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THE IMPORTANCE OF ULTRASOUND IN DETECTING EMBRYONIC DEVELOPMENTAL ANOMALIES IN THE EARLY STAGES OF PREGNANCY (5–10 WEEKS)

Abstract

Detection of embryonic developmental anomalies in the early stages of pregnancy (5-10 weeks) is one of the most important tasks of prenatal diagnostics. This article analyzes the possibilities of detecting structural and functional anomalies in embryonic development through ultrasound examination. Early ultrasound examination allows for the identification of risk factors associated with the embryo's heart function, lung and normal development, as well as genetic or chromosomal disorders. The article examines various ultrasound modes (2D, 3D, Doppler) and their diagnostic effectiveness, as well as discusses the clinical significance of the identified anomalies and pregnancy management strategies.

Keywords: Pregnancy, Early term, Embryonic developmental anomaly, Ultrasonography Prenatal diagnostics, Doppler examination, 3D ultrasound.

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HOMILADORLIKNING ERTA MUDDATLARIDA (5–10 HAFTALARDA) EMBRION RIVOJLANISH ANOMALIYALARINI ANIQLASHDA ULTRATOVUSHNING AHAMIYATI

Annotatsiya

Homiladorlikning erta muddatlarida (5–10 haftalarda) embrion rivojlanish anomaliyalarini aniqlash prenatal diagnostikaning eng muhim vazifalaridan biridir. Ushbu maqolada ultratovush tekshiruvi orqali embrion rivojlanishidagi strukturaviy va funktsional anomaliyalarni aniqlash imkoniyatlari tahlil qilinadi. Erta muddatdagi ultratovush tekshiruvi embrionning yurak faoliyati, o'pka va me'yoriy rivojlanishi, shuningdek, genetik yoki kromosomal buzilishlar bilan bog'liq xavf omillarini aniqlash imkonini beradi. Maqolada ultratovushning turli rejimlari (2D, 3D, Doppler) va ularning diagnostik

samaradorligi ko'rib chiqilgan, shuningdek, aniqlangan anomaliyalarning klinik ahamiyati va homiladorlikni boshqarish strategiyalari muhokama qilingan.

Kalit so'zlar: Homiladorlik, erta muddatlar, embrion rivojlanish anomaliyasi, ultrasonografiya prenatal diagnostika, Doppler tekshiruvi, 3D ultratovush.

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ЗНАЧЕНИЕ УЛЬТРАЗВУКОВОГО ИССЛЕДОВАНИЯ В ВЫЯВЛЕНИИ АНОМАЛИЙ РАЗВИТИЯ ЭМБРИОНА НА РАННИХ СРОКАХ БЕРЕМЕННОСТИ (5-10 НЕДЕЛЬ)

Аннотация

Выявление аномалий эмбрионального развития на ранних сроках беременности (5-10 недель) является одной из важнейших задач пренатальной диагностики. В данной статье анализируется возможность выявления структурных и функциональных аномалий развития эмбриона с помощью ультразвукового исследования. Раннее ультразвуковое исследование позволяет выявить факторы риска, связанные с сердечной деятельностью, легочным и нормальным развитием эмбриона, а также генетическими или хромосомными нарушениями. В статье рассматриваются различные режимы ультразвука (2D, 3D, доплеровский) и их диагностическая эффективность, а также обсуждается клиническая значимость выявленных аномалий и стратегии ведения беременности.

Ключевые слова: Беременность, ранние сроки, аномалия развития эмбриона, ультразвукография, пренатальная диагностика, доплеровское исследование, трехмерный ультразвук.

Introduction

Assessment of embryonic development in the early stages of pregnancy (5-10 weeks) is one of the most important areas of prenatal medicine. During this period, the main organ systems of the embryo are formed, and their functional and structural development begins. Therefore, the detection of developmental anomalies at these periods is of great importance not only from a medical point of view, but also from the point of view of genetic counseling, pregnancy management, and optimization of future neonatal outcomes.

Early embryonic developmental anomalies can manifest in various ways: these can be disorders in the development of the cardiovascular system, nervous system, bones and joints, as well as internal organs. Some abnormalities are due to chromosomal or genetic causes, while others result from exogenous effects, toxins, infections, or chronic diseases in the mother's body. Therefore, it is important to use accurate and reliable diagnostic methods in the early stages of pregnancy.

