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Original Research Article

PREDICTIVE VALUE OF FETAL RENAL ARTERY DOPPLER INDICES IN IDIOPATHIC OLIGOHYDRAMNIOS AND POLYHYDRAMNIOS

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ABSTRACT

Background: Amniotic fluid volume is a vital marker of fetal well-being, and deviations such as oligohydramnios or polyhydramnios are associated with adverse perinatal outcomes, including low birth weight, fetal distress, and increased operative deliveries. While the etiology of amniotic fluid disorders is multifactorial, fetal renal perfusion plays a crucial role in regulating amniotic fluid production through urine output. Doppler velocimetry of the fetal renal artery provides a non-invasive means of assessing renal vascular resistance, which may reflect underlying fluid abnormalities. The aim is to determine the predictive value of fetal renal artery doppler indices in idiopathic oligohydramnios and polyhydramnios.

Materials and Methods: Prospective longitudinal study carried out in Dept of Radiodiagnosis from September 2022 to march 2024 in 90 Pregnant women age (21- 30 years) 28- 36 weeks of gestational age are included in study. Participants divided as 3 groups as Group I have included 30 women with normal amniotic fluid, Group II have included 30 women with oligohydramnios, Group III has included 30 women with polyhydramnios.

Results: Majority of the study participants were between 26- 30 years 53 (58.9%), followed by 21- 25 years 37 (41.1%). There is variability in the literature regarding the correlation between renal artery Doppler measurements and oligohydramnios. Low birth weight was more common in cases of oligohydramnios with a significant p-value (<0.01). Fetal distress was significantly higher in oligohydramnios cases ($p < 0.01$). Higher caesarean section rates were observed in oligohydramnios cases, significantly different from other groups. AFI decreases as gestational age advances, with significant variations starting at the 33rd week and becoming more evident after the 38th week. High RA-RI values correlate with higher fetal distress, lower birth weight, and higher caesarean section rates, all statistically significant ($p < 0.01$). High RA-PI values showed no significant difference.

Conclusion: Fetal renal artery Doppler, particularly the resistance index (RI), is a valuable predictor of adverse outcomes in idiopathic oligohydramnios, correlating with higher rates of fetal distress, lower birth weight, and increased caesarean deliveries. Renal artery Doppler thus provides a useful non-invasive tool for risk stratification and timely intervention, whereas PI values showed limited predictive significance in our study.

Keywords: Renal artery Doppler, Oligohydramnios, Polyhydramnios, Amniotic fluid index (AFI), Perinatal outcome, Resistance index (RI), Pulsatility index (PI), Fetal distress.

INTRODUCTION

For the fetus to survive and remain healthy inside the uterus there must be sufficient amount of amniotic fluid. An important factor in the dynamics of amniotic fluid is renal perfusion Amniotic fluid volume has been termed as oligohydramnios if the actual volume of the amniotic fluid is <500 ml or as polyhydramnios if the volume is >2000 ml. The normal amniotic fluid volume varies with gestational age.[1] Around 14 cm is the median AFI level from week 20 to week 35, after which the volume starts to decrease. Growth retardation, dysmaturity, fetal asphyxia, meconium staining, and congenital malformations have all been associated to oligohydramnios. Polyhydramnios has been correlated to Aneuploidy, macrosomia, and fetal structural abnormalities. There are many causes of polyhydramnios, such as diabetes mellitus, isoimmunization, fetal infections, and placental abnormalities, but most (50–60%) of the polyhydramnios cases appear to be idiopathic.

An increased or decreased amniotic fluid volume is also thought to be a factor in the increased incidence of complications during labour, an approximately two-fold increased risk of operative delivery. Intermittent evaluation of renal artery (RA) doppler waveforms during the early stages of pregnancy may help to identify changes in amniotic fluid dynamics.

The three ultrasound techniques used to label amniotic fluid volume as elevated are the amniotic fluid index2 (AFI) (24 or 25 cm),1. the single deepest pocket (SDP) technique (>8 cm).[2] subjective evaluation of amniotic fluid volume. Most studies identify the fluid as increased if any of the ultrasound assessments, the AFI, SDP, or the subjective assessment, have labeled the amniotic fluid volume as high. There are two things to keep in mind while assessing the volume of amniotic fluid. First, the volume of amniotic fluid during the early stages of pregnancy is substantial in comparison to the volume of the fetus and should not be mistaken with polyhydramnios. On the other hand, amniotic fluid in term patients typically has a relatively small volume, making it possible to see only small pockets. Second, patients who are obese often appear to have less than normal volumes of amniotic fluid. This could disperse sound waves and produce artifactual echoes in the amniotic fluid. Our study is done to determine the predictive value of fetal renal artery doppler indices in idiopathic oligohydramnios and polyhydramnios.

