

Ultrasound Evaluation of the Relationship between Fetal Lateral Ventricle Diameter and Biometric Parameters

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Abstract

Background: We aimed to assess the relationship between fetal lateral ventricular width and biometric measurements with ultrasound examination.

Materials and Methods: A prospective case-control study on 178 fetuses as the control group with lateral ventricle diameter 4-7.9 mm and 80 fetuses as the case group with lateral ventricle diameter 8-12 mm. The study was done at Shariati hospital (Tehran, Iran), from 2015 to 2019. All patients underwent a detailed ultrasound exam according to ISUOG guideline and biometric measurements, including head circumference, biparietal diameter, abdominal circumference, femur length, humerus length, cerebellar diameter, cisterna magna width, average ultrasound gestational age, and estimated fetal weight was done. At least two follow-up ultrasound examinations at 26-28 weeks of gestational age and 32-34 weeks of gestational age were performed to evaluate ventricle size, and fetuses with lateral ventricle width above 12 mm were excluded. Then we compared fetal biometric measurements, mentioned above, in these groups.

Results: The mean maternal age, maternal past medical history, obstetrical history, mode of conception, fetal presentation, and fetal gender did not differ between the groups. We compared 187 patients as the control group with 80 patients as the case group at the same gestational age and gender. The mean ventricular width in the case group was 8.6 mm, and in the control group was 5.9mm. The study group had significantly larger head circumference, biparietal diameter, femur length, and estimated fetal weight compared with the control group ($P < 0.05$).

Conclusion: The lateral ventricular width is dependent on other biometric parameters such as head circumference, biparietal diameter, and general fetal size, and larger ventricle width is associated with larger parameters.

Key Words: Biometric, Fetal, Cerebral Ventriculomegaly, Lateral Ventricle, Ultrasound.

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1- INTRODUCTION

A mid-trimester fetal ultrasound scan is a crucial fetal screening and is also used to detect congenital anomalies. Most countries offer at least one mid-trimester scan as part of standard prenatal care (1-2). Assessment of the lateral ventricles of the fetal brain is a part of the routine mid-trimester fetal ultrasound exam (3). The diameter of the lateral ventricles remains stable between 15 and 40 weeks of gestation, with means of 7.6 mm and upper limit of normal (10 mm) (4-6). Ventriculomegaly is a frequent marker of abnormal cerebral development and has been defined as the atrial diameter of 10mm or more in several studies (4, 5, 7).

Ventricle dilatation is classified as mild: 10 to 12 mm; moderate: 13 to 15 mm; and severe: 16 mm or more (8). The prevalence of mild ventriculomegaly is less than 1 in 100 pregnancies. It is the most common prenatally diagnosed cerebral anomaly (9-11). Isolated mild ventriculomegaly is usually a normal variant, and postnatal evaluation is usually normal without neurodevelopmental delay (8). It is a benign finding in most cases, but it may be associated with a variety of different etiologies, including infections, chromosomal anomalies, and cerebral migration abnormalities (12).

The prognosis depends on the severity of ventriculomegaly and the presence of associated conditions. In previous studies, the neurodevelopmental delay has been shown in 8-10% of cases of mild ventriculomegaly (8-10). In a 2014 meta-analysis, including over 700 cases of isolated mild ventriculomegaly (10-15mm), the overall prevalence of developmental delay was 7.9% and was similar to background rate (13). Also, a 2017 meta-analysis has shown the incidence of neurodevelopmental delay in cases of the isolated unilateral ventriculomegaly with an atrial width of <15 mm is similar to that reported in cases

of isolated bilateral ventriculomegaly and close to that reported in the general population (14). Large multicenter prospective studies are needed in order to ascertain the risk of neurodevelopmental delay in mild ventriculomegaly. Moreover, some studies suggested the correlation between lateral ventricle width and other fetal biometric measurements such as biparietal diameter, occipitofrontal diameter, and head circumference (15-16). This relationship may be the rationalization of high normal prognosis in isolated mild ventriculomegaly reported in later studies. Furthermore, we designed this study to determine whether the width of fetal lateral ventricles are related to biometric measurements. This study aimed to compare biometric measurements in two groups of fetuses: lateral ventricle width 4-8mm and 8-12mm, and to determine whether fetuses with wider ventricles also have other larger fetal biometric measurements.