Ultrasonography (Ultrasonography) is recognized today as the most widely used, safe, and effective method in prenatal diagnostics. With the help of ultrasound, the size of the embryo, heart activity, the structure of organ systems, as well as developmental anomalies are assessed in real time. While 2D ultrasound is the most commonly used standard method, 3D and Doppler technologies increase the ability to see the precise structures of the embryo and assess blood circulation parameters. This contributes to the early detection of anomalies in the early stages of pregnancy and the adoption of appropriate clinical decisions.

Also, through morning diagnostics, it is possible to individually plan the strategies used during pregnancy. For example, with a detected heart or nervous system anomaly, it is possible to consult with geneticists, conduct additional monitoring during pregnancy, or, if necessary, make a decision on fetal management. Therefore, ultrasound examination in the early stages of pregnancy is an important tool not only for detecting developmental disorders in the embryo, but also for the safe continuation of pregnancy and improvement of neonatal outcomes.

Today, many studies have analyzed the diagnostic effectiveness of ultrasound and showed its high sensitivity and accuracy in detecting embryonic developmental anomalies in early stages. At the same time, there is a risk of ultrasound limitations and incomplete detection of anomalies, in which cases it is recommended to use them in combination with additional genetic tests and other visual examinations.

In this regard, the importance of detecting embryonic developmental anomalies by ultrasound in the early stages of pregnancy is relevant and important not only in clinical practice, but also in the areas of medical research and genetic counseling.

Methods and materials

This study is aimed at assessing the effectiveness of ultrasound examination in detecting embryonic developmental anomalies in the early stages of pregnancy (5-10 weeks). The research was conducted by prospective and observational methods.

1. Participants of the study:

150 mothers at 5-10 weeks of pregnancy were admitted to the study during 2024-2025.

2. Research methods:

Ultrasonography:

Pregnant women were examined in 2D, 3D, and Doppler modes. The test included the following parameters:

- Embryo length (CRL - crown-rump length);
- Cardiac activity (HR - heart rate);
- Development of the nervous system and partially internal organs;
- Additional anomalies (e.g., the skeletal system, joints).

Table 1. Description of ultrasound parameters used in the study

Parameter	Description	Verification method
CRL (mm)	Embryonic length, determination of gestational age	2D ultrasound
HR (HR/min)	Heart rate, detection of abnormalities	Doppler

Organ development	Development of the nervous system, heart and internal organs	2D & 3D ultrasound
Anomalies	Structural disorders, changes in joint and skeletal system	2D & 3D ultrasound

Diagnostic criteria:

Anomalies were assessed according to the following ultrasound classification:

1. Anomaly of the cardiovascular system;
2. Anomaly of the nervous system;
3. Skeletal and articular anomalies;
4. Developmental disorders of internal organs (liver, kidneys, lungs);
5. Multisystem or complex anomalies.

Statistical analysis:

The data were analyzed in the SPSS 26.0 program. The mean values (Mean $\pm$ SD), median, and range indicators were calculated. The percentage of anomalies and the degree of detection by ultrasound were analyzed.

3. Ethical aspects:

In the study, written consent was obtained from all participants. The research was conducted in accordance with the requirements of the State and International Ethics Committees.

Results

The study analyzed the results of ultrasound examination of 150 pregnant women at early stages (5-10 weeks). Embryonic developmental anomalies manifested differently in early stages.

1. Gestational age and embryo size

The average gestational age of the participants was 7.2 ± 1.5 weeks, and the length of the embryo (CRL) was in the range of 5.8-33.2 mm. A significant correlation was observed between gestational age and CRL ($r = 0.92$, $p < 0.01$).

Table 2. Distribution of gestational age and CRL

Gestational age (weeks)	Number of participants (n)	Average CRL (mm) $\pm$ SD	Min-Max CRL (mm)
5-6	30.	8.2 ± 2.1	5.8-10.5
7-8	70.	15.6 ± 3.4	11.2-20.5
9-10	50.	27.8 ± 4.6	21.5-33.2

2. Heart function (HR)

The heart rate was observed in the range of 110-140 bpm at 5-6 weeks, 140-170 bpm at 7-8 weeks, 150-180 bpm at 9-10 weeks. In 8% of cases, HR was below or above normal, which is recommended to be determined by further examination and genetic counseling.

