PRENATAL TACTICS OF ULTRASONOGRAPHIC EXAMINATION OF THE FETUS IN EARLY PREGNANCY

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ABSTRACT

To study defects and chromosomal abnormalities of the fetus, we retrospectively analyzed results of comprehensive dynamic survey of 26,404 pregnant women aged 18-50 years old at 6 to 40 weeks of pregnancy. Of them, 25,956 (98.3%) women had physiological course of pregnancy, 448 (1.7%) women had abnormal pregnancy. For the diagnosis of fetal defects, we carried out ultrasound, biochemical, invasive and cytogenetic studies. The results of study showed that the majority of fetal defects and pathological course of pregnancy was noted in women at the age of 21-25 years old, since at this age period women have the highest number of pregnancies. At the older age, we noted a gradual decrease in the number of pregnant women, as well as the number of abnormalities of the fetus. Based on the analysis of the results obtained, we have developed an algorithm for early fetal ultrasound examination. In order to exclude non-developing pregnancy and intrauterine fetal death, as well as for early diagnosis of fetal defects, we recommend screening women in the first trimester of pregnancy.

UDC CLASSIFICATION & KEYWORDS

■ 618.2-073.43 ■ Pregnancy ■ Fetal Defects ■ Algorithm of Diagnosis ■ Ultrasound Examination

INTRODUCTION

According to the WHO, 2.5-3% of newborns found a variety of defects. Of them, about 1% are genetic diseases, and 0.5% - chromosomal. The rate of congenital defects is average 1.5-2%. The frequency of congenital defects increases with age, and by the end of the first year of life up to 5-7% due to manifestation of undetected birth defects [1,14,16].

In most cases, fetal defects are combined with chromosomal abnormalities, which are often accompanied by intrauterine fetal growth retardation, amounting from 2 to 7.4% of cases [2,3,4,5,15,18,23]. The infant mortality from congenital and hereditary diseases is 30-40% [1,2,13]. Therefore, detection of primary defects of the fetus at ultrasound examination is of crucial importance for the medical-genetic prediction, as well as for further pregnancy management.

The risk factors for the birth of children with fetal defects are reported to be age of parents, radiation damage, receiving drugs and biological factors [15]. The risk of teratogenic effects of damaging factors on the fetus is determined by the peculiarities of metabolism of chemicals in the mother and fetus. Therefore, age of mother is also possible risk factor which leads to metabolic changes or disturbances, thus, to the formation of fetal defects [2,10,14,20]. For example, congenital defects of the musculoskeletal and respiratory systems are more frequently observed in young mothers less than 22 years old. Multiple fetal defects are prevalent in mothers older than 35 years old. Thus, the role of age factor in the genesis of congenital defects is significant, although the proportion of women older than 35 years old who giving birth is not exceed 5.5%. We should note this factor in prognosis, although the underlying causes of children births with congenital defects are still unknown [15].

Because of modern ultrasound machines, prenatal ultrasound diagnosis of congenital defects is non-invasive, not difficult method which can identify significant defects even at 11-14 weeks of gestation [6,8,9,11,22]. However, published evidence show that the sensitivity of ultrasound in prenatal diagnosis of congenital defects in early pregnancy depends on the method of ultrasound examination. The sensitivity varies average from 32.3% in transabdominal access, to 50.9% in transvaginal access, respectively [4,8,10,12,18]. Taking the above-mentioned into account, there is need for a comparative analysis of children with defects, depending on age of mothers.

Objective: To evaluate the diagnostic accuracy of fetal defects in early pregnancy.

Materials and methods

In order to study fetal defects and chromosomal abnormalities, we retrospectively analyzed results of comprehensive dynamic survey of 26,404 pregnant women who had been consulted in the Republican Screening Center routinely in terms of 6 to 40 weeks of pregnancy. Of them, 25,956 (98.3%) women had physiological course of pregnancy, 448 (1.7%) women had abnormal pregnancy.

For the diagnosis of fetal defects, we conducted ultrasound, biochemical, invasive and cytogenetic studies. In order to measure fetometric, biometric and Doppler parameters, we first carried out primary ultrasound examination of pregnant women. In case of deviation of the above indicators from the norm, the second stage was the measurement of biochemical parameters. If we found changes of biochemical parameters, we performed the third stage - invasive and cytogenetic diagnosis.

Fetometric parameters were compared with regional regulatory indicators of Uzbekistan, Doppler and biometric parameters were compared with normative indicators developed by The Fetal Medicine Foundation [7,8].

