

The role of resistance index in fetal renal artery in causing oligohydramnios among overdue pregnant women

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Abstract

Objectives; to know whether resistance index in fetal renal artery is significantly reduced among overdue pregnant women with oligohydramnios

Methods; a total of 25 overdue pregnant women with oligohydramnios versus 25 with normal liquor were selected to participate in the study with their resistance index in the renal artery, umbilical artery and middle cerebral artery were measured

Results; resistance index in the renal artery of the fetus was significantly higher among women with oligohydramnios than control normal women; 0.73 ± 0.03 versus 0.70 ± 0.01 . No statistically significant change was observed among the two groups with regard to the umbilical artery and middle cerebral artery resistance index.

Conclusion; since the fetal artery resistance index was found to be significantly higher among overdue pregnant women with oligohydramnios, this biometric variable may be used as a screening test for fetuses at risk of hypoxia.

Key words; overdue, post term, renal artery blood flow, resistance index of renal artery

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INTRODUCTION

Post term pregnancy affect 5- 10% of the overall pregnant women ^[1]. Despite the etiology of post term pregnancy is exactly unknown, strong association has been found with fetal congenital anomaly, male fetus and placental sulfatase deficiency ^[2]. Post term pregnancy is usually associated with oligohydramnios, macrosomia and placental insufficiency ^[3]. Oligohydramnios per se predispose to cord compression and further augment hypoxia to the fetus ^[4]. Many papers published in the last 10 years suggest that reduced fetal blood flow to the kidneys may play a role in the etiology of oligohydramnios through reduction of fetal urine output ^[5]. So the aim of this study is to compare the renal blood flow among overdue pregnant women whom pregnancy complicated with oligohydramnios versus control overdue women with normal amount of liquor.

PATIENTS AND METHODS

Settings

All the women enrolled in this study were selected from AL-Yarmook Teaching Hospital. The study lasted between January to September 2012. During this period a total of 50 pregnant overdue pregnant women were selected to participate in this study. For all the patients their verbal consent was taken. The study was approved by the Arab Committee For Medical Specialization.

Methods

Initially all overdue pregnant women attending the outpatient clinic were selected. After thorough examination including general and obstetrical assessment, samples of urine and blood were sent for albumin and blood haemoglobin level. Random blood sugar was also assessed. Gestational age was assessed by Naegele's rule and only taken from those women

with regular cycles and remember exactly their last menstrual date. Further investigation was routine ultrasound for fetal biometric assessment and amount of liquor was assessed by Amniotic Fluid Index (AFI). All overdue pregnant women with high risk situation like preeclampsia, diabetes mellitus, placenta previa and other high risk situation were excluded from the study. The woman was considered eligible to enter the study is overdue pregnant woman who didn't exceed 10 days after 280 day or full term pregnancy and spontaneous onset of labor occur within 10 days after due. Women who required induction of labor were excluded from the study as induction may bias the result. For women found to be eligible to enter the study, they were further sent to umbilical artery, renal artery and cerebral artery resistance index measurement in AL-Yarmook Hospital's ultrasound department. In addition they were further given special format to be filled during labor by the resident doctor in charge. At the end of the study a total of 25 women were considered as study group as they were found to have oligohydramnios overdue and spontaneous onset of labor, while 25 women were taken as control, as post dates is a woman who is between 40 and 32 weeks, while post date is woman who passed 42 weeks.

Statistical analyses

All continuous data were expressed as mean and standard deviation, and compared with t student test. Regression lines were constructed to evaluate the correlation between amount of liquor and gestational age. Lastly, receiver operator characteristic curve was constructed to calculate the cut off value for renal artery resistance index between oligohydramnios women versus women with normal liquor amount. Power analysis was done to calculate the minimum size required which was 9 women for each group. While the required size group at alpha equal 0.05 and beta equal 0.1, are 12 patients. Accordingly our study results with 25 patients to study group and 25 patients to control groups are so far reliable.

RESULT

In table 1 the overall characteristics of women in both groups are shown. The most significant finding is despite the presence of significant difference in the amniotic fluid index among two groups, only resistance index in the renal artery was significant; P= 0.003. Meanwhile neither resistance index in the cerebral artery and umbilical artery were significant; p value 0.98 and 0.9, respectively. The number of cesarean sections which is significantly higher among study group agrees with this assumption. In figure 1 Box and

Whisker plot of mean resistance index is shown for study and control groups.

