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Normal range of fetal brain structures in the second trimester ultrasound screening

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Abstract

The aim of the study was the development of normative values of the sizes of the main structures of fetal brain. The latter are the subject to evaluation in the second trimester ultrasound screening. Results of the survey of 385 fetuses were selected during the end-to-end echographic observation in the period from 16 to 28 weeks of gestation. This was performed in order to develop normative percentile values of the width of the cavum septum pellucidum, width of the lateral ventricles, transverse cerebellar diameter and anteroposterior diameter of the cisterna magna. For the analysis, we used only the data obtained from the examination of patients in which pregnancy ended with term delivery and the birth of normal healthy children. Based on the data obtained, we developed percentile values (mean, 5^{th} and 95^{th} percentiles) of the studied structures, which can be used for prenatal diagnosis of congenital malformations of the brain in the second trimester of pregnancy.

Keywords: fetus, second-trimester screening, brain, cavum septum pellucidum, lateral ventricles, cerebellum, cisterna magna, ultrasound examination.

INTRODUCTION

The second trimester ultrasound screening includes an obligatory assessment of the main structures of the fetal brain. Previously, most of these structures were assessed mainly visually, i.e. subjectively without biometrics methods. This often led to false-negative conclusions. Therefore, at this moment it is necessary to develop a modern standardized biometric evaluation of the main structures of the fetal brain during the second trimester ultrasound screening.

According to the recommendations of the Russian Association of Medical Ultrasound Examination Professionals in Perinatology and Gynecology [10] and the International Society for Ultrasound Diagnostics in Obstetrics and Gynecology [6], fetal brain structures to be screened include septum pellucidum, lateral ventricles, cerebellar hemispheres and cerebellar vermis, cisterna magna. Numerical values of these structures must be indicated in the second trimester ultrasound screening protocol.

When assessing the width of cavum septum pellucidum (WCSP), the width of the lateral ventricles (WLV) and the anteroposterior size of cisterna magna (APSCM) of the fetal brain in the second trimester of pregnancy, many specialists use the threshold value of 10 mm. First of all, this refers to the lateral ventricles of the fetal brain [1, 7, 8, 9, 11, 12, 13, 14, 16, 17, 21, 23]. This approach does not allow to establish early manifestations of the dilation of lateral ventricles in fetus accurately and to carry out an expanded prenatal neurosonography in time.

There are also disagreements regarding the methodology for measuring WLV in a fetus. Initially, WLV had been measured in the region of the posterior margin of the vascular plexus [15]. ISUOG guidelines on the evaluation of fetal CNS in the second trimester of pregnancy also suggest the use of the posterior edge of the vascular plexus as a landmark for calipers installation (ISUOG, 2007). However, somewhat later, it was shown that the level of the posterior margin of the vascular plexus might be different. So, one needs a more permanent landmark, such as parieto-occipital sulcus [4].

In addition, it should be emphasized that the existing standards for the size of the cavum septum pellucidum, lateral ventricles, cerebellum and cisterna magna in the fetus (depending on the period of pregnancy) were often developed separately rather than in the same group of fetuses in one population [2, 3, 18, 19, 20, 22].

Due to this fact, the aim of the study was the development of normative values of the sizes of the brain's main structures in the second trimester of pregnancy in one sample of fetuses according to the unified modern methods of their evaluation.

METHODS

The results of the study of 385 fetuses obtained during end-to-end echographic observation in the period from 16 to 28 weeks were used for the development of normative parameters of the main structures of fetal brain in the second trimester of pregnancy. In all the examined patients the pregnancy resulted in term deliveries and the birth of normal healthy children. The mean age of the examined patients was 28.2 years. The selection criteria were the following:

1) The known date of the last menstruation in case of 26-30-day cycle;
2) Uncomplicated course of pregnancy;

3) The presence of a monocarpic pregnancy without signs of any pathology in fetus;
4) Withdrawal from oral contraceptives within 3 months before the conception cycle;
5) Term birth and normal fetus with birth weight within the normative values (more than 10th and less than 90th percentile by weight and body length depending on the gestational age).

Measurements of WCSP, WLV, APSCM and transverse diameter of the cerebellum (TDC) of the fetal brain in the second trimester of pregnancy were obtained retrospectively following fetal brain imaging on the ultrasound device Voluson E8 (GE) by using convection abdominal volume scan sensor. Analysis of volumetric reconstructions was carried out on a personal computer by using specialized software 4D View (GE).

RESULTS

The multiplanar fetal brain reconstruction was used in order to assess WCSP and to obtain an axial section of the head (for determining biparietal size). WCSP was regarded as the maximum distance between its walls. At the same time, the following procedure was strictly adhered: symmetrical axial section of both hemispheres of the fetal head at the level of the olfactory tubercles; M-echo was clearly visualized throughout all length and interrupted only in the projection of the cavum septum pellucidum; in the occipital region of M-echo we received a clear image of the great cerebral vein (ambient cistern) in the form of V-shaped structure. Calipers were placed in a point where the lines surrounding cavum septum pellucidum were most distant from each other. At the same time the line connecting the calipers was perpendicular to the lines, thus limiting the cavum septum pellucidum.

During our studies, it was established that fetal cavum septum pellucidum was an easily identifiable structure when using an axial plane of scanning in the second trimester of pregnancy. In our studies, definition of WCSP was achieved in 100% of successfully collected volumetric reconstructions.

During the study of the fetal WCSP, a gradual increase in the fetal period was observed between 16 and 28 weeks of gestation. According to our results, numerical values of fetal WCSP averaged to 2.8 (1.8-3.8) mm in 16/0-16/6 weeks and 6.1 (4.5-7.7) mm in 27/0-27/6 weeks (see the table 1).

