

ASSOCIATION OF ABNORMAL AMNIOTIC FLUID VOLUME AND ABNORMAL DOPPLER IN THIRD PREGNANCY TRIMESTER WITH PRETERM BIRTH PREGNANT FEMALES

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ABSTRACT

Background: Perinatal mortality in India has been linked to preterm birth with it being considered as vital contributor. Preterm birth presents with incidence ranging from 13% to 19% of all live Indian births and has large interstate variations.

Aim: The present study aimed to assess the diagnostic efficacy and association of abnormal amniotic fluid volume (AFV) and abnormal Doppler in the third pregnancy trimester with preterm birth pregnant females.

Methods: The study assessed 289 females where the staging of fetal growth restriction, fetal structure, growth, and environment, estimation of preterm preeclampsia risk, ultrasound assessment, and fetal Doppler studies were done in the third trimester. Association in abnormal amniotic fluid volume and abnormal Doppler was assessed with preterm birth along with diagnostic efficacy of doppler and amniotic fluid volume.

Results: Among 315 females, 25.39% (n=80) of females had preterm birth before 37 weeks of gestation. In 190 females with normal fetal Doppler and abnormal AFV, 21.05% (n=40) had preterm birth. Preterm preeclampsia was associated with the preterm birth. The diagnostic efficacy of both AFV and abnormal fetal Doppler is good in predicting preterm birth.

Conclusions: The present study concludes that third-trimester fetal Doppler studies can help reduce the rate of preterm birth by helping in the assessment of fetal well-being which contradicts the belief that third-trimester fetal Doppler can lead to iatrogenic preterm birth. The association is present between preterm preeclampsia and preterm birth, and early identification in high-risk females and aspirin therapy initiation can have beneficial effects on preterm birth.

Keywords: Amniotic fluid volume, color Doppler, preeclampsia, preterm birth

INTRODUCTION

Doppler ultrasound studies and scans are considered reliable and are widely used to assess the growth and well-being of the developing fetus along with deciding the optimal timing of childbirth and evaluating the stage of FGR (fetal growth restriction). Previous literature data has reported that Doppler studies have high efficacy in identifying the utility and efficacy of doppler studies in identifying the categorization of fetuses depending on their growth to decide further management strategies, assessing the fetal cardiovascular adaptation to the hypoxia, and identify the uteroplacental insufficiency in the pregnant females.¹

Chronic changes in the fetal environment are accurately assessed with the amniotic fluid making it a reliable parameter and a part of the biophysical profile score that is used to assess the well-being of the fetus in the third trimester of pregnancy. The existing literature data suggest that isolated oligohydramnios are not linked to growth restriction and adverse perinatal outcomes in the fetus. A progressive decrease in the amniotic fluid volume can assess the chronic alterations in the fetal environment and the early-onset FGR. In nearly 20% to 30% of the cases, oligohydramnios can be seen one week before acute deterioration.²

The screening protocol for screening females in the third trimester of pregnancy following the Samrakshan program of the Indian Radiological and Imaging Association uses the trimester-specific fetal Doppler studies along with fetal Doppler studies, staging of FGR depending on EFW (estimated fetal weight), fetal structure, growth, and environment, estimation of preterm preeclampsia, and routine ultrasound assessment of all the pregnant females.³

Preterm births are a vital contributor to perinatal mortality in developing nations such as India. The WHO (World Health Organization) has reported that almost 15 million of the births in a year are preterm births. The preterm birth has an incidence rate of 13% to 20% of all the live births in India. However, a large variation is seen between and within the states.⁴

The present study aimed to assess the direction and magnitude of possible association of abnormal amniotic fluid volume and abnormal Doppler studies in the third trimester of pregnancy with preterm births. The study also aimed to assess the diagnostic efficacy of abnormal amniotic fluid volume and abnormal Doppler for preterm birth in pregnant Indian females.

MATERIALS AND METHODS

The present Clinical study was aimed to assess the direction and magnitude of possible association of abnormal amniotic fluid volume and abnormal Doppler studies in the third trimester of pregnancy with preterm births. The study also aimed to assess the diagnostic efficacy of abnormal amniotic fluid volume and abnormal Doppler for preterm birth in pregnant Indian females. The study population was from the Department of Obstetrics and Gynecology and

referred to Department of Radiodiagnosis of the Institute. Verbal and written informed consent was taken from all the subjects before study participation.

The inclusion criteria for the study were pregnant females, having singleton pregnancies, and being willing to participate in the study. All the Doppler scans and ultrasounds were done by two radiologist experts in their field. The exclusion criteria for the study were females who did not give consent for study participation, females with twin or multiple pregnancies, and females whose complete information on the outcomes of childbirth was not retrieved. In all the included females, after 28 weeks of gestation, demographic and clinical data were collected for all the subjects along with the assessment of fetal movements, breathing, heart rate, liquor assessment, fetal growth and biometry, and assessment of CPR (cerebroplacental ratio). Also, a Doppler study of the middle cerebral artery, umbilical artery, and uterine artery was done in all the included subjects.

Following this, the maternal comorbidities were noted in detail including the onset of FGR and preeclampsia from the existing hospital records and data. The adequacy of amniotic fluid volume was done using the single deepest vertical pocket (SDP) and four-quadrant AFI (amniotic fluid index).⁵ Polyhydramnios was assessed with SDP of >8 , whereas, Oligohydramnios was defined as the absence of pocket measuring a minimum 2×1 cm and AFI of ≤ 5 cm.

Doppler indices for uterine artery were evaluated in the third trimester with a transabdominal approach. Abnormal Doppler indices were considered with uterine artery pulsatility index (PI) $> 95^{\text{th}}$ centile. The identification of left and right uterine arteries was done at the expected crossover with the external iliac artery, and the Doppler sampling gate was set at nearly 2mm. After identification of the arteries, waveforms were assessed from the pulsed wave doppler. The PI was assessed following a minimum of three identical waveforms.⁶ Doppler indices for uterine artery were evaluated at free loop cord and PI of uterine artery of $>95^{\text{th}}$ centile was taken as abnormal.⁷

MCA Doppler waveforms were evaluated to attain peak systolic volume with manual calipers or auto trace and abnormal MCA PI was taken for $<5^{\text{th}}$ centile. Doppler gate was placed at the proximal third of MCA near its origin in the internal carotid artery keeping an angle of 0° between ultrasound beam and blood flow direction. CPR was calculated by dividing MCA PI by UA PI. Abnormal results were considered for CPR PI of $<5^{\text{th}}$ centile.⁸ In cases with abnormal CPR or mean UtA PI, absent or reversed end-diastolic flow was assessed.

In all the pregnant females, fetal growth, biometry, and estimated fetal weight were assessed. Staging of the fetal growth was done utilizing a composite model including the Doppler indices and fetal weight depending on the model of Figueras and Gratacos in 2014. The fetus was considered small for gestational age if the estimated fetal weight was 3^{rd} to 10^{th} percentile with normal Doppler indices.

The Doppler imaging and findings were sent to the referring Obstetrician who was the primary decision maker concerning the childbirth. The information concerning admission to neonatal ICU, the onset of preeclampsia in the later stages of the third trimester, birth weight of the child, stillbirths, live births, and gestational age at the time of delivery. The childbirth before 37 weeks of gestational age was considered preterm birth.

The data gathered were analyzed statistically using the SPSS software version 21.0 (IBM Corp., Armonk, NY, USA). The data were expressed as mean and standard deviation and frequency and percentages. The p-value of <0.05 was considered as the level of statistical significance.

RESULTS

The present Clinical study was aimed to assess the direction and magnitude of possible association of abnormal amniotic fluid volume and abnormal Doppler studies in the third trimester of pregnancy with preterm births. The study also aimed to assess the diagnostic efficacy of abnormal amniotic fluid volume and abnormal Doppler for preterm birth in pregnant Indian females. The study assessed 289 females with singleton pregnancy. The mean age of study females was 28.6 ± 4.5 years. There were 10.03% (n=29) females in the age range of >35 years. The mean gestational age was 34.3 ± 2.2 weeks. SLE was seen in 0.34% (n=1) subjects. Diabetes, hypertension, nullipara, and spontaneous conception were seen in 1.03% (n=3), 1.38% (n=4), 64.01% (n=185), and 96.82% (n=280) subjects respectively. FGR of stages 1, 2, 3, and 4 were seen in 11.07% (n=32), 0.34% (n=1), 0.34% (n=1), and 0.34% (n=1) subjects respectively. EFW was <3rd, 3rd-10th, 10th-50th, and >50th percentile in 5.88% (n=17), 15.22% (n=44), 68.85% (n=199), and 10.38% (n=60) subjects respectively. Neonatal mortality, stillbirths, and birth weight <2500 grams were seen in 0.69% (n=2), 0.34% (n=1), and 21.10% (n=61) subjects respectively. Birth weight was 2741.3 ± 510.6 grams. Preterm births, preterm preeclampsia, abnormal liquor, and abnormal fetal Doppler were seen in 28.02% (n=81), 3.46% (n=10), 14.87% (n=43), and 18.68% (n=54) subjects respectively. Both liquor and fetal Doppler were abnormal in 9.34% (n=27) subjects. Polyhydramnios and oligohydramnios were seen in 2.76% (n=8) and 21.79% (n=63) subjects respectively (Table 1).

On assessing the abnormal fetal parameters in the study subjects, it was seen that abnormal fetal Doppler was seen in 28.37% (n=82) of subjects. Cerebropoplacental ratio of <5th percentile was seen in 13.14% (n=38) study subjects. Middle cerebral artery PI was <5th percentile in 12.45% (n=36) study subjects, umbilical artery PI was >95th percentile in 13.49% (n=39) study subjects, and mean uterine artery PI was >95th percentile in 7.61% (n=22) study subjects respectively as shown in Table 2.

Concerning the correlation of abnormal liquor to FGR stage and small for gestational age infants in study participants, it was seen that in 259 subjects with no FGR, abnormal liquor and small for gestational age babies were seen in 17.76% (n=46) subjects. In subjects with FGR stages 1, 2, 3, and 4, abnormal liquor and small for gestational age infants were seen in 50% (n=16), 100%

(n=1), 100% (n=1), and no study subjects respectively. The 95% CI for no FGR, stage 1, 2, 3, and 4 FGR was 15.4-21.7, 37.3-61.3, 9.7-90.4, 34.4-100, and 0 respectively as summarized in Table 3.

For assessment of preterm birth by liquor state and fetal Doppler study in study subjects, in polyhydramnios, abnormal fetal Doppler study was seen in 50% (n=4) subjects. Abnormal fetal Doppler study also resulted in preterm birth in 25.39% (n=16) subjects with oligohydramnios, in 34.21% (n=13) subjects with Cerebroplacental ratio <5th percentile, in 25% (n=9) subjects with MCA PI <5th percentile, 30.76% (n=12) subjects with Umbilical artery PI >95th percentile, 40.90% (n=9) subjects with Mean uterine artery PI >95th percentile, 30.23% (n=13) subjects with only abnormal liquor, 37.03% (n=20) subjects with abnormal fetal doppler, 25.92% (n=7) subjects with both fetal doppler and liquor abnormal, and in 21.16% (n=40) subjects with both fetal doppler and liquor normal respectively as depicted in Table 4.

DISCUSSION

The study assessed 289 females with singleton pregnancy. The mean age of study females was 28.6±4.5 years. There were 10.03% (n=29) females in the age range of >35 years. The mean gestational age was 34.3±2.2 weeks. SLE was seen in 0.34% (n=1) subjects. Diabetes, hypertension, nullipara, and spontaneous conception were seen in 1.03% (n=3), 1.38% (n=4), 64.01% (n=185), and 96.82% (n=280) subjects respectively. FGR of stages 1, 2, 3, and 4 were seen in 11.07% (n=32), 0.34% (n=1), 0.34% (n=1), and 0.34% (n=1) subjects respectively. EFW was <3rd, 3rd-10th, 10th-50th, and >50th percentile in 5.88% (n=17), 15.22% (n=44), 68.85% (n=199), and 10.38% (n=60) subjects respectively. Neonatal mortality, stillbirths, and birth weight <2500 grams were seen in 0.69% (n=2), 0.34% (n=1), and 21.10% (n=61) subjects respectively. These findings were similar to the studies of Trivedi P et al⁹ in 2018 and Chawanpaiboon S et al¹⁰ in 2019 where authors assessed subjects with demographic data comparable to the present study.

Birth weight was 2741.3±510.6 grams. Preterm births, preterm preeclampsia, abnormal liquor, and abnormal fetal Doppler were seen in 28.02% (n=81), 3.46% (n=10), 14.87% (n=43), and 18.68% (n=54) subjects respectively. Both liquor and fetal Doppler were abnormal in 9.34% (n=27) subjects. Polyhydramnios and oligohydramnios were seen in 2.76% (n=8) and 21.79% (n=63) subjects respectively. These findings were comparable to the findings of Rai RK et al¹¹ in 2019 and Kannaujiya A et al¹² in 2022 where authors reported similar fetal-maternal characteristics as a present study in their study subjects.

The study results showed abnormal fetal parameters in the study subjects, it was seen that abnormal fetal Doppler was seen in 28.37% (n=82) of subjects. Cerebroplacental ratio of <5th percentile was seen in 13.14% (n=38) study subjects. Middle cerebral artery PI was <5th percentile in 12.45% (n=36) study subjects, umbilical artery PI was >95th percentile in 13.49% (n=39) study subjects, and mean uterine artery PI was >95th percentile in 7.61% (n=22) study

subjects respectively. These results were consistent with the studies of Cosmi E et al¹³ in 2005 and Baschat AA et al¹⁴ in 2001 where authors suggested abnormal fetal parameters in their study subjects as seen in the results of the present study.

It was also seen that the correlation of abnormal liquor to FGR stage and small for gestational age infants in study participants, it was seen that in 259 subjects with no FGR, abnormal liquor and small for gestational age babies were seen in 17.76% (n=46) subjects. In subjects with FGR stages 1, 2, 3, and 4, abnormal liquor and small for gestational age infants were seen in 50% (n=16), 100% (n=1), 100% (n=1), and no study subjects respectively. The 95% CI for no FGR, stage 1, 2, 3, and 4 FGR was 15.4-21.7, 37.3-61.3, 9.7-90.4, 34.4-100, and 0 respectively. These findings were in agreement with the previous findings of Rossi AC et al¹⁵ in 2013 and Zhang J et al¹⁶ in 2004 where a similar correlation in abnormal liquor to FGR stage and small for gestational age infants was seen in the study of the authors.

Concerning the assessment of preterm birth by liquor state and fetal Doppler study in study subjects, in polyhydramnios, abnormal fetal Doppler study was seen in 50% (n=4) subjects. Abnormal fetal Doppler study also resulted in preterm birth in 25.39% (n=16) subjects with oligohydramnios, in 34.21% (n=13) subjects with Cerebroplacental ratio <5th percentile, in 25% (n=9) subjects with MCA PI <5th percentile, 30.76% (n=12) subjects with Umbilical artery PI >95th percentile, 40.90% (n=9) subjects with Mean uterine artery PI >95th percentile, 30.23% (n=13) subjects with only abnormal liquor, 37.03% (n=20) subjects with abnormal fetal doppler, 25.92% (n=7) subjects with both fetal doppler and liquor abnormal, and in 21.16% (n=40) subjects with both fetal doppler and liquor normal respectively. These results were in line with the studies of Naveiro-Fuentes M et al¹⁷ in 2016 and Ferrazi E et al¹⁸ in 2019 where results similar to the present study were reported by the authors in their studies.

