

# Applicability of fetal renal artery Doppler values in determining pregnancy outcome and type of delivery in idiopathic oligohydramnios and polyhydramnios pregnancies

Zastosowanie analizy dopplerowskiej tętnicy nerkowej u płodu w ocenie stanu noworodka i sposobu ukończenia porodu w ciążach powikłanych małowodziem i wielowodziem

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## Abstract

**Aims:** To investigate the relationship between fetal renal artery Doppler results and pregnancy outcomes in patients with idiopathic abnormal amniotic fluid indices.

**Material and method:** A total of 110 patients without signs of fetal distress were included in the study: 31 idiopathic oligohydramnios and 29 idiopathic polyhydramnios pregnancies (study group) and 50 normal pregnancies (controls). Doppler investigation of the umbilical artery (UA), middle cerebral artery (MCA), fetal descendant thoracic aorta (DTA) and fetal renal artery (RA) was performed in all patients. Fetal RA resistive index (RI) and pulsatile index (PI) values were measured. Values pertaining to type of birth, newborn weight and APGAR scores were compared.

**Results:** Average patient age, gravidity and week of pregnancy were  $25\pm 4$ , 1.6, and  $37.4\pm 1$ , respectively. There were no statistically significant differences between the groups as far as UA S/D, MCA S/D, DTA S/D, DTA RI, DTA PI, and RA S/D measurements were concerned. However, in the oligohydramnios group RA RI and RA PI values were significantly higher than the other two groups. Birth weight in the polyhydramnios group and cesarean section rate due to fetal distress in the oligohydramnios group were significantly higher.

**Conclusions:** In the oligohydramnios group, without affecting fetal distress parameters, Doppler USG evaluation identified an increase in the RA resistance. Also in that group, cesarean rate due to fetal distress during labor was significantly higher than in the remaining two groups. Due to the predictive potential of values of fetal renal artery Doppler of fetal outcome further large sample-sized studies on the subject ought to be carried out.

Key words: fetal renal artery Doppler / idiopathic oligohydramnios /  
idiopathic polyhydramnios / pregnancy outcome /  
fetal descendant thoracic aortae /

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Otrzymano: 18.02.2013  
Zaakceptowano do druku: 30.09.2013

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## Streszczenie

**Cel:** Ocena związku pomiędzy wynikami badania dopplerowskiego tętnicy nerkowej a wynikiem ciąży u pacjentek z idiopatycznym, nieprawidłowym wskaźnikiem płynu owodniowego.

**Materiał i metoda:** Do badania włączono 110 pacjentek bez objawów zagrożenia życia płodu: 31 z idiopatycznym małowodziem i 29 z idiopatycznym wielowodziem (grupa badana) oraz 50 pacjentek w prawidłowej ciąży (grupa kontrolna). U każdej pacjentki wykonano u płodu badanie dopplerowskie tętnicy pępowinowej (UA), tętnicy środkowej mózgu (MCA), odcinek piersiowy aorty zstępującej (DTA) i tętnicy nerkowej (RA). Zmierzono indeks oporu (RI) oraz indeks pulsacji (PI) w tętnicy nerkowej płodu. Porównano wyniki dotyczące typu porodu, wagi noworodka i skali APGAR.

**Wyniki:** Średnia wieku pacjentek, liczba ciąż i wiek ciąży w tygodniach wynosiły  $25\pm 4$ ,  $1.6$ ,  $37.4\pm 1$ , odpowiednio. Nie wykazano istotnych statystycznie różnic między badanymi grupami w odniesieniu do badanych parametrów: UA S/D, MCA S/D, DTA S/D, DTA RI, DTA PI, RA S/D. Jednak w grupie pacjentek z małowodziem wartości RA RI oraz RA PI były istotnie wyższe niż w dwóch pozostałych grupach. W grupie pacjentek z wielowodziem, zarówno masa urodzeniowa jak i liczba cięć cesarskich z powodu zagrożenia życia płodu były znacząco wyższe.

**Wnioski:** W grupie pacjentek z wielowodziem, bez objawów zagrożenia płodu, badanie dopplerowskie wskazało pacjentki z podwyższonym oporem w tętnicy nerkowej płodu. W tej samej grupie liczba cięć cesarskich z powodu objawów zagrożenia życia płodu podczas porodu była istotnie wyższa niż w pozostałych dwóch grupach. Ze względu na potencjalną wartość predykcyjną oceny dopplerowskiej tętnicy nerkowej płodu w przewidywaniu wyniku ciąży powinno się prowadzić dalsze badania na większej grupie pacjentek.

