

**MODERN INNOVATIVE TECHNOLOGIES IN ULTRASOUND DETECTION
OF GASTRIC TUMORS**

Abdughanisher Karimov Alijon ugli
Impuls Medical Institute
Abdughanisher.karimov@mail.ru

Abstract: Gastric cancer is one of the most widespread malignant tumors in the world. Detection of the disease in its early stages significantly increases patient survival and treatment effectiveness. This article analyzes the diagnostic capabilities of modern ultrasound technologies used in detecting gastric tumors, specifically endoscopic ultrasound (EUS) and three-dimensional/four-dimensional (3D/4D) ultrasound examination methods. According to research results, endoscopic ultrasound has higher accuracy indicators compared to traditional diagnostic methods and allows detailed examination of all layers of the gastric wall. 3D/4D ultrasound technologies create the possibility of spatial visualization of tumor volume, location, and relationship with adjacent organs. The advantages and limitations of modern ultrasound methods are discussed.

INTRODUCTION. Gastric cancer remains a serious problem in the global healthcare system. According to World Health Organization (WHO) data, gastric cancer ranks third in annual causes of death. The prognosis of the disease is largely determined by the stage at which it is detected. While gastric cancer detected in early stages has a five-year survival rate exceeding 90%, in advanced stages this indicator decreases to 5%.

Modern medicine employs various diagnostic methods for detecting gastric pathologies: endoscopy, computed tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET), and ultrasound examination. Ultrasound diagnostics is widely used due to its safety, relative affordability, and non-invasive nature. However, traditional transabdominal ultrasound has limited capabilities in detecting gastric tumors.

In recent years, the rapid development of medical technologies has led to significant achievements in ultrasound diagnostics as well. Innovative technologies such as endoscopic ultrasound (EUS), three-dimensional (3D), and four-dimensional (4D) ultrasound have created new possibilities in detecting and evaluating gastric tumors. These methods provide high resolution, spatial visualization, and the ability for dynamic assessment in real-time.

The aim of the research is to evaluate the diagnostic value of modern ultrasound technologies used in detecting gastric tumors and to determine their place in clinical practice.

RESEARCH METHODS AND MATERIALS. In preparing this article, international and local scientific literature published between 2015-2024, clinical research results, and meta-analysis data were analyzed. The technical characteristics, diagnostic accuracy indicators, and clinical application results of endoscopic ultrasound, 3D, and 4D ultrasound technologies were studied as research objects.

Endoscopic Ultrasound (EUS) Technology. Endoscopic ultrasound is one of the most advanced methods of modern diagnostics, combining endoscopy and ultrasound technologies. In this method, a high-frequency ultrasound transducer is inserted directly into the gastric cavity using an endoscope. This ensures maximum proximity to the gastric wall, enabling high-precision imaging.

The main advantages of EUS include the following. First, the use of high-frequency transducers (7.5-20 MHz) allows separate examination of five layers of the gastric wall. Second, accurate assessment of tumor invasion depth is crucial for determining T-stage. Third, visualization of perigastric and regional lymph nodes is necessary for evaluating N-stage. Fourth, there is the possibility of obtaining tissue samples through fine needle aspiration (FNA) under endoscopic control.

Clinical studies show that EUS achieves 85-90% accuracy in determining gastric cancer stage, which is higher than CT (65-75%) and MRI (70-80%). EUS has particular advantages in detecting early-stage tumors (T1-T2) and small lymph node metastases.

3D and 4D Ultrasound Technologies. Three-dimensional ultrasound (3D US) enables reconstruction of the spatial structure of tumors. Modern equipment takes hundreds of two-dimensional sections in a few seconds and automatically processes them into three-dimensional images. This method creates the following possibilities: accurate calculation of tumor volume, assessment of complex spatial geometry of tumor shape, visualization of relationships with adjacent structures (blood vessels, lymph nodes), and provision of detailed anatomical information for surgical planning.

Four-dimensional ultrasound (4D US) adds the time dimension to 3D technology, displaying dynamic three-dimensional images in real-time. This is particularly useful in assessing tumor blood supply and in the surgical intervention planning process.

Modern 4D ultrasound equipment has the capability to generate 30-60 volumetric images per second, enabling real-time observation of the characteristics of tumors and surrounding tissues. Contrast-enhanced 3D/4D ultrasound methods provide the opportunity to study tumor blood supply and neoangiogenesis processes in detail.

RESULTS AND DISCUSSION. Results of international studies demonstrate that endoscopic ultrasound has high diagnostic efficacy in staging gastric cancer. In large-scale studies conducted in Japan, South Korea, and China, EUS accuracy in assessing the degree of gastric wall invasion was 82-92%. In evaluating regional lymph node status, sensitivity was 80-85%, and specificity was 75-80%.

3D and 4D ultrasound technologies provide additional valuable information. Studies have shown that 3D reconstruction reduces the error rate in determining tumor volume from 10% to 3-5%. This is important for surgical planning and evaluating treatment effectiveness.

Contrast-enhanced EUS (CE-EUS) has even higher diagnostic value. The use of microbubble contrast agents enables detailed assessment of tumor blood supply and differentiation between benign and malignant tumors. Studies have confirmed that CE-EUS increases the accuracy of characterizing gastric tumors by 15-20%.

Modern ultrasound technologies also have limitations. EUS depends on operator skill, and training experienced specialists requires time. In the presence of gastric stenosis or large tumors, passing the endoscope may be difficult. 3D/4D ultrasound requires expensive equipment and is not available in all medical institutions. Additionally, artifacts may appear when imaging mobile tumors.

A comprehensive approach is recommended for early detection of gastric cancer. Traditional gastroendoscopy for initial screening, EUS for suspicious cases, 3D/4D ultrasound for detailed preoperative assessment, and histological examination for confirmatory diagnosis should be combined.

CONCLUSION. Modern ultrasound technologies, particularly endoscopic ultrasound and 3D/4D imaging methods, play an important role in detecting and evaluating gastric tumors. EUS is considered the gold standard in determining cancer stage due to its high spatial resolution and ability to obtain tissue samples. 3D and 4D technologies provide valuable information for detailed assessment of tumor spatial characteristics and surgical planning.

Wider implementation of these methods in clinical practice can improve indicators for early-stage detection of gastric cancer and significantly enhance patient prognosis. In the future, integration of artificial intelligence algorithms into ultrasound diagnostics, development of even higher-frequency transducers, and combination with molecular imaging methods will create new diagnostic possibilities.

Research results indicate the necessity of implementing modern ultrasound technologies in Uzbekistan's medical institutions and improving specialist qualifications. This will be an important step toward improving early diagnostic indicators for gastric cancer and expanding opportunities for preserving patient lives.

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