Fetal Renal Volume and Renal Artery Doppler in Normal and Intrauterine Growth Restricted Fetuses

Hani Maged Abd El-Aal and Osama Deif

Obstetrics and Gynecology Department, Faculty of Medicine, Al-Azhar University, Cairo, Egypt
Email: drhanymaged@hotmail.com

Abstract: Objective: To evaluate the difference between fetal renal artery and fetal kidney volume by Doppler in normal and intrauterine development limited fetuses. **Design:** A prospective cross sectional investigation. **Setting:** Department of Obstetrics and Gynecology, Al-Azhar University. **Sample:**100 pregnant women, half (n=50) with normal fetal growth parameter, and other half (n=50) with restricted fetal growth. **Methods:** Fetal renal volume was measured using 3DUS. Both fetal renal and umbilical arteries indices were examined by Doppler. **Main outcome measures:** Relationship of Doppler measures to volume of fetal kidney, and like of biometric indices of the fetus to combined volume of fetal kidney. **Results:** Pooled fetal renal volume was significantly decreased in growth limited fetuses than in control fetuses as the Mean of combined renal volume in IUGR was (21.0 ± 0.1) while in normal fetuses was (31.24±2.31). All fetal biometric parameters were positively liked with combined kidney volume. Concerning the umbilical artery Doppler and fetal renal artery Doppler there was significantly difference between the two groups as the intrauterine growth restricted fetuses have a high Doppler. **Conclusion:** Intrauterine growth retardation seemed to be related with a statistically significant reduction in the renal volume than the normally growth fetuses. The renal artery Doppler shows also significant difference between the two groups, which matches with other studies. This work supports the hypothesis that intrauterine growth retardation may be connected to renal disorder and hypertension in advanced life and renal volume can be used as a parameter for prediction of IUGR.
[Hani Maged Abd El-Aal and Osama Deif. **Fetal Renal Volume and Renal Artery Doppler in Normal and Intrauterine Growth Restricted Fetuses.** *Life Sci J* 2019;16(2):1-4]. ISSN: 1097-8135 (Print) / ISSN: 2372-613X (Online). http://www.lifesciencesite.com. 1. doi:10.7537/marslsj160219.01.

Keywords: Intrauterine growth retardation, fetal renal artery Doppler; Fetal kidney volume.

1. Introduction

Generally, it is known that the human kidney originates from three continuous embryonic phases. Transitory development and degeneration of the pronephros and mesonephrosfetal kidneys happens in the days 23 and 112. These embryonic fetal kidneys have no effect on the function of fetal kidney. The 3rd or functional stage of development is known asmetanephros and this is the permanent kidney. It initiates growth on day 30, starting from nephrons which is the functional parts in the kidney. The kidneys in the fetuses are not similar to the rest of body organs where the full cell proliferation happens in the 3rdtrimester, whereas, the process of nephrogenesis lasts until 34–36 weeks of pregnancy with about 60% of nephrons are constituted in the 3rd trimester [(1)].

Studies concerning the volume of kidney during the fetal period in human being during different stages of gestation revealed that intrauterine growth retardation is associated by diminished in renal volume matched to normal fetuses with suitable weight for pregnancy period [(2)].

Therefore the obstacles for getting normal development of fetus in the uterus are important to expect the risk factors that will face the fetus ante-and postnatal, such as preterm birth, adverse neonatal and long-term health outcomes and stillbirth. Hence, antenatal appreciation and observing of intrauterine growth retardation (IUGR) is an essential element of prenatal carefulness. IUGR is determined as a US assessment of fetal weight below the 10% for anestimated pregnancy age [(3)].

Valuation of the fetal kidneys is an important section of an obstetric US. Accurate data concerning kidney volume is critical to detecting kidney aberrations and discovering deviations in growth of fetal kidney. One of the benefits from using US imaging in diagnosis of kidney disordered, is being cost effective, safe, and are used extensively for estimation of fetal kidney volume, perfusion and echotexture. There are a great advance in the manufacturing of US instruments, two and three-dimensional ultrasound are available nowadays and used widely in evaluation of kidney development [(1)].

With regard to Doppler ultrasound and it is applications in Gynecology & Obstetrics`s clinic, it is non-invasive method to assess pregnancy outcome, useful in examination of placental and fetal vessels and can give valuable data of fetoplacental health status. In addition, Doppler US can determine absolute velocities in an artery, calculation of resistance index (RI), thus can be used for detecting fetal compromise accompanying with an abnormal fetal or uteroplacental circulation [(4)].

2. Methods

This prospective, cross-sectional study was conducted from February 2017 to May 2018. All women attending the antenatal care clinic of Obstetrics and Gynecology Department, Sayed Galal Hospital, Faculty of Medicine, Al Azhar University, were invited to participate after taking an informed consent. Inclusion criterions were singleton pregnancy more than 34Weeks of gestation. Maternal Age 20-36 years and the patient must be sure of last menstrual period. Exclusion criteria include multiple pregnancy, uterine anomalies, fetuses with any congenital anomalies, structural anomalies both renal and non-renal, unclear renal margins and poorly visualized kidneys were excluded.

