

Application of digital methods and artificial intelligence capabilities for diagnostics in obstetrics and gynecology

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Abstract

The article analyzes the use of digital methods and artificial intelligence capabilities for diagnostics in the field of obstetrics and gynecology. The author notes that digital methods and artificial intelligence (AI) have a high potential for the diagnosis of gynecological diseases, since it can analyze medical images and other medical data with great accuracy and speed. For example, AI can help in the diagnosis of cervical cancer by identifying anomalies in digital images and screening tests. The use of AI can also help in the recognition of other gynecological diseases, such as endometriosis, uterine fibroids, polyps, etc. In addition, AI can help improve the efficiency and accuracy of diagnostics, as well as reduce the time required to process medical data. This can be especially important in cases where diagnosis needs to be done quickly in order to start treatment as early as possible. However, it should be noted that AI cannot completely replace the experience and expertise of doctors. Still, it can help doctors make more accurate diagnoses and develop more effective treatment strategies.

Keywords

Obstetrics, Gynecology, Diagnostics, Digital methods, Artificial intelligence.

Imprint

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Introduction

Digital methods and artificial intelligence are of great importance for diagnostics in obstetrics and gynecology. Digital methods allow the creation and processing of medical images, such as ultrasound images, magnetic resonance images and computed tomography. This allows doctors to get more detailed information about the patient's health and make a more accurate diagnosis. Artificial intelligence can process large amounts of data and find hidden patterns in them [1]. This helps doctors identify the risks of developing diseases and improve the prediction of pregnancy outcomes.

Decision support systems based on artificial intelligence can help doctors quickly and accurately determine the diagnosis and choose the most effective treatment for each patient.

Also, artificial intelligence can detect anomalies in the health of patients at an early stage, which allows doctors to take measures to prevent the development of diseases and improve treatment outcomes.

Telemedicine technologies and digital methods allow doctors to consult and diagnose remotely, which is especially important in a pandemic and for patients in remote areas. The use of artificial intelligence allows for more accurate diagnostics, which can contribute to the early detection of dangerous conditions, such as uterine or breast cancer.

Thus, digital methods and artificial intelligence play an important role in diagnostics in obstetrics and gynecology, allowing doctors to obtain more accurate information about the health of patients and improve treatment outcomes.

The purpose of the study is to analyze the use of digital methods and artificial intelligence capabilities for diagnostics in the field of obstetrics and gynecology.

Materials and methods

When writing the work, the analysis of publications and monographs of Russian and foreign authors was carried out, the data obtained were studied using comparative and analytical research methods.

Results

Artificial intelligence (AI) is of great importance in medical diagnostics, due to its ability to analyze large amounts of medical data and identify hidden patterns that may be invisible to a human doctor. AI is used in medical diagnostics for the following purposes [2].

1. Image analysis. AI can be used to analyze medical images such as X-rays, magnetic resonance imaging (MRI) and ultrasound images. Machine learning algorithms used in AI can be trained based on a large number of images and help identify hidden patterns that may indicate the presence of a disease or a patient's condition. For example, AI can be used to detect tumors or other abnormalities on X-rays, to diagnose eye diseases in retinal photographs, or to diagnose heart diseases in echocardiography images.

2. Analysis of patient data. AI can analyze large amounts of medical data, such as blood test results, X-rays and other medical images, and help doctors identify diseases faster and more accurately. For example, AI can be used to analyze a patient's medical data and identify hidden risk factors for the development of certain diseases, such as stroke, diabetes and cardiovascular diseases.

3. Decision support. AI can be used to support a doctor's decision-making in the diagnosis of diseases. For example, AI can be used to predict the likelihood that a patient will have a certain disease, or to determine the best treatment based on the patient's medical history and other medical data.

4. Monitoring the patient's condition: AI can help doctors in monitoring the patient's condition and determining changes in his health. AI algorithms can analyze data received from wearable devices, health monitors and other devices and identify any changes that may indicate progressive diseases or adverse symptoms.

5. Disease prediction: AI can be used to predict diseases such as diabetes, Alzheimer's disease and cardiovascular diseases. AI algorithms can analyze a patient's medical data and identify disease risks, which allows doctors to develop more effective prevention and treatment measures [3].