Screening was performed in women aged 18-50 years old, mean age of women with physiological course of pregnancy was 27 years old. The average age of women with abnormal pregnancy was 26 years old.

Ultrasound examination was carried out on the apparatus 11 HD PHILIPS, biochemical examination was conducted on the apparatus DELFIA VIKTOR, cytogenetic examination was performed using an electron microscope. Statistical analysis was performed using Microsoft office Excel 2010.

Results and discussion

According to results of the study, all women with abnormal pregnancy were divided into 5 groups. The first group consisted of 230 (51.34%) women whose pregnancies were complicated by single fetal defects, the second group included 39 (8.71%) women whose pregnancies were complicated by multiple defects of the fetus, in the third group were 99 (22.10%) women with non-developing pregnancy, the fourth group consisted of 69 (15.4%) women whose pregnancies were complicated by intrauterine fetal death, and the fifth group included 11 (2.46%) women with hydatidiform mole.

Among single fetal defects, the CNS defects were 49.13%, defects of face and neck - 12.61%, defects of the cardiovascular system - 11.3%, defects of the respiratory system - 0.43%, defects of the digestive system - 8.7%, defects of the musculoskeletal system - 6.96%, and defects of the urinary system - 10.87%, respectively. The distribution of fetal defects is shown in Table 1.

TRIMESTER	I	%	II	%	III	%	Total	%
Spina bifida	2	0,87	5	2,17	-	-	7	3,04
Diastomatomyelia	-	-	2	0,87	-	-	2	0,87
Body stalk anomaly	3	1,3	1	0,43	-	-	4	1,73
Anencephaly	1	0,43	20	8,7	1	0,43	22	9,56
Arnol - Chiari malformation	-	-	10	4,35	3	1,3	13	5,65
Exencephaly	9	3,91	22	9,57	1	0,43	32	13,91
Dandy-Walker syndrome	-	-	9	3,91	1	0,43	10	4,34
Vein of Galen atresia	-	-	-	-	1	0,43	1	0,43
Hydrocephalus	-	-	13	5,65	3	1,3	16	6,95
Holoprosencephaly	-	-	4	1,74	-	-	4	1,74
Tumors of the head	-	-	2	0,87	-	-	2	0,87
Acrofacial syndrome	-	-	1	0,43	-	-	1	0,43
Neck hygroma	9	3,91	14	6,09	-	-	23	10
Face defect	-	-	2	0,87	-	-	2	0,87
Face teratoma	-	-	1	0,43	1	0,43	2	0,86
Epignatus	-	-	1	0,43	-	-	1	0,43
Congenital heart defect	1	0,43	19	8,26	6	2,61	26	11,3
Diaphragmatic hernia	-	-	1	0,43	-	-	1	0,43
Esophageal atresia	-	-	2	0,87	-	-	2	0,87
Gastroschisis	-	-	9	3,91	-	-	9	3,91
Omphalocele	3	1,3	6	2,61	-	-	9	3,91
Achondrogenesis	1	0,43	12	5,22	2	0,87	15	6,52
Foot contracture	-	-	1	0,43	-	-	1	0,43
Renal agenesis	-	-	3	1,3	-	-	3	1,3
Megacystis	2	0,87	1	0,43	1	0,43	4	1,73
Polycystic kidney disease	-	-	17	7,39	1	0,43	18	7,82
Total	31	13,48	178	77,39	21	9,13	230	100

Source: Author

Among the defects of:

1. the CNS: spina bifida was 6.19%, diastomatomyelia - 1.77%, body stalk anomaly - 3.54%, anencephaly - 19.47%, Arnold-Chiari malformation - 11.5%, exencephaly - 28.32%, Dandy-Walker syndrome - 8.85%, vein of Galen atresia - 0.88%, hydrocephalus - 14.16%, holoprosencephaly - 3.54%, tumor of the head - 1.77% of cases;
2. face and neck: acrofacial syndrome was 3.45%, neck hygroma - 79.31%, face defect - 6.9%, face teratoma - 6.9%, epignatus - 3.45%;
3. the digestive system: esophageal atresia was 10%, gastroschisis - 45%, omphalocele - 45%;
4. the musculoskeletal system: achondrogenesis was 93.75%, foot contracture - 6.25%;
5. the urinary system: renal agenesis was 12%, megacystis - 16%, polycystic kidney disease - 72%;
6. the cardiovascular system - only heart defects;
7. the respiratory system - only diaphragmatic hernia.