One hundred women were included, 50 were from uncomplicated pregnancies and 50 with intrauterine growth restriction (IUGR). The study was approved by the local hospital ethics committee.

Group A: including patients with intrauterine growth retardation (50females).

Group B: including patients with normal pregnancy (50 females).

Gestational age was based on the first day of the last normal menstrual period and confirmed by either first or early second-trimester ultrasound scan. Fetal biometry including head circumference, abdominal circumference, and femur length and estimated fetal weight was measured.

Measurement of fetal renal volume done with VOCAL (Virtual Organ Computer Aided Analysis) method. Using three-dimensional US systems with VOCAL method gives a good agreement with true kidney volumes [(5)].

Fetal renal Doppler was done by using color Doppler.

Data analysis

All statistical analyses were performed using the Statistical Package of Social Sciences version 20.0 for Windows (SPSS Inc., Chicago, IL, USA).

3. Results

The mean gestational age by date in IUGR group ± SD was 36.72± 1.53 weeks and for normal group was 37.74±1.41 with no difference between the two groups but the mean gestational age by ultrasound was in IUGR 32.5 ±2.02 and in the normal group was 36.72±1.40.

Table (1): Comparison between both groups as regards gestational age

Gestational age		Range	Mean ± S. D	p. value
G. age by date	Group A	35 – 39	36.72 ± 1.53	0.812
	Group B	34.5 – 39	36.79 ± 1.41	
G. age by US	Group A	28 – 35.2	32.50 ± 2.02	0.001*
	Group B	34.5 – 39	36.79 ± 1.40	

Table (2): Comparison between both group as Right, Left and combined renal volumes. Our study showed that there is significant difference between renal volumes in both groups as the IUGR has smaller kidney than normal group

Renal volume		Range	Mean ± S. D	p. value
Right	Group A	9.3 – 11.2	10.35 ± 0.58	0.001*
	Group B	12.9 – 18.40	15.44 ± 1.76	
Left	Group A	9.4 – 11.6	10.65 ± 0.62	0.001*
	Group B	13.3 – 18.7	15.80 ± 1.62	
Combined	Group A	18.9 – 22.4	21.0 ± 1.0	0.001*
	Group B	26.7 – 36	31.24 ± 2.31	

Table (3): shows that there's significant difference in the measurements of renal artery Doppler between the two groups.

Renal artery Doppler		Range	Mean ± S. D	p. value
RA Resistive index	Group A	0.89 – 0.98	0.94 ± 0.02	0.001*
	Group B	0.7 – 0.86	0.79 ± 0.04	
RA Pulsatile index	Group A	1.76 – 2.01	1.90 ± 0.08	0.001*
	Group B	1.3 – 1.6	1.49 ± 0.07	

Table (4): shows that there's significant difference in Doppler study of umbilical artery between the two groups.

Umbilical artery Doppler		Range			Mean	±	S. D	p. value
UA RI	Group A	0.75	–	0.98	0.87	±	0.01	0.001*
	Group B	0.58	–	0.6	0.59	±	0.01	
UA PI	Group A	1.41	–	1.95	1.74	±	0.14	0.001*
	Group B	0.73	–	0.89	0.80	±	0.144	

4. Discussion

Development of fetus is a consequence of complex interfaces among the genetic growth prospective of the fetus and the effect of the mother intrauterine circumstances. Etiology of intrauterine growth retardation are commonly divided as fetal, maternal or placental. Conversely, such discrepancy is somewhat hypothetical, where these aspects frequently not can be distinguish from each other. IUGR is diagnosed when ultrasound-estimated fetal weight is lower than 10thpregnancy age. The presence of IUGR is an index of pathologic retardation in the development of fetus responsible for drop in fetal weight [(6)].

Extensive circulatory changes occur in fetuses with IUGR caused by placental insufficiency. These changes which are called redistribution or (brain–sparing) effect result in a reduction in the peripheral vascular resistance and accordingly, increased blood flow in organs which are essential for survival (e.g. brain and heart) and decreased blood flow in other parts (e.g. limbs, liver and kidneys) [(7)].

The aim of our study was to compare the fetal kidneys volume between normal fetuses and IUGR fetuses. We also aimed to compare fetal renal artery Doppler in the same groups.

Since the greatest general meaning used for IUGR is weight of fetus lower than 10th percentile for pregnancy age; we tried to take in our consideration this definition in choosing our cases, so all IUGR cases had EFW<10 percentile.