In general, the use of AI in medical diagnostics can improve the accuracy of diagnosis and increase the speed of detection of diseases, which can lead to more effective treatment and increase the chances of recovery of the patient.

In addition, the use of AI in medical diagnostics can also reduce healthcare costs by reducing the num-

ber of unnecessary tests and examinations. Doctors may need less time to analyze the patient's medical data, as AI can process them faster and more efficiently, which allows them to devote more time to patients and improve the quality of medical care [4].

However, the use of AI in medical diagnostics may also raise certain concerns. Some patients may not trust the automatic analysis of medical data, and may require additional examinations and confirmations from a human doctor. In addition, AI may have limitations in identifying certain diseases that may be unusual or have complex symptoms [5].

In general, the use of AI in medical diagnostics can have many advantages and challenges. Despite this, continuous improvement of AI technologies and their adaptation to medical practice can improve the results of diagnosis and patient care, reduce healthcare costs and increase the chances of recovery. The use of AI in healthcare has great potential to improve patient outcomes and optimize healthcare processes. However, it is necessary to ensure proper protection of patient data and comply with ethical and legal norms when using AI in medicine.

Let's consider the possibilities and methods of applying digital diagnostics and AI methods in obstetrics and gynecology.

1. Fetal cardiotocography. Cardiotocography (CTG) was an early development in the field of obstetrics. CTG is the most important device for assessing the condition of the fetus by measuring the fetal heart rate and uterine contractions. The fetal heart rate pattern reflects the response of the fetal heart and central nervous system to hemodynamic changes. Numerous CTG studies have been conducted since 1980. A recent meta-analysis showed that a 50% reduction in neonatal seizures was associated with continuous CTG monitoring. Despite its clinical importance, it is difficult to ensure objectivity between interpretations, and, above all, regular observations are necessary to avoid a long gap between the detection of suspicious patterns and intervention.

In order to overcome the limitations in the interpretation of CTG by humans, artificial intelligence has been used for this purpose using modern computer systems, and many experiments are currently being conducted. AI systems are not affected by human limitations, such as fatigue, distraction, bias, poor communication, cognitive overload or fear of harm [6].

2. Ultrasound echography. First of all, AI is used and actively studied in obstetrics for ultrasound anal-

ysis, which generates standardized data. Ultrasound is a safe, non-invasive method of prenatal diagnosis. Despite the standard use of ultrasound, measurements are difficult under circumstances such as maternal obesity, motion blur, lack of boundaries, acoustic shadow, speckle noise and low signal-to-noise ratio. In addition, manual ultrasound screening is slow and error-prone, and two-dimensional images are mostly stored in databases. Therefore, the use of new technologies to improve the primary images obtained or to help in the extraction and standardization of measurements is of great importance.

A few years ago, machine learning was first applied to ultrasound images of the fetus. In particular, thanks to machine learning, it became possible to obtain and distinguish different parts of the fetal body, so many studies have presented algorithms that automatically extracted and measured fetal structures and fetal biometrics from ultrasound images. Currently, there is a semi-automatic program for fetal ultrasound analysis (this is a semi-automatic program, because the program automatically performs body measurements using an AI algorithm after the sonographer or doctor selects the appropriate image of each body part). One example involves the automatic acquisition of a standard scanning plane, demonstrated by evaluating two-dimensional transventricular ultrasound images of the fetal brain and three-dimensional transthalamic ultrasound images in the plane measuring the biparietal diameter and circumference of the fetal head.

Other studies report on the effectiveness of using machine learning in identifying fetal structures and organs to identify congenital anomalies.

In order to obtain high-quality images within an appropriate period of time, staff should be trained in qualified procedures related to the process of scanning obstetric images. Obtaining an ultrasonic plane by hand has been developed, but has not yet been standardized; however, a recent study has shown that the probe guidance system provides a useful navigation signal to targets such as the standard plane of some structures [7].