2- MATERIALS AND METHODS

2-1. Study design and population

This prospective case-control study was performed in a single tertiary referral center, Perinatology department of Shariati hospital in Tehran, Iran, from September 2015 to January 2019. This study consists of the patients that have been referred for a detailed ultrasound exam following the detection of ventricular dilatation, and patients referred for routine mid-trimester ultrasound exam at a gestational age ranging from 18 to 24 weeks. A convenient sampling method was used to examine 258 singleton fetuses between 18 and 24 weeks of gestational age.

2-2. Methods

Gestational age was determined according to the first ultrasound exam. Since the reported means of the lateral ventricle is about 7.6 mm (4), we divided the patients into two groups: those with the lateral

ventricle width less than 8 mm (4-7.9 mm), and those with the lateral ventricle width 8-12 mm. All patients underwent a detailed ultrasound exam according to ISUOG guideline (3), and biometric measurements were done. The fetal parameters that were measured and collected in both groups included head circumference, biparietal diameter, abdominal circumference, femur length, humerus length, cerebellar diameter, lateral ventricle width, cisterna magna width, average ultrasound gestational age, and estimated fetal weight. The atrium of lateral ventricles was measured in the transventricular plane at the level of the glomus of the choroid plexus, perpendicular to the long axis of the ventricular cavity; the calipers were positioned inside the echoes generated by the lateral walls at the level of the parieto-occipital fissure (4-6). The widest part of the posterior lateral ventricle farthest from the transducer was measured. The ventricular width is gender-dependent, and ventriculomegaly is more common in males (male to female sex ratio is 1.7) (12). We matched fetuses in both groups according to gestational age at ultrasound exam and fetal gender. Then we compared biometric parameters including head circumference, biparietal diameter, abdominal circumference, femur length, humerus length, cerebellar diameter, cisterna magna width, average ultrasound gestational age, and estimated fetal weight in these two groups.

2-3. Measuring

All ultrasound exams were done by a single well-trained sonographer using a 5-MHz curvilinear abdominal probe.

2-4. Ethical consideration

The study was approved by the Ethical Review Board in Tehran University of Medical Sciences, Tehran, Iran (IR.TUMS.MEDICINE.REC.1399.001).

2-5. Inclusion and exclusion criteria

The inclusion criteria were the following: singleton pregnancies; gestational age confirmed by ultrasound examination in the first trimester; absence of other fetal malformations and intrauterine fetal growth restriction; absence of maternal disease included diabetes, hypertension, and connective tissue disorders. Those patients with lateral ventricle diameter 10-12 mm underwent serologic evaluation for TORCH and karyotype study. A targeted ultrasound exam to rule out other anomalies was done, and the fetal brain was examined using a multiplanar approach according to ISUOG guideline (6) to assess other neurologic findings and fetuses with normal karyotype and negative TORCH study were included.

At least two follow-up ultrasound examinations during pregnancy at 26-28 weeks of gestational age and 32-34 weeks of gestational age were performed in these cases to evaluate ventricle size. Fetuses with lateral ventricle width above 12 mm were excluded. The two groups were matched according to gestational age and fetal gender. Then we compared fetal biometric measurements in these groups. Fetuses with lateral ventricle width above 12 mm or with other cerebral anomalies were excluded.

2-6. Data Analyses

Categorical variables were described as frequency and percentage. Continuous variables were described using mean and SD. Groups were compared using the Chi-square test or Fisher exact test for categorical variables and independent sample t-test for continuous variables. All statistical tests were two-tailed, and $P < .05$ was considered statistically significant. IBM SPSS version 16.0 was used for statistical analyses.

3- RESULTS

This study consists of 178 fetuses as the control group with lateral ventricle

diameter 4-7.9 mm and 80 fetuses as the case group with lateral ventricle diameter 8-12 mm. In this study, there were 12 fetuses with lateral ventricle width 10 mm or more, all of them included in the study had a normal karyotype, negative torch serology, normal neurosonography, normal follow-up ultrasounds and normal neurodevelopmental exam after birth. Male gender was significantly higher in the case group, 67% (n=53), and 52% (n=70) in case and control groups, respectively. Since fetal gender influences the biometric parameters, we added randomly 45 male fetuses in the control group to match the two groups. After matching, we compared one hundred and seventy-eight patients as the control group with eighty patients as the case group at the same gestational age and gender (Table.1).

