Fetal Renal Artery Indices of Second and Third Trimesters of Pregnancy in Idiopathic Oligohydrominos by Pulsed Wave Doppler Ultrasonography

Original Article

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ABSTRACT

Background: Amniotic fluid volume is an indicator of fetal well-being in second and third trimesters of pregnancy and oligohydramnios is diagnosed when this volume is less than 500 ml. Flow velocity waveforms of the renal arteries by doppler ultrasonography provide a sensitive method to predict changes in amniotic fluid dynamics and index in early stages of pregnancy.

Aim: To determine the relation of renal artery flow velocity waveforms with normal pregnancies and with pregnancies complicated by oligohydraminos using doppler ultrasonography.

Methods: A doppler ultrasound device was used to assess the renal artery pulsatility index (PI), resistance index (RI), systolic/diastolic (S/D) ratio. 3 consecutive waveforms from each fetus were traced and the average values used for final analysis.

Results: Maternal age ranged from (20 -40) years. Fetal age ranged from (21 -38) weeks. In oligohydramnios cases, median of (PI) in Lt kidney was (1.99) and in Rt kidney was (2.14), while median of (RI) in Lt kidney was (0.8372) and in Rt kidney was (0.852). While in normal cases median of (PI) in Lt kidney was (1.4584) and in Rt kidney was (1.4124), while median of (RI) in Lt kidney was (0.71) and in Rt kidney was (0.69988).

Conclusion: There is a relation between renal arteries flow velocity waveforms and oligohydraminos by using doppler Ultrasonography. Oligohydramnios with markedly changes in PI & RI values especially in the third trimester is an indicator for rapid delivery to save fetal life. Oligohydramnios could be predicted according to changes in PI & RI values.

Key Words: Oligohydramnios, pulsatility index, resistance index.

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INTRODUCTION

In the second and third trimesters of pregnancy, amniotic fluid volume is an indicator of fetal well-being. As a description of amniotic fluid volume, oligohydramnios refers to decreased volume of fluid less than 500 ml.[1]. However, according to Moore and Cayle, the mean amniotic fluid index (the four-quadrant sum of amniotic fluid pockets) changes weekly[2].

Oligohydramnios or polyhydramnios are characteristic features of structural and functional anomalies and signal indicating that additional assessments or antenatal testing are required[3].

Persistent oligohydramnios has been associated with fetal abnormalities, such as thick meconium staining, limb anomalies, growth retardation, dysmaturity and fetal asphyxia due to inhibition of lung growth[4,5].

Therefore, many studies have focused on these curable diseases and attempt to improve the fetal outcomes[6,7].

The kidney is an important organ in intra uterine life for formation of amniotic fluid. Renal artery emerges straight from the aorta just below the 12th rib. The left renal artery is usually a little higher and longer than on the right one[8].

Flow velocity waveforms from branches of the abdominal aorta including the renal arteries potentially provide a more sensitive method to predict the adequacy of fetal oxygenation than an examination of aortic flow[9].

Doppler velocimetric parameters correlate blood flow and peak systolic velocity during gestation with the amount of amniotic fluid (the amniotic fluid index)[10,11].

By using ultrasound imaging, the fetal renal circulation can be assessed. Intermittent assessment of renal artery flow velocity waveforms during the early stages of pregnancy may help in predicting changes in amniotic fluid dynamics[12].

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PATIENTS AND METHODS

The study was prospective study included (50) pregnant ladies, (25) of them were normal while (25) of them suffered from oligohydramnios. These patients were investigated at the radiology department of El- Menshawy General Hospital in Tanta. The study Started from April 2018 and ended at April 2019. The age of the pregnant ladies ranged from (20 to 40) years old and the study was done during (20 to 38) weeks of pregnancy.

A written informed consent was obtained from all patients after full explanation of all benefits and risks of the procedures.