3. Fetal echocardiography. Fetal echocardiography (ECG) has been used relatively recently; however, this imaging method is important for perinatal care, as it is very useful for the diagnosis and monitoring of intrauterine growth retardation, twin transfusion syndrome and congenital heart abnormalities. Monitoring of fetal cardiac function using ultrasound is dif-

ficult due to involuntary fetal movements, small fetal heart size, fetal palpitations, limited access to the fetus and lack of specialists in fetal echocardiography [8].

For cases with congenital heart abnormalities, an intelligent navigation method called "FINE" has been developed, which can detect four types of abnormalities. Experts demonstrated a deep learning method that identifies the five most important projections of the fetal heart and segmentation of cardiac structures. They found that hypoplasia syndrome of the left heart was the most frequently detected anomaly compared to normal structures and Fallo's notebook at gestational age from 18 to 24 weeks. Although progress has been made in obtaining optimal images in a short period of time with a minimal learning curve and extracting standardized planes using large databases with AI technology, there remain limitations in evaluating relevant images with subsequent clinical decisions in the field. fetal heart compared to other organs [9].

Assessment of gestational age and prediction of premature birth, aneuploidy and asymptomatic short length of the cervix were also investigated using machine learning algorithms. An effective system for predicting fetal brain abnormalities has been developed. Currently, programs based on deep learning are used to automatically measure parameters indicating the progression of labor (for example, the angle of progression). AI-based programs have advantages in terms of obtaining more objective results and can be useful for parameters that are clinically important, but may have errors between measurements. For example, amniotic fluid measurements are subject to errors between measurements that can influence treatment decisions, and AI-based programs are being developed that can automatically measure these elements. In addition, AI-based programs can be useful for measurements that require full training and experience of diagnostic specialists, such as the transparency of the collar space, and these methods can be combined with a robot manipulator that performs scanning for automatic scanning. extract standardized fetal images [10].

MRI is being actively studied along with ultrasound. In obstetrics, MRI is usually performed to detect fetal brain diseases and the severity of placenta previa. Thus, in one study, by analyzing 59 MRI scans with fetal ventriculomegaly using various artificial intelligence methods, the need for additional treatment necessary after birth, such as the removal of cerebrospinal fluid, was predicted with 91% accuracy. In other

words, AI can provide information about the need for appropriate treatment along with MRI diagnostics.

In addition, placenta-related MRI applications have been extensively studied. The presence of placental adhesions was diagnosed with 100% sensitivity, 88.8% specificity and 95% accuracy by using artificial intelligence methods using MRI of 99 pregnant women diagnosed with placenta previa. To accurately measure the volume of the placenta and the distribution of vessels on the surface of the placenta, MRI of 44 pregnant women, including those with twins, was used. These results will provide important information for understanding and treating transfusion syndrome.

Discussion

As in other fields of medicine, artificial intelligence finds application in obstetrics and gynecology. At the present stage, the use of digital diagnostics and artificial intelligence (AI) methods is considered in obstetrics and gynecology as the dominant tool for interpreting CTG and heart rate, helping in determining complications of pregnancy and premature birth, as well as when considering discrepancies in interpretation among clinicians. These benefits help clinicians reduce infant and maternal mortality and morbidity. In addition, AI can be an important tool for creating algorithms to identify asymptomatic women with a shorter cervix length who are at risk of premature birth (PB). Also, the main advantages of the extensive AI storage capacity can help in determining the risk factors for preterm birth using extensive genomic data and multiomics, thereby reducing pregnancy complications, reducing surgery time and helping surgeons to train in realistic conditions [11].

3D printers can offer materials that mimic real fabrics and help students practice working with a realistic model. In addition, the three-dimensional image provides a better deep perception than its two-dimensional counterparts, allowing the surgeon to create preoperative plans for the size and depth of tissues [12].

AI applications allow you to solve certain problems in diagnosis and treatment. Experts came to the conclusion that AI can expand knowledge and help practitioners in decision-making in the field of gynecology and obstetrics. Interpretation of cardiotocography (CTG) and fetal physiology can be facilitated by AI limiting the adverse effects of childbirth. However, this interpretation of CTG may be subject to distortion and human error due to higher variability within

the observer and between observers. A study aimed at distinguishing this deep learning (DL) and machine learning (ML) can be an addition to fetal monitoring and objectively supports the identification of the need for cesarean section during childbirth.. Machine learning is a part of AI, which in a broad sense determines the ability of a machine to simulate intelligent human behavior [13].