The mean maternal age, maternal past medical history, obstetrical history, and mode of conception did not differ between the groups. The mean gestational age in the control group was 20.3 weeks (+-5.31), and in the case group it was 20.5 weeks (+-5.15), and there was no statistical difference between the two groups (p=0.05). The mean ventricular width in the case group was 8.6 mm (+-0.63), in the control group was 5.9 mm (+-0.77). The case group had a significantly larger head circumference (181.2 versus 190mm, p=0.002), biparietal diameter (49 versus 51.4mm, p<.001), femur length (33.65 versus 35mm, p=0.005), and estimated fetal weight (367.07 versus 410.84gr, p<.001) compared with the control group (Table.2).

Table-1: Population and ultrasound characteristics between the case and control groups.

Characteristics	Case group (n=80)	Control group (n=178)	P-value
Maternal age (year)	31.1	32	.123
Gravida	2 (1-3)	2 (1-3)	.55
Parity	1 (0-2)	1(0-2)	.78
Mode of conception			.58
Spontaneous	76 (95%)	165 (93%)	
Ovulation Induction	2 (2.5%)	7 (4%)	
IVF	2 (2.5%)	6 (3%)	
Gestational age at exam(week)	20.3	20.5	.005
Fetal gender			.65
Male	66%	65%	
Female	34%	34%	
Fetal presentation			.03
Cephalic	75 (94%)	160 (90%)	
Breech	3 (3.8%)	12 (7%)	
Other	2 (2.5%)	6 (3%)	

Continuous variables are presented as mean (standard deviation), categorical variables are presented as number (%).Groups were compared using Chi-square test or Fisher exact test for categorical variables and independent sample t-test for continuous variables. Fetuses as the control group with lateral ventricle diameter 4-7.9 mm, and fetuses as the case group with lateral ventricle diameter 8-12 mm, IVF: In vitro fertilization

Table-2: Fetal biometric parameters of the study and control group.

Ultrasound parameter	Case group (n=178)	Control group (n=80)	P-value
Gestational age at exam (days)	145.30 (8.9)	143.22 (7.1)	0.005
Max ventricular width (mm)	11	7.8	
Mean ventricular width (mm)	8.65(0.63)	5.95(0.77)	<0.001
Biparietal diameter (mm)	51.4 (9.7)	49.1(7.1)	<0.001
Head circumference (mm)	190(9.5)	181(12.3)	

Femoral length (mm)	35 (10.1)	33.65 (7.7)	0.005
Abdominal circumference (mm)	165 (9.8)	159.5 (7.6)	0.001
Estimated fetal weight (gr)	410.8 (98.7)	367.07 (69.8)	<0.001
Cisterna magna (mm)	6.3 (1.2)	5.9 (0.9)	0.001
Cerebellar diameter (mm)	20.87 (1.5)	20.28 (1.2)	0.001

Continuous variables are presented as mean (standard deviation). Groups were compared using independent sample t-test. Fetuses as the control group with lateral ventricle diameter 4-7.9 mm, and fetuses as the case group with lateral ventricle diameter 8-12 mm.

4- DISCUSSION

This study was to assess the correlation between fetal lateral ventricular width and biometric measurements with ultrasound examination. This study aimed to compare biometric measurements in two groups of fetuses: lateral ventricle width 4-8 mm and 8-12 mm, and to determine whether fetuses with wider ventricles also have other larger fetal biometric measurements. The main finding of our study was that the lateral ventricular width is dependent on other head parameters such as head circumference, biparietal diameter, and generally fetal size. Reliable detection of ventricular dilatation is a critical part of the routine obstetric examination because of the clinical significance of the findings. For more than 20 years, the upper limit for a normal ventricular width has been 10mm, unrelated to gestational age, gender, and other biometric measurements (7).