Multiple fetal defects developed in 39 pregnant women. In this case, a combination of two defects was identified in 92.31%, the combination of three defects in 7.69% of cases (Table 2). In most cases, there was the combination of heart defects - 37.33%, the CNS defects and defects of face and neck were recorded in equal amounts to 18.67%, defects of the musculoskeletal system were detected in 10.67%, defects in the gastrointestinal tract and urinary system were in 9.33% and 5.33% of cases, respectively.

Table 2 demonstrates that combination of congenital heart defects (CHD) with defects of the CNS was 10.67%, with defects of face and neck - 12%, with defects of the gastrointestinal tract (GIT) - 6.67%, of the musculoskeletal system -

6.67%, and urinary tract defects - 1.33% of cases, respectively. Defects of the CNS were combined with defects of face and neck in 5.33%, with defects of the gastrointestinal tract - 1.33%, and defects of the CNS in 1.33% of cases, respectively. Defects of face and neck were combined with defects of the urinary system in 1.33% cases. Defects of the musculoskeletal system (MSS) were combined with defects of the gastrointestinal tract, urinary system, and with each other in 1.33% cases, respectively.

According to the obstetric history, non-developing pregnancy was recorded in most cases - 55.31%, intrauterine fetal death was reported in 38.55%, hydatidiform mole was detected in 6.15% of cases (Table 3). In most cases, intrauterine fetal death, non-developing pregnancy and hydatidiform mole were registered between the ages of 21 to 25 years old.

In the first trimester of pregnancy, non-developing pregnancies are most frequently recorded - 54.19%, intrauterine fetal death was noted in 18.44%, and hydatidiform mole was found in 6.15% of cases, respectively. In the second trimester of

Table 2. The distribution of multiple fetal malformations

Defects	Total		CNS		Face and neck		CHD		GIT		Urinary system		MSS	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
CNS	14	18,67	1	1,33	4	5,33	8	10,67	1	1,33	-	0	-	0
Face and neck	14	18,67	4	5,33	-	0	9	12	-	0	1	1,33	-	0
Congenital heart defects	28	37,33	8	10,67	9	12	-	0	5	6,67	1	1,33	5	6,67
Gastrointestinal tract	7	9,33	1	1,33	-	0	5	6,67	-	0	-	0	1	1,33
Urinary system	4	5,33	-	0	1	1,33	1	1,33	-	0	1	1,33	1	1,33
Musculoskeletal system	8	10,67	-	0	-	0	5	6,67	1	1,33	1	1,33	1	1,33
Total	75	100	14	18,67	14	18,67	28	37,33	7	9,33	4	5,33	8	10,67

Source: Author

pregnancy, in most cases was noted intrauterine fetal death - 18.99% and non-developing pregnancy in 1.12% of cases, respectively (Table 4).

The results of our study showed that the highest peak of fertility of women both with physiological and abnormal pregnancies, as well as women with fetal defects after pregnancy was noted between the ages of 21 to 25 years old. Then, there was noted a gradual decrease in the number of pregnant women, as well as the number of abnormalities of the fetus (Tables 3 and 5).

Comparative evaluation showed direct correlation (0.93) between the number of women with physiological pregnancy and pregnancy complicated by fetal defects, as well as high correlation (0.9) between the number of pregnant and women with non-developing pregnancies (Figures 1 and 2). Our studies show that the greater number of pregnancies in women of certain age, the more pathological course of pregnancy and fetal defects at this age.

Table 3. The distribution of women with abnormal course of pregnancy by age

	18-20 years		21-25 years		26-30 years		31-35 years		36-50 years		Total	
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%
Non-developing pregnancy	10	5,59	46	25,7	19	11,61	21	11,73	2	1,68	99	55,31
Intrauterine fetal death	3	1,68	22	12,29	19	10,61	14	7,82	11	6,15	69	38,55
Hydatidiform mole	2	1,12	3	1,68	3	1,68	1	0,56	2	1,12	11	6,15

Source: Author

Table 4. The distribution of women with abnormal course of pregnancy by trimester

	I trimester		II trimester		III trimester		Total	
	Amount	%	Amount	%	Amount	%	Amount	%
Non-developing pregnancy	97	54,19	2	1,12	-	-	99	55,31
Intrauterine fetal death	33	18,44	34	18,99	2	1,12	69	38,55
Hydatidiform mole	11	1,12	-	-	-	-	11	6,15

