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CLINICAL SIGNIFICANCE OF SONOELASTOGRAPHY IN THE ULTRASOUND DIAGNOSIS OF OVARIAN TUMORS

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Resume. *Ovarian tumors are among the most common and clinically significant gynecological pathologies, profoundly affecting women's reproductive health. In the early stages, these tumors often present with minimal or nonspecific clinical symptoms, and their morphological variability complicates differentiation between benign and malignant lesions. Early diagnosis and accurate differential assessment are critical for improving treatment outcomes and optimizing patient care. Conventional B-mode ultrasound is limited in assessing tissue stiffness, elasticity, and internal structure, restricting accurate and timely diagnosis and sometimes leading to unnecessary invasive procedures. Therefore, there is an increasing demand for highly informative, non-invasive diagnostic methods. Sonoelastography, a modern real-time ultrasound imaging technique, provides a new perspective for evaluating ovarian tumors. This method allows both quantitative and qualitative assessment of tissue elasticity and stiffness, facilitates differentiation between benign and malignant lesions, detects subtle structural changes, and evaluates capsule integrity and fibrous tissue composition. Advanced techniques, including strain and shear-wave elastography, as well as color elastography mapping, enhance differential diagnostic accuracy and allow earlier detection of malignancies. Sonoelastography simplifies the diagnostic process, optimizes clinical decision-making, enables ovarian preservation in reproductive-age women, reduces the need for invasive procedures and costly radiological examinations, and improves patient safety. The method has demonstrated high sensitivity, diagnostic accuracy, and clinical applicability, contributing to reproductive health preservation and improved treatment outcomes. This article provides a comprehensive analysis of the diagnostic potential, advantages, limitations, clinical applications, and future perspectives of sonoelastography. It also reviews international research and guidelines, emphasizing its practical significance for early detection, differential diagnosis, and optimization of patient management strategies in ovarian tumors.*

Keywords: *sonoelastography, ultrasound, ovarian tumors, malignancy, differential diagnosis, tissue elasticity, early detection, clinical decision-making, reproductive health, non-invasive diagnostics, clinical practice.*

КЛИНИЧЕСКОЕ ЗНАЧЕНИЕ СОНОЭЛАСТОГРАФИИ В УЛЬТРАЗВУКОВОЙ ДИАГНОСТИКЕ ОПУХОЛЕЙ ЯИЧНИКОВ

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Резюме. Опухоли яичников относятся к числу наиболее распространённых и клинически значимых гинекологических патологий, существенно влияющих на репродуктивное здоровье женщин. На ранних стадиях данные новообразования часто протекают с минимальными или неспецифическими клиническими проявлениями, а их морфологическое разнообразие затрудняет дифференциацию доброкачественных и злокачественных процессов. Ранняя диагностика и точная дифференциальная оценка имеют решающее значение для улучшения результатов лечения и оптимизации ведения пациентов.

Традиционное ультразвуковое исследование в В-режиме ограничено в оценке жёсткости, эластичности и внутренней структуры тканей, что снижает точность и своевременность диагностики и в ряде случаев приводит к необоснованным инвазивным вмешательствам. В связи с этим возрастает потребность в высокоинформативных и неинвазивных методах диагностики.

Соноэластография — современная технология ультразвуковой визуализации в режиме реального времени — открывает новые возможности в оценке опухолей яичников. Метод позволяет проводить как количественную, так и качественную оценку эластичности и жёсткости тканей, способствует дифференциации доброкачественных и злокачественных образований, выявлению минимальных структурных изменений, а также оценке целостности капсулы и содержания фиброзной ткани.

Применение современных технологий, включая компрессионную (strain) и сдвиговую (shear-wave) эластографию, а также цветовое эластографическое картирование, повышает точность дифференциальной диагностики и обеспечивает более раннее выявление злокачественных процессов.

Соноэластография упрощает диагностический алгоритм, оптимизирует принятие клинических решений, способствует сохранению яичников у женщин репродуктивного возраста, снижает необходимость инвазивных процедур и дорогостоящих лучевых методов обследования, а также повышает безопасность пациентов. Метод продемонстрировал высокую чувствительность, диагностическую точность и клиническую применимость,

способствуя сохранению репродуктивного здоровья и улучшению результатов лечения.

В данной статье представлен комплексный анализ диагностических возможностей, преимуществ, ограничений, клинического применения и перспектив развития соноэластографии. Также рассмотрены международные исследования и клинические рекомендации, подчёркивающие её практическую значимость для раннего выявления, дифференциальной диагностики и оптимизации тактики ведения пациенток с опухолями яичников.

Ключевые слова: соноэластография, ультразвуковое исследование, опухоли яичников, злокачественность, дифференциальная диагностика, эластичность тканей, ранняя диагностика, клиническое решение, репродуктивное здоровье, неинвазивная диагностика, клиническая практика.

Relevance. In recent years, the problem of preserving women's reproductive health has been considered one of the most important directions of modern medicine. Among these problems, ovarian tumors occupy a special place, being distinguished by their high incidence, latent clinical course, and late detection. Ovarian tumors occupy one of the leading positions in the structure of gynecological diseases and remain one of the causes of oncological mortality among women. In particular, due to the poor manifestation or complete absence of clinical signs in the early stages of the disease, tumors are often detected at late stages, which sharply reduces the effectiveness of treatment. The morphological and histological diversity of ovarian tumors creates significant diagnostic difficulties in differentiating benign and malignant processes. Traditional clinical examinations and laboratory methods do not allow for a complete assessment of the biological characteristics of tumors.

At present, ultrasound examination is considered the main screening method for the detection of ovarian tumors; however, conventional B-mode ultrasound does not provide sufficient information about tissue density, elasticity, and stromal structure of tumors. This situation may lead to misdiagnosis between benign and malignant tumors and, as a result, to excessive invasive interventions or, conversely, to delays in adequate therapeutic measures. In modern medicine, the

introduction of minimally invasive, highly accurate, and patient-safe diagnostic technologies is considered one of the urgent tasks. From this perspective, sonoelastography—a modern ultrasound technology that allows real-time assessment of tissue elasticity and stiffness—has great scientific and practical significance in the diagnosis of ovarian tumors.

Using sonoelastography, it is possible to evaluate the mechanical properties of tumors, to perform more accurate differential diagnosis between benign and malignant processes, and also to detect the risk of tumor malignization at early stages. The implementation of sonoelastography in clinical practice increases the possibility of preserving the ovaries in women of reproductive age, reduces the number of unnecessary surgical procedures and invasive biopsies, and decreases the need for expensive radiological examinations. This not only contributes to preserving patients' quality of life and reproductive health, but also increases the economic efficiency of the healthcare system.

To date, the diagnostic capabilities, advantages, and limitations of sonoelastography in the diagnosis of ovarian tumors have not been sufficiently studied in a systematic manner. Despite the existence of some foreign studies, issues related to comprehensive evaluation of this method, its integration into clinical protocols, and its application in local conditions remain relevant. Therefore, the scientific investigation of the role of modern ultrasound technologies, particularly sonoelastography, in the diagnosis of ovarian tumors and the assessment of its diagnostic significance constitute an актуal scientific and practical task. The above-mentioned circumstances determine the relevance of this research topic and substantiate the necessity of conducting scientific studies aimed at improving early diagnosis, differential assessment, and treatment strategies for ovarian tumors.

Materials and methods. This scientific study is aimed at evaluating the diagnostic capabilities of modern ultrasound technologies, in particular

sonoelastography, in the diagnosis of ovarian tumors. The study was conducted on the basis of comprehensive examinations incorporating clinical, instrumental, and analytical approaches. As the study material, women in whom space-occupying lesions in the ovarian region were identified were selected. The study included patients belonging to different age groups, including those in the reproductive, premenopausal, and postmenopausal periods. Patients were selected based on clinical complaints, anamnestic data, and the results of gynecological examinations. Patients with suspected ovarian tumors were included in the study, while cases with secondary tumors of other organs, acute inflammatory processes, and severe extragenital pathologies were excluded. For each patient, data on clinical anamnesis, reproductive history, characteristics of the menstrual cycle, and hormonal status were collected. All patients underwent general clinical examination, gynecological inspection, bimanual examination, and assessment of general condition. Clinical symptoms were correlated with the localization, size, and presumed biological characteristics of ovarian tumors. Ultrasound examination was used as the main instrumental method for the evaluation of ovarian tumors. The examination was performed using transabdominal and transvaginal ultrasound probes. In B-mode, the shape, contours, size, internal structure, capsule condition, and relationship with surrounding tissues of ovarian tumors were assessed. Particular attention was paid to solid and cystic components within the tumors, septa, papillary projections, and signs of heterogeneity of the internal structure. Sonoelastography was applied as the main methodological component of the study. Sonoelastographic examination made it possible to assess the elasticity and stiffness of tumors in real time. During the study, strain elastography and shear-wave elastography technologies were used. Using sonoelastography, the mechanical properties of ovarian tumors, degree of elasticity, homogeneity of internal structure, and stiffness gradients were analyzed. Through color elastographic mapping (elasto-mapping), differences in elasticity in various zones of tumors were identified, and features characteristic of benign and malignant