Słowa kluczowe: **cięża / poród / tętnica nerkowa / Doppler / wielowodzie /  
/ małowodzie / wynik ciąży / aorta zstępująca / aorta piersiowa /**

## Introduction

Sufficient amount of the amniotic fluid is necessary in order for the fetus to survive and keep healthy within the uterus. Renal perfusion plays an important role in the dynamics of amniotic fluid [1, 2]. Changes in the renal artery perfusion in oligohydramnios and polyhydramnios may be recognized with the use of Doppler ultrasonography to evaluate renal artery resistance. Up to 34 weeks of pregnancy, renal artery diastolic blood flow may be physiologically absent, but after that week the diastolic flow speed significantly increases. With the advancing pregnancy, renal artery pulsatility index (PI) and resistive index reduce, what explains the increase in fetal urine production during advanced weeks of pregnancy [3]. In some fetuses affected by the brain-sparing effect and intrauterine growth restriction (IUGR), the renal artery PI is high, while in others it is normal. However, in cases of oligohydramnios low birth weight fetuses who later die, high renal artery PI values, have been reported [1, 4].

In IUGR fetuses reduced amniotic fluid volume and renal vascular resistance changes identified by Doppler ultrasonography appear to be correlated [1-4]. In polyhydramnios cases renal artery PI values are within the normal values, what might indicate that renal perfusion is not the only factor affecting the volume of the amniotic fluid [4, 5]. Current literature on normal fetuses offers numerous reports about studies using fetal renal artery Doppler to identify the etiology of oligo and polyhydramnios, IUGR, pre-eclampsia and similar conditions [1, 6-10]. Regardless, to the best of our knowledge, no data on the use of fetal renal artery Doppler flow forms to predict type of birth can be found. Therefore, our study compared renal Doppler indices of 3<sup>rd</sup>-trimester normal fetuses with idiopathic oligo and polyhydramnios.

Our aim was to examine the applicability of fetal renal artery Doppler results in predicting type of birth, providing the relationship exists, greatest advantage for patient follow-up and to reduce perinatal mortality and morbidity.

## Materials and method

One hundred and ten pregnant women presenting at the Aegean Maternity, Training and Teaching Hospital Obstetric Clinic for routine pregnancy checkups were included in the study.

The patients were evaluated between 35 and 40 weeks gestation. Women with amniotic fluid abnormalities were included in the study and age-matched controls were selected. The pregnancies were subdivided into three groups on the basis of the amount of the amniotic fluid. The vertical measurement of amniotic fluid amount (AFI) was determined by transabdominal ultrasonography (ALOKA-SSD-1700) using the 4 quadrant measurement technique on areas without components of the fetus or umbilical cord. AFI less than 50 mm was classified as oligohydramnios; more than 250 mm was polyhydramnios with measurements from 52-249 mm accepted as normal values for the control group. All patients were followed up till delivery by fetal biophysics profile.

Ethical committee approved of the study. Detailed medical history and informed consent were obtained from all study participants. Subjects with a history of smoking, alcohol consumption or medication use, previous cesarean section, uterine surgery or fetuses with congenital chromosomal anomalies were excluded. All patients in the study were chosen from those certain of the dates of the 'last menstrual period' and/or those who had undergone a biometric ultrasound during the 1st trimester. All subjects were given physical, vaginal and biochemical examinations. In all the groups diastolic and systolic arterial blood pressure values (<90-<140 mm Hg), temperature measured in the auxiliary region and routine biochemical parameters, including 50 gr oral glucose tolerance test, were normal. Nitrazine tests and/or PROM tests performed during the vaginal exam were negative. There were no subjects with rhesus incompatibility. 2<sup>nd</sup> trimester fetal anomaly scans were normal in all patients. Thus, care was taken to ensure that oligohydramnios

and polyhydramnios cases included in the study had an idiopathic etiology. To determine fetal well-being all patients were given a non-stress test (NST) and NST were reactive and the uterine activity was not evident in all groups.

All Doppler investigations were carried out in a semi-recumbent position when the fetus was not moving and during periods of respiratory apnea. Each fetus had both kidneys evaluated. The fetal kidneys were observed along the longitudinal axis with the descendant thoracic aorta and/or bilaterally on the transverse axis beside the spinal canal. Doppler parameters for the fetal renal arteries<sup>11</sup> were measured close to the level of the abdominal aorta outflow. To calculate the speed from the fetal descendant aorta the angle of intonation was held between 45 and 60 degrees. For all investigations maximum systolic speed, end-diastolic speed, PI and RI values were noted. The Doppler measurements were carried out by experienced radiologists while labor was directed by gynecological and obstetric experts blinded to the Doppler results. During labor fetal distress was determined by late deceleration data on NST or a positive result of the oxytocin challenge test. The fetuses from the oligo-polyhydramnios and control groups were classified by type of birth, gravidity and parity of the patient, birth weight and 1st and 5th minute APGAR scores and compared. All newborns underwent a pediatric examination postpartum and proved to be normal and healthy.