Table 1 The overall epidemiological characteristics among women in control and study groups

| characteristics | Study group (N=25) | Control group (N=25) | P value |
|-------------------------------------|--------------------|----------------------|---------|
| Age (years) | 26.24±4.8 | 25.6±4.2 | 0.63 |
| Parity | 2.9±1.3 | 2.52±1.3 | 0.27 |
| Gestational age at delivery | 286.4±3.0 | 286.6±3.8 | 0.79 |
| Resistance index Umbilical artery | 0.54±0.02 | 0.54±0.02 | 0.98 |
| Resistance index Cerebral artery | 0.64±0.22 | 0.65±0.02 | 0.90 |
| Resistance index Renal artery | 0.73±0.03 | 0.70±0.01 | 0.003 |
| Amniotic fluid index | 2.80±0.70 | 8.73±3.54 | 0.0001 |
| Cesarean section for fetal distress | 4 (16 %) | 17 (68%) | 0.0005 |
| APGAR 1 minute | 2.80±0.81 | 5.13±0.62 | 0.0001 |
| APGAR 5 minutes | 5.16±0.62 | 8.34±0.71 | 0.0001 |

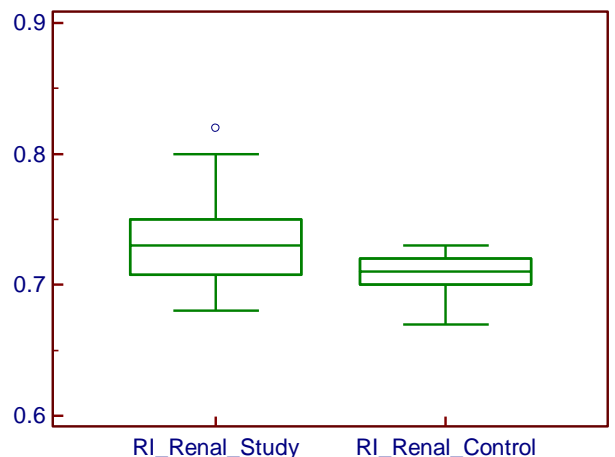


Figure 1 Box and Whisker plot for renal artery resistance index in fetuses within study group among those in control group

In order to shed more light on the correlation of AFI and renal artery resistance index, a regression line was constructed above between Renal artery resistance index as independent factor and AFI as dependent factor as shown above. The negative slope indicates inverse relationship with highly significant correlation; $P < 0.001$ as shown in figure 2. The characteristics of equation are given also.

$$y = 15.1996 + -16.9208 x, \text{ Coefficient of correlation} = -0.88$$

| Parameter | Coefficient | Std. Error | 95% CI | t | P |
|-----------|-------------|------------|----------------------|---------|--------|
| Intercept | 15.1996 | 1.6402 | 11.8066 to 18.5926 | 9.2669 | <0.001 |
| Slope | -16.9208 | 2.2558 | -21.5459 to -12.2958 | -7.5682 | <0.001 |

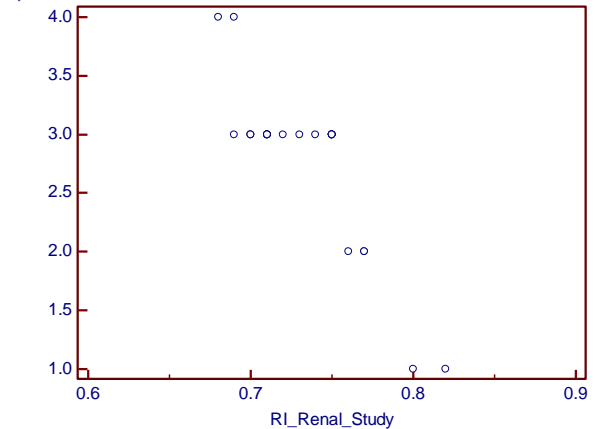
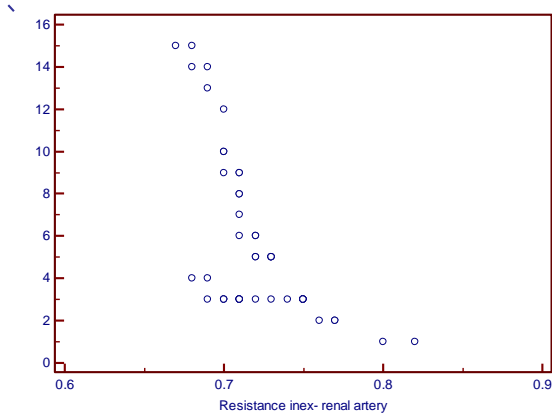


