ORIGINAL RESEARCH

Diagnostic Value of Transabdominal Ultrasonography in Gastrointestinal Malignant Tumors

Jing-yun Dong, MD; Yan-bing Gao, MD; Li-wei Tang, MD; Jing Zheng, MD

ABSTRACT

Objective • To explore the application value of transabdominal ultrasonography in the diagnosis of gastrointestinal malignant tumors.

Methods • This study retrospectively analyzed the transabdominal ultrasound imaging data of 284 patients with gastrointestinal tumors admitted to our hospital from April 2019 to March 2022 and assessed the accuracy of transabdominal ultrasound in diagnosing different types of gastrointestinal tumor diseases. The diagnostic accuracy of transabdominal ultrasonography for TNM staging of gastrointestinal malignancies was calculated.

Results • The sensitivity and specificity of transabdominal ultrasonography in the diagnosis of gastric cancer were (82.40% and 83.72%, respectively), colon cancer (77.78% and 88.35%, respectively), gastric stromal tumor (95.45% and 93.65%, respectively), gastric lymphoma (72.22% and 94.66%, respectively), colorectal lymphoma (80.00% and 95.42%, respectively), gastric mucosal hypertrophy (85.71% and 96.69%, respectively), and pyloric hypertrophy (92.59% and 97.79%, respectively). Among the 284 patients included, 152 patients had malignant tumors, including 34 patients with stage I, 30 patients with stage II, 51 patients with stage III, and 37 patients with stage IV. The accuracy of transabdominal ultrasonography for TNM staging of gastrointestinal malignancies was 85.53% (130/152).

Conclusion • Transabdominal ultrasonography shows promise as a diagnostic tool for gastrointestinal malignant tumors; however, it is recommended to be used in conjunction with other detection methods such as fibrous gastrointestinal tract examination to minimize the risk of missed diagnoses and misdiagnoses. The study highlights the potential of transabdominal ultrasonography as a non-invasive and accessible diagnostic method for gastrointestinal malignancies. Further research and advancements in imaging technologies are crucial for enhancing diagnostic capabilities and improving patient outcomes in the future. (*Altern Ther Health Med.* 2025;31(1):380-385).

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INTRODUCTION

In recent years, there has been a significant increase in the incidence of gastrointestinal malignant tumors in China, with a trend towards younger onset ages. This can be attributed to changes in lifestyle and dietary habits among the Chinese population.[1] Studies have provided evidence linking the development of these tumors to unhealthy habits such as excessive drinking and smoking.[2] Gastrointestinal malignant tumors pose a significant threat to human life and health. Despite advancements in medical research, many patients in China still face challenges such as disease recurrence and local metastasis after treatment.[3] Among patients with intestinal malignant tumors, the liver is particularly vulnerable to metastasis, which not only presents a significant treatment challenge but also reduces the overall survival rate of patients. Therefore, early diagnosis and treatment are crucial in controlling the patient's condition and improving long-term prognosis.[4]

Transabdominal ultrasound is a widely acceptable examination technique due to the advantages of simple operation, low cost, non-invasive and painless, and no special equipment requirements.[5] Transabdominal ultrasonography, a widely employed medical imaging technique, utilizes high-frequency sound waves emitted by a handheld transducer placed on the abdomen. These sound waves traverse the abdominal wall, interacting with internal organs and producing echoes that are detected by the transducer. The information is then processed by a computer to generate real-time images on a monitor. This technique enables the visualization of abdominal structures, including tumors, as they reflect sound waves differently. Anechoic contrast agents are substances utilized to enhance the quality of ultrasound imaging. These