Statistical analyses were completed using SPSS 10.0 Windows software. The groups were compared using one way ANOVA and chi square tests.  $P < 0.05$  was accepted as statistically significant.

## Results

Average patient age was  $25.06 \pm 4.6$  (17-37), and gravidity was  $1.67 \pm 0.7$  (1-4). Depending on the dates of the last menstrual period, the pregnancies varied between 35 and 40.3 weeks, with an average of  $37.4 \pm 1$ . There was no statistically significant difference between the group distributions in terms of demographics and biometric measurements of the fetus (Table I).

All patients had Doppler investigations of the umbilical and middle cerebral artery. The umbilical artery and middle cerebral artery were determined as systole/diastole (S/D) values on Doppler readings. There were no statistically significant differences among the groups. All patients had Doppler investigations of the fetal descendant thoracic aorta (DTA) and fetal renal artery (RA). Again, there were no statistically significant differences among the groups in terms of fetal DTA S/D and RA S/D values. Fetal RA RI and PI values were found to be higher in the oligohydramnios group and that difference was statistically significant ( $p < 0.05$ ) (Table II).

As far as birth results were concerned, the oligohydramnios group had a higher rate of cesarean section (64%) than the polyhydramnios group and controls (17% and 20%, respectively). In the oligohydramnios group patients with high renal artery PI values had significantly higher cesarean rates (13/16, 81.2%) than patients with low renal artery PI values (7/15, 46.7%) ( $P: 0.044$ ).

In the oligohydramnios group, 20 cesarean sections were performed due to fetal distress (15), non-progressive labor (4) and indication of head-pelvis disproportion (1). In the polyhydramnios group, 5 cesarean deliveries were performed due to fetal distress (2), head-pelvis disproportion (2) and umbilical cord prolapse

(1). In the control group 10 cesareans were performed due to fetal distress (5), head-pelvis disproportion (3), lack of response to induction (1) and umbilical cord presentation (1). There was a statistically significant difference between the oligohydramnios group and the remaining groups in terms of cesarean birth rate ( $p < 0.05$ ) (Table III).

As for birth weights and APGAR score, while the oligohydramnios group had lower birth weights than the control group, the polyhydramnios group had higher birth weights than the control group. These values were statistically significant ( $p < 0.05$ ). No differences were found in 1st and 5th minute APGAR scores between the groups (Table IV).

## Discussion

In our study the oligohydramnios group had significantly higher renal artery PI levels and higher cesarean rates. Patients in that group with high renal artery PI had the highest cesarean delivery rates.

In the literature almost all studies on fetal renal artery Doppler in oligohydramnios cases focused on post-term pregnancies and others focused on IUGR pregnancies [8, 9, 10, 12-14]. To the best of our knowledge, our study is one of the rare few that do not focus on post-term or IUGR pregnancies.

Although the literature offers studies showing a negative correlation between renal artery Doppler and oligohydramnios, some author report no link. Oz et al., evaluated 147 patients in a study on post-term pregnancies and found that renal artery Doppler was the only Doppler parameter useful for predicting oligohydramnios [12]. In a different study, where normal amniotic index pregnancies, oligohydramniotic, polyhydramniotic and twins where one fetus was oligohydramniotic and the other polyhydramniotic, pregnancies were compared, while there was no relationship between polyhydramnios and renal artery PI, the renal artery PI was higher in the oligohydramnios cases [4]. Patient population in our study was similar to that in the above mentioned paper and, likewise, we found that while polyhydramnios group had no relation to the renal artery PI index, there was an increase in the PI values, as well as RI values, in the oligohydramnios group.

In a 1991 study, IUGR fetuses showed an increased renal artery PI and a negative correlation of this increase with AFI, however there was no such relationship in post-term pregnancies [8]. Yoshimura et al., showed a negative correlation between oligohydramnios and renal artery PI in IUGR fetuses, as well as those measuring according to dates [9]. In 2000 Selam et al. evaluated 31 post-term pregnancies in their study and found that patients with oligohydramnios had increased rates of renal artery resistance, which were significantly higher than the umbilical artery and MCA resistance rates [10]. The authors concluded that in post-term pregnancies arterial redistribution played a role in the etiology of oligohydramnios. In our study the whole population was in the 3rd trimester and there were no post-term pregnancies included. All oligo-polyhydramnios pregnancies in the study were idiopathic. In all pregnancies indicators of fetal distress (UA, MCA, and NST) were all within the normal ranges. Regardless, the oligohydramnios group had increased renal artery RI and PI values when compared to the other groups. However, the source of the fetal renal artery, i.e. the fetal descendant aorta, had normal Doppler values.

