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Letters to the Editor
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High-Intensity Focused Ultrasound (HIFU): Emerging Roles in Oncology and Neuromodulation

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High-Intensity Focused Ultrasound (HIFU) is a non-invasive therapeutic platform that uses focused acoustic energy to generate precise zones of tissue destruction. The principal mechanism is thermal ablation, in which temperatures in the focal region exceed 60°C, inducing coagulative necrosis. Mechanical effects such as cavitation bubble formation and collapse in tissue may contribute to cellular disruption in certain contexts. Treatment can be guided by real-time ultrasound, which offers portability and cost advantages, or magnetic resonance (MR), which provides superior targeting accuracy and real-time thermometry but requires more complex infrastructure (1).

Focal therapy has emerged as an intermediate option between active surveillance and radical whole-gland treatments. HIFU aims to eradicate clinically significant tumor foci while preserving urinary and sexual function. The INDEX randomized controlled trial enrolled 625 men with low- to intermediate-risk disease and randomized 301 to focal HIFU. At a median follow-up of five years, 77% remained free from radical or systemic therapy, 96% were pad-free continent, and <2% experienced severe urinary toxicity. No rectal injuries were reported.(2) A large multi-institutional propensity-matched study compared 625 HIFU patients to 625 radical prostatectomy patients, showing equivalent three-year metastasis-free survival (98% vs. 99%) but significantly better urinary continence (96% vs. 78%) and erectile function preservation (80% vs. 45%) after HIFU.(3) These outcomes, though encouraging, require confirmation in additional randomized settings with extended follow-up. The 2025 NCCN Clinical Practice Guidelines in Oncology: Prostate Cancer classify focal therapy, including HIFU, as an option for carefully selected men typically within clinical trials or registries. The guidelines stress the need for shared decision-making and explicit patient counseling regarding the investigational status of these modalities (NCCN, Version 1.2025).

Beyond oncology, HIFU is being explored for cardiovascular neuromodulation. The carotid body, a peripheral chemoreceptor influencing sympathetic drive, represents a novel therapeutic target for drug-resistant hypertension. Low-intensity focused ultrasound directed at the carotid bifurcation can modulate afferent signaling without vascular injury. In a 2024 randomized, sham-controlled trial involving 124 patients with uncontrolled hypertension despite ≥3 antihypertensive agents, Takei et al. reported a mean office systolic BP reduction of −18.5 mmHg at six months versus −4.2 mmHg in the sham group. No significant neurological or vascular complications occurred.(4) A pooled analysis of six clinical studies including 412 patients undergoing non-invasive ultrasound neuromodulation—most targeting the carotid body- demonstrated mean systolic and diastolic BP reductions of −14.7 mmHg and −7.6 mmHg at three to six months compared with control, with no significant increase in adverse events. (5) While these early data are promising, trial populations remain modest, follow-up durations are limited, and cardiovascular outcome data are lacking.

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HIFU outcomes vary by device platform, energy parameters, and imaging modality. Operator learning curves influence treatment accuracy, and patient selection criteria, particularly in focal prostate therapy, are evolving. (1) In prostate applications, retreatment rates approach 20% at five years in some series, and complications include urinary stricture, urinary retention, and rare rectal injury. (2) For neuromodulation, optimal targeting parameters, ideal patient phenotypes, and mechanisms of sustained BP reduction remain under investigation. (5) Economic and logistical considerations also affect adoption. MR-guided platforms entail substantial capital investment, while ultrasound-guided devices offer lower cost but less imaging precision. Reimbursement pathways are inconsistent globally, limiting accessibility. (3).

HIFU represents an emerging, evidence-supported approach in localized prostate cancer, with the potential to preserve function while maintaining cancer control in selected patients. In cardiovascular medicine, early-phase data suggest that carotid body–targeted HIFU neuromodulation can produce clinically meaningful BP reductions in resistant hypertension without major safety concerns. The future integration of HIFU into routine practice will depend on further technological refinement, rigorous patient selection frameworks, and the completion of large-scale randomized trials with long-term follow-up to confirm durability, cost-effectiveness, and patient-centered outcomes

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