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Original Research Article.

Role of ARFI Elastography in Assessment of Differences in Quantitative Placental Elasticity in Normal Versus Intra Uterine Growth Retarded Pregnancies

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ABSTRACT

Objective: This study is aimed at comparing quantitative elasticity of placenta using acoustic radiation force impulse (ARFI) elastography in normal versus intra uterine growth retarded pregnancies.

Materials and Methods: Seventy healthy pregnant women at gestation age of 25-40 weeks with singleton fetus were evaluated in this study. The study sample comprised fifty three normal and seventeen pregnancies with growth retarded fetuses. ARFI elastography was used for quantitative evaluation of placental stiffness via Placental shear wave velocity (SWV) measurements and values were compared between the two groups.

Results: Higher placental minimum, maximum and mean SWV measurements, were seen in the pregnancies with growth retardation compared to the normal ones [0.94, 0.66], [4.20, 3.60], and [2.37 ± 0.5, 1.70 ± 0.3;], respectively [p = 0.010]

Conclusion: Placental elasticity assessed quantitatively using ARFI elastography is lower in intra uterine growth retarded pregnancies versus normal pregnancies.

Keywords: Acoustic Radiation Force Impulse Elastography, Intra Uterine Growth Retardation, Placental Stiffness.

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INTRODUCTION

Placental tissue has rapid growth and differentiation providing communication between mother and fetus. It comprises of maternal and fetal components. Abnormalities and pathologies of placenta are of immense importance as they can compromise fetoplacental and maternal placental circulation and hence fetal growth and outcome. Ultrasound and color doppler can provide information regarding placental abnormalities including its development, positioning, vasculature but this does not cover placental functioning adequately.[1]

Elastography can evaluate soft tissue stiffness non-invasively.[2] The use of elastography has been extensive in characterizing breast, prostate, thyroid lesions, in quantification of hepatic fibrosis and has been introduced in other areas as well.[3-10]

Acoustic radiation force impulse (ARFI) has been transpiring above manual compression for elastography.[11-13] ARFI includes virtual touch tissue imaging (VTI) and virtual touch tissue quantification (VTQ). VTQ can provide shear wave velocity (SWV) corresponding to tissue stiffness.[14] ARFI scores over manual compression elastography being repeatable, less subjective and more operator-independent.

This study aimed to assess role of ARFI elastography in quantitative evaluation of placental elasticity in pregnant women and to determine its correlation with fetal growth, development and outcome.

MATERIALS AND METHODS

Cases

The study conducted was a prospective one duly permitted by the institutional Ethical Committee and informed written consent was obtained from all participants. The study was conducted on 70 pregnant women between 25 to 40 weeks duration of gestation. The mean participants were 18-35 years of age (Mean 23 years, standard deviation [SD]- 4 years), coming to the antenatal outpatient clinic from July 2017 to November 2017. Only singleton pregnancies were included. Pregnancies with diseases like diabetes, pre eclampsia or any fetal abnormality which could have a bearing on fetal growth were excluded. Placentae at deep posterior location (8 cm or more) were excluded (maximum penetration depth being 8 cm). Fetal growth / weight chart by Doubilet et al[15] was used for characterization of fetal growth retardation. Taking fetal weight less than 10th percentile for that gestation age as cut off, 17 out of 70 cases were diagnosed with fetal growth retardation.

Imaging Technique and Analysis

B-mode US, Doppler US and ARFI elastography were carried in supine position using Acuson S2000™ (Siemens, Erlangen, Germany) provided with the curvilinear probe (6C1 HD 2.0-4.5 MHz). Five samples each were taken from center and edge of placenta avoiding cord insertion site. (Fig 1) Patient had to hold breath for duration of less than 5 seconds at end inspiration. The ROI was kept at 1x0.5 cm .Shear wave velocity (Vs) was estimated at five ROIs each at centre and edge of placentas. The mean SWV (mean SWV) values were recorded.

To analyze relation between placental stiffness and birth weight, linear regression analysis of correlations between Vs values and values from SD of birth weight (Z score) was done. Z score estimation was based on estimated birth weight values by Doubilet et al.[15]

Statistical Analysis

SAS EG 16.0 (Statistical Analysis Software Enterprise Guide) was used for statistical analysis. Box plot analysis and t-test were used to compare and analyse values from two groups.