agents consist of small gas-filled bubbles enclosed in a shell. When exposed to ultrasound waves, these bubbles resonate, generating strong echoes that enhance the reflection of signals. The term 'anechoic' indicates that these agents produce regions on the ultrasound image with minimal echoes, thereby increasing the contrast between tissues. Anechoic contrast agents play a valuable role in improving the visibility of blood vessels and facilitating the delineation of organs, resulting in more precise and detailed ultrasound images. They are particularly beneficial in situations where conventional ultrasound techniques face limitations, such as visualizing blood vessels or differentiating between various types of tissues.[6] In the specific context of gastrointestinal tumors, this imaging modality plays a crucial role in early detection, localization, and characterization, facilitating informed decisions by healthcare professionals regarding treatment and management. While transabdominal ultrasonography offers advantages such as non-invasiveness and real-time imaging, limitations exist, such as potential hindrances from gas or fluid in the gastrointestinal tract and a lower level of detail compared to some other imaging methods, such as such as Computed Tomography (CT), Magnetic Resonance Imaging (MRI), Positron Emission Tomography (PET), and Endoscopic Ultrasound (EUS) and nuclear medicine scans. It may not be available for diagnosing gastrointestinal malignant tumors, because the secretions and a large amount of gas in the human gastrointestinal tract may affect the results of ultrasound diagnosis,[6] emphasizing the imperative for a refined diagnostic tool that can offer enhanced precision in early detection and subsequent treatment planning. Addressing these limitations is crucial for advancing patient care and prolonging survival rates in the face of gastrointestinal malignancies.

Accordingly, the present study retrospectively analyzed the transabdominal ultrasound imaging data of 284 patients with gastrointestinal tumors. Retrospective studies are efficient, particularly when dealing with a large sample size, and cost-effective as they eliminate the need for extensive data collection. The ready availability of historical data enhances feasibility, especially in studying a substantial patient group. The longitudinal aspect of retrospective designs allows for tracking changes over time, essential for understanding the progression of gastrointestinal tumors. However, addressing potential biases, such as selection bias, information bias, and confounding variables, is crucial for reliable findings. In summary, the retrospective design was chosen for efficiency, cost-effectiveness, and data availability, with researchers mindful of mitigating biases throughout the study.

MATERIALS AND METHODS

Study design and participants

General information. This study retrospectively analyzed the transabdominal ultrasound imaging data of 284 patients with gastrointestinal tumors admitted to our hospital from April 2019 to March 2022. Among the 284 patients, there were 173 males and 111 females; their ages ranged from 37 to 66 years, with an average age of (52.17 ± 10.09) years; pathological types: 125 cases of gastric cancer, 27 cases of colon cancer, 44 cases of gastric stromal tumor, 18 cases of gastric lymphoma, 15 cases of colorectal lymphoma, 28 cases of gastric mucosal hypertrophy, and 27 cases of pyloric hypertrophy.

Informed Consent Process. Before the study began, participants received detailed information about its purpose, procedures, potential risks, and benefits. Trained staff ensured understanding and answered questions. Participants provided written, voluntary consent, with assurances of confidentiality. For those with language barriers, interpreters or translated materials were used.

Patient Confidentiality Measures. To protect patient privacy, all data, including medical records, were assigned unique identifiers. Access was restricted to authorized staff, and data were stored securely. Any shared data were anonymized, and during analysis, results were presented in aggregate. The study adhered to data protection regulations, promptly addressing any confidentiality concerns.

Ethical Approval. This study has been approved by the Ethics Committee of our hospital. The protocol, including consent procedures and confidentiality measures, underwent a thorough ethical review. Modifications were approved, ensuring continuous compliance. The study prioritized participants' rights, safety, and welfare, following principles outlined in the Declaration of Helsinki and ethical guidelines.

Inclusion and exclusion criteria

Inclusion criteria. 1) All patients were diagnosed with gastrointestinal tumors by clinically relevant pathological examinations. This criterion strengthens the accuracy of the patient cohort, ensuring that they indeed have the condition under investigation; 2) All patients were expected to survive more than 3 months. This criterion helps ensure that patients have a sufficient duration for observation, contributing to the study's reliability and minimizing the impact of short-term survival on the results; 3) All patients had symptoms such as bloody stools, fatigue, and abdominal pain of varying degrees. This criterion ensures that the selected participants exhibit symptoms commonly associated with gastrointestinal tumors, aligning with the study's focus; 4) All patients were ready to cooperate with inspection. This criterion ensures that participants actively engage in the required diagnostic procedures, contributing to the study's robustness.

