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e integration of advanced technologies into ultrasound systems has signi cantly improved its performance in oncology. Contrast-enhanced ultrasound (CEUS) is one such advancement that has greatly enhanced tumor visualization. By using microbubble contrast agents, CEUS improves the ability to visualize blood ow within tumors, providing detailed information about tumor vascularity. is is particularly helpful in evaluating liver lesions, where it aids in di erentiating between benign and malignant masses. e enhanced contrast allows oncologists to better characterize tumor features such as perfusion patterns and vascular anomalies, which are common in malignant tumors. Elastography, another major advancement in ultrasound technology, is particularly useful in oncology for assessing tumor sti ness. In malignant tumors, tissue sti ness is o en increased due to the higher collagen content and altered tissue architecture. Elastography quanti es this sti ness, providing a non-invasive method to evaluate the mechanical properties of tumors. Shear wave elastography, a more advanced form of elastography, measures the velocity of shear waves through tissue, o ering more precise and reliable results. is technique has been successfully applied in the monitoring of liver, breast, and prostate cancers [4]. 3D and 4D ultrasound imaging technologies have further enhanced ultrasound's capabilities, allowing for more detailed and accurate tumor assessments. ese technologies provide a three-dimensional view of tumors, o ering a clearer picture of their size, shape, and location within the body. is is particularly bene cial for evaluating complex tumors located in di cult-to-reach areas. e ability to visualize tumors in three dimensions aids in planning surgical or radiation treatments by providing a more precise understanding of the tumor's relationship to surrounding structures [5]. Additionally, arti cial intelligence (AI) has begun to play a role in ultrasound imaging, particularly in image analysis. AI algorithms can assist in the automatic detection and classi cation of tumors, reducing the time required for diagnosis and improving accuracy. By analyzing large datasets of ultrasound images, AI can identify patterns and

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tumors in the liver, kidney, and prostate [3] features indicative of malignancy that might be overlooked by human examiners. is can help improve the consistency and reliability of ultrasound in oncology, particularly in busy clinical environments.

Looking ahead, the potential for ultrasound in oncology appears promising. As the eld of personalized medicine continues to grow, ultrasound will likely play a critical role in tailoring treatments to individual patients. e ability to assess tumor sti ness, blood ow, and other characteristics using elastography and Doppler ultrasound could allow for more personalized treatment strategies. For example, these techniques might help determine the aggressiveness of a tumor, guiding decisions about the most appropriate therapeutic approach. e integration of ultrasound with other imaging modalities, such as magnetic resonance imaging (MRI) and positron emission tomography (PET), is another exciting prospect. Hybrid imaging systems that combine the strengths of di erent modalities could provide more comprehensive information, enhancing diagnostic accuracy and treatment planning. For example, combining ultrasound with MRI could provide superior so -tissue contrast, which would be particularly bene cial for evaluating tumors in complex anatomical regions, such as the brain or pelvis [6]. Ultrasound-guided therapies, including gene therapy and immunotherapy, may also become more prevalent in the future. Techniques like sonoporation, which uses ultrasound to temporarily open cell membranes and enhance the delivery of therapeutic agents, hold promise for improving the e ectiveness of these novel treatments. By enabling targeted drug delivery directly to tumors, ultrasound could play a vital role in improving the outcomes of gene therapies and immunotherapies [7].

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Advanced ultrasound techniques, including elastography, contrast-enhanced ultrasound (CEUS), and 3D ultrasound, have signi cantly