Ultrasonography with artificial intelligence has the potential to accelerate the use of medical ultrasound in various clinical settings with wider use by medical personnel. Therefore, the use of AI in ultrasound during pregnancy can help doctors in sorting and diagnosing the body of pregnant women. For example, in obstetric pelvic ultrasound and echocardiography, where visual analysis and measurements are important, video clips will offer the entire group of relevant structured data that allows for spatiotemporal analysis and enhance the benefits of artificial neural networks (ANN).

Specialists investigated the accuracy of ultrasound diagnostics based on AI algorithms in the diagnosis of pregnancy in patients with complicated brain tumors. The accuracy of diagnostics based on AI was 94.50%, and the K-value was 0.99. Similarly, another group of researchers has developed an artificial bee colony algorithm, processed Doppler ultrasound images, which can significantly improve the quality of ultrasound images, reduce image noise and largely improvise the possibilities of clinical diagnosis of the disease at different stages of pregnancy, up to the birth of a child [14].

During pregnancy, placental images in patients with arterial hypertension, if defined, differ from populations without hypertension. The findings have proven to be effective as a marker for predicting hypertensive disorders of pregnancy (HDP), as it is a non-invasive and cost-effective method for promoting future directions. Therefore, it is important to use AI to evaluate variations in the texture of the ultrasound image of the placenta in pregnant women with hypertension and normal outcomes. Consequently, this opens up an approach to the development of a textural feature extraction module that could assess adverse pregnancy outcomes before proceeding to clinical manifestations of the disease [15].

Diagnostic support tools based on artificial intelligence have demonstrated higher efficiency in various medical aspects. However, the clinical application of AI remained difficult due to the lack of explanatory ability of AI solutions, which is commonly referred to

as the black box problem. This problem makes it tedious to build trust with these medical professionals. However, visualizing the internal representation of a deep neural network maximizes explanatory ability and improvises the level of confidence of a medical professional in AI solutions. Some specialists have applied a new explicable graphic diagram based on INS, which supports ultrasound screening of the fetal heart, which, as a rule, has a low frequency of detection of congenital heart defects at the stages of the second trimester due to the complexity of mastering this technique. As a result, the effectiveness of AI screening in the second and third trimesters for the diagnosis of pregnant women using a diagram representation increases from 96 to 97.50% among experts, and then from 82 to 89% among colleagues.

In addition, the ultrasound plane of the fetus is changing rapidly, since fetal movement requires an algorithm capable of evaluating moving images in a real-time environment. For the development and validation of the AI system, a system of prenatal ultrasound diagnostics of AI (PAICS) is proposed to determine various models of intracranial fetal abnormalities in standardized sonographic reference planes for screening any malformations of the congenital central nervous system (CNS) [16].

Another group of authors evaluated the effectiveness of the AI method based on automated analysis of fetal-cerebral morphology of the fetus on a standard cranial ultrasound section to predict the parameters of gestational age in the II and III trimesters of pregnancy in fetuses of women. Comparative evaluation was carried out by comparing with existing formulas using standardized fetal biometrics [17].

Premature birth is one of the leading causes of neonatal mortality. Predicting premature birth in the first and second trimesters of pregnancy will help to improvise pregnancy outcomes. Accordingly, research explains the creation of an effective model for predicting premature birth. Various studies have helped to use sonographic measurements of the length of the cervix to predict premature birth in the first trimester of pregnancy.

In accordance with this application of AI, the choice of a viable embryo remained the main problem in other medical areas of ECO. This seems to be important for evaluating the results leading to a shorter gestation period, which leads to the live birth of a healthier baby. The researchers said AI capabilities will bring automa-

tion, precision and standardization to ECO, which has generated more enthusiasm and gained momentum in commercial sectors. Moreover, AI applications in embryology have attracted considerable attention and demonstrated reliability in various fields of reproduction science. In addition, AI-based strategies can be fast, objective, and meaningful.

The wide usefulness of AI for assessing the characteristics of patients, such as ovarian reserve, endocrine status, diagnostic test, endocrine status, is also recognized. Thanks to the help and tools of AI, these parameters contribute to the likely results of successful ECO.