Figure 2 a regression line between renal artery resistance index and amniotic fluid index for all women in both groups

Regression Equation

In addition as shown below we have segregated two regression lines taking the same variables for both study group and control. The characteristics of lines are shown below.

$$y = 15.1996 + -16.9208 x$$

| Parameter | Coefficient | Std. Error | 95% CI | t | P |
|-----------|-------------|------------|----------------------|---------|--------|
| Intercept | 15.1996 | 1.6402 | 11.8066 to 18.5926 | 9.2669 | <0.001 |
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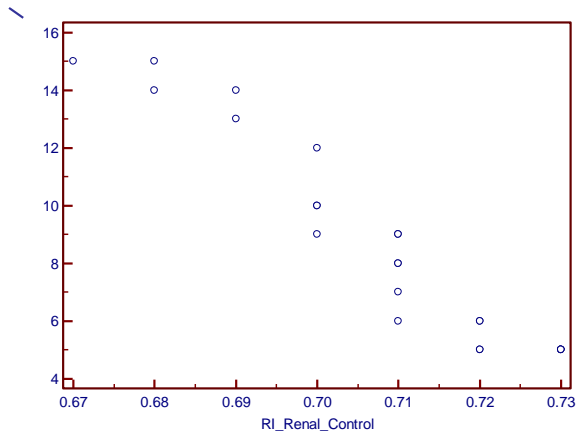


Figure 3 regression lines between AFI and resistance index for both study groups separately: left study group; right: control group

Regression Equation for study group

Comparison of both coefficients of correlations has shown highly statistically significant difference between their coefficients as shown in table 2 and figure 3. The P value was 0.0333 which indicates significant increase of resistance index among women who develops oligohydrannios versus women with normal liquor.

Regression Equation for control group

| $y = 150.7854 + -197.9757 x$ | | | | | |
|------------------------------|-------------|------------|------------------------|----------|---------|
| Parameter | Coefficient | Std. Error | 95% CI | t | P |
| Intercept | 150.7854 | 9.4013 | 129.2543 to 168.3365 | 15.8260 | <0.0001 |
| Slope | -197.9757 | 13.2864 | -225.6063 to -170.3451 | -14.9006 | <0.0001 |

Table 2 Comparison between regression lines for the study and control groups regarding correlation of coefficients between the two lines

| Group | Sample size | Coefficient of correlation | P value between coefficient of correlation among two lines |
|----------------------|-------------|----------------------------|--|
| Study group | 25 | -0.95 | P = 0.0333 |
| Control group | 25 | -0.84 | |

Finally in order to predict the renal artery resistance index cut off value which is associated with oligohydramnios, ROC curve was constructed as shown in figure 4. Table 3 shows the different cut off values with their sensitivities and specificities. The value with grey asterisks (> 0.73) has the highest level. Fetuses with resistance index in the renal artery above 0.73 are 50 % liable to develop oligohydramnios, while fetuses with renal artery resistance index equal or below this value are 100 % with normal amount of liquor.

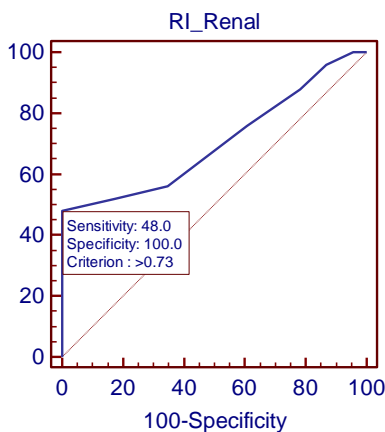


Figure 4 ROC curve for renal artery resistance index with various cut off values

Table 3 which shows different cut off values with their associated sensitivities and specificities

| Resistance index | Sensitivity | 95% CI | Specificity | 95% CI |
|------------------|-------------|--------------|-------------|--------------|
| ≥0.67 | 100.00 | 86.3 - 100.0 | 0.00 | 0.0 - 14.8 |
| >0.67 | 100.00 | 86.3 - 100.0 | 4.35 | 0.1 - 21.9 |
| >0.68 | 96.00 | 79.6 - 99.9 | 13.04 | 2.8 - 33.6 |
| >0.69 | 88.00 | 68.8 - 97.5 | 21.74 | 7.5 - 43.7 |
| >0.7 | 76.00 | 54.9 - 90.6 | 39.13 | 19.7 - 61.5 |
| >0.71 | 56.00 | 34.9 - 75.6 | 65.22 | 42.7 - 83.6 |
| >0.72 | 52.00 | 31.3 - 72.2 | 82.61 | 61.2 - 95.0 |
| >0.73 | 48.00 | 27.8 - 68.7 | 100.00 | 85.2 - 100.0 |
| >0.82 | 0.00 | 0.0 - 13.7 | 100.00 | 85.2 - 100.0 |

DISCUSSION

As far as this study is concerned, it was obvious from the results that renal artery blood flow was significantly reduced among women with oligohydramnios compared to controls with normal liquor. While at the same time no statistically significant changes were found among both groups with regard to umbilical and middle cerebral artery Doppler indices. In order to explain this paradox we considered the already few studies which are published about this subject exclusively expanded over 20 years ago.

Oz et al [5], studied 147 well-dated, singleton, post term pregnancies, of which 21 (14.3%) had oligohydramnios. He observed reduced renal artery end-diastolic velocity in fetal renal artery. He suggests that increased arterial impedance is an important factor

in the development of oligohydramnios in prolonged pregnancies.

Zimmermann ^[6] evaluated total of 153 pregnant women, of at least 287 days' menstrual age. Doppler resistance indices in the umbilical artery did not change significantly with increasing gestation from 41 to 43 weeks. None of the patients showed absent diastolic flow in the umbilical artery.

Bar-Hava ^[7], in his study evaluated resistance index in the fetal middle cerebral, renal, and umbilical arteries in 57 post term pregnancies. Semi quantitative assessment of amniotic fluid volume was obtained by use of the ultrasonographically determined amniotic fluid index. He concluded that oligohydramnios was not associated with a major redistribution of blood flow in post term patients, suggesting that the cause of oligohydramnios in these patients is related to birth weight rather than to renal perfusion.

Lam et al ^[8], assessed amniotic fluid volume, middle cerebral artery pulsatility index and umbilical artery pulsatility index, were determined in 118 well-dated singleton pregnancies admitted for routine induction of labor at 41 weeks. He concluded that Middle cerebral artery pulsatility index is better marker than amniotic fluid volume or umbilical artery pulsatility index in predicting the risk of thick meconium-stained liquor in labor in uncomplicated post dated pregnancy at 41 weeks.

Senat^[9], has provided more reasonable conclusion. Simply he monitored fetal condition including assessment of amniotic fluid by single deepest pool twice a week from 41 weeks of gestation. Induction of labor could be considered when oligohydramnios is diagnosed by single deepest pool less than 2 cm. Accordingly, Senat et al stressed that the amount of liquor is still more reliable indicator of post term fetus at risk of hypoxia.

Selam et al ^[10], concluded that oligohydramnios in post-term pregnancies is associated with arterial redistribution of fetal blood flow typifying the brain sparing effect and with decreased resistance in the middle cerebral artery.

Veille et al ^[11], concluded that in prolonged pregnancies there is a significant relationship between And until then with further similar studies a final conclusion may be put whether this assumption can be true or wrong.

the amniotic fluid index and the fetal renal systolic/diastolic ratio. In pregnancies associated with oligohydramnios the systolic/diastolic ratio is significantly higher than in those with normal amniotic fluid volume. These data suggest that intra renal flow in prolonged pregnancies complicated with oligohydramnios is significantly reduced.

Finally, [Mitra SC](#) ^[12] evaluated whether correlation exists between the resistance index (RI) of the umbilical artery compared to the resistance index of the fetal renal artery, and hourly urine output by fetuses of normal pregnancies. He found that increased resistance index in both renal and umbilical arteries are significantly correlated to 24 hours urine output among fetuses.

At final conclusion after reviewing all the above articles is that a hypothesis can be put to explain all agreements and disagreements among various papers and this paper. First the placenta of post date women start to show signs of placental insufficiency as a normal complication once pregnancy bypass 40 weeks in the form of hypoxia to the fetus. The first reaction of the fetus is reduction of the blood flow to the kidney as part of blood sparing effect to the brain so renal resistance index becomes higher first. Should the condition progress oligohydramnios develop due to reduced urinary output. Umbilical cord becomes compressed between the fetal body and uterine wall with reduction of blood flow to the fetus so at this point Doppler resistance index in the umbilical artery becomes higher. And should delivery is not achieved ultimately the fetal blood flow to the brain become reduced with increase in the resistance index of middle cerebral artery. It seems to be that is the most logical explanation to the all findings mentioned above. Accordingly from this hypothesis we have chosen renal artery resistance index as a primary variable which may predict fetal hypoxia better than other two arteries. A cut off value has been calculated equivalent to 0.73 with reasonable sensitivity 48 % and specificity 100 % was chosen. Whether this hypothesis work or not is absolutely unknown. As a conclusion we urge our colleague to introduce renal artery resistance index as auxiliary ante partum test for women with past date pregnancy in addition to other ante partum fetal wellbeing tests to predict fetuses at risk of hypoxia.

REFERENCES

- 1- Norwitz ER, Snegovskikh VV, Caughey AB. Prolonged pregnancy: when should we intervene? *Clin Obstet Gynecol.* Jun 2007; 50(2):547-57.
- 2- Savitz DA, Terry JW Jr, Dole N, et al. Comparison of pregnancy dating by last menstrual period, ultrasound scanning, and their combination. *Am J Obstet Gynecol.* Dec 2002; 187(6):1660-6.
- 3- Bennett KA, Crane JM, O'shea P, et al. First trimester ultrasound screening is effective in reducing post term labor induction rates: a randomized controlled trial. *Am J Obstet Gynecol.* Apr 2004; 190(4):1077-81.
- 4- Peipert JF, Donnenfeld AE. Oligohydramnios: a review. *Obstet Gynecol Surv.* 1991 Jun; 46(6):325-39. Review
- 5- Oz AU, Holub B, Mendilcioglu I, Mari G, Bahado-Singh RO. Renal artery Doppler investigation of the etiology of oligohydramnios in postterm pregnancy. *Obstet Gynecol.* 2002 Oct; 100(4):715-8.
- 6- Zimmermann P, Albäck T, Koskinen J, Vaalamo P, Tuimala R, Ranta T. Doppler flow velocimetry of the umbilical artery, uteroplacental arteries and fetal middle cerebral artery in prolonged pregnancy. *Ultrasound Obstet Gynecol.* 1995 Mar; 5(3):189-97.
- 7- 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 Aug; 173(2):519-22.
- 8- Lam H, Leung WC, Lee CP, Lao TT. The use of fetal Doppler cerebroplacental blood flow and amniotic fluid volume measurement in the surveillance of postdated pregnancies. *Acta Obstet Gynecol Scand.* 2005 Sep; 84(9):844-8.
- 9- Sénat MV. Management of post-term pregnancies: the role for AFI, biophysical score and doppler. *J Gynecol Obstet Biol Reprod (Paris).* 2011 Dec; 40(8):785-95.
- 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 May; 15(5):403-6.
- 11- Veille JC, Penry M, Mueller-Heubach E. Fetal renal pulsed Doppler waveform in prolonged pregnancies. *Am J Obstet Gynecol.* 1993 Oct; 169(4):882-4.
- 12- Mitra SC, Ganesh V, Apuzzio JJ. Fetal renal artery and umbilical artery Doppler flow and fetal urine output. *Am J Perinatol.* 1995 Jan; 12(1):11-3