MATERIALS AND METHODS

Study design: Prospective longitudinal study
Study setting: This study was carried out in Dept of Radiodiagnosis, Mediciti institute of medical sciences, Ghanpur
Period of study: September 2022 to march 2024
Study population: Antenatal women (21 to 30 years of age)
Sample size: 90
Study tools: GE Voluson S8 Ultrasound machine using B-mode and Doppler.
Inclusion criteria:
Pregnant women age (21- 30 years)
Pregnant women 28- 36 weeks of gestational age
Exclusion criteria:
Patients with any additional co- morbidities
Known fetal congenital malformations or abnormalities
Data collection procedure: After obtaining written and informed consent from the participant, a pre-designed proforma was used to collect the clinical details of the patients. A detailed USG examination was performed (DOPPLER-USG), and using colour flow Doppler; single renal artery whichever is better visualised were evaluated at the level of their origin from the abdominal aorta.

The sample size was determined by grouping the patients into three groups. Women were divided into three groups:

- Group I have included 30 women with normal amniotic fluid
- Group II have included 30 women with oligohydramnios.
- Group III has included 30 women with polyhydramnios

Statistical analysis: The collected data were analysed with IBM SPSS Statistics for Windows, Version 26.To describe the data, descriptive statistics frequency analysis, percentage analysis were used for categorical variables and the mean & SD were used for continuous variables. To find the significant difference in the multivariate analysis, one way ANOVA with Tukey's Post-Hoc test was used. To find the significance in categorical data Chi-Square test was used. In all the above statistical tools, the probability value 0.05 was considered a significant level.

RESULTS

Table 1: Distribution of study participants according to age (n= 90)

Age (years)	Frequency (N)	Percentage (%)
21- 25	37	41.1
26- 30	53	58.9
Total	90	100

In the present study, out of 90 study participants, majority were between 26- 30 years 53 (58.9%), followed by 21- 25 years 37 (41.1%).

Table 2: Relation between birth weight, fetal distress and type of delivery and amniotic fluid index (n=90)

Birthweight (Kgs)	AFI			Total	X2 value	P-value
	Normal	Oligo	Poly			
<2.5	0	21	14	35	32.073	0.000
≥ 2.5	30	9	16	55		
Total	30	30	30	90		
Fetal distress						
Present	4	22	18	44	23.834	0.000
Absent	26	8	12	46		
Type of delivery						
Vaginal delivery	22	6	13	41	17.29	0.000
Caesarean	8	24	17	49		

Significant; †Chi square value

It is clear that low birth weight rate was more among study participants with oligohydramnios and this is highly statistically significant with P- value<0.01.

In fetal distress was higher among study participants with oligohydramnios in comparison to individuals with oligohydramnios and normal individuals and this association is highly statistically significant with P- value <0.01.

In caesarean section deliveries were more among study participants with oligohydramnios and this association is highly statistically significant with P-value< 0.01.

Table 3: Correlation of RA-PI, RI and Amniotic Fluid Index (AFI)

RA -PI	AFI			Total	X2 value	P- value
	Normal	Oligohydramnios	Polyhydramnios			
Correlation of RA-PI and Amniotic Fluid Index (AFI)						
Abnormal	0	3	2	5	2.97	0.23
Caesarean	30	27	28	85		
Total	30	30	30	90		
Correlation of RA-RI and Amniotic Fluid Index (AFI)						
Abnormal	0	24	1	25	61.26	0.000
Caesarean	30	6	29	65		
Total	30	30	30	90		

Interpretation: In the current study, majority of the study participants with oligohydramnios had abnormal RA- PI value in comparison to individuals with polyhydramnios and normal individuals but this difference was not statistically significant with P-value >0.05.

Interpretation: It is clear that, majority of the study participants with oligohydramnios had abnormal RA-RI value in comparison to individuals with polyhydramnios and normal individuals and this difference was highly statistically significant with P-value <0.01.

Table 4: Correlation of RA-PI, RIand Birthweight

RA -PI	Birthweight			X2 value	P- value
	<2.5	>2.5	Total		
Abnormal	3	2	5	0.993	0.37
Normal	32	53	85		
Total	35	55	90		
RA-RI					
Abnormal	18	7	25	15.969	0.00
Normal	17	48	65		
Total	35	55	90		

Interpretation: In the current study, majority of the study participants with abnormal RA- PI values had low birth weight children but this difference was not statistically significant with P- value >0.05.

Interpretation: In the current study, low birth weight rate was more among study participants with abnormal RA- RI values and this difference was highly statistically significant with P- value <0.01.

Table 5: Correlation of RA-PI, RI and Fetal Distress

RA -PI	Fetal Distress			X2 value	P- value
	<2.5	>2.5	Total		
Abnormal	3	2	5	0.993	0.37
Normal	41	44	85		
Total	44	46	90		
RA-RI					
Abnormal	19	6	25	15.969	0.001
Normal	25	40	65		
Total	44	46	90		

Interpretation: In the current study, fetal distress was more among study participants with abnormal RA- PI values but this difference was not statistically significant with P- value >0.05.

Interpretation: In the current study, fetal distress was more among study participants with abnormal RA- RI values and this difference was highly statistically significant with P- value <0.01.

Table 6: Correlation of RA-PI, RI and Type of Delivery

RA -PI	Fetal Distress			X2 value	P- value
	<2.5	>2.5	Total		
Abnormal	1	4	5	1.394	0.37
Normal	40	45	85		
Total	41	49	90		
RA-RI					
Abnormal	4	21	25	12.191	0.001
Normal	37	28	65		
Total	41	49	90		

Interpretation: It is clear that study participants with abnormal RA- PI values had higher rate of caesarean section deliveries but this difference was not statistically significant with P- value >0.05.

Interpretation: It is clear that study participants with abnormal RA- RI values had higher rate of caesarean section deliveries and this difference was highly statistically significant with P- value <0.01.

Table 7: comparison of gestational age with AFI (N=90)

Gestational age	Mean	SD	F-Value	p-Value
Normal	32.40	2.29	3.217	0.04
Oligo	30.90	2.17		
Poly	31.60	2.40		

The above table shows the comparision of gestational age with AFI by using one way ANOVA where F-value =3.217, P-value=0.04, which shows a stastical significant difference at the p<0.05 level.

DISCUSSION

In the present study, high renal artery resistance index (RA-RI) was significantly associated with oligohydramnios and correlated with higher fetal distress, lower birth weight, and increased caesarean section rates. By contrast, renal artery pulsatility index (RA-PI) did not show a significant association.

Renal Artery Resistance Index (RA-RI)

In our study, high RA-RI values were significantly associated with oligohydramnios, and correlated with higher fetal distress, lower birth weight, and increased caesarean delivery rates ($p < 0.01$). This finding highlights that increased renal vascular resistance leads to reduced renal perfusion and decreased urine output, thereby contributing to oligohydramnios.

Our results are in concordance with Oz et al,[3] who found renal artery Doppler to be the only useful Doppler parameter in predicting oligohydramnios in post-term pregnancies. Similarly, Akin et al,[4] observed that although baseline indicators of fetal distress were normal in idiopathic oligohydramnios, RA-RI and PI were elevated, and this group showed higher caesarean section rates for fetal distress compared to normal and polyhydramnios groups. Benzer et al,[5] also supported the association, reporting that oligohydramnios was linked with lower birth weight and SGA infants, with renal artery indices serving as a useful predictor of adverse outcomes.

Renal Artery Pulsatility Index (RA-PI)

Unlike RA-RI, RA-PI did not show a statistically significant difference in our study. This suggests that PI may be less reliable than RI in predicting oligohydramnios and its complications in non-post-term, non-IUGR pregnancies. This contrasts with Medhat et al,[6] and Abdel Gaied et al,[7] who found that RA-PI values increased as AFI decreased and were useful in predicting oligohydramnios. Jain et al,[8] also reported significant correlations of raised RA-RI and RA-PI with NICU admissions. On the other hand, Scott et al,[9] did not find consistent changes in RA-PI across serial measurements in oligohydramnios, aligning more closely with our findings. These differences could be due to variation in gestational age at assessment, sample size, or technical factors in Doppler measurement.

Birth Weight vs. AFI

We found that birth weight was significantly lower in oligohydramnios compared to control and polyhydramnios groups ($p < 0.01$). This reinforces that oligohydramnios is associated with growth restriction and adverse perinatal outcomes.

Our results mirror those of Figueroa et al,[10] who found a mean reduction of 162 g in birth weight among oligohydramnios cases and higher incidences of low birth weight and preterm births. Benzer et al,[4] similarly reported increased rates of SGA infants in oligohydramnios. However, Akin et al,[5] observed no difference in birth weight between idiopathic oligohydramnios and control groups, though polyhydramnios cases had significantly higher birth weights. This suggests that while oligohydramnios is often linked with growth restriction, the relationship may depend on underlying etiology and population studied.