Exclusion criteria. 1) Patients with other malignant tumors. This criterion avoids potential confounding factors associated with different tumor types; 2) Patients with systemic diseases. Systemic diseases could introduce variables that complicate the interpretation of results; 3) Patients with relevant examination contraindications. These conditions may affect the patient's ability to cooperate with examinations and communicate relevant information, potentially introducing biases; 4) Patients with psychiatric diseases or communication disorders. These criteria contribute to the methodological strength of the research by focusing on a specific and well-defined patient population while minimizing potential confounding factors.

Methods

The patients were required to maintain an empty stomach for at least 8 hours before the examination and then underwent transabdominal ultrasonography.

Transabdominal Ultrasonography Equipment and Techniques. For transabdominal ultrasonography, state-of-the-art equipment was employed, including the Philips HD11 and GE730 EXPERT color ultrasound systems. The abdominal probe, operating at a frequency range of 3.5-5.5 MHz, played a pivotal role in achieving high-quality imaging.

Preparation and Medication. Before initiating the examination, an instant gastrointestinal ultrasound aid was meticulously prepared. Boiling water was used to brew and mix the aid, ensuring optimal consistency after stirring. This aid was crucial in enhancing image clarity during the procedure.

Gastroduodenal Ultrasound Examination. During gastroduodenal ultrasound, the patient's dosage was meticulously determined based on body weight. The examination involved maintaining left and right lateral positions, supine positions, and sitting positions. To ensure comprehensive observation, patients were instructed to cooperate with breathing. Detailed examinations of the duodenum, gastric antrum, gastric body, gastric fundus, and cardia were performed. Both short-axis and long-axis sections were closely scrutinized for abnormal lesions. The examination also included a meticulous evaluation of gastric wall peristalsis around the stomach and duodenum.[7]

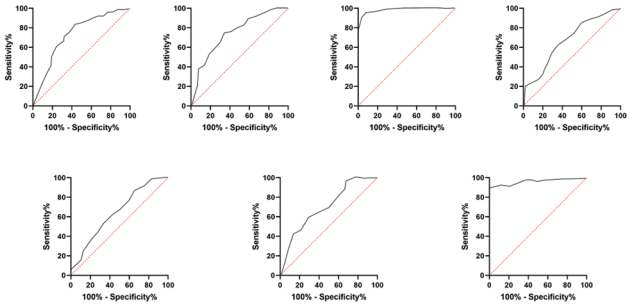
Colon Ultrasound Examination. For patients undergoing colon ultrasound with a retention enema, a laxative was administered a day before the examination. Post-defecation cleaning enema, the examination was conducted in the supine position. An appropriate amount of gastrointestinal ultrasound aid was instilled, followed by reverse ultrasonography from the rectum to the cecum.[8]

Small Bowel Ultrasonography. Small bowel ultrasonography was conducted directly under fasting conditions. The umbilical area was selected as the central focus during the inspection. Multiple cross-sections, including oblique, horizontal, and vertical scans, were performed to observe the existence or expansion of the bowel.[9] Upon identification of lesions, meticulous measurement records were documented by medical staff. The obtained images were stored on the workstation for subsequent collaborative review and analysis by radiologists. This comprehensive approach ensured a thorough evaluation of the gastrointestinal tract using advanced equipment and standardized protocols.

Outcome measures

(1) The sensitivity and specificity of transabdominal ultrasonography in diagnosing different types of gastrointestinal tumor diseases were calculated. (2) The accuracy of transabdominal ultrasonography for TNM staging of gastrointestinal malignant tumors was assessed.

Figure 1. Sensitivity and Specificity ROC Curves of Different Gastrointestinal Tumor Disease Types



Note: Transabdominal ultrasonography exhibited varying levels of accuracy in diagnosing different gastrointestinal conditions. Specifically, its sensitivity and specificity for detecting gastric cancer were 82.40% and 83.72%, respectively. For colon cancer, the values were 77.78% (sensitivity) and 88.35% (specificity). Notably, transabdominal ultrasonography demonstrated high sensitivity and specificity in diagnosing gastric stromal tumors (95.45% and 93.65%, respectively), colorectal lymphoma (80.00% and 95.42%, respectively), gastric mucosal hypertrophy (85.71% and 96.69%, respectively), and pyloric hypertrophy (92.59% and 97.79%, respectively). However, for gastric lymphoma, the sensitivity was 72.22%, and the specificity was 94.66%.

Table 1. Sensitivity and Specificity of Transabdominal Ultrasonography in the Diagnosis of Different Types of Gastrointestinal Tumor Diseases (n = 284)

Pathological type	n	Sensitivity	Specificity
Stomach cancer	125	82.40% (103/125)	83.72% (144/172)
Colon cancer	27	77.78% (21/27)	88.35% (235/266)
Gastric stromal Tumor	44	95.45% (42/44)	93.65% (236/252)
Gastric lymphoma	18	72.22% (13/18)	94.66% (266/281)
Colorectal Lymphoma	15	80.00% (12/15)	95.42% (271/284)
Gastric mucosal Hypertrophy	28	85.71% (24/28)	96.69% (263/272)
Pyloric Hypertrophy	27	92.59% (25/27)	97.79% (266/273)

Table 2. Diagnostic Accuracy of TNM Staging of Gastrointestinal Malignant Tumors by Transabdominal Ultrasonography (n = 152)

	n	Transabdominal ultrasound (n)				Accuracy (%)
		Stage I	Stage II	Stage III	Stage IV	
Stage I	34	28	3	2	1	82.35% (28/34)
Stage II	30	1	24	3	2	80.00% (24/30)
Stage III	51	0	5	44	2	86.27% (44/51)
Stage IV	37	0	0	3	34	91.89% (34/37)
Total	152	29	32	52	39	85.53% (130/152)

RESULTS

Sensitivity and specificity of transabdominal ultrasonography in the diagnosis of different types of gastrointestinal tumor diseases

According to Figure 1, the sensitivity and specificity of transabdominal ultrasonography in the diagnosis of gastric cancer were (82.40% and 83.72%, respectively), colon cancer (77.78% and 88.35%, respectively), gastric stromal tumor (95.45% and 93.65%, respectively), gastric lymphoma (72.22% and 94.66%, respectively), colorectal lymphoma (80.00% and 95.42%, respectively), gastric mucosal hypertrophy (85.71% and 96.69%, respectively), and pyloric hypertrophy (92.59% and 97.79%, respectively) (Table 1).

The diagnostic accuracy of transabdominal ultrasonography for TNM staging of gastrointestinal malignant tumors

Among the 284 patients included in this study, 152 patients had malignant tumors, including 34 patients with stage I, 30 patients with stage II, 51 patients with stage III, and 37 patients with stage IV. The diagnostic accuracy of transabdominal ultrasonography for TNM staging of gastrointestinal malignancies was 85.53% (130/152), as shown in Table 2.

DISCUSSION

Gastrointestinal malignancies are associated with considerable morbidity and mortality.[10,11] Research indicates that the type of disease and its benign and malignant nature should be identified as soon as possible in patients with gastrointestinal tumors, and targeted and efficient intervention strategies should be formulated correspondingly, which is essential for improving the prognosis of patients.[12,13] At present, the commonly used method for clinical diagnosis of gastrointestinal tumor diseases is fiberoptic endoscopy. This technique is highly feasible in gastrointestinal mucosal lesions but its diagnostic sensitivity for gastrointestinal submucosal tumors is relatively low. Worse yet, it is criticized due to the limitation in middle-aged and elderly patients with cardiovascular and cerebrovascular diseases.[14]

Transabdominal ultrasonography, a non-invasive examination modality, has reaped remarkable fruits in clinical applications in recent years. A prior study indicates that transabdominal ultrasonography is capable of detecting gastrointestinal mucosal lesions effectively, and clearly demonstrates the nature of gastric submucosal tumors, which assists physicians in determining the internal structure of the tumor, the extent of the lesion, and the depth of invasion, and accurately formulate corresponding treatment strategy.[15] In addition, acknowledging the pivotal role of patients' experience in the acceptance and efficacy of medical procedures, potential aspects of the transabdominal ultrasound examination are discussed. These include the generally comfortable and painless nature of the procedure, with patients lying down on an examination table and a gel applied to the abdomen to facilitate sound wave transmission. Communication with the sonographer is crucial, emphasizing the importance of addressing patient concerns and maintaining an open line of communication throughout the relatively quick procedure, which typically lasts around 30 minutes or less. Patient comfort encompassing positioning, privacy, and sensitivity to individual needs, with an emphasis on modesty and cultural aspects should be considered. According to Zhang et al.,[16] transabdominal ultrasound not only has many advantages such as non-invasiveness, no cross infection, ideal safety, etc., but also predicts tumor stage, metastasis, degree of invasion and internal structure, etc. Importantly, it substantially makes up for the lack of fiber endoscopy detection. However, the human gastrointestinal tract contains a large amount of fluid, gas, and gastrointestinal secretions, which challenges the diagnosis using ultrasonography.[17]

Excitingly, anechoic contrast agents and other filling methods with water help to avert the interference caused by the above factors on the examination as evidenced by multiple clinical studies.[18] In addition, transabdominal ultrasonography can accurately identify the structural layers of the gastrointestinal wall in patients, which is conducive to the assessment of the extent of tumor infiltration and the observation of the healing of the lesion and the growth of the tumor outside the cavity, compensating for the inadequate inspection of conventional gastrointestinal endoscopy.[19] Vanhauwaert et al.[20] used fiberoptic endoscopy to diagnose gastric cancer, and found that the sensitivity and specificity of gas barium double angiography in the diagnosis of gastric cancer were 76.57% and 79.28%, respectively; the sensitivity and specificity of abdominal ultrasonography in the diagnosis of gastric cancer were 82.40% and 83.72%, respectively.

In this study, the accuracy of transabdominal ultrasound in TNM staging of gastrointestinal malignant tumors was 85.53% (130/152). The results suggest that transabdominal ultrasonography can be used as one of the screening methods for gastrointestinal malignancies. The sensitivity and specificity of diagnostic methods for tumor detection vary across different tumor types due to a multitude of factors. Tumor characteristics, including histological type, size, morphology, and biological behavior, influence the accuracy of detection methods such as imaging and biopsy. The anatomical challenges posed by the location of tumors, especially in complex or difficult-to-access regions, contribute to variations in sensitivity and specificity. Proximity to critical structures and organs may impact specificity. The choice of imaging modality and technique, each with its strengths and limitations, plays a crucial role, and operator expertise can influence interpretation. Patient-specific factors, such as physiological variations and cooperation during procedures, further contribute to variability. Recognizing these factors is essential for tailoring diagnostic approaches and optimizing the accuracy of tumor detection methods, ultimately improving patient outcomes.

Although transabdominal ultrasonography might not be the preferred choice for diagnosing gastrointestinal malignancies, its value in screening is outstanding. The documented diagnostic accuracy of transabdominal ultrasonography in detecting gastrointestinal malignant tumors holds significant implications for clinical practice, patient management, and early intervention. While serving as a potential non-invasive screening tool, transabdominal ultrasound's notable accuracy suggests a role in early detection, enabling timely intervention and improving prognoses. Its complementary nature with existing diagnostic methods, such as fiberoptic endoscopy, can enhance overall diagnostic accuracy, reducing the dependency on more invasive procedures. The non-invasive aspect of transabdominal ultrasound may lead to a patient-friendly

approach, and the precise tumor characterization it offers contributes to individualized treatment planning. The modality's capacity for monitoring tumor growth and treatment efficacy facilitates improved follow-up strategies, impacting patient outcomes. Furthermore, if proven reliable, transabdominal ultrasound could influence healthcare resource utilization by potentially streamlining diagnostic pathways and optimizing resource allocation for gastrointestinal tumor screening and detection. Therefore, in cases of suspected individuals are found after examination, physicians should recommend that patients undergo fiberoptic gastrointestinal endoscopy, surgical biopsy, and other diagnostic methods to further confirm the diagnosis.