processes were compared. In addition to ultrasound examination, color and power Dopplerography were applied. Using this method, the characteristics of tumor blood supply, the degree of vascularization, and the nature of blood flow were assessed. Dopplerographic parameters were subjected to comparative analysis with sonoelastographic results. All ultrasonographic and sonoelastographic parameters were compared with clinical data and established diagnoses. Based on the obtained data, the diagnostic significance of sonoelastography in the diagnosis of ovarian tumors was evaluated. The study analyzed the advantages, limitations, and possibilities of clinical application of sonoelastography in comparison with conventional ultrasound examinations. The obtained results were systematized, compared across groups, and subjected to comprehensive analysis. The study results were compared with data from scientific literature and foreign studies, which made it possible to more deeply assess the role and significance of sonoelastography in the diagnosis of ovarian tumors.

Results and discussion. In the course of this study, the diagnostic capabilities of modern ultrasound technologies, in particular sonoelastography, in the diagnosis of ovarian tumors were comprehensively evaluated. The obtained results were subjected to comparative analysis with conventional ultrasound examinations, and the clinical significance and practical advantages of sonoelastography were determined. According to the study results, although conventional B-mode ultrasound examination is of great importance in assessing the anatomical characteristics of ovarian tumors—such as shape, contours, size, and internal structure—it was found to be insufficient in providing adequate information about the biological properties of tumors and tissue elasticity. In some cases, benign and malignant tumors exhibited similar appearances on ultrasound images, which complicated differential diagnosis.

When sonoelastography was applied, the ability to assess the mechanical properties of ovarian tumors was significantly expanded. The results of elastographic examinations demonstrated that benign tumors had relatively soft

tissues with homogeneous elasticity, and uniform color distribution was observed on elastographic maps. In contrast, malignant processes were characterized by increased tumor stiffness, heterogeneous distribution of elasticity, predominance of stiff zones, and pronounced differences in elasticity gradients. These features were assessed as important diagnostic criteria for the identification of malignant processes.

The use of strain and shear-wave elastography technologies made it possible to analyze the internal structure of tumors in greater depth. In particular, determining the ratio of stiff and soft tissues, evaluating the condition of the capsule, and comparing the elasticity of stromal components were of great importance in the differential diagnosis of benign and malignant processes. Through color elastographic mapping, differences in elasticity between the central and peripheral zones of tumors were identified, providing additional information for assessing the probability of malignization.

Examinations performed in combination with Dopplerography further enriched the sonoelastography results. When the characteristics of tumor blood supply were compared with elasticity parameters, it was observed that tumors with higher stiffness more frequently exhibited signs of increased vascularization. This indicated that the combined use of sonoelastography and Dopplerography increases diagnostic accuracy.

The obtained results had a direct impact on the clinical decision-making process. In cases where benign processes were suspected based on sonoelastography findings, conservative follow-up or minimally invasive approaches were selected, whereas in patients with a high probability of malignant processes, timely referral for more in-depth examination and surgical treatment was made possible. In particular, the increased possibility of ovarian preservation in women of reproductive age was assessed as one of the important clinical advantages of the method.

The results of this study are consistent with data reported in foreign scientific sources. Numerous international studies have noted the high sensitivity and specificity of sonoelastography in the differential diagnosis of ovarian tumors. Our observations also confirm that sonoelastography has higher informativeness compared to conventional ultrasound examinations. At the same time, operator dependence of the method and the presence of technical limitations in certain cases were identified, and these aspects were discussed.

Overall, the study results demonstrated that sonoelastography is an important additional diagnostic method in the diagnosis of ovarian tumors. This technology has high effectiveness in the differential evaluation of benign and malignant processes, early diagnosis, and selection of individualized treatment strategies. The widespread implementation of sonoelastography into clinical practice is of great importance for preserving women's reproductive health, reducing unnecessary invasive interventions, and enabling early detection of oncogynecological diseases.

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