-Excel and analysed using SPSS 26.0. Qualitative data were expressed as percentages and analysed using chi-square tests, while quantitative data were presented as mean±SD and analysed using independent tests.

RESULTS

Table 1: Baseline Characteristics of Study Participants

Variable	Cases: Pre-eclamptic pregnancies n = 50	Controls: Normal pregnancies n = 50	Statistical test	p-value
Age, years, Mean ± SD	27.12 ± 4.90	25.56 ± 3.61	Independent t-test	0.078
Gestational age at evaluation <37 weeks	46 (92.0%)	45 (90.0%)	Chi-square test	0.727
Gestational age at evaluation ≥37 weeks	4 (8.0%)	5 (10.0%)		
Multigravida	32 (64.0%)	28 (56.0%)	Chi-square test	0.414
Primigravida	18 (36.0%)	22 (44.0%)		

In [Table 1], The baseline characteristics were comparable between the two groups. The mean age was 27.12 ± 4.90 years in pre-eclamptic pregnancies and 25.56 ± 3.61 years in normal pregnancies, with no significant difference (p = 0.078). Most women

were evaluated before 37 weeks in both groups: 46 cases (92.0%) and 45 controls (90.0%) (p = 0.727). Multigravida status was also similar, seen in 32 cases (64.0%) and 28 controls (56.0%) (p = 0.414). Thus, both groups were comparable at baseline.

Table 2: Blood Pressure Profile at Time of Evaluation

Blood pressure parameter	Cases: Pre-eclamptic pregnancies n = 50	Controls: Normal pregnancies n = 50	Statistical test	p-value
SBP, Mean ± SD, mmHg	155.02 ± 15.92	112.60 ± 8.24	Independent t-test	0.001
DBP, Mean ± SD, mmHg	99.74 ± 11.05	76.16 ± 6.67	Independent t-test	0.001
SBP, Median (Min–Max), mmHg	159 (110–180)	111 (98–132)	Mann–Whitney U test	0.001
DBP, Median (Min–Max), mmHg	100 (70–118)	76 (64–88)	Mann–Whitney U test	0.001

In [Table 2], The blood pressure profile showed a significant difference between the two groups. The mean SBP and DBP were higher in pre-eclamptic pregnancies 155.02 ± 15.92 mmHg and 99.74 ± 11.05 mmHg, compared to normal pregnancies 112.60 ± 8.24 mmHg and 76.16 ± 6.67 mmHg, respectively (p

= 0.001). Similarly, median SBP and DBP were also higher in cases, 159 mmHg and 100 mmHg, compared to controls, 111 mmHg and 76 mmHg. This confirms that the case group had significantly raised blood pressure at evaluation.

Table 3: Comparison of Mean Placental Elastography Values Between Cases and Controls

Placental elastography value	Cases: Pre-eclamptic pregnancies n = 50	Controls: Normal pregnancies n = 50	Total N = 100	Statistical test	p-value
Mean SWE/ARFI value, kPa, Mean ± SD	6.58 ± 2.05	3.41 ± 1.15	5.00 ± 2.30	Independent t-test	<0.001

In [Table 3], The mean placental SWE/ARFI value was significantly higher in pre-eclamptic pregnancies 6.58 ± 2.05 kPa compared to normal pregnancies 3.41 ± 1.15 kPa. The overall mean value among all participants was 5.00 ± 2.30 kPa. This difference was

statistically highly significant ($p < 0.001$), indicating that placental stiffness was markedly increased in pre-eclamptic women compared with normal pregnant women.

Table 4: Regional Placental Elastography Values in Different ROI

Placental ROI	Measurement	Cases Median (Min–Max)	Controls Median (Min–Max)	Statistical test	p-value
Central maternal	Mean	6.22 (1.30–16.03)	3.04 (0.88–9.27)	Mann–Whitney U test	0.001
Central maternal	Max	8.17 (2.21–19.40)	4.34 (1.35–15.80)	Mann–Whitney U test	0.001
Central fetal	Mean	5.89 (2.18–19.44)	2.95 (0.36–10.56)	Mann–Whitney U test	0.001
Central fetal	Max	7.21 (3.09–33.80)	3.89 (0.69–23.23)	Mann–Whitney U test	0.001
Peripheral maternal	Mean	5.42 (1.00–16.09)	3.21 (0.64–5.55)	Mann–Whitney U test	0.001
Peripheral maternal	Max	6.72 (2.23–24.51)	3.97 (0.86–9.42)	Mann–Whitney U test	0.001
Peripheral fetal	Mean	5.62 (3.37–18.76)	3.40 (1.04–9.36)	Mann–Whitney U test	0.001
Peripheral fetal	Max	6.96 (3.95–25.45)	4.52 (1.22–13.71)	Mann–Whitney U test	0.001

In [Table 4], Regional placental elastography values were significantly higher in pre-eclamptic pregnancies across all regions of interest. The median mean values were higher in cases than controls at the central maternal 6.22 vs 3.04 kPa, central fetal 5.89 vs 2.95 kPa, peripheral maternal 5.42 vs 3.21 kPa, and peripheral fetal regions 5.62 vs 3.40 kPa. Maximum values were also higher in cases in all regions, and all differences were statistically significant ($p = 0.001$), suggesting increased placental stiffness in pre-eclampsia throughout the placenta.

complications were seen in controls ($p < 0.001$). LSCS delivery was more common in cases 32 (64.0%) than controls 11 (22.0%), and preterm delivery was also higher in cases 26 (52.0%) compared to controls 6 (12.0%). IUGR/reduced birth weight at delivery and low APGAR scores were significantly more frequent in pre-eclamptic pregnancies, showing adverse perinatal outcome ($p < 0.001$).