Obstacles to high sensitivity during pregnancy consist of various unknown parameters that lead to successful ECO results, which is necessary for AI training. Large datasets, including computer vision, were used for this statement to maximize prediction capabilities. Several other previous attempts have been made using AI techniques to evaluate human oocytes, predict normal fertilization, and analyze embryo development to the blastocyst stage (BS). The methods even evaluate the implantation potential by means of static images of oocytes in the period before and after pregnancy [18].

Another common gynecological disease is pelvic floor dysfunction (PFD). The main clinical manifestations are pelvic organ prolapse, sexual dysfunction, loss of urine and fecal incontinence. From this point of view, the study examines the advantages of using ultrasound technology and rehabilitation training depending on the AI algorithm in restoring postpartum pelvic organ prolapse. Consequently, AI algorithms have a good effect on the processing of ultrasound images.

Various consumer wearable devices, including smart rings and smart watches, can track semi-continuous physiological indicators such as body temperature, heart rate variability and normal heart rate, as well as oxygen saturation and blood pressure. They also track other behavioral indicators such as sleep quality, sleep duration, relative location of patients and their activity. The process of tracking these physiological parameters has obvious advantages for accurately determining conditions associated with early pregnancy, including gestational hypertension and preeclampsia [19].

The most common digital technologies and the use of AI during pregnancy are heart rate and activity tracking. However, the integration of special tools would make it possible to achieve more from conception to the postpartum period.

In the modern era, the use of AI in gynecology has increased dramatically; as the incidence increases, the detection process needs to be improved. In this context, various researchers have used the advantages of AI to predict diseases. Thus, AI is used in gynecology to detect endometrial carcinoma, ECO, uterine sarcoma and intraepithelial neoplasia of the cervix, etc.

AI is primarily defined as the study of algorithms. This repetitive and massive research gives machines the ability to perform tasks and reason about cognitive goals. In this way, machines can recognize objects, make decisions, and solve problems. AI has been developed as the most important field in various industries, which has led to incredible potential. Simplified efficiency and prognostic efficiency associated with the diagnosis of diseases using AI, mainly in clinical imaging tasks, are equivalent or even superior to those of doctors, and they may have advantages in terms of determining and ensuring stable characteristics. AI has achieved performance equivalent to that of medical experts in a particular field of medicine, including obstetrics and gynecology.

Conclusions

In recent years, digital diagnostic methods have become widely used in obstetrics and gynecology, allowing to increase the accuracy of diagnosis and improve the quality of women's healthcare. One of the most common methods is ultrasound diagnostics. With the help of ultrasound scanning, it is possible to obtain an image of the uterus, ovaries, fetus during pregnancy, as well as to assess the condition of tissues. Ultrasound diagnostics is safe for patients and allows you to get results quickly.

Another method is magnetic resonance imaging (MRI). MRI allows you to get a more detailed image of the pelvic organs and surrounding tissues, which can be useful in the diagnosis of diseases of the female genital organs, such as endometriosis, fibroids, tumors, etc.

Digital colposcopy is a diagnostic method that allows you to visualize the cervix and assess the presence of changes on it. This method allows early detection of precancerous and cancerous changes in the cervix.

Digital methods of infection diagnostics, such as PCR diagnostics and enzyme immunoassay, are also used in gynecology. These methods allow you to quickly determine the presence of infection and choose the appropriate treatment.

In general, digital diagnostic methods have become an important tool in obstetrics and gynecology, allowing early detection of diseases and more accurate diagnosis. In addition, modern digital diagnostic methods can be used to assess the functional state of the reproductive system of women. For example, by monitoring basal temperature, assessing hormone levels, determining the electrical activity of the pelvic floor muscles and other methods, it is possible to identify the causes of menstrual disorders, infertility and other problems related to the function of the reproductive system.

One of the new directions in digital diagnostics is the use of artificial intelligence and machine learning to analyze medical data. For example, various machine learning algorithms can be used to automatically interpret the results of ultrasound diagnostics and MRI, which allows you to speed up the diagnostic process and improve its accuracy.

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