The study performed by Udoh and colleagues, a cross-sectional descriptive study of 685 fetuses in Southern Nigeria, showed that lateral ventricular diameter did not have any significant correlation with fetal characteristics such as gender, estimated fetal weight, and fetal head circumference throughout gestation. These findings were not compatible with our results. They concluded that 10 mm is the acceptable normal upper limit for the fetal lateral ventricular diameter of fetuses in Southern Nigeria, but there is no statistical or clinical evidence for this claim in this study. In their study, all fetuses had a lateral ventricular diameter of less than 10 mm, and there was no clinical evidence

about larger lateral ventricles (20). On the other hand, a large prospective study of 608 healthy single fetuses, with two years' follow-up, suggested currently used cutoffs for normal atrial size are too low. They showed four standard deviation above the mean is 12mm, and all six fetuses with lateral ventricle diameter between 10-12 mm had the normal condition in two years' follow-up. However, the number of these fetuses is too small, Hilpert in this study showed measurements in the range of 10-12 mm are not necessarily abnormal. If 10 mm or greater defines ventriculomegaly, some normal fetuses would be targeted for special interventions, including increased sonographic surveillance, karyotype determination, or other invasive procedures, and possible termination of the pregnancy for a suspected CNS abnormality (17).

We agree with Hilpert about lateral ventricle width between 10 and 12mm. The study of Pagani in 2014 and the study of Scala in 2017 also confirmed this opinion, and they found that neurodevelopmental outcome in cases of isolated mild ventriculomegaly is the same as the general population (13-14). We think that a 10-mm atrial measurement is too low for an absolute cutoff of normalcy. Other qualitative and quantitative signs are needed to make the diagnosis of ventriculomegaly. In the study of Gilmore and colleagues on 34 children with prenatal isolated mild ventriculomegaly, it was associated with enlargement of the lateral ventricles after birth, as well as greater gray matter volumes and delayed or abnormal maturation of white matter on

MRI (21). In this study, the upper limit of the lateral ventricle width has not been detected, and the definition of isolated mild ventriculomegaly is not clear. The approach for evaluation of other malformations is not obvious, and this conclusion may be due to other pathologies. Also, the clinical significance of these findings is not evaluated. In the study of Bercovitz¹ and colleagues, fetuses with mild ventriculomegaly have significantly higher OFD percentiles compared to healthy fetuses, but the clinical importance of this finding was not determined (22). Then the evidence to consider ventriculomegaly as lateral ventricle width above 10mm is weak, and large, long-term studies with clinical evaluation of neurodevelopment in children are needed. Whereas, there is a general consensus that most cases with ventricular diameter 10-12 mm are a normal variant and do not need additional workup, in this study we tried to evaluate the relationship between lateral ventricular size and biometric measurements.

Our result is similar to those of Fishel and colleagues that compared 91 fetuses with isolated mild ventriculomegaly to 91 fetuses with a normal width of the lateral ventricle at the same gestational age and gender. They confirmed an association between biparietal diameter, occipitofrontal diameter, head circumference, estimated fetal weight with lateral ventricle width (16). Fishel and colleagues concluded that isolated mild ventriculomegaly could be related to other larger fetal biometric measurements and may not necessarily mean a pathological condition, but they agreed that in order to assess this finding larger cohort studies and long-term follow-up should be conducted. In our study, we also found an association between the larger ventricular width and larger fetal biometric parameters such as biparietal diameter, head circumference, and estimated fetal weight.

This association may be the cause of some isolated mild ventriculomegaly. It can be shown that the use of lateral ventricular width as a relation of fetal head parameters may be more precise than the absolute width of the lateral ventricle, and maybe consideration of a definite cutoff to the diagnosis of ventriculomegaly is not correct. This association between the larger ventricle and larger fetal head may be the explanation of many conflicts.

4-1. Study Limitations

There was no long-term follow-up to assess neurological function.

5- CONCLUSION

The lateral ventricular width may be dependent on other biometric parameters such as head circumference, biparietal diameter, and general fetal size, and larger ventricle width is associated with larger parameters. Isolated mild ventriculomegaly may be related to other larger fetal biometric measurements and may not be a pathological condition. In order to assess these findings, larger cohort studies and long term follow-up studies are needed.

6- CONFLICT OF INTEREST: None.

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