- All women were placed in the semi-recumbent position.
- Each woman was assisted for about 20 minutes.
- All measurements were taken during the period of absence of fetal movement.
- The technique for the fetal renal artery Doppler blood flow velocity waveform assessment was performed according to Haugen *et al*. 2004[13].
- First an image of a frontal plane was taken of the fetal abdomen to visualize the abdominal aorta and its bifurcation at the level of the fetal kidneys.
- Identification of a straight segment of the renal artery as it reaches the kidney parenchyma from the descending aorta was made by using colour flow Doppler.
- Then, the sector angle and depth of the penetration was optimized. The scanning plane was adjusted to obtain an insonation angle as closed to 0° as possible but always <30°.
- Appropriate low-filter (50-75Hz) settings were used in order to preserve the end- diastolic component of the of the renal artery waveform.
- The Doppler gate (1.5 to 2.0 mm) was placed within the lumen of the renal artery away from the aorta and before any emergent branches.
- Renal artery pulsatility index (PI), resistance index (RI), systolic/diastolic (S/D) ratio, and presence or absence of end-diastolic blood flow were assessed by Pulsed wave Doppler Ultrasonography. Three consecutive waveforms from each fetus were traced and the average values were used for the final analysis.

Ethical consideration

a. A written informed consent was obtained from all patients after full explanation of all benefits and risks of the procedures.

b. The study protocol was approved by local ethics committee.

RESULTS

Age of the patients ranged from (20 -40) years with the mean value of (28.16) years and a median value of (29.5) (Table 1).

Table 1: Distribution of the studied cases according to age of the mother (n = 50)

	No.	%
Age (years)		
< 30	27	54.0
≥ 30	23	46.0
Min. – Max.	20.0 – 39.0	
Mean ± SD.	28.16 ± 6.0737	
Median	29.5	

Age of the fetuses ranged from (21 -38) weeks with the mean value of (28.72) years and a median value of (29.5) (Table 2).

Table 2: Distribution of the studied cases according to age of the fetus (n = 50)

	No.	%
Age (years)		
20-30	17	34.0
31-38	33	66.0
Min. – Max.	21.0 – 38.0	
Mean ± SD.	28.72 ± 5.946	
Median	29.5	

About 50% of cases were normal and 505 suffered from oligohydramnios (Table 3)

Table 3: Numbers of normal and oligohydramnios pregnant ladies. (n = 50)

Cases	No.	%
Normal	25	50.0
Oligohydramnios	25	50.0

With comparison of the resistance index (RI) and Pulsatility index (PI) of the fetal renal artery of the normal pregnant ladies with (RI) and (PI) of ladies suffered from oligohydramnios by Pulsed wave Doppler Ultrasonography, 5 only of the oligohydramnios cases revealed normal results and 20 cases were abnormal (Table 4).

Table 4: Number of normal and abnormal results of (RI) and (PI) in oligohydramnios cases. (n= 25)

Cases	No.	%
Abnormal ratios	20	80.0
Normal ratios	5	20.0

The ratios of (RI) & (PI) of renal artery in oligohydraminos cases in right and left kidneys were summarized in (Table 5) and those of normal cases were observed in (Table 6).

Table 5: ratios of (RI) & (PI) of renal artery in oligohydraminos cases (n = 25).

Cases	RI right kidney	RI left kidney	PI right kidney	PI left kidney
Case no. 1	0.84	0.83	2.2	2
Case no. 2	0.84	0.84	2.1	2.2
Case no. 3	0.86	0.84	2.4	2.2
Case no. 4	0.83	0.82	2.1	2
Case no. 5	0.83	0.81	2.8	2.7
Case no. 6	0.80	0.81	1.9	1.7
Case no. 7	0.81	0.80	2.5	2.3
Case no. 8	0.82	0.81	2.4	2.3
Case no. 9	0.83	0.82	1.9	1.7
Case no. 10	1.1	1	2.7	2.5
Case no. 11	1.2	1.1	2.8	2.6
Case no. 12	0.90	0.91	2.5	2.4
Case no. 13	0.80	0.82	1.5	1.4
Case no. 14	0.83	0.81	2.4	2.3
Case no. 15	0.90	0.91	2.5	2.4
Case no. 16	0.88	0.86	2.4	2.2
Case no. 17	0.84	0.82	2	1.8
Case no. 18	0.86	0.85	2.4	2.2
Case no. 19	0.90	0.91	2.5	2.3
Case no. 20	0.84	0.82	2.1	2
Case no. 21	0.75	0.73	1.45	1.3
Case no. 22	0.76	0.75	1.5	1.4
Case no. 23	0.73	0.72	1.3	1.1
Case no. 24	0.77	0.75	1.55	1.35
Case no. 25	0.78	0.79	1.6	1.4