CONCLUSIONS

Considering its limitations, the present study concludes that third-trimester fetal Doppler studies can help reduce the rate of preterm birth by helping in the assessment of fetal well-being which contradicts the belief that third-trimester fetal Doppler can lead to iatrogenic preterm birth. The association is present between preterm preeclampsia and preterm birth, and early identification in high-risk females and aspirin therapy initiation can have beneficial effects on preterm birth.

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TABLES

Characteristics	N	%
Mean age (years)	28.6±4.5	
Age >35 years	29	10.03
Mean gestational age (weeks)	34.3±2.2	
SLE	1	0.34
Diabetes mellitus	3	1.03
Chronic hypertension	4	1.38
Nulliparous	185	64.01
Spontaneous conception	280	96.82
FGR		
No FGR	259	89.61
Stage 1 FGR	32	11.07
Stage 2 FGR	1	0.34
Stage 3 FGR	1	0.34
Stage 4 FGR	1	0.34
Estimated fetal weight (percentile)		
<3 rd	17	5.88
3 rd -10 th	44	15.22
10 th -50 th	199	68.85
>50 th	60	10.38
Neonatal mortality	2	0.69
Stillbirths	1	0.34
Birthweight <2500 grams	61	21.10
Birth weight (grams)	2741.3±510.6	
Preterm births	81	28.02
Preterm preeclampsia	10	3.46
Abnormal liquor	43	14.87
Abnormal fetal doppler	54	18.68
Both liquor and fetal Doppler abnormal	27	9.34
Both liquor and fetal Doppler normal	189	65.39
Polyhydramnios	8	2.76
Oligohydramnios	63	21.79

Table 1: Demographic and disease characteristics of study subjects

Parameters of fetal Doppler	N	%
Abnormal fetal doppler	82	28.37
Cerebroplacental ratio <5 th percentile	38	13.14

MCA PI <5th percentile	36	12.45
Umbilical artery PI >95th percentile	39	13.49
Mean uterine artery PI >95th percentile	22	7.61

Table 2: Abnormal fetal Doppler parameters in the study subjects

Stages of FGR	N	%	95% CI
No FGR (n=259)	46	17.76	15.4-21.7
FGR stage 1 (n=32)	16	50	37.3-61.3
FGR stage 2 (n=1)	1	100	9.7-90.4
FGR stage 3 (n=1)	1	100	34.4-100
FGR stage 4 (n=1)	0	0	0

Table 3: Assessing the correlation of abnormal liquor to FGR stage and small for gestational age infants in study participants

Characteristics	N	%	95% CI
Polyhydramnios (n=8)	4	50	-
Oligohydramnios (n=63)	16	25.39	-
Cerebroplacental ratio <5th percentile (n=38)	13	34.21	23.3-43.7
MCA PI <5th percentile (n=36)	9	25	17.6-38.3
Umbilical artery PI >95th percentile (n=39)	12	30.76	22.9-43.2
Mean uterine artery PI >95th percentile (n=22)	9	40.90	29.9-57.6
Only abnormal liquor (n=43)	13	30.23	22.5-41.2
Only abnormal fetal Doppler (n=54)	20	37.03	28.1-46.3
Both fetal Doppler and liquor abnormal (n=27)	7	25.92	15.6-38.1
Both fetal Doppler and liquor normal (n=189)	40	21.16	17.5-25.7

Table 4: Assessment of preterm birth by liquor state and fetal Doppler study in study subjects