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The role of focused ultrasound for pediatric brain tumors: current insights and future implications on treatment strategies

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Abstract

Introduction: Focused ultrasound (FUS) is an innovative and emerging technology for the treatment of adult and pediatric brain tumors and illustrates the intersection of various specialized fields, including neurosurgery, neuro-oncology, radiation oncology, and biomedical engineering.

Objective: The authors provide a comprehensive overview of the application and implications of FUS in treating pediatric brain tumors, with a special focus on pediatric low-grade gliomas (pLGGs) and the evolving landscape of this technology and its clinical utility.

Methods: The fundamental principles of FUS include its ability to induce thermal ablation or enhance drug delivery through transient blood-brain barrier (BBB) disruption, emphasizing the adaptability of high-intensity focused ultrasound (HIFU) and low-intensity focused ultrasound (LIFU) applications.

Results: Several ongoing clinical trials explore the potential of FUS in offering alternative therapeutic strategies for pathologies where conventional treatments fall short, specifically centrally-located benign CNS tumors and diffuse intrinsic pontine glioma (DIPG). A case illustration involving the use of HIFU for pilocytic astrocytoma is presented.

Conclusion: Discussions regarding future applications of FUS for the treatment of gliomas include improved drug delivery, immunomodulation, radiosensitization, and other technological advancements.

Keywords: Blood-brain barrier disruption; Clinical trials; Focused ultrasound; Glioma; Sonodynamic therapy.