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Focused ultrasound in pediatric neurosurgery: a scoping review of opportunities and challenges

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Abstract

Background: Transcranial focused ultrasound (FUS) non-invasively transmits acoustic energy across the skull, resulting in biological effects. Although early studies focused on adult movement disorders, transcranial FUS is now being explored for pediatric patients as well. Here, we review the emerging applications of transcranial FUS in pediatric neurosurgery and explore the unique considerations for this patient population.

Methods: A scoping review was conducted using PRISMA-ScR guidelines.

Results: A total of 20 studies were included. Six clinical investigations reported the outcomes of 22 individual patients, ten of whom underwent thermal ablation of brain tumors or lesions. Eleven patients underwent sonodynamic therapy of brainstem tumors without adverse effects, and one patient underwent blood-brain barrier (BBB) opening prior to the infusion of doxorubicin. Preclinical studies further explored the use of low-intensity FUS to transiently disrupt the BBB and improve the delivery of therapeutic agