Kashf Journal of Multidisciplinary Research
Vol: 02 - Issue 11 (2025)
P-ISSN: 3007-1992 E-ISSN: 3007-200X
https://kjmr.com.pk

SONOGRAPHIC EVALUATION OF FETAL RENAL ARTERY IN OLIGOHYDRAMNIOS AND POLYHYDRAMNIOS IN 3RD TRIMESTER OF PREGNANCY

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Article Info

Abstract

Background: The fetal renal artery Doppler assessment provides crucial insight into fetal renal perfusion and its association with amniotic fluid volume during the third trimester. Abnormalities in amniotic fluid, such as oligohydramnios and polyhydramnios, are common complications that may reflect underlying disturbances in renal or placental function. Evaluating renal artery indices, including the Resistive Index and Pulsatility Index, can help identify fetal hemodynamic changes and potential risks to fetal well-being.

Methodology: The present descriptive cross-sectional research study was carried out in Ali Hospital, Allahabad, District Kasur, and a period of four months. Sixty two third trimester pregnant women were utilized where 30 had oligohydramnios (AFI 5 cm or less) and 32 polyhydramnios (AFI 25 cm or more). The ultrasound probe that was used was Toshiba 300X curvilinear probe and frequency 2-9 MHz and fetal renal artery Doppler index (RI, PI, ratio of S/D) had been documented. Analysis of data was performed with the help of SPSS 25 and descriptive statistics and cross tabulations were implemented.

Results: This study utilized 62 (30 = 48.4) pregnant women in the 3 rd trimester; 30 (48.4) possessing oligohydramnios (AFI 0 to 5 cm) and 32 (51.6) possessing polyhydramnios (AFI 25 to 99 cm) AFI. The average age of the mothers was 29.33 years with SD of 6.43 and the average gestation was 33.81 and SD of 3.39 weeks. The average fetal weight was 2726.94 /738.32. The Biparietal Diameter of the head (Mean), Circumference of Head, Circumference of the Abdomen and Femur Length were compatible with the gestational age. Both RI and PI valves were more elevated in Oligohydramnios group than in polyhydramnios group and this is indicated by, the increased renal vascular resistance and decreased value of renal perfusion respectively.

Conclusion: In the third trimester of pregnancy, the amniotic fluid is linked to the fetal renal artery sonography which is a good predictor of the fetal renal perfusion. High resistance indices in renal artery have been linked to oligohydramnios that is an indicator of poor blood circulation to the kidney and low urine volumes. Polyhydramnios is also associated with low resistance indices that indicates high renal perfusion and renal output of urine. Therefore, the fetal renal artery Doppler is an inexpensive, non-invasive and practical routine of assessing renal functioning, existence of maladjusted fetuses, and enhancing obstetric intervention in the circumstance of anomalies in the amniotic fluid.

Keywords:
Pulsatility index (PI), Resistive index (RI), Amniotic fluid index (AFI)

INTRODUCTION

Changes in the peripheral circulation and change in flow that occurs in the developing fetal renal artery can be traced to changes in the amount of amniotic fluid. Each side has a renal artery that typically branches off the aorta and this enables one to examine sufficiently the renal blood flow that is renovated. The renal blood flow is a high resistance system, which reduces towards the end of pregnancy.[1]

Renal Artery Doppler was used to calm high risk pregnancy with disturbed blood flow of fetus. It is well known that once a fetus is impaired, there is more blood flow to the vital organs in comparison to non-essential organs such as kidneys. Indirect measure of loss, therefore, can be measured as resistance of RA of the renal functioning of the body at early stages. Once a coronal image of the kidneys of the fetus has been obtained, the color flow Doppler will be able to monitor the RA between the aorta and kidney.[2]

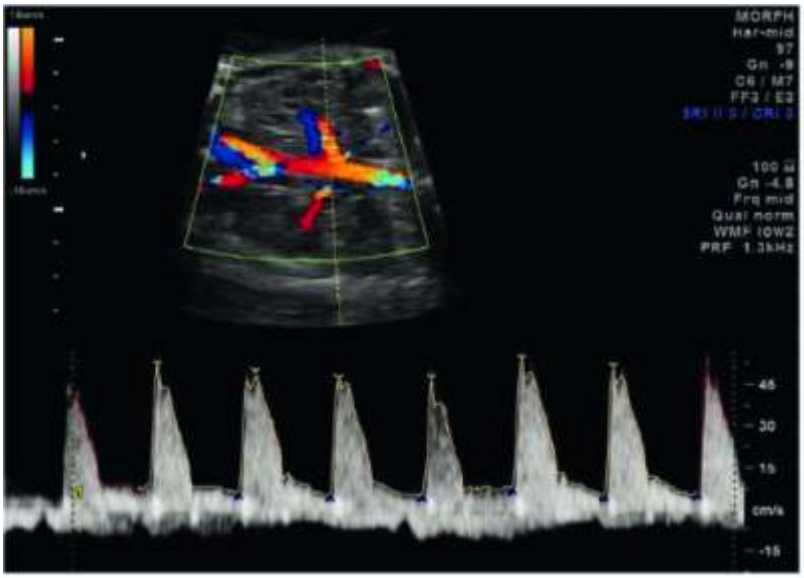


Figure 1: Fetal Renal Artery Doppler[2]

This sonographic examination is referred to as fetal renal artery Doppler and it is necessitated to analyze the movement of blood in the kidneys and to identify a possible problem with the kidneys of the fetus. This is more so in the third trimester whereby owing to the change in the amniotic fluid quantity; norm hydramnios, oligohydramnios and polyhydramnios may severely affect the mother fetus.[3] The kidneys also play a major role in the fetus development process in secretion of amniotic fluid as a result of urine discharge and therefore, the Doppler description of the kidneys is beneficial in the determination of the status of kidneys in fetuses such as stenosis or obstruction.[4] These are paramount parameters as RI and PI that present invaluable information on the development and renal perfusion.[5]

Amniotic fluid (AF) is a liquid that surrounds the fetus in the amniotic cavity in the process of intrauterine development, and participates in the provision of the fetus with a normal growth of development in an unhindered, sterile and thermos controlled environment. The functions of the

Amniotic fluid can be divided into physical, functional and homeostasis. The amniotic fluid helps to cushion the baby against infection, trauma and also assists in maintaining the body temperature of the baby. It regulates the movements of the fetus, thus, the formation of the musculoskeletal system and at the same time, it prevents the crushing of umbilical cord and placenta and thereby, prevents the fetus against vascular and nutritional diseases. The fetus also drinks the amniotic fluid and this aids in the growth of the gastrointestinal system. The fluid inflow and outflow in the amniotic space adds up to form the volume of the amniotic fluid (AFV).[6] The amniotic fluid index (AFI), single deepest pocket (SDP) and subjective assessment (which is visualization of the fluid volume not measured) are the most common techniques of estimating AFV that seems to be maintained and retained in a dynamic equilibrium.[7]

It has two semi quantitative measures of AFV, and they are AF index and deepest vertical pocket (DVP). At 20 weeks, AFV can be administered in a pregnant woman either through AFI or DVP. Sufficient AFI method would involve viewing of whole uterus and subsequently dividing the uterus into four equal parts. All vessels, all umbilical cords, or umbilical cord of largest fluid pocket (measured in centimeters) in each quadrant not in contact with any part of the fetus or any vessels is measured as long as the operator holds US probe perpendicular to the floor. The quantification begins at the edges of the fluid pocket and then proceeds to the uterus or fetal spaces which are deeper. This fluid pocket should be distinctly at least 1 cm in width in order to be captured under AFI or under DVP. The AFI is a combination of the four measures. The biggest pocket in the whole uterus is determined and measured in order to measure the DVP. Of significance, this is instead of the AFI where maximum pocket of fluid can be placed anywhere other than in one of the outer quadrants and may be more central.[8] Amniotic fluid index (AFI) should be used for diagnosing oligohydramnios.[9]AFI is one of the essential components of fetal biophysical profile and its values correlate well with adequacy of fetal renal perfusion. Normally it peaks at 32 to 34 weeks of gestation and thereafter there is a gradual reduction in amniotic fluid due to increase in concentrating capacity of fetal kidneys. However, a drastic reduction in its quantity may indicate underlying placental insufficiency, which has definite implications on growing fetus. The values between 8 and 25 are considered to be normal, 5–8 low normal, and less than 5 oligohydramnios.[10]

The volume of amniotic fluid during the second and third trimesters of pregnancy is a signifier of wellbeing of fetus when the amniotic fluid is being tested in the antenatal fetus. The oligohydramnios and polyhydramnios are the sizes of the amniotic fluids that have become the typical features of both the structural and functional anomalies that alert the health care provider that further tests or antenatal tests should be done.[11]

The amniotic fluid in the uterus is essential in adequate development and survival of the fetus. The amniotic fluid index (AFI) of less than 5 cm has been established to be considered as oligohydramnios (low amniotic fluid). It is not long since the importance of the content present in the amniotic fluid as a determinant of fetal status has become known to people. The amniotic fluid has numerous functions throughout the development of the fetus. It shields the fetus against damage, is antimicrobial and aids the gastrointestinal and the musculoskeletal systems to develop. It helps in keeping the fetus temperature, fluid and movement of the fetus. The amniotic fluid is invariable in its pressure and the loss of lung fluid which is critical in the pulmonary development is avoided. The fluid also ensures that

compressing of umbilical cord does not occur. Reduction in the amount of the amniotic fluid is usually one of the first indicators of a complication of the fetus, or the mother. The 5 cm AFI cutoff was reported to be associated with the high risk of term and near-term pregnancy and to birth of a small-for-gestational-age infant; non-reassuring fetal heart rate, still birth, and infant mortality. Another common etiological cause of oligohydramnios is ruptured membranes, abnormalities congenital and placental insufficiency. It is said to be associated with high morbidity in the maternal and fetal. The metabolic conditions that lead to the emergence of perinatal morbidity and mortality include the elevated rates of caesarean delivery of the infants owing to the fetal distress, the low Apgar scores and the meconium aspiration syndrome which in turn is the normal concentration of amniotic fluid that is imperative toward the movement of the fetus, development of the lung and digestive systems.[12] Norm hydramnios refers to the normal level of amniotic fluid, which is essential for the protection and development of the fetus. Oligohydramnios indicates reduced levels of amniotic fluid, while polyhydramnios refers to excessive levels.[13]The inadequate level of amniotic fluid is known as oligohydramnios whereas the excessive level is termed polyhydramnios. The recent developments in ultrasound make it possible to monitor the status of the kidney in the fetus and fluid status more accurately.[14]

Typical Oligohydramnios Low amniotic fluid usually is associated with renal abnormalities at birth. The study has also established that 17.45 percent of the instances of the affected cases could be attributed to fetal renal pathologies (hydronephrosis and polycystic kidneys).[15] It has been established that oligohydramnios is also associated with maternal dehydration, placental insufficiency, or fetal urinary pathologies.[16] Routine ultrasound is also required particularly in hypertensive or preeclamptic women to control the risks as well as to ensure that the fetus is not compromised.[17]

Polyhydramnios is on the other one, which is determined due to the presence of too much fluid in the amniotic fluid. This disorder is complicated by the pregnancy and is usually associated with the defects of the babies such as the gastrointestinal impairments and neurological conditions. Polyhydramnios is a fluctuating phenomenon since it is about 1-2 percent in the pregnancies. The problems that come about in this condition are preterm birth, placenta abruption and malposition, out of the 60 percent cases, 40 percent of them are idiopathic.[14] Etiologies of polyhydramnios in mothers have been found to be diabetes mellitus and infections like TORCH and the prevalence rate of occurrence with diabetes mellitus was 7.5 in 2004.[18] The fo etal etiologies of polyhydramnios include fo etal malformation and tumor, musculoskeletal malformation, chromosomal malformation, immuno-non immunological hydrops fetalis, and multiple gestation with 0.2 to 2.0.[19]

Urogenital, abdominal, and abdominal wall abnormalities proved to show the highest rates of abnormalities in the volume of the Amniotic fluid. The volume of abnormal amniotic fluid was identified as an abnormality in the urogenital anomalies in over 50 percent of the fetuses, 54.86 percent (oligohydramnios 34.72 percent, polyhydramnios 20.14 percent). The volume of amniotic fluid (polyhydramnios 31.44, oligohydramnios 12.38) was also abnormal in the fetuses with abdominal abnormalities and abdominal wall abnormalities (43.82). In most cases, we identified that the volume of abnormal abdominal fluid in more than 30 percent of the fetuses with the abnormality of the craniospinal, thoracic, and lung abnormalities, limb malformations, and ossification abnormalities. Only at about 20.20, craniofacial and cardiovascular anomalies determined the defects of the volume

of amniotic fluid.[20]

Presence of oligohydramnios or polyhydramnios presentation of structural and functional aberrations is also suggestive to the health care provider that further testing or further antenatal testing will be undertaken. Its abnormalities such as the presence of meconium staining, presence of a congenital abnormality, growth retardation, dysmaturity and fetal asphyxia, and polyhydramnios have been associated with oligohydramnios and fetal structural abnormality, aneuploidy and macrosomia. Some of the causes of polyhydramnios include diabetes mellitus, isoimmunization, fetus infections and placental abnormalities but the majority (50 -60) cases of polyhydramnios are believed to be idiopathic. Increased or decreased amniotic fluid is also considered a factor leading to the increased rate of complications in the delivery process and the increased risk is two-fold more is the risk of operation delivery and cesarean section due to non-reassuring patterns of the fetal heart rate and poor perinatal outcome.[21]

Around 50% of polyhydramnios cases have no known cause (idiopathic), highlighting the need for ongoing ultrasound monitoring to manage the condition. Accurate diagnosis is vital as it helps mitigate risks like respiratory problems and developmental delays in the fetus.[22] The need to perform proper diagnosis is predetermined by the fact that such complications as breathing difficulties and postponement of the fetuses development that is not violated with the assistance of ultrasound, one of the non-radiation technologies, and which could be performed in real-time, could be identified. It is necessary because it can, continuously, monitor the conditions of the prenatal state of things, given its accessibility, safety, and the ability to evaluate the anatomy, the amount of the fluids, and blood flow, which allow identifying the issues that are identified at an early stage. The significant variables in the measurement of the fetal renal blood flow are doppler indices that contain resistive index (RI) and Pulsatility index (PI) variables. The high value of RI and PI may indicate the elasticity of the vascular resistance and may be a result of the renal pathology.[23]

Oligohydramnios and polyhydramnios run a risk of a severe pregnancy complication and are less likely to pay attention to the basic tests of renal health, and the existing monitoring procedures usually do not include essential tests of renal health. In this paper, doppler ultrasound is applied to examine blood flow of fetal renal artery in different circumstances of amniotic fluid. The study]will be of major importance to the research on the perception of renal functions, early diagnosis of renal abnormalities and prenatal care practices that will eventually lead to desirable health outcomes by mothers and fetuses by bridging the research gap.

Literature Review

The article by Waleed Adel et al. (2024) assesses the connections between fetal renal artery Doppler and the indices of the amniotic fluid volume. 68 pregnant women at post term were separated into 2 groups. The initial category was oligohydramnios (AFI smaller than 5 cm) and the second one was normal (AFI greater than 5-25 cm) amniotic fluid capacity. Doppler analysis evaluated the nature of the fetal renal artery such as blood flow (FRABF), resistance index (RI), Pulsatility index (PI), acceleration time (AT) and systolic/diastolic ratio (S/D). Findings: It was established that there was a positive and strong relationship between AFI and FRABF. On the other hand, the Doppler of renal artery indices: RI, PI, PS and AT had a significant negative correlation with AFI (correlation

coefficients r= -0.549, r= -0.330, r= -0.258 and r= -0.478 respectively; p-values < 0.05). The p-values of the Doppler indices differed significantly between the study and control groups (p-values of all differences are below 0.05). In the Doppler ultrasonography, the correlation between renal artery flow waveforms and oligohydramnios is seen. The changes in RI, PI, AT, and FRABF values can be considered to be indicators of fast delivery during the post-term pregnancies when the amniotic fluid volume is not normal.[24]

In order to test the relationship between Fetal renal artery doppler (PI) and (PI Value) and pregnancy outcome in patients with abnormal amniotic fluid index, Dr. Saurabh Atram et al. (2025) test the association between fetal renal artery doppler (PI Value), Middle cerebral artery and Umbilical artery doppler index (PI Value) and pregnancy outcome in patients with an abnormal amniotic fluid index. It was a prospective study that was carried out to observe 150 patients, having selected the subjects after the inclusion or exclusion criteria. The Pulsatility index of Fetal renal artery, MCA and Umbilical artery were monitored and the Amniotic fluid volume in 20 to 22 weeks and 32 to 34 weeks of Gestational age was documented. The information regarding the pregnancy outcomes were recorded in terms of gestational age on delivery, mode of delivery. Among all AFI categories in the 2nd trimester, the Doppler difference did not indicate any significant difference among the 150 patients of the study with PI of Fetal renal artery (0.339), MCA (0.828), UA (0.538). However in the 3rd trimester a great difference is achieved between Fetal RA (PI) 32 weeks and Abnormalities of amniotic fluid (P-Value 0.001) as well as the negative outcomes like increase in cesarean section, preemies and incidences of fetal distress. Despite significant differences in CA and UA Doppler index in AFI groups in P-Value of 0.887 and 0.842 respectively. The conclusion that was arrived at in this paper was that there is a correlation between Fetal renal artery PI and amniotic fluid disorders in the Third trimester. An increase in fetal RA PI increases in oligohydramnios and hence increasing cesarean births, preterm births and increasing incidence of fetal distress when in the pregnancy with Polyhydramnios Fetal RA PI is lesser.[25]

Sarkar Krishnendu et al. (2023) study entails the comparison of fetal renal artery flow velocity waveforms in oligohydramnios against normal pregnancies and also to determine the statistical significance of the result between the two Groups and the correlation of the results to the fetal outcome or not. Cases (Group-A) consisted of all pregnant women in 3 th trimester with gestational age between 32 weeks to 36 weeks who had isolated oligohydramnios. Group-B Controls Group-B Controls were normal 3 nd trimester pregnancies with gestational age of 32 weeks to 36 weeks old between the study period of Jan 2018 to Dec 2019. The pulse stability index (PI; mean ± SD) of the umbilical artery of Group-A patients was 1.073045171.0637 and Group-B patients 1.001259014.01400 with P = 0.0023. The umbilical artery S/D ratio (mean + SD) between patients of Group-A and patients of Group-B were 2.9120 +0.2476 and 2.5135 + 0.2751 respectively with P = 0.0001. The average renal artery PI (mean SD) of Patients in Group-A was 2.5863 +/- 0.2608 and average renal artery PI in Group-B was 2.4737 +/- 0.2648 and P=0.0240. It was also established that the mean birth weight and Apgar Score was also statistically significant in the two Groups. The distribution of mean renal artery PI and umbilical artery PI was also greater in cases of Oligohydramnios when compared to normal cases. The patients at the Neonatal intensive care unit were more in the category of oligohydramnios which had the abnormal renal artery doppler index.[26]

Sanghamitra Paladugu et al. (2020) had an article comparing the correlation between perinatal outcomes and renal artery Doppler index and umbilical artery Doppler index. An observational study will be employed, whereby a potential study will be done on women who visit an antenatal clinic and have given birth to a baby within a period of August 2016-May 2018 in a tertiary care hospital in the Department of Obstetrics and Gynecology. The ultrasonography was carried out regularly (at 28-31 weeks); the patients were followed-up in 4 weeks after that and the Doppler indices were measured. Among the 394 patients who were studied, the p-values of p index Pulsatility and resistance vessel index of the renal artery in the FGR, oligohydramnios, preterm birth and low birth weight were higher than the umbilical artery Doppler indices. Lastly renal artery Doppler indices showed to be more efficient in forecasting poor perinatal outcomes in mild cases of uteroplacental insufficiency. Renal artery Doppler indices also had the advantage of identifying these changes earlier than the umbilical artery Doppler which may have been an early indicator, and the Pulsatility index was more specific and sensitive.[27]

The article Zakaria Sanad et al. (2019) are testing the relationship between the flow velocity waves of renal artery (RA) and umbilical artery (UA) and the volume of amniotic fluid in normal pregnancy, in polyhydramnios or oligohydramnios pregnancy complications.60 patients were analyzed in the article. The patients were controlled with regard to maternal age, gestational age and parity during sonography regarding RA Doppler indices of the Pulsatility index (PI) and resistance index at 22, 28 and 34 weeks. Group I included 20 patients of normal amniotic fluid index, group II included 20 patients of oligohydramnios and group III included 20 patients of polyhydramnios. At 22 weeks, at 28 weeks and at 34 weeks the values of RA PI were more in the group II than in group I. The statistical significance of PI at the 28 gestation was significant (P = 0.016). The UA PI and index resistance of group II was also higher at week 28 of gestation than group I. It terminated the increase of the RA PI in the early pregnancy period before the onset of oligohydramnios. There were fewer RA PI in the situation of pregnancies in which polyhydramnios developed.[11]

The HM Fawad et al. (2025) article evaluates the difference in the hemodynamics of the maternal renal artery in pregnancies with oligohydramnios and the normal ones based on the Doppler indices and compares them with normal pregnancies. It is a cross-sectional study that participant population is 50 pregnant women which was selected by use of convenience sampling. Characteristics of oligohydramnios included amniotic fluid index (AFI) below 5 cm and single vertical pocket below 2 cm or an AFI below 10th percentile relative to gestational age. Resistive Index(RI), Pulsatility Index (PI) and Systolic/Diastolic(S/D) ratio of the renal artery were the measurements taken. Renal artery Doppler index was statistically different in normal and oligohydramnios groups. The average RI of oligohydramnios (0.625 +0.111) was greater than the normal pregnancies (0.575 +0.111). Similarly, PI was greater in oligohydramnios group (1.475+0.111) than normal (1.200+0.111). It had also increased the S/D ratio (2.975 ± 0.111 vs. 2.500 ± 0.111). The fact that the changes in the renal artery Doppler indices are great, suggests the impairment of the maternal hemodynamics, which explain the role of Doppler ultrasonography in the diagnosis of high-risk pregnancy monitoring.[28]

The study by Iura et al. (2005) was aimed at establishing the quality of hemodynamics of fetal renal arteries in normal pregnancies using the color Doppler ultrasound. It was principally aimed at establishing baseline Doppler parameters, such as velocity of the blood flow and trends of the wave

forms, of simple pregnancies. Based on the study of these trends, the researchers aimed to come up with a reference frame in the evaluation of renal artery flow, both in the normal and high-risk pregnancies. The study utilized detailed Doppler measurements of fetal renal arteries whose findings reported predictable and consistent trends of hemodynamics in normal fetuses. The reason is that these normative values might prove helpful in comparison in the case of dysfunctional pregnancy that involves such conditions as oligohydramnios and polyhydramnios. The study identifies the significance of color Doppler ultrasound as a non-invasive method to check on the fetus and its application in the early detection of fetal complications resulting in better treatment provided to the mother and improvement of the pregnancy outcome.[29]

The study conducted by Benzer et al. (2015) explored the predictability of the fetal renal artery Doppler indices during the second and third trimester of the low-risk pregnancies complicated with the idiopathic oligohydramnios and polyhydramnios. Its purpose was to establish whether the outcome of such Doppler measurements could be predicted and sure of the presence of adverse results in the case where other maternal or fetal situations were uninvolved. The researchers also assessed Doppler waveforms and related them to clinical results such as fetal distress, mode of delivery and wellbeing of the newborn baby. They reported that there were high differences in the Doppler indices between normal and both abnormalities in the fluid hence the definition that renal artery Doppler is predictable. The paper recommends the adoption of the Doppler measurements during routine prenatal care to enable handling and improve the outcome of the pregnancy where abnormal levels of amniotic fluid have been experienced.[21]

The article Akin et al. (2018) focused on the relevance of fetal renal artery Doppler levels to predict either the outcome of pregnancy and mode of delivery in the case of idiopathic oligohydramnios and polyhydramnios. The aim of the study was to determine whether these Doppler measurements could help in assessment of risks of pregnancy and decision on delivery. The authors found that the outcome of fetal distress, cesarean birth and baby health had a strong correlation with the presence of abnormal fluid parameters in pregnant women with the assistance of Doppler data analysis. The paper has ended by concluding that the renal artery Doppler is a useful non-invasive instrument that can assist in decision-making in the clinical environment besides enhancing prenatal care in pregnancies with abnormal amniotic fluid volumes.[30]

Rizazli et al. (2021) The study aimed to compare fetal left modified myocardial performance index (Mod-MPI) and renal artery Doppler indices between the isolated Oligohydramnios fetuses and the normal volume of amniotic fluid. It was a prospective cohort study; 25 cases of isolated oligohydramnios pregnancy were found and 25 healthy, and of the same gestation age, controls, 24+0 to 36+6 weeks of gestation. The initial outcome measure was to compare left modified MPI and mean fetal renal artery Pulsatility index. The second outcome was to make a comparison of the adverse perinatal outcomes in the groups. The isolated oligohydramnios group also had a great difference in the isovolumetric relaxation time ($p=0.009$) and mean Mod-MPI ($p=0.001$). The PI of mean renal arteries was not any different between the two groups. Compared with the control group, the difference in birth weight ($p=0.041$) and birth gestational age ($p=0.001$) was much lower, as well as the incidences of pre-37 weeks delivery ($p=0.034$) and Cesarean section as a result of non-reassuring fetal heart rate testing ($p=0.021$) had significant value difference in women with isolated oligohydramnios. The use of Mod-

MPI was not significantly related to the negative perinatal outcomes. Solitary oligohydramnios in fetuses is associated with high left Mod-MPI that could be occasioned by mild diastolic heart dysfunction. High-level Mod-MPI has been not linked with unfavorable perinatal outcomes or apparently to be able to assist in the management of less than 37-gestational-week pregnancies with isolated oligohydramnios.[31]

Ozkan et al. (2016) conducted a comparison between the use of Doppler ultrasound on the fetal renal artery hemodynamics in post-term pregnancies and having oligohydramnios. This was to find out whether it was feasible to take the Doppler reading which was able to reflect the renal functioning of the fetus and establish whether the pregnancy outcome in such risky situations. The researchers could identify that the waveforms of the renal arteries were significantly changed and the result of the waveforms correlated with the fetus compromise through the comparison of the results with the normal ones. The article states that fetal renal artery Doppler has a clinical meaning in non-invasive fetal health and dealing with down-term fetuses with a small amniotic fluid.[32]

The authors of the research by Haugen et al. (2017) examined how the Doppler blood flow velocity waveforms change in the various positions of the fetal renal arteries i.e. the proximal and the distal positions of both right and left arteries. This was to add the site specific variations to the accuracy of prenatal Doppler measurements. The possibility of variability on different locations and sides and the need to account the variability when conducting clinical examinations were identified with the assistance of an in-depth analysis of the waveforms. The results are applied to highlight the points that measurement sites should be standardized to improve fetal renal artery doppler measurements.[33]

The article by Erdogan et al. (2015) represented the study that evaluated the impact of the conservative treatment on the Doppler indices of fetal renal artery on pregnancy with polyhydramnios. It was aimed at assessing the effect of non-invasive interventions (bed rest and hydration control) on the renal arterial blood flow and pregnancy outcome. The pre-/post-treatment doppler parameters showed that there were significant changes in the renal hemodynamics towards an improvement level. The results show that the conservative management could improve the severity of polyhydramnios and renal artery Doppler is an appropriate tool in the observation of the answer and clinical management.[34]

Hamed and Saeed (2023) article was dedicated to the oligohydramnios. The idea was to determine whether hydration therapy would help in improving the wellbeing of the fetus as well as the effects of intravenous hydration in the mothers on the level of amniotic fluid and the fetal Doppler indices of a pregnancy through augmentation of the parameters of fluid and blood flow. It was carried out by controlled trial and entailed the Doppler assessment of the amniotic fluid and umbilical arteries in pre- and post-IV hydration groups and a great enhancement of the amniotic fluid and renal and umbilical artery indices. The researchers found out that intravenous hydration is a non-invasive and easy method of fluid replacement where oligohydramnios and fetal outcomes are considered.[35]

The hypotheses of the study that are formulated by Hesham Farouk et al. (2022) are to identify the correlation between the normal pregnancy renal artery flow velocity waveforms and the correlation between the normal pregnancy and oligohydramnios based on the Doppler ultrasonography. Measuring, Pulsatility index, resistance index, systolic/diastolic ratio of the renal artery were performed assisted with the Doppler ultrasound device, and the 3 waveforms of each fetus were traced

and the average of 3 waveforms were supposed to be the final ones. The mother was between 20 and 40 years. The fetus was aged between 21-38 weeks. Median of Pulsatility index of right kidney was 2.14 and median of resistance index of right kidney 0.852 compared to median of Pulsatility index in left kidney 1.99 and median of resistance index, left kidney 0.8372. Although the median of Pulsatility index of left kidney, right kidney was 1.4584 and 1.4124 respectively, the median of resistance index of left kidney were 0.71 and 0.69988 respectively. It eliminated the correlation between flow velocity waveforms of renal arteries and oligohydramnios using the Doppler Ultrasonography. It is a sign that delivery should be carefully performed in a hurry to save the life of the unborn child as oligohydramnios with radically different values of Pulsatility index and resistance are typical of the third trimester. It was possible to predict oligohydramnios by the variation in the values of the Pulsatility index and resistance.[36]

Melek Akdogan et al. (2015) aimed to compare the fo etal renal blood flow, via the color Doppler ultrasonography. The fo etal renal artery Pulsatility index of the sample of the patients that received polyhydramnios at the onset of the treatment and those patients that had the standard amniotic fluid index during the conservative treatment were analyzed. It was a prospective study, which was conducted to test 39 foetuses with polyhydramnios at gestational week of 26-36. These parameters were fo etal development parameters, right and left fo etal renal artery PI and amniotic fluid index, which were measured at the time when the treatment was initiated to all these patients. Among such patients, 19 who answered the conservative treatment were also re- measured again when the amniotic fluid index returned to its normal levels and the statistical tests were done on the renal artery PI in the pretreatment and post treatment periods. In this research, the inclusion criterion was noted by the study which covered 19 patients who responded to the conservative treatment and the polyhydramnios criteria. The measurement of fo etal renal artery PI in the patients was 2.08 (1.5-3.0) at first sonographic and 1.94 (1.53-2.69) after the conservative treatment. The two groups were however not statistically different (p=0.117). In the current study, there was no statistically significant difference in the fo etal renal artery PIS of the patient in the study before and after the conservative intervention to deal with poly hydramnios. It might indicate that the renal arterial supply of blood might not be relevant in the renal artery PI hence these findings could not be applied as one of the measures in the assessment of polyhydramnios.[37]

3.1: OBJECTIVE

To investigate Sonographic Evaluation of Fetal Renal Artery in Oligohydramnios and Polyhydramnios in 3rdTrimester of Pregnancy.

3.2: PROBLEM STATEMENT

Those complications that are found to be of utmost significance to the health of the fetus and the health of the mother like the oligohydramnios and polyhydramnios during the third trimester cannot be well diagnosed using the available diagnostic instruments. The existing use of umbilical artery Doppler and structural ultrasound is not typically well placed to give conclusive findings on the functioning of the renal which is one of the foretellers of the size of the amniotic fluid. The low sample size of the patients undergoing polyhydramnios is one of the weaknesses because there is inadequate analysis of RA indices in the sample. This was explained by low rates of referral of cases of polyhydramnios and

the rate of gestational diabetes mellitus among the low socioeconomic status patients who constitute the majority in the hospital is very low.

3.3: OPERATIONALDEFINITIONS

Oligohydramnios:

Oligohydramnios is diagnosed when the amniotic fluid index (AFI) is 5 cm or less, or when the deepest vertical pocket (DVP) of amniotic fluid is less than 2 cm.[38]

Polyhydramnios:

Polyhydramnios is mild (AFI 24 cm and above or a DVP 8 cm and above), moderate (AFI 30 cm and above or DVP 12 cm and above) and severe (AFI greater and DVP greater).[19]

Perinatal Outcome:

The perinatal outcomes were: gestational age at birth, Apgar level 1 and 5 minutes, umbilical artery cord pH, level of base excess, neonatal intensive care unit and neonatal intensive care unit admission reason. The reasons behind admission were preterm births, sepsis assessment, chorioamnionitis, respiratory depression, hypoglycemia, meconium removal, respiratory morbidity, and perinatal mortality.[39]

Fetal renal Artery Doppler Index:

It is also important to note such hemodynamic parameters as systolic/diastolic ratio (S/D), the Pulsatility index (PI), and resistance index (RI). Evaluation of renal artery indices provide significant information about renal vessels.[40]

3rd Trimester:

Third trimester ultrasound screening permits examination of the fetal presentation, fetal growth, fetal anatomy, placental abnormalities, amniotic fluid and cord abnormalities. The optimal time at which fetal presence and growth deformities can be monitored is during 35-37 week of gestation in case of low-risk pregnancys.[41]

MATERIAL AND METHODS

4.1: Study Design: Descriptive Cross Sectional Study

4.2: Settings: Ali hospital Ilah bad District Kasur

4.3: Study Duration: 4 months

4.4: Sample Size: $n= \frac{Z^2}{d^2} P (1-P)$

n=62

4.5: Sampling Technique: Convenient sampling technique.

4.6: Sample Selection: Convenient

4.6.1: Inclusion Criteria

- Pregnant women in the third trimester (≥28 week's gestation).
- Singleton pregnancies.
- Diagnosed cases of oligohydramnios (AFI≤5cm) or polyhydramnios (AFI≥25cm) and matched controls with normal AFI.

4.6.2: Exclusion Criteria

- Multiple pregnancies.
- Known fetal anomalies.

4.7: Equipment: Toshiba 300X, curvilinear probe with frequency of 2to 9 MHz (ZubaiM).

4.8: ETHICAL CONSIDERATIONS

When carrying out the research and upholding the ethical rights of the research subjects, one will observe the rules and regulations required by the ethical committee of Superior University, Lahore.

- The informed consent of all the participants was written.
- Fact finding and collection of data that was held in confidence.
- The customers were remaining anonymous in the course of the research.
- The participants were informed that the process of study does not have any drawbacks or harm.
- They said that they could withdraw at any juncture during the process of the study.
- There is no known risk of the research.
- The participant would receive returns that would emanate in the event of his/her involvement in this research.
- We do not tell anybody about your privacy. No work founded on this work was to give you your identity.
- Participation in this research study will be voluntary. Whether to take part or not is your prerogative and you may at any time, withdraw your consent to take part. There will be no consequences of not participating in this study.

4.9: DATA COLLECTION PROCEDURE

Written informed consent was given to the patients, and data collection was conducted in a conventional approach to data collection that meets the guidelines of the research methodology. The questions were collected orderly with the help of the questionnaire and datasheets basing on the preset variables.

Scanning Technique:

The participants will all be provided with regular antenatal and color Doppler ultrasound with the aid of a convex probe. Long-axis Fetal renal artery Doppler will further be carried out in the long-axis of kidney at a less than 30 degrees insonation and the RI and PI value will be recorded as the average of three consecutive readings when the fetus is in minimal movement. The amniotic fluid index, four-quadrant assessment will be administered and based on the findings, the participants will be categorized as norm hydramnios, oligohydramnios or poly hydramnios.

4.10: DATA ANALYSIS PROCEDURE

Data assessment and analysis were done using the statistical package of social sciences (SPSS) 25 and Microsoft excel 2016 to determine the distribution data. Standard deviation (SD) and mean of the continuous variables have been calculated. Categorical variables have been calculated by use of frequency and percentage. The information obtained was saved in Microsoft Office.

RESULTS

This paper has used 62 pregnant women in the third trimester (30 (48.4) of the group had oligohydramnios (AFI ≤ 5 cm), 32 (51.6) with polyhydramnios (AFI ≥ 25 cm). The mean age of the mothers was 29.33 years and the standard deviation of 6.43 years and the mean gestational age was 33.81 weeks and a standard deviation of 3.39 weeks. The weight of the fetuses was 2726.94 738.32 grams as an average. Mean Biparietal Diameter, Head Circumference, Abdominal Circumference and Femur Length were related to the gestational age. The OH group was found to have higher value of RI and PI implying that the former has a higher renal vascular resistance and the PH group has lower value of RI and PI indicating a better renal perfusion.

Table 1: Descriptive Statistics

The mean maternal age was 29.33 ± 6.43 years, and the mean gestational age was 33.81 ± 3.39 weeks.

Descriptive Statistics

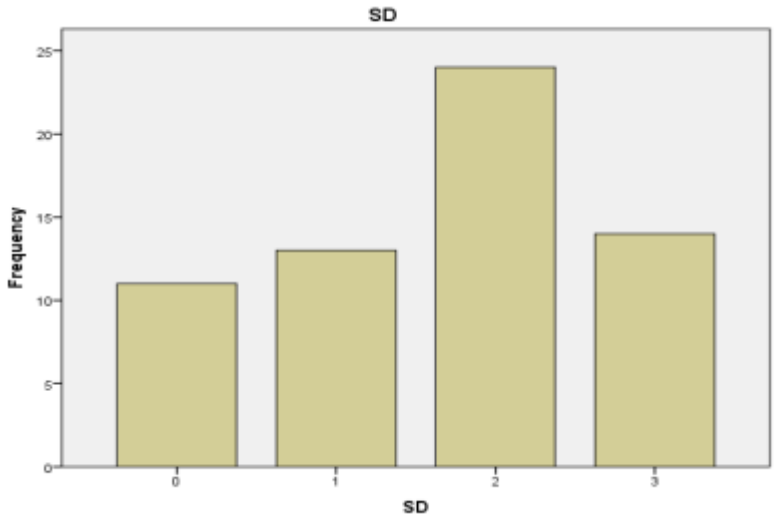
	N	Minimum	Maximum	Mean	Std. Deviation
Maternal age	62	18.2	39.9	29.335	6.4316
Gestational age	62	28.2	39.8	33.811	3.3905
Fetal weight	62	1500.2	3791.0	2726.944	738.3269
BPD	62	70.6	99.5	84.787	9.0583
HC	62	250.4	358.4	301.765	30.6047
AC	62	243.1	359.7	296.540	31.5590
FL	62	45.5	74.8	58.476	9.9592
SD	62	2.0	3.8	2.955	.5731
RI	62	.5	.8	.644	.0934
PI	62	.9	1.5	1.177	.1954
Valid N (listwise)	62				

Table 2: S/D of Renal Artery

The majority of cases (38.7%) had an S/D ratio categorized as level 2 which is 3.1-3.5, followed by 22.6% at level 3 which is 3.6-4.

S/D

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	11	17.7	17.7	17.7
	1	13	21.0	21.0	38.7
	2	24	38.7	38.7	77.4
	3	14	22.6	22.6	100.0
	Total	62	100.0	100.0	



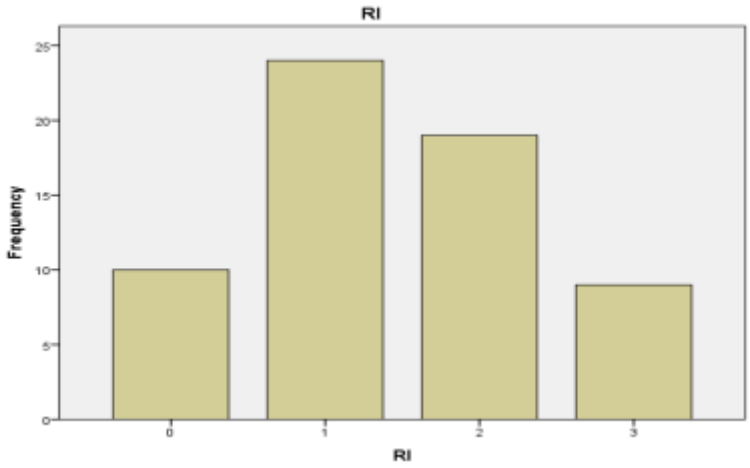
Graph 1: S/D of Renal Artery

Table 3: RI of Renal Artery

Most cases (38.7%) had an RI value at level 1(0.6), while 30.6% were at level 2(0.7).

RI

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	10	16.1	16.1	16.1
	1	24	38.7	38.7	54.8
	2	19	30.6	30.6	85.5
	3	9	14.5	14.5	100.0
	Total	62	100.0	100.0	



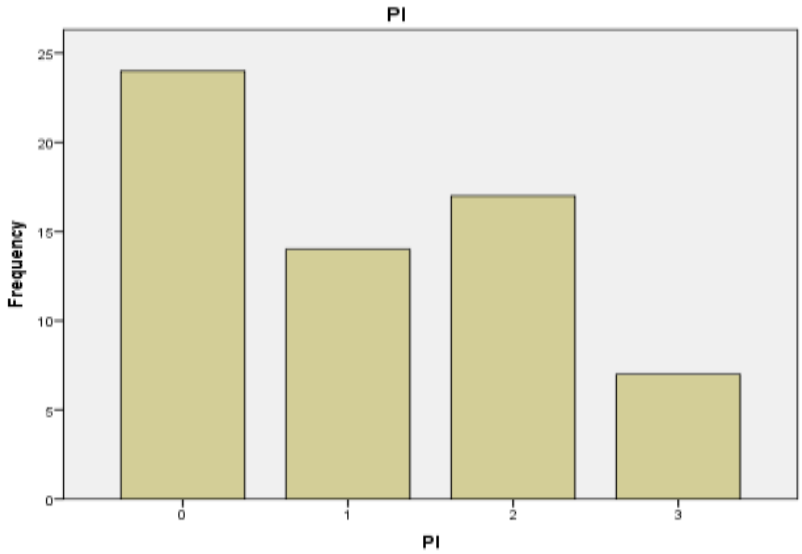
Graph 2: RI of Renal Artery

Table 4: PI of Renal Artery

The majority (38.7%) had PI at level 0(0.9-1), followed by 27.4% at level 2(1.3-1.4).

PI

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	24	38.7	38.7	38.7
	1	14	22.6	22.6	61.3
	2	17	27.4	27.4	88.7
	3	7	11.3	11.3	100.0
	Total	62	100.0	100.0	



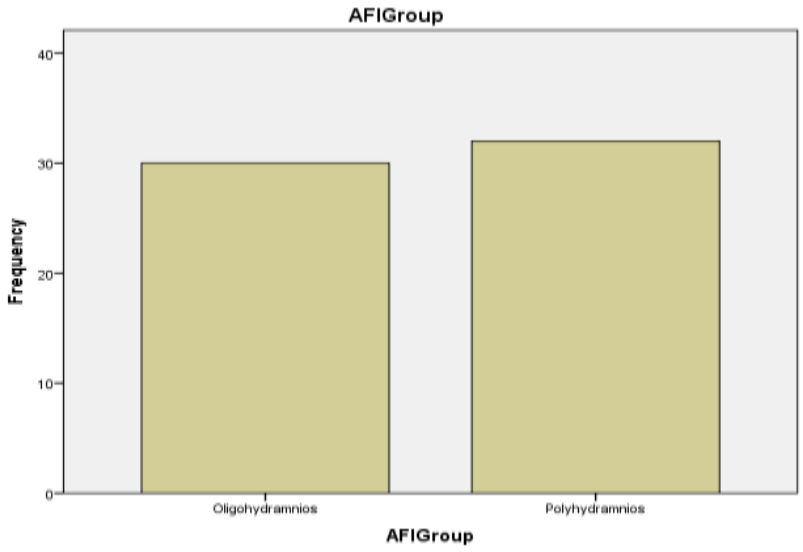
Graph 3: PI of Renal Artery

Table 5: AFI Group

The study population was divided into two groups based on the Amniotic Fluid Index. There were 30 (48.4%) cases of oligohydramnios and 32 (51.6%) cases of polyhydramnios.

AFI Group

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Oligohydramnios	30	48.4	48.4	48.4
	Polyhydramnios	32	51.6	51.6	100.0
	Total	62	100.0	100.0	



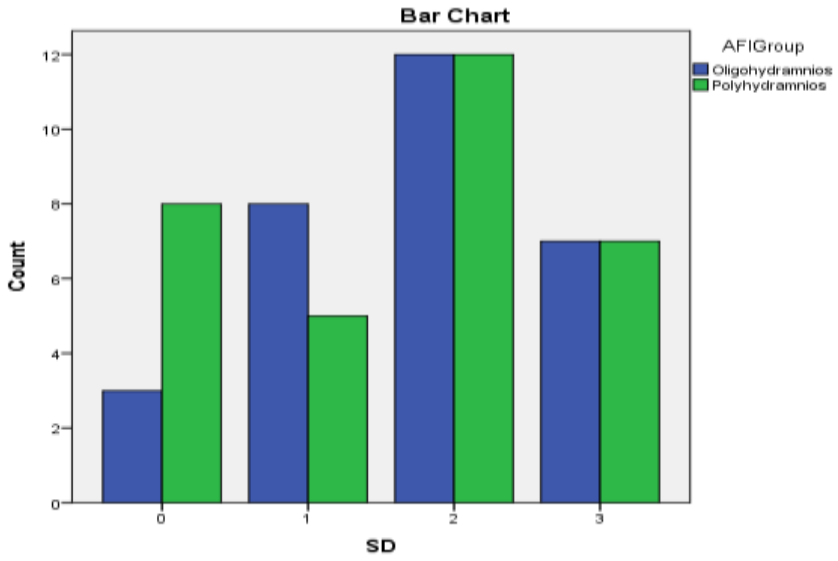
Graph 4: AFI Group

Table 6: Crosstabulation of S/D and AFI Group

Crosstab

Count

		AFI Group		Total
		Oligohydramnios	Polyhydramnios	
S/D	0	3	8	11
	1	8	5	13
	2	12	12	24
	3	7	7	14
Total		30	32	62



Graph 5: Crosstabulation of S/D and AFI Group

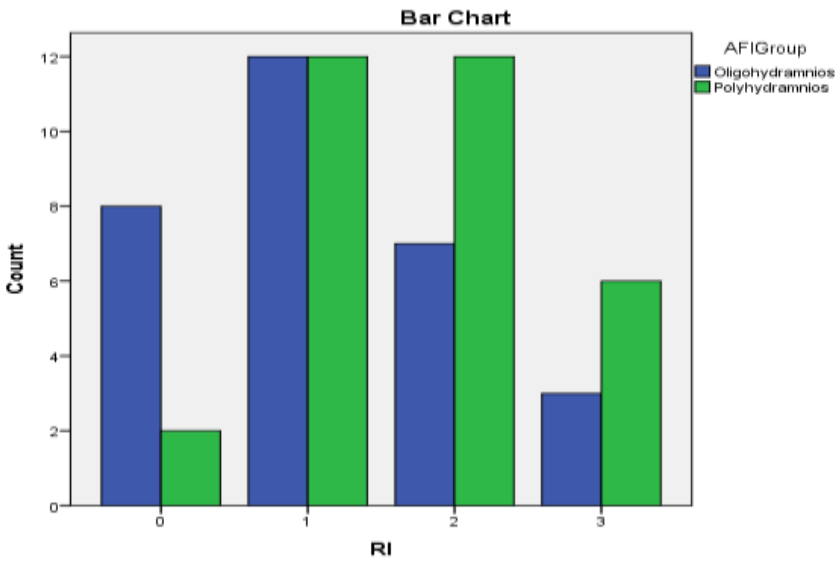
Table 7: Crosstabulation of RI and AFI Group

This table demonstrates the distribution of Resistive Index across the two AFI groups. Higher RI values were observed more frequently in the oligohydramnios group.

Crosstab

Count

		AFI Group		Total
		Oligohydramnios	Polyhydramnios	
RI	0	8	2	10
	1	12	12	24
	2	7	12	19
	3	3	6	9
Total		30	32	62



Graph 6: Crosstabulation of RI and AFI Group

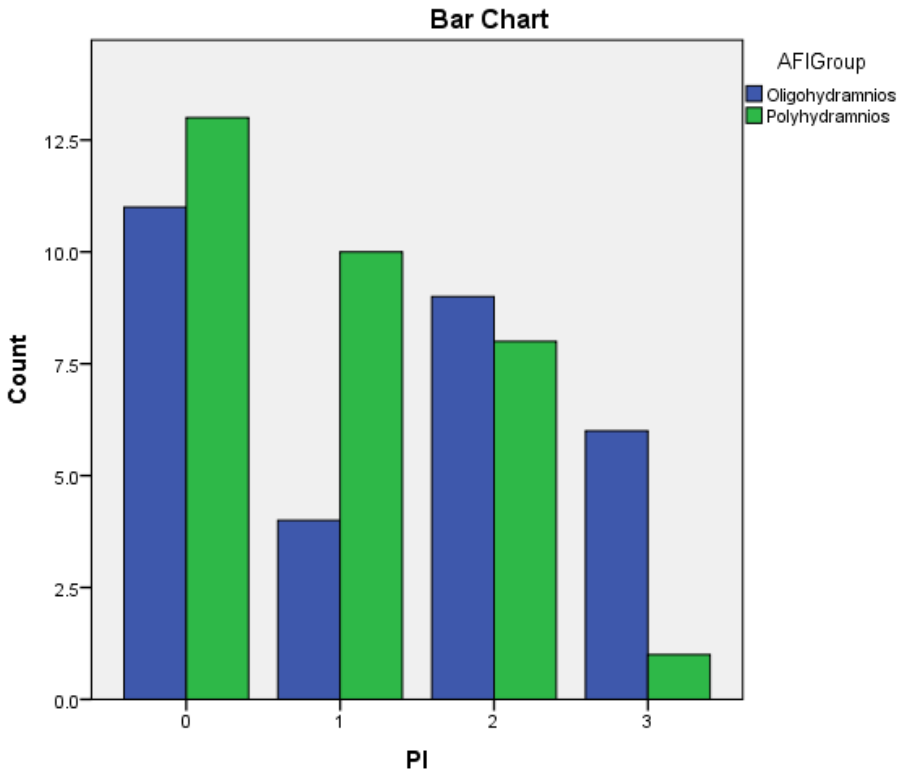
Table 8: Crosstabulation of PI and AFI Group

The crosstabulation below represents the association between Amniotic Fluid Index groups and Pulsatility Index levels. The oligohydramnios group generally showed higher PI levels.

Crosstab

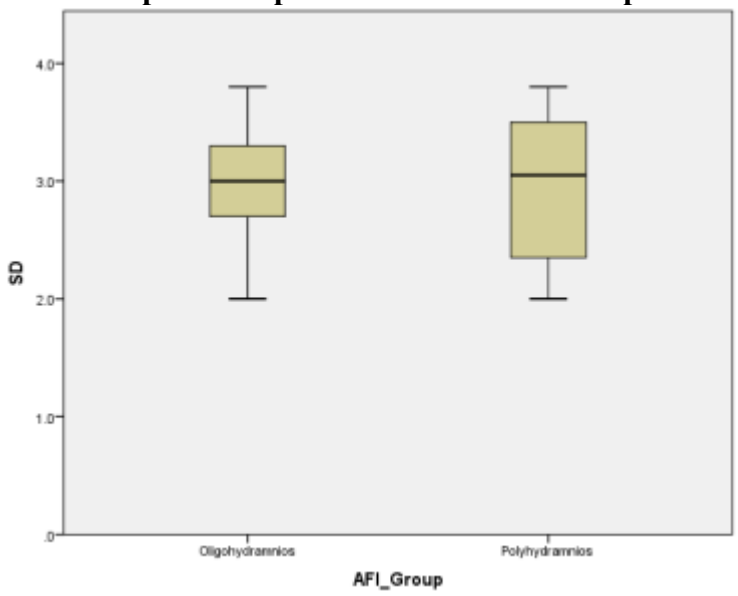
Count

		AFI Group		Total
		Oligohydramnios	Polyhydramnios	
PI	0	11	13	24
	1	4	10	14
	2	9	8	17
	3	6	1	7
Total		30	32	62

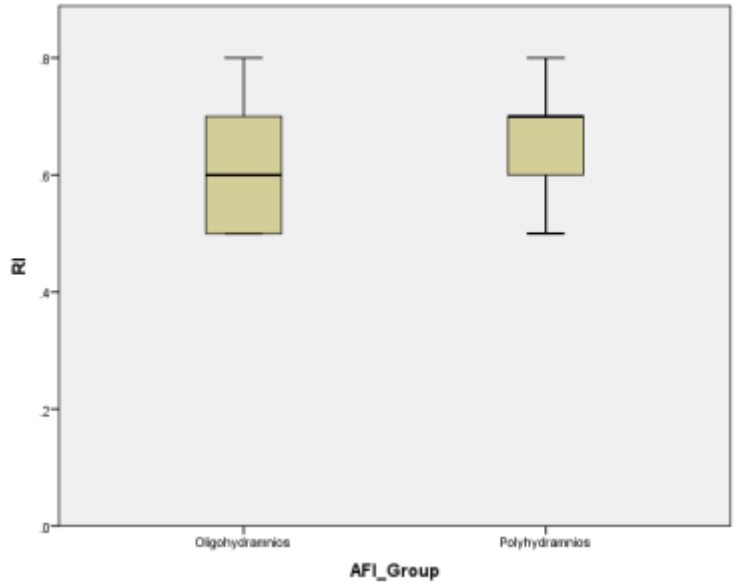


Graph 7: Crosstabulation of PI and AFI Group

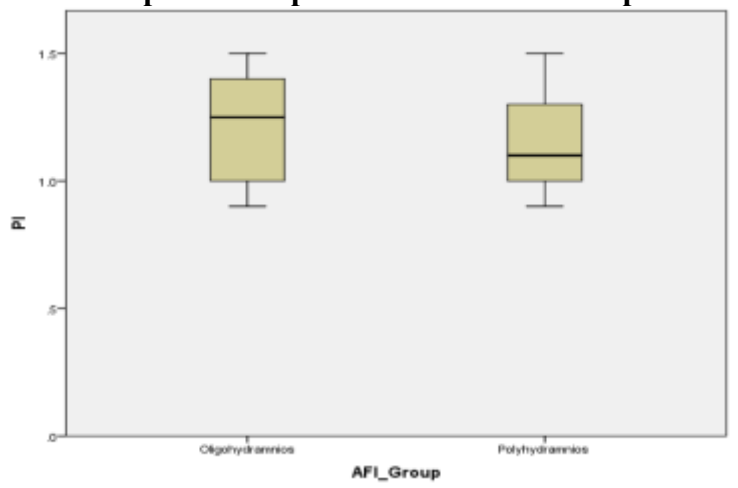
Graph 8: Boxplot of S/D and AFI Group



Graph 9: Boxplot of RI and AFI Group



Graph 10: Boxplot of PI and AFI Group



DISCUSSION

The present study aimed to evaluate the relationship between fetal renal artery Doppler indices and amniotic fluid volume in the third trimester of pregnancy, with particular focus on cases of oligohydramnios and polyhydramnios. The findings demonstrated significant variations in the Doppler parameters, specifically the Resistive Index and Pulsatility Index, between these two conditions. The mean RI and PI were markedly higher in fetuses with oligohydramnios, indicating increased vascular resistance and reduced renal perfusion, whereas both indices were lower in fetuses with polyhydramnios, reflecting enhanced renal perfusion and urine production. A significant negative correlation between amniotic fluid index and Doppler indices further supports the physiological relationship between renal hemodynamics and amniotic fluid regulation.

The elevated renal artery resistance indices observed in oligohydramnios can be explained by fetal hemodynamic redistribution in response to chronic hypoxia or placental insufficiency. During such conditions, blood flow is preferentially directed toward vital organs, including the brain, myocardium, and adrenal glands, at the expense of the kidneys and peripheral circulation. This brain-sparing effect leads to decreased renal perfusion and consequently reduced fetal urine output, resulting in decreased amniotic fluid volume. These findings align with those of Waleed Adel et al. (2024) and Sarkar et al. (2023), who also reported significantly higher renal artery RI and PI values in pregnancies complicated by oligohydramnios.[24, 26] Similarly, Sanghamitra Paladugu et al. (2020) found that renal artery Doppler indices were more sensitive predictors of adverse perinatal outcomes than umbilical artery Doppler, especially in cases with mild uteroplacental insufficiency.[27]

In contrast, reduced RI and PI values in polyhydramnios cases suggest increased renal perfusion, likely leading to excessive fetal urine production and accumulation of amniotic fluid. This observation is consistent with study by Zakaria Sanad et al. (2019), which found lower renal artery PI in pregnancies complicated by polyhydramnios. Enhanced renal blood flow in these cases may be attributed to maternal diabetes, increased fetal osmotic diuresis or elevated glomerular filtration rates. [11] Akdogan et al. (2015) further noted that conservative management of polyhydramnios could normalize renal artery hemodynamics, demonstrating the dynamic nature of these physiological adaptations.[34]

The significant inverse correlation between AFI and fetal renal artery Doppler indices observed in this study emphasizes the crucial role of renal perfusion in maintaining amniotic fluid balance. As AFI decreases, renal vascular resistance increases, leading to diminished urine output, whereas increased AFI corresponds to reduced resistance and enhanced diuresis. These findings underscore the diagnostic value of renal artery Doppler sonography as a non-invasive, reliable tool for evaluating fetal renal function and overall well-being. By integrating renal artery assessment with umbilical and middle cerebral artery Doppler studies, clinicians can obtain a comprehensive view of fetal hemodynamics and identify compromised fetuses earlier.

Clinically, these results hold significant implications for the management of pregnancies complicated by abnormal amniotic fluid volume. In cases of oligohydramnios, elevated renal artery resistance should alert clinicians to possible placental insufficiency or fetal compromise, necessitating close monitoring and potential early intervention. Conversely, in cases of polyhydramnios, the detection of low renal

resistance may guide investigation into maternal and fetal causes such as diabetes or gastrointestinal anomalies. The current findings are consistent with prior research and reinforce the importance of fetal renal artery Doppler as part of routine third-trimester sonographic evaluation, offering valuable insight into fetal renal hemodynamics, placental function, and perinatal outcomes.

7.1: CONCLUSION

Sonographic assessment of the fetal renal artery provides significant insight into fetal renal perfusion and its relationship with amniotic fluid volume in the third trimester of pregnancy. Oligohydramnios is associated with increased renal artery resistance indices, reflecting decreased renal blood flow and reduced urine production. Polyhydramnios is associated with decreased resistance indices, reflecting increased renal perfusion and urine formation. Hence, fetal renal artery Doppler assessment is a non-invasive, reliable, and valuable tool for evaluating renal function, identifying compromised fetuses, and improving obstetric management in pregnancies with amniotic fluid abnormalities.

7.2: RECOMMENDATION

Future research with larger, multi-center samples is recommended. Routine inclusion of fetal renal artery Doppler assessment in third trimester ultrasound may improve early detection of fetal compromise and enhance pregnancy management.

7.3: LIMITATIONS

The study was limited by a relatively small sample size and single center setting, which may limit the generalization of findings. Additionally, the absence of long-term neonatal follow-up prevented assessment of postnatal outcomes related to Doppler changes.

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