Source: Author

Table 5. The distribution of women with abnormal pregnancy by age

Defects	Age (years)										Total	%
	18-20		21-25		26-30		31-35		36-50			
	Amount	%	Amount	%	Amount	%	Amount	%	Amount	%		
CNS	20	8,7	57	24,78	20	8,7	10	4,35	6	2,61	113	49,13
Face and neck	2	0,87	12	5,22	8	3,48	3	1,3	4	1,74	29	12,61
Congenital heart defects	-	-	15	6,52	6	2,61	4	1,74	1	0,43	26	11,3
Respiratory system	-	-	-	-	-	-	1	0,29	-	-	1	0,29
Gastrointestinal tract	2	0,87	12	5,22	4	1,74	2	0,87	-	-	20	8,7
Urinary system	2	0,87	11	4,78	7	3,04	5	2,17	-	-	25	10,87
Musculoskeletal system	2	0,87	8	3,48	4	1,74	2	0,87	-	-	16	6,96

Source: Author

Evaluation of ultrasonic parameters based on the frequency of detection of fetal defects, depending on the duration of pregnancy, allows creating an algorithm of diagnosis of the first and second trimesters of pregnancy.

A survey of women in the first trimester of pregnancy should be conducted in the following order. The definition of the crown-rump length (CRL) of the fetus is a priority which is the standard score in the calculation of gestational age. If necessary, in addition to measurements of the CRL, can be calculated fetometric parameters of the head (BPD, head circumference), abdominal circumference, as well as the lengths of bones of the upper and lower limbs.

Figure 1. The relationship between the number of women with physiological pregnancy and women whose pregnancies were complicated by fetal defects (Norma/Defects)

Source: Author

In a detailed study of the anatomical structures and organs of the fetus in the first trimester of pregnancy, first we investigate the central nervous system. In the early stages of pregnancy, among defects of the CNS was observed predominantly exencephaly, which is accompanied by changes in the size of head of the fetus. After the measurement and assessment of the CNS, we start to study the cervical spine, which is in most cases accompanied by the fetal neck cystic hygroma. Further examination should be carried out by measuring the size of abdomen. Usually, changes of the size of abdomen in early pregnancy develop in omphalocele. The final stage of evaluation of the anatomical structures of the fetus is the

Figure 2. The relationship between the number of women with physiological and pathological course of pregnancy (Norma/Non-developing pregnancy)

Source: Author

measurement of indicators of the musculoskeletal system that occur in skeletal dysplasias, as well as chromosomal abnormalities.

In the second trimester of pregnancy, the study of the anatomical structures of the fetus should begin with assessment of the CNS status. After studying the CNS is necessary to study defects of anterior abdominal wall, organs of abdominal cavity, and retroperitoneal space. Further, the cardiovascular system and organs of face and neck should be studied. The final stage of evaluation of fetal defects in the second trimester of pregnancy is the assessment of the musculoskeletal system of fetal limbs.

In the third trimester, we must first study the cardiovascular system and the central nervous system. Upon detection of fetal defects, we should also be aware that some congenital defects are combined with each other. According to our data, CNS defects are often combined with heart defects, defects of face and neck, defects of the gastrointestinal tract and the musculoskeletal system. Based on the analysis of the results obtained, we have developed an algorithm for early fetal ultrasound examination (Figures 3 and 4).

Conclusion

In prenatal diagnosis of fetal defects, we recommend to use a single algorithm of ultrasonographic examination. Practitioners should not rely on age of pregnant woman, conducting more detailed screening for fetal defects in women older than 35 years old. The majority of fetal defects and pathological course of pregnancy is more common for women at the age from 21 to 25 years old, since at this age period women have the highest number of pregnancies.

In order to exclude non-developing pregnancy and intrauterine fetal death, as well as for early diagnosis of fetal defects, there is the need for screening in the first trimester of pregnancy. Inclusion of the first trimester into screening program allows timely forming the risk groups of birth of children with fetal defects, creates the questions of further pregnancy management, thereby, reduces obstetric complications, as well as maternal and infant mortality.

Figure 3. Algorithm of Ultrasound Examination of congenital fetal defects in the first trimester of pregnancy

Source: Author

Figure 4. Algorithm of Ultrasound Examination of congenital fetal defects in the second trimester of pregnancy

Source: Author

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