Fetal Distress vs. AFI

Our study showed that fetal distress was significantly more frequent in oligohydramnios than in other groups ($p < 0.01$). This supports the view that reduced amniotic fluid compromises fetal tolerance to labour and increases risk of intrapartum hypoxia. These results align with Dasari et al,[11] who found AFI ≤8 cm and MVP ≤2 cm to be predictive of fetal distress in prolonged pregnancies. Khatun Ansari et al,[12] also highlighted that oligohydramnios is associated with IUGR, prolonged labour, caesarean section for fetal distress, and NICU admissions. Our findings are further supported by Akin et al,[5] who observed higher caesarean sections for fetal distress despite normal baseline distress indicators in oligohydramnios groups.

Type of Delivery vs. AFI

We noted a significantly higher rate of caesarean section deliveries in oligohydramnios cases, primarily due to fetal distress. This reflects the clinical decision to expedite delivery in compromised fetuses. Our results are consistent with Akin et al,[5] and Rossi et al,[13] who both reported higher rates of surgical delivery in oligohydramnios, with Rossi demonstrating a two-fold increased risk of caesarean for fetal distress. Similarly, Shiferaw et al,[14] observed a 40.8% caesarean section rate among mothers with oligohydramnios in late-term and post-term pregnancies, although they found no significant differences in outcomes between induced and spontaneous labour. These findings highlight the variability in obstetric practice but overall reinforce the increased likelihood of caesarean section in oligohydramnios.

Gestational Age vs. AFI

We observed a statistically significant correlation between gestational age and AFI ($p < 0.05$), with AFI declining as gestation advanced. This physiologic reduction in amniotic fluid volume is well established. Our findings are in agreement with Agwu et al,[15] who reported gradual reduction of AF with advancing gestation, and Machado et al,[16] who found AFI values to remain relatively constant until 33 weeks, followed by a progressive decrease after 38 weeks. This supports the importance of considering gestational age when interpreting AFI and Doppler parameters.

RA Indices vs. AFI and Adverse Outcomes

Overall, our study confirms that high RA-RI, but not RA-PI, correlates with oligohydramnios, fetal distress, lower birth weight, and increased caesarean sections.

This is consistent with Akin et al. and Jain et al., who reported significant associations of high renal Doppler indices with adverse perinatal outcomes. Benzer et al,[4] also described rising RA-PI before the development of oligohydramnios, suggesting that these indices may serve as early predictors. Conversely, Scott et al,[9] did not find consistent longitudinal changes, highlighting the ongoing debate in the literature. Taken together, these findings suggest that renal artery Doppler indices, particularly RA-RI, are useful in risk stratification, although variability across studies underscores the need for larger multicentric trials.

Finally, although our study did not find RA-PI to be significant, other authors such as Medhat et al,[6] and Abdel Gaied et al,[7] reported that RA-PI values increased as AFI decreased, suggesting that PI may also be valuable under certain conditions. Jain et al,[8] additionally showed that elevated RI and PI values correlated with increased NICU admissions. These variations may reflect differences in gestational age, inclusion criteria, and measurement timing.

Limitations

1. **Sample Size:** The study's findings are based on a relatively small sample size of 90 participants.
2. **Study Setting:** The research was conducted at a single institution (Dept of Radiodiagnosis, Mediciti Institute of Medical Sciences, Ghanpur), which may introduce location-specific biases and limit the applicability of the findings to different settings or regions.
3. **Exclusion Criteria:** By excluding patients with additional co-morbidities and known fetal congenital malformations or abnormalities, the study may not account for the full spectrum of cases encountered in clinical practice. This might limit the applicability of the findings to a more diverse population.
4. **Confounding Factors:** Potential confounding factors, such as maternal hydration status, fetal position during the ultrasound, and inter-patient variability in physiological conditions, may influence the Doppler measurements and the study outcomes. These factors were not controlled or accounted for in the analysis.

CONCLUSION

Renal artery Doppler indices, particularly increased resistance index (RI) and pulsatility index (PI), are significantly associated with oligohydramnios and adverse pregnancy outcomes such as low birth weight, fetal distress, and higher caesarean section rates. The findings suggest that Doppler evaluation of the fetal renal artery can serve as a useful non-invasive tool in predicting oligohydramnios-related complications, enabling timely intervention and improved perinatal outcomes.

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