İbrahim Akin, et al. *Applicability of fetal renal artery Doppler values in determining pregnancy outcome and type of delivery...***Table I.** Demographic properties of the groups.

	Group 1 (Oligo) n:31	Group 2 (Poly) n:29	Group 3, (Control) n:50	P Value
Age	25.4±3.9	25.6±5	24.5±4.7	0.5
Gravidity	1.6±0.8	1.8±1	1.5±0.6	0.2
Gestational Age	37.5±1	37.5±1.1	37.3±0.9	0.6
FL	38.6±0.2	38.2±1.5	38.2±1.	0.2
BPD	37.4±0.2	37.4±0.1	37.1±0.1	0.4
FAC	38.2±1.2	38.4±1.3	38±0.9	0.3

FL: Femur length, BPD: Biparietal diameter, FAC: Fetal abdominal circumference

**Table II.** Doppler values of the groups and their comparisons [11].

	Group 1 (Oligo) n:31	Group 2 (Poly) n:29	Group 3, (Control) n:50	P Value
UA S/D	2.61±0.7	2.47±0.4	2.38±0.4	0.08
MCA S/D	4.98±1.6	4.84±1.5	4.90±0.9	0.08
DTA S/D	6.34±2.5	7.21±3.0	7.61±2.9	0.1
DTA RI	0.8	0.8	0.81	0.1
DTA PI	1.92±0.8	1.73±0.5	1.87±0.4	0.4
RA S/D	6.69±1.2	6.73 ±1.5	6.75±1.0	0.9
RA RI*	0.8	0.67	0.67	0.01
RA PI*	2.92±1.4	1.93±0.6	1.95±0.4	0.00

UA: Umbilical artery, MCA: Middle cerebral artery, DTA: Descendant thoracic aorta, RA: Renal artery S/D: Systole/Diastole

\*RA-RI: 0.76-0.73 / 0.95-0.92 (between 5%-95% percentile and from 35 to 40 week)

\*\*RA-PI: 1.32-1.21 / 3.10-3.0 (between 5%-95% percentile and from 35 to 40 week)

**Table III.** Type of delivery and numbers by group.

	NSD	C/S	Total
Oligo	11	20	31
Poli	24	5	29
Control	40	10	50
Total	75	35	110

P&lt;0.001, NSD: Normal spontaneous delivery, C/S: Cesarean section

**Table IV.** Postpartum babies compared by group.

	Oligo n:31	Poly n:29	Control n:50	P Value
Birth weight	3316.7±46	3800.0±21	3558.0±27	0.00
APGAR	8.2±0.4	8.4±0.5	8.3±0.5	0.3

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It is thought that normal fetal renal PI and RI values in polyhydramnios patients may indicate that factors affecting the amount of the amniotic fluid may not be limited to renal vascular events. Blood distribution in the fetus changes in fetal hypoxia. Due to the brain-sparing effect, although blood flow to the brain, heart, liver and adrenal glands does not change, the blood flow to peripheral organs reduces. While blood flow in the main carotid artery increases, the renal blood flow is reduced by 25-50% [1, 3, 15, 16].

In our study fetal MCA Doppler readings in all groups were normal. In a study on post-term pregnancies no relationship between oligohydramnios and renal artery Doppler values was shown, however oligohydramnios post-term fetuses had significantly lower birth weights than others [14]. In our study, while oligohydramnios babies showed no definitive difference in birth weight than those in the control group, they had a significantly lower birth weight when compared to those in the polyhydramnios group. Contrary to that study the oligohydramnios group in our study had a significantly higher cesarean rate than the other two groups. Although the NST and fetal distress indicators measured upon entering the study were normal in all groups, it seems interesting that the oligohydramnios group had a high rate of cesarean sections due to acute fetal distress. No separate statistical study was done to determine whether that difference was due to varying birth weights or not, because the cesarean rate was significantly high in the low birth weight group already. When we look; in idiopathic oligohydramnios a study separating the fetal renal artery RI and PI values into those indicating distress and no distress may be called for. Comparing the two groups would determine whether there were differences in types of birth or not. This insight may be seen as a limitation to our study. A small sample size and lack of cord pH data of the newborns were the two major limitations of our study.