Table 3. Heart activity (HR) distribution

Gestational age (weeks)	Average HR (HR/min) $\pm$ SD	HR deviation from norm (%)
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5-6	125 ± 12	3%
7-8	155 ± 15	5%
9-10	165 ± 13	8%

3. Anomalies of embryonic development

Ultrasonographic examination revealed various developmental anomalies in 14 (9.3%) fetuses:

- Anomalies of the cardiovascular system - 5 cases (3.3%)
- Anomalies of the nervous system - 4 cases (2.7%)
- Skeletal system and joints - 3 cases (2%)
- Disorders of internal organs - 2 cases (1.3%)

Table 4. Distribution of detected anomalies

Type of anomaly	Identified cases (n)	Percent (%)
Cardiovascular system	5.	3.3
Nervous system	4.	2.7
Skeletal system and joints	3.	2.0
Internal organs	2.	1.3
Total	14.	9.3

4. Diagnostic effectiveness

If the sensitivity of detecting anomalies using 2D ultrasound was 78%, then with the use of 3D and Doppler modes, the sensitivity increased to 92%. At the same time, some complex or multi-system anomalies are clearly confirmed only with the help of 3D images.

The results show that the detection of embryonic developmental anomalies using ultrasound in the early stages of pregnancy is effective, and the use of 3D and Doppler modes significantly increases diagnostic accuracy.

Discussion

The results of this study further confirm the importance of ultrasound examination in detecting embryonic developmental anomalies in the early stages of pregnancy (5-10 weeks). The 9.3% of embryonic anomalies identified in the study are consistent with many international studies, which also showed that the frequency of anomalies in the early stages is around 8-12%. At the same time, our results show that the sensitivity of anomalies detected by 2D ultrasound can be lower, which justifies the use of 3D and Doppler modes.

Cardiovascular system anomaly is the most common type of disorder, indicating that the fetus is one of the vital organ systems at an early stage. Disorders of the nervous and skeletal systems were also significantly detected, which indicates the importance of early diagnosis in making appropriate clinical decisions during pregnancy. The results of the study show that through early detection of anomalies, it is possible to consult with geneticists, individually plan the pregnancy management regimen, and reduce risk factors for fetal development.

3D ultrasound and Doppler examination significantly increase diagnostic accuracy compared to the 2D method. For example, complex structures or multi-system anomalies are more accurately detected using 3D images, while Doppler is important in detecting cardiovascular system disorders. At the same time, anomalies detected by ultrasound in early stages can sometimes be incomplete, therefore additional genetic tests or repeated examinations in later stages are recommended.

Among the limitations of our study are the relatively small number of participants and the limited ability to identify some complex anomalies. At the same time, the accuracy of ultrasound depends on the operator's experience and the technological capabilities of the equipment. Therefore, it is recommended to use qualified specialists and modern equipment for early ultrasound examination.

In conclusion, the diagnostic effectiveness of ultrasound examination in the early stages of pregnancy is high, which serves as an important tool for early detection of developmental disorders in the embryo and safe continuation of pregnancy. At the same time, the use of 3D and Doppler modes increases the possibilities of detecting anomalies and facilitates the adoption of clinical decisions on pregnancy management.

Conclusion

Ultrasound examination in the early stages of pregnancy (5-10 weeks) serves as an effective and reliable diagnostic tool for detecting embryonic developmental anomalies. The results of the study showed that developmental disorders in the cardiovascular, nervous, skeletal, and internal organs can be detected at an early stage, which allows for timely planning of pregnancy management and genetic counseling.

3D ultrasound and Doppler examination significantly increase the sensitivity of anomaly detection compared to the 2D method and allow for the detection of complex or multisystem disorders. When ultrasonographic monitoring and additional genetic tests are used together, it is possible to reduce risk factors during pregnancy and improve neonatal outcomes.

In future studies, diagnostic accuracy can be further improved by increasing the number of participants, updating ultrasound equipment, and improving operator skills. At the same time, regular ultrasound examination in the early stages of pregnancy is recommended for all pregnant women, especially in cases of risk of developmental anomalies.

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