The standardized approach to the screening of the size of the lateral ventricles of the fetal brain was the following: to study their width at the level of the atrium communicating anteriorly with the body of the lateral ventricle, posteriorly - with the posterior horn, and in the bottom - with the lower horn. In order to evaluate WLV, a multiplanar reconstruction of the fetal brain was used that allowed obtaining an axial section with the help of volumetric echography. Measurements were carried out at the level of olfactory tubercles with strictly symmetrical images of both hemispheres at the point opposite to the forming parieto-occipital sulcus, perpendicular to the walls of the posterior horn of the lateral ventricle. Calipers were placed at the border of the transition of the echogenic line of the medial and lateral walls into the anehogenous lumen of the lateral ventricle.

Table 1. Normative values of the width of cavum septum pellucidum (WCSP), width of the lateral ventricles (WLV), transverse diameter of cerebellum (TDC) and anteroposterior size of cisterna magna (APSCM) of the fetal brain in the second trimester of pregnancy.

Pregnancy, weeks/days	WCSP, mm			WLV, mm			TDC, mm			APSCM, mm		
	Percentile											
	5th	50th	95th	5th	50th	95th	5th	50th	95th	5th	50th	95th
16/0-16/6	1.8	2.8	3.8	4.7	6.0	7.3	14	16	18	2.4	4.0	5.6
17/0-17/6	2.1	3.2	3.3	4.8	6.1	7.4	15	17	19	2.6	4.2	5.8
18/0-18/6	2.4	3.6	4.8	4.9	6.2	7.5	16	18	20	2.8	4.4	6.0
19/0-19/6	2.7	4.0	5.3	5.0	6.3	7.6	17	19	21	3.0	4.6	6.2
20/0-20/6	2.9	4.3	5.7	5.1	6.4	7.7	18	20	22	3.2	4.8	6.4
21/0-21/6	3.2	4.6	6.0	5.1	6.5	7.9	19	21	23	3.4	5.1	6.8
22/0-22/6	3.5	4.9	6.4	5.2	6.6	8.0	20	23	26	3.6	5.4	7.2
23/0-23/6	3.7	5.2	6.7	5.3	6.8	8.3	21	24	27	3.9	5.7	7.5
24/0-24/6	3.9	5.5	7.1	5.4	6.9	8.4	23	26	29	4.1	6.0	7.9
25/0-25/6	4.1	5.7	7.3	5.5	7.0	8.5	25	28	31	4.2	6.2	8.2
26/0-26/6	4.3	5.9	7.5	5.6	7.2	8.7	27	30	33	4.4	6.4	8.4
27/0-27/6	4.5	6.1	7.7	5.7	7.3	8.8	29	32	35	4.6	6.6	8.6

During the conducted studies, it was established that lateral ventricles of the fetus were an easily identifiable structure in the second trimester of pregnancy. In our studies, WLV assessment was achieved in 100% of successfully collected volumetric reconstructions.

When studying fetal WLV of the fetus, its gradual increase was established in the period from 16 to 28 weeks of pregnancy. According to our results, numerical values of fetal WLV were averaged to 6.0 (4.7-7.3) mm in 16/0-16/6 weeks and 7.3 (5.7-8.8) mm in 27/0-27/6 weeks of pregnancy (see the table).

In order to assess TDC and APSCM, we used the multiplanar reconstruction of the fetal brain in order to obtain an axial section with the help of volumetric echography. Evaluation of TDC and APSCM was carried out in axial plane passing through the posterior cranial fossa and cerebellum. TDC was evaluated as the maximum value of the transverse dimension of the cerebellum from the outer edge of one hemisphere to the outer edge of the other hemisphere, while APSCM was evaluated as the maximum size from the posterior surface of the cerebellar vermis to the inner surface of the occipital bone. In our studies, the assessment of TDC and APSCM was also achieved in 100% of successfully collected volumetric reconstructions.

When studying fetal TDC and APSCM, we established a gradual increase in these parameters in the period from 16 to 28 weeks of pregnancy. According to our results, numerical values of fetal TDC averaged to 16 (14-18) mm in 16/0-16/6 weeks and 32 (29-35) mm in 27/0-27/6 weeks of gestation (see the table).

DISCUSSION

The obtained results showed that the numerical values of the dimensions of the cavity of the transparent septum, lateral ventricles, cerebellum and cisterna magna of the fetus gradually increased during the second trimester of pregnancy. At the same time, the developed normative parameters of WCSP, WLV, TDC, and APSCM had certain peculiarities in comparison with previously published nomograms.

Thus, a comparative analysis of the obtained WCSP with the results of a single similar study [3] showed that numerical values of WCSP in our study at the beginning of the second trimester of pregnancy had been smaller, but starting from 22 weeks of gestation average numerical values of WCSP were almost identical. However, a confidence interval was smaller.

The comparative analysis of nomograms of WLV also revealed divergences with other researchers [15]. According to the obtained results, WLV has slightly lower values up to 24 weeks of pregnancy. Apparently, these differences are caused by the fact that in their studies, WLV assessment in fetus was carried out in the region of the posterior edge of the vascular plexus, and not in the point opposite to the parieto-occipital sulcus (according to modern requirements).

The comparative analysis of the data obtained by nomographs of TDC and APSCM in this study with the results of other studies [5,19] obtained long ago showed the presence of certain differences including a slight overestimation of the numerical values of TDC and APSCM. However, these differences did not have a valid nature.

CONCLUSION

Thus, the percentile values of the developed main structures of the fetal brain can be used for their standardized objective evaluation and also to make timely prenatal diagnosis of congenital malformations of the brain in the second trimester of pregnancy.

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