Despite the study's focus on the diagnostic accuracy of transabdominal ultrasonography in gastrointestinal malignancies, several limitations need consideration. Potential sources of bias, including selection bias and operator-dependent variability, may affect the robustness of the findings. Moreover, the retrospective design introduces the possibility of recall bias. The applicability of the results to diverse patient populations is also a concern, with variations in demographics and anatomical factors influencing the performance of transabdominal ultrasound. However, despite these limitations, transabdominal ultrasonography holds significant value in clinical settings, especially as a screening tool for gastrointestinal malignancies. Its non-invasive nature makes it an attractive initial diagnostic approach, particularly in populations where other methods might be less feasible or contraindicated. While acknowledging its limitations, the modality's quick, cost-effective, and accessible imaging can facilitate early detection and intervention, serving as a crucial first step in the diagnostic pathway, especially in settings with limited resources or where advanced diagnostic tools may pose challenges. Addressing current limitations and leveraging technological advancements can further enhance the role of transabdominal ultrasonography in improving early detection and patient outcomes.

The study's findings on the diagnostic accuracy of transabdominal ultrasonography in gastrointestinal malignancies suggest several promising directions for future research. One key area is the exploration of combined imaging modalities, such as integrating transabdominal ultrasonography with CT scans or MRI, to augment overall diagnostic precision and overcome the limitations associated with the individual modalities. Operator expertise and training in transabdominal ultrasonography emerge as critical aspects for further investigation, with a focus on evaluating the impact of operator skill on diagnostic outcomes. Standardizing training programs and protocols for healthcare professionals conducting transabdominal ultrasonography could mitigate variability in results across different clinical settings. Additionally, future research could refine the use of transabdominal ultrasonography in specific patient populations, addressing challenges such as obesity or anatomical variations. Exploring advanced technologies, including three-dimensional or contrast-enhanced ultrasound, in conjunction with transabdominal ultrasonography may offer improved visualization capabilities. Investigating the role of transabdominal ultrasonography in real-time monitoring and guiding interventions could further expand its clinical applications, particularly in situations requiring immediate feedback for decision-making during procedures. Overall, these research avenues aim to optimize transabdominal ultrasonography's integration with complementary modalities, enhance operator training, address patient-specific challenges, and explore real-time applications, contributing to its effectiveness in diagnosing and managing gastrointestinal malignancies.

CONCLUSION

This article underscores the promising diagnostic benefits of transabdominal ultrasonography in detecting gastrointestinal malignant tumors. Its non-invasive nature, coupled with the ability to characterize tumor features, thereby, positioning it as a valuable screening tool. Emphasizing its role in complementing other diagnostic modalities, such as fiberoptic endoscopy, and transabdominal ultrasonography becomes crucial to ensure a comprehensive assessment and accurate diagnosis. To sum up, transabdominal ultrasonography has a promising diagnostic benefit in the diagnosis of gastrointestinal malignant tumors but it should also be used in conjunction with detection methods such as fibrous gastrointestinal tract to avoid the missed diagnosis and misdiagnosis. This integrated approach allows clinicians to leverage the advantages of multiple techniques, providing a more nuanced understanding of gastrointestinal malignancies and facilitating well-informed decision-making for patient management and intervention strategies.

AUTHOR DISCLOSURE STATEMENT

The authors declare that they have no competing interests.

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DATA AVAILABILITY STATEMENT

All data generated or analyzed during this study are included in this published article.

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