The ratios of the peak systole (PS) and end diastole (ED) in the right and left kidneys of cases with oligohydramnios were noticed in (Table 7,Graph 1). As compared with the

Table 6 : ratios of (RI) & (PI) of renal artery in normal cases (n = 25)

Cases	RI right kidney	RI left kidney	PI right kidney	PI left kidney
Case no. 1	0.75	0.73	1.52	1.4
Case no. 2	0.64	0.62	1.23	1.3
Case no. 3	0.74	0.73	1.74	1.6
Case no. 4	0.72	0.7	1.84	1.75
Case no. 5	0.73	0.75	1.25	1.4
Case no. 6	0.70	0.72	1.31	1.22
Case no. 7	0.66	0.68	1.28	1.15
Case no. 8	0.68	0.7	1.46	1.55
Case no. 9	0.71	0.72	1.34	1.48
Case no. 10	0.72	0.7	1.51	1.66
Case no. 11	0.73	0.71	1.52	1.75
Case no. 12	0.78	0.8	1.68	1.78
Case no. 13	0.77	0.75	1.61	1.75
Case no. 14	0.73	0.7	1.42	1.35
Case no. 15	0.64	0.68	1.13	1.25
Case no. 16	0.72	0.7	1.54	1.62
Case no. 17	0.74	0.72	1.4	1.6
Case no. 18	0.77	0.75	1.72	1.9
Case no. 19	0.67	0.69	1.31	1.15
Case no. 20	0.62	0.64	1	1.2
Case no. 21	0.69	0.71	1.2	1.4
Case no. 22	0.77	0.76	1.6	1.3
Case no. 23	0.67	0.64	1.08	1.25
Case no. 24	0.78	0.75	1.52	1.35
Case no. 25	0.67	0.7	1.1	1.3

results of the normal cases, those ratios were revealed in (Table 8),Graph 2).

Table 7: ratios of peak systole (PS) and end diastole (ED) of cases with oligohydramnios (n= 25)

Right kidney		Left kidney	
Peak systole	End diastole	Peak systole	End diastole
82.6	35.1	81.5	33.4
78.0	28.5	76.3	28.7
79.5	11.1	79.8	10.8
77.0	12.9	77.3	12.0
17.2	4.8	16.7	4.3
43.2	7.3	43.7	7.0
32.3	6.5	31.4	5.9
68.6	14.6	107.5	13.8
90.7	15.8	90.2	15.6
25.1	4.8	25.4	4.5
14.0	2.5	14.3	2.7
21.1	5.7	21.6	5.9
26.3	5.4	25.8	5.6
51.7	8.02	51.0	7.5
51.1	8.02	50.9	7.9
37.2	8.02	37.0	7.08
54.2	5.7	53.8	5.3
35.8	7.2	35.6	7
34.4	5.8	34.8	6.2
16.8	4.7	17.2	5.3
24.5	5.9	24.8	6.1
48.6	9.2	47.3	8.4
38.7	7.9	38.5	7.2
54.3	8.7	53.7	8.2
42.4	11.9	42.1	11.7

Table 8: Ratios of peak systole (PS) and end diastole (ED) of normal cases (n= 25)