In our study concerning the maternal age, there was no statistically significant difference between the two groups as the mean maternal age in cases was (26.94±3.27 years) and in control group was (26.30 ±3.47 years); P value =0.345. and both groups were matched for number of parity and the result revealed that there is no significant deference between both groups as the number of parity in cases was (1.86 ±1.34 times) and in control group was (1.76 ±1.33 times); P value = 0.709.

Our study showed that, although the two groups were very nearby in their GA by date of last menstrual period as the mean gestational age by date in cases was (36.72±1.53 weeks) and in control group was (36.79± 1.41 weeks) there was significant difference between the two groups as regard gestational age by ultrasound as the mean gestational age by scan in cases was (32.5±2.02 weeks) and control group was (36.79±1.40 weeks).

Although the two groups of our study were very close in their GA and, their biometric measurements were significantly lower in IUGR group.

In 2008, there was a study in the Comparison of fetal and neonatal growth curves for determining IUGR and showed that (All body size dimensions were significantly elevated in AGA than in IUGR) [(8)].

Concerning the umbilical artery Doppler and fetal renal artery Doppler there was significant difference between the two groups as the mean of resistive index of umbilical artery of IUGR cases was (0.87±0.01) and for control group was (0.59 ±0.01) and the mean of umbilical artery pulsatile index in IUGR cases was (1.74 ±0.14) and in control group was (0.80 ±0.144). As regard renal artery resistive index in IUGR cases was (0.94±0.02) and in control group was (0.79 ± 0.004) and renal artery PI in IUGR was (1.90 ± 0.08) and in normal fetuses was (1.49 ±0.07)

Our results meet with a previous study, which revealed that there was significantly variation was realized among the Doppler measurements of renal artery in growth restricted and normal fetuses. It is observed that the renal artery demonstrated slightly declined systolic rates with upsurge in the pulsatility index in growth restricted fetuses [(9)].

In our study concerning renal volume we found that there was significant difference between the two groups as the IUGR cases had smaller renal volume than normal group.

The mean of the right renal volume in IUGR group was (10.35±0.58) and in control group was (15.44±1.76) with significant p value <0.05, in the left side the renal volume in IUGR group was (10.65 ± 0.65) and in normal group was (15.80± 1.62) with significant p value <0.05.

Conclusion:

- The advantage of 3-D U/S in assessing fetal renal volume is that the dataset can be stored at the time of examination and analyzed later to calculate

volume. Also this dataset can be manipulated later to view the kidney in the coronal and sagittal planes, in addition to the transverse plane in which the sweep was obtained.

- Fetal renal volume and renal artery Doppler are affected significantly with IUGR and it can be used as a parameters for prediction of IUGR.

Reference

1. Sonja B, David W, Donna R *et al.* (2017): Evaluation of fetal kidney growth using ultrasound: A systematic review. European Journal of Radiology, 96:55–64.
2. Verburg BO, Geelhoed JJ, Steegers EA, Hofman A, Moll HA *et al.* (2007): Fetal kidney volume and its association with growth and blood flow in fetal life: The Generation R Study. Kidney Int., 72: 754-761.
3. Easter SR, Eckert LO, Boghossian N, Spencer R, Oteng-Ntim E, Ioannou C *et al.* (2017): The brighton collaboration fetal growth restriction working group. fetal growth restriction: case definition & guidelines for data collection, analysis, and presentation of immunization safety data. Vaccine, 35: 6546–6554.
4. Everett TR, Lees CC (2012). Beyond the placental bed: Placental and systemic determinants of the uterine artery Doppler wave form. Placenta, 33(11): 893–901.
5. Yoshizaki CT, Francisco RPV, De Pinho JC, Ruano R, & Zugaib M (2013): Renal Volumes Measured by 3-Dimensional Sonography in Healthy Fetuses From 20 to 40 Weeks. Journal of Ultrasound in Medicine, 32(3): 421–427.
6. Gutaj P & Wender-Ozegowska E (2016). Diagnosis and Management of IUGR in Pregnancy Complicated by Type 1 Diabetes Mellitus. Current Diabetes Reports, 16(5):1531–1547.
7. Giussani DA. (2016). The Fetal Brain Sparing Response to Hypoxia: Physiological Mechanisms. The Journal of Physiology, 594:1215–1230.
8. Marconi AM, Ronzoni S, Bozzetti P, Vailati S, Morabito A, & Battaglia FC. (2008). Comparison of Fetal and Neonatal Growth Curves in Detecting Growth Restriction. Obstetrics & Gynecology, 112(6):1227–1234.
9. Ratnaparkhi C, Kurve S, Mitra K, Onkar P, Kulkarni A, Kant D (2015): "Correlation between Fetal Renal Volume and Fetal Renal Doppler in Normal and Growth Restricted Fetuses: An Initial Experience". Journal of Evolution of Medical and Dental Sciences, 4(63): 10956-10966.

1/22/2019