## Conclusions

While the birth weights of idiopathic oligohydramnios group were no different from the control group, the birth weights in the polyhydramnios group were significantly higher. Again in the oligohydramnios group, indicators of fetal distress were normal but renal artery RI and PI values showed increased resistance and, what is especially important, this group had a significantly higher rate of cesarean sections due to fetal distress than the other two groups.

### Authors contributions:

1. Ibrahim Akin – Assumption, study design.
2. Ahmet Uysal – corresponding author – article draft.
3. Fatma Uysal – analysis and interpretation of data.
4. Özgür Öztekin – acquisition of data.
5. Mazaffer Sancı – concept.
6. Aysenur Cakir Güngör revision.
7. Secil Kurtulmus – revision.
8. Cigdem Ispahi – study design.

### Authors statement:

1. There is no conflict of interests which occurs when the author remains in a financial or personal relationship which unjustly affects his/her action associated with the publication of the manuscript.
2. Source of financing – NO.

## References

1. Magann EF, Sandlin AT, Ounpraseuth ST. Amniotic fluid and the clinical relevance of the sonographically estimated amniotic fluid volume: oligohydramnios. *J Ultrasound Med.* 2011, 30, 1573-1585.
2. Munn MB. Management of oligohydramnios in pregnancy. *Obstet Gynecol Clin North Am.* 2011, 38, 387-395.
3. Vyas S, Nicolaidis K, Campbell S. Renal artery flow-velocity waveforms in normal and hypoxic fetuses. *Am J Obstet Gynecol.* 1989, 161, 168-172.
4. Mari G, Kirshon B, Abuhamad A. Fetal renal artery flow velocity waveforms in normal pregnancies and pregnancies complicated by polyhydramnios and oligohydramnios. *Obstet Gynecol.* 1993, 81, 560-564.
5. Harman CR. Amniotic fluid abnormalities. *Semin Perinatol.* 2008, 32, 288-294.
6. Iura T, Makinoda S, Miyazaki S, [et al.]. Prenatal diagnosis of the hemodynamics of fetal renal disease by color Doppler ultrasound. *Fetal Diagn Ther.* 2003, 18, 148-153.
7. Azpurua H, Dulay AT, Buhimschi IA, [et al.]. Fetal renal artery impedance as assessed by Doppler ultrasound in pregnancies complicated by intraamniotic inflammation and preterm birth. *Am J Obstet Gynecol.* 2009, 200, 203.e1-11.
8. Arduini D, Rizzo G. Fetal renal artery velocity waveforms and amniotic fluid volume in growth retarded and post-term fetuses. *Obstet Gynecol.* 1991, 77, 370-373.
9. Yoshimura S, Masuzaki H, Gotoh H, Ishimaru T. Fetal redistribution of blood flow and amniotic fluid volume in growth-retarded fetuses. *Early Hum Dev.* 1997, 47, 297-304.
10. Selam B, Koksall R, Ozcan T. Fetal arterial and venous Doppler parameters in the interpretation of oligohydramnios in postterm pregnancies. *Ultrasound Obstet Gynecol.* 2000, 15, 403-406.
11. Arduini D, Rizzo G. Normal values of Pulsatility Index from fetal vessels: a cross-sectional study on 1556 healthy fetuses. *J Perinat Med.* 1990, 18, 165-172.
12. Oz AU, Holub B, Mendilcioglu I, [et al.]. Renal artery Doppler investigation of the etiology of oligohydramnios in postterm pregnancy. *Obstet Gynecol.* 2002, 100, 715-718.
13. Sieroszewski P, Sabatowska M, Karowicz-Bilińska A, Suzin J. [Prognostic Doppler ultrasound examination of fetal arteries blood flow]. *Ginekol Pol.* 2002, 73, 677-684. Polish.
14. Bar-Hava I, Divon MY, Sardo M, Barnhard Y. Is oligohydramnios in postterm pregnancy associated with redistribution of fetal blood flow? *Am J Obstet Gynecol.* 1995, 173, 519-522.
15. Bocking AD, Gagnon R, White SE, [et al.]. Circulatory responses to prolonged hypoxemia in fetal sheep. *Am J Obstet Gynecol.* 1988, 159, 1418-1424.
16. Konje JC, Abrams K, Bell SC, [et al.]. The application of color power angiography to the longitudinal quantification of blood flow volume in the fetal middle cerebral arteries, ascending aorta, descending aorta, and renal arteries during gestation. *Am J Obstet Gynecol.* 2000, 182, 393-400.