Right kidney		Left kidney	
Peak systole	End diastole	Peak systole	End diastole
55.2	11.7	55	11.2
69.9	17.7	69.5	17.5
38.5	11.4	38	11.1
47.7	14	47.2	13.5
16	5.1	16.7	5.5
36.2	10.1	37.1	10.5
17.2	4.8	17.8	5.2
14	2.5	14.8	3.1
30.3	8.3	30	8.1
13.7	4	13.9	4.1
11.3	3.4	12	3.7
22.9	7.4	21.6	7.1
12.4	4.2	12.9	4.5
19.5	4.7	19.1	4.2
30.9	6.8	31.1	7.2
21.1	5.7	21.8	5.9
24.7	5.4	24.1	5.01
23.8	5.4	23.2	5.1
23	5.4	23.5	5.6
70.4	18.4	70.9	19
30.6	4	30.1	3.8
19.5	7.4	19.1	7.1
33.1	5.1	34	5.4
54.8	12.7	53.7	12.2
22.3	8	23.1	8.7

Table 9: Data of renal artery in oligohydramnios cases (n =25)

Maternal age	28.16 ± 6.0737 years old
Gestational age	28.72 ± 5.946 weeks
PI	Left kidney : 1.99 - Right kidney : 2.14
RI	Left kidney: 0.8372 - Right kidney : 0.852
PS	Left kidney : 48.876 - Right kidney : 45.812
ED	Left kidney : 9.5232 - Right kidney : 9.8424

Table 10: Data of renal artery in normal cases (n=25)

Maternal age	28.16 ± 6.0737 years old
Gestational age	28.72 ± 5.946 weeks
PI	Left kidney : 1.4584 - Right kidney : 1.4124
RI	Left kidney: 0.71 - Right kidney : 0.69988
PS	Left kidney : 30.408 - Right kidney : 30.36
ED	Left kidney : 7.7632 - Right kidney : 7.744

DISCUSSION

During the current study there was a decrease in the ratios of renal artery (PI) with gestational advancement , that happened due to increase in renal perfusion and decrease in renal vascular resistance which increases the fetal urine out put[14].

There is no significant difference between PI of group with oligohydramnios and the group of normal amniotic fluid and this was in agreement with the results of Benzer *et al*[12] study.

Tubular reabsorption was noted as an important factor in determining the pathogenesis of oligohydramnios . In early gestation, there is increase in renal perfusion that causes physiological increase in fetal urine out put , however later on with increase in gestational age the fetal urine out put decreases. So in prolonged pregnancy oligohydramnios will occurs due to increase in tubular reabsorption of urine caused by higher sensitivity to vasopressin[15].

Regarding maternal age group

In the current study, the age of the 100 pregnant ladies ranged from (20-40) years old with the mean value of (28.16) years and a median value of (29.5). These results were in agreement with the study of Benzer *et al*.[12] who performed a study on a 300 pregnant ladies whose age ranged from (17-44) years old with a mean value of (28.4).

Also these results were in agreement with the study of Akshaya *et al*.[16] who performed a study on a 50 pregnant ladies whose age ranged from (18-35) years old with a mean value of (25.21).

Moreover this work coincided with the study of Guin *et al*.[17] who performed a study on a 200 pregnant ladies whose age ranged from (15-31) years old and the mean value was (24.71) and with the study of Figueira *et al*.[10] who performed a study on a 63 pregnant ladies whose mean value of age was (27 ± 3).

Regarding gestational age group

In the current study the gestational age ranged from (21 -38) weeks with the mean value of (28.72) years and a median value of (29.5). These findings agreed with those of Guin *et al*.[15] who performed a study on a 200 pregnant ladies with a gestational age ranged from (20 and 42) weeks and with those of Benzer *et al*.[12] who performed a study on a 300 pregnant ladies with a gestational age ranged from (22 and 34) weeks.

On the other hand, the results of the current study were not in agreement with the study of Rossi *et al*.[5] who performed their study on an older fetal age ranged from (37- 42) gestational weeks, Akshaya *et al*.[16] who performed his study on a 50 pregnant ladies with an older fetal age ranged from (34-40) gestational weeks and Figueira *et al*.[10] who performed a study on a 63 pregnant ladies with an older fetal age ranged from (34-41) gestational weeks.