DISCUSSION

In the present study, baseline maternal characteristics were comparable between pre-eclamptic and normal pregnancies, with no significant difference in mean maternal age (27.12 ± 4.90 vs 25.56 ± 3.61 years; $p=0.078$), gestational age distribution before 37 weeks (92.0% vs 90.0%; $p=0.727$), and multigravida status (64.0% vs 56.0%; $p=0.414$), indicating adequate matching between groups. Similar comparability between study groups was observed by Karaman et al. (2016).^[8] who evaluated singleton third-trimester pregnancies with comparable demographic profiles among controls, gestational hypertension, and pre-eclamptic women. The present study also demonstrated significantly elevated blood pressure parameters in pre-eclamptic pregnancies, with mean SBP and DBP of 155.02 ± 15.92 mmHg and 99.74 ± 11.05 mmHg compared to 112.60 ± 8.24 mmHg and 76.16 ± 6.67 mmHg in controls ($p=0.001$), consistent with the diagnostic criteria for pre-eclampsia described by Amaral et al. (2017).^[2] The mean placental SWE/ARFI value was significantly higher in pre-eclamptic pregnancies (6.58 ± 2.05 kPa) than normal pregnancies (3.41 ± 1.15 kPa) ($p<0.001$), suggesting increased placental stiffness in diseased placentas. Similar findings were reported by Meena et al. (2022).^[12] who observed higher mean placental elasticity in women developing pre-eclampsia (4.61 kPa vs 2.51 kPa), and by El Gebally et al. (2023).^[11] and Karaman et al. (2016).^[8] who also demonstrated significantly increased placental stiffness in pre-eclamptic pregnancies across different placental regions.

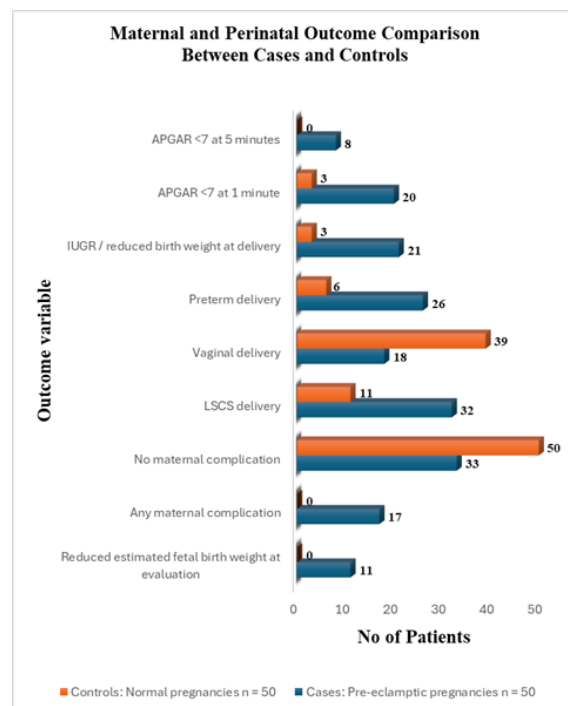


Figure 1: Maternal and Perinatal Outcome Comparison between Cases and Controls

[Figure 1] Shows Maternal and perinatal outcomes were poorer in pre-eclamptic pregnancies compared to normal pregnancies. Reduced estimated fetal birth weight at evaluation was seen in 11 cases (22.0%) and none of the controls ($p = 0.006$). Maternal complications occurred in 17 cases (34.0%), while no

Regional placental elastography values were significantly higher in pre-eclamptic pregnancies across all placental regions, with higher median mean values at the central maternal (6.22 vs 3.04 kPa), central fetal (5.89 vs 2.95 kPa), peripheral maternal (5.42 vs 3.21 kPa), and peripheral fetal regions (5.62 vs 3.40 kPa), with all differences being statistically significant ($p=0.001$). Similar findings were reported by Karaman et al. (2016).^[8] who demonstrated significantly increased placental elasticity values in pre-eclamptic pregnancies, particularly at the peripheral fetal surface. El Gebally et al. (2023).^[11] also observed significantly higher stiffness values in all placental regions and layers among pre-eclamptic women, with the greatest difference in the central placenta, supporting the diffuse increase in placental stiffness observed in the present study. The present study additionally demonstrated poorer maternal and perinatal outcomes in pre-eclamptic pregnancies, including increased maternal complications (34.0%), higher LSCS rates (64.0%), preterm delivery (52.0%), reduced fetal birth weight, IUGR, and low APGAR scores ($p<0.001$). These findings are consistent with Amaral et al. (2017).^[2] who reported that pre-eclampsia is associated with preterm delivery, low birth weight, and increased maternal and neonatal morbidity. Unlike previous studies primarily focusing on diagnostic elastography parameters, the present study additionally correlated increased placental stiffness with adverse fetomaternal outcomes.

CONCLUSION

The present study demonstrated that placental shear wave elastography values were significantly higher in pre-eclamptic pregnancies compared to normal pregnancies, indicating increased placental stiffness in pre-eclampsia. Elevated SWE/ARFI values were consistently observed across central and peripheral placental regions, suggesting diffuse placental involvement associated with abnormal placentation and uteroplacental vascular insufficiency. Pre-eclamptic pregnancies also showed significantly adverse maternal and perinatal outcomes, including increased maternal complications, higher rates of LSCS and preterm delivery, reduced fetal birth weight, IUGR, and lower APGAR scores. These findings establish a clear association between increased placental stiffness and poor fetomaternal outcome. The study supports the utility of placental ARFI elastography as a reliable, non-invasive

adjunctive imaging modality for differentiating normal and pre-eclamptic pregnancies in the second and third trimester. Placental elastography may aid in early risk stratification, closer antenatal surveillance, and timely obstetric intervention, thereby potentially improving maternal and neonatal outcomes.

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