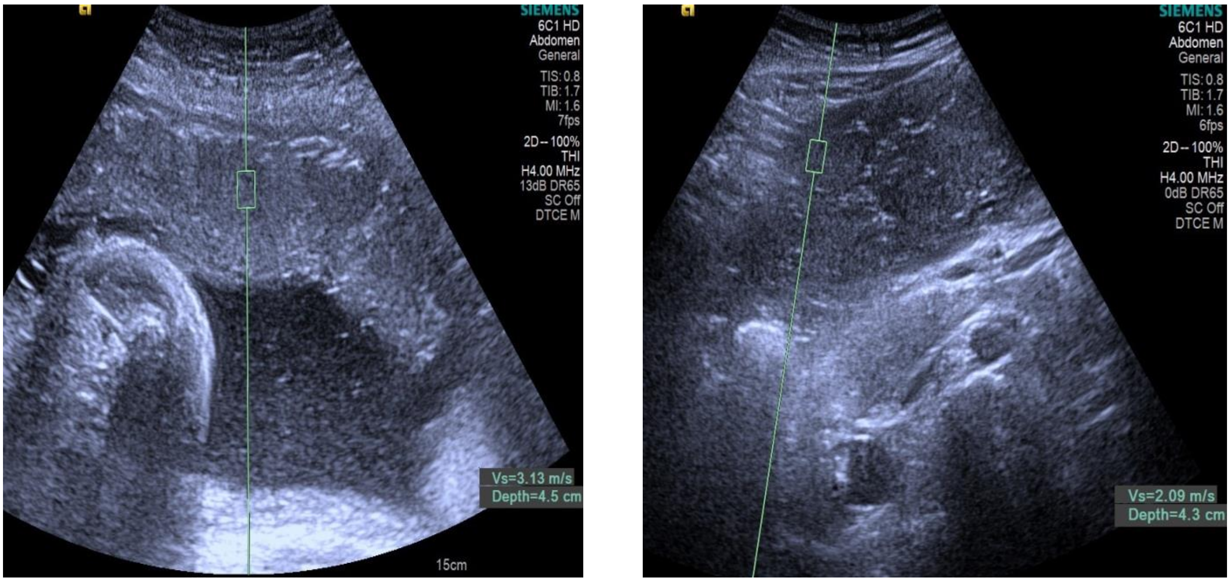

Fig 1: Showing SWV measurement of placenta.

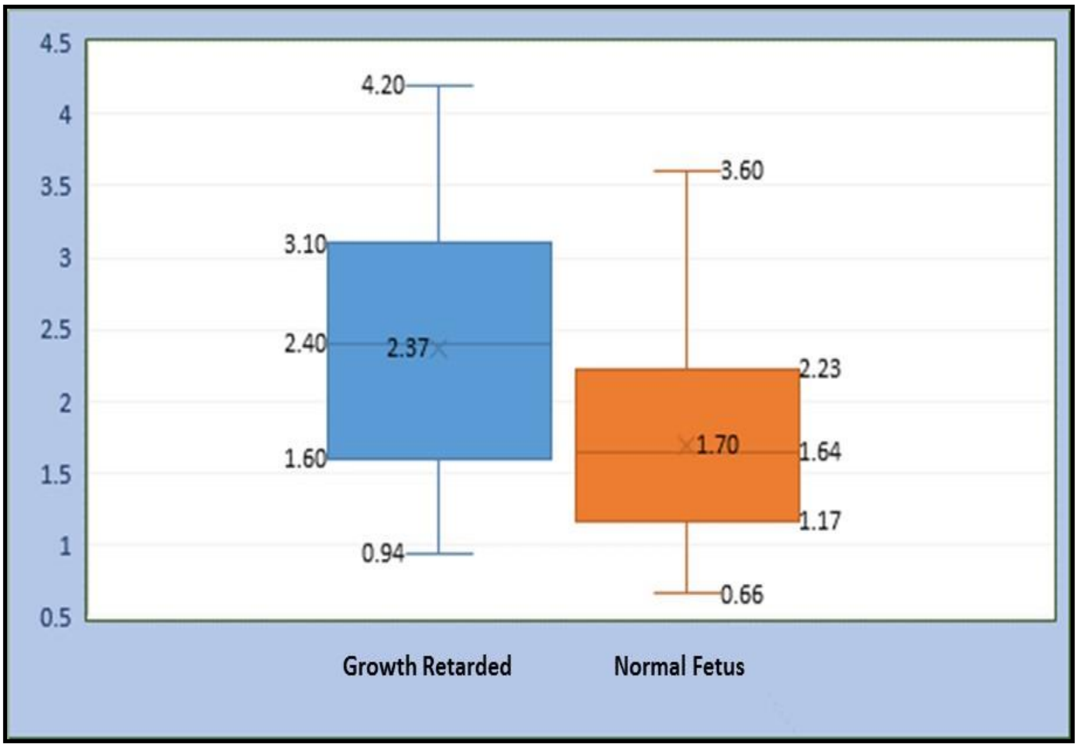

Fig 2: Showing comparative evaluation of ARFI measurements in normal versus growth retarded pregnancies

RESULTS

Mean Vs values from ROIs placed in central and marginal location were not significantly indifferent in either group. In the FGR cases, minimum maximum and mean Vs values were higher compared to the normal ones (Fig. 2). p value <0.05 by two tailed test was considered statistically significant.

DISCUSSION

Evaluation of placental morphology and functioning antenatally is indispensible owing to the onus it has on fetal growth. Evaluation of tissue elasticity can give quantitative information of its functioning. ARFI generates a shear wave that propagating through the tissue under evaluation can give quantitative analysis of its elasticity via Vs values. ARFI besides being objective, reproducible can be implemented in the same appointment for sonographic fetal evaluation.

Studies on placental elasticity are limited. Sugitani et al[16] conducted an ex-vivo study using ARFI elastography that reported higher SWV values in the pregnancies culminating to growth retarded fetuses. Z Yamanka et al[17] established positive correlation between placental stiffness and fetal growth. Arioz Habibi H et al[18] and Durhan G et al[19] reported stiffer placentas in Intra uterine growth retarded pregnancies.

In our study no significant differences were appreciable in Vs measurements in central or marginal locations in FGR cases as well as normal cases. Similar results were shown by Li WJ et al.[9]

Studies base on strain elastography and SWV measurements have found stiffer placentas in pregnant women with pre-eclampsia[20,21] and in cases having anomalies of fetus.[22]

A relatively small sample size is one of the limitations of our study. Limited depth of evaluation disabled evaluation of 8 cm or deeper posterior placentas. Long duration and high power of ARFI pulse poses risk of thermal and mechanical damage to tissues. Studies[23-25] however have demonstrated Thermal Index (T I) and mechanical Index (M I) associated with ARFI to be in safe limits as per Food and Drug Administration (FDA) standards.

In conclusion, placentas were found to be stiffer in cases of fetal growth retardation in comparison to normal patients. ARFI elastography hence can provide a convenient, objective, safe method for placental elasticity evaluation.

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