Regarding (RI) ratios

In the current study the renal artery resistance index (RI) values of the oligohydramnios cases ranged from (0.73 – 1.2) in which the RI values in (5) cases of total (25) oligohydramnios cases ranged from (0.73 – 0.78) and these results were in normal range , while RI values in (20) cases of total (25) oligohydramnios cases ranged from (0.8 – 1.2) and these results were higher than normal ranges.

These results were in agreement with the results in the study of Benzer *et al*.[12] in which the RI ratio was (0.99 ± 0.02). Also they were in agreement with the results in the study of Oz *et al*.[18] in which the RI ratio was 0.8843 ± 0.11 and with the results in the study of Akın *et al*.[19] in which the RI ratio was 0.8.

Regarding the (PI) ratio

In the current study the renal artery pulsatility index (PI) values of the oligohydramnios cases ranged from (1.3 – 2.8) in which the PI values in (5) cases of total (25) oligohydramnios cases ranged from (1.3 – 1.6) and these results were in normal range , while PI values in (20) cases of total (25) oligohydramnios cases ranged from (1.9 – 2.8) and these results were higher than normal ranges.

These findings coincided with those of Benzer, *et al*.[12] in which the PI ratio was (2.87 ± 0.55) and with those of Figueira, *et al*[10] in which the PI ratio was (2.34 ± 0.52) and with those of Akın, *et al*.[19] in which the PI ratio was (2.92 ± 1.4).

SELECTED CASES

Case No. 1

First case was a 27 years old pregnant lady, examined at 28 weeks of gestation with decreased amount of amniotic fluid, AFI: 6, with RI of Rt renal artery: 0.9 and PI of Rt renal artery: 2.57. RI of the Lt renal artery was high: 0.91 and PI of the Lt renal artery: 2.4 . RI of the umblical artery was: 0.69.

Case No. 2

This case was a 29 years old pregnant lady, examined at 30 weeks of gestation with decreased amount of amniotic fluid, AFI: 7 , with RI of the Lt renal artery was: 0.82 and RI of the Rt renal artery was: 0.84. Also PI of the Lt renal artery was: 2.3 and PI of the Rt renal artery was: 2.4 . RI of the umblical artery was: 0.65.

Case No. 3

This case was a 29 years old pregnant lady, examined at 35 weeks of gestation with decreased amount of amniotic fluid, AFI: 5, with RI of the Rt renal artery was: 0.89 and RI of the Lt renal artery was: 0.86. PI of the Rt renal artery was: 2.4 and PI of the Lt renal artery was: 2.2. RI of the umblical artery was: 0.67.

Case No. 4

In this case there was an adequate amount of amniotic fluid, AFI: 13. She was a 27 years old pregnant lady, examined at 30 weeks of gestation with RI of Rt renal artery: 0.78 and RI of Lt renal artery: 0.75. PI of Rt renal artery was: 1.5 and PI of Lt renal artery was: 1.3. RI of the umblical artery was: 0.63.

Case No. 5

In this case there was an adequate amount of amniotic fluid, AFI: 14. She was a 27 years old pregnant lady, examined at 29 weeks of gestation with RI of the Rt renal artery was: 0.77 and RI of the Lt renal artery was: 0.76 . PI of the Rt renal artery was: 1.6 and PI of the Lt renal artery was: 1.3. RI of the umblical artery was: 0.62.

CONCLUSION

- There was a relation between of renal arteries flow velocity waveforms and oligohydraminos using Pulsed wave Doppler Ultrasonography.
- Oligohydramnios with markedly changes in the PI & RI values especially in the third trimester is an indicator for rapid delivery to save the life of the fetus.
- Oligohydramnios could be predicted according to changes in the PI & RI values.
- Oligohydramnios with changes in PI & RI may be caused by renal disease, so that the mother after delivery must follow up the renal function of her baby.
- The topic of this research was new and there were not much papers to compare their results to the results of the current study, so the recommendation is to carry out more researches in this topic in order to get more data.

CONFLICT OF INTERESTS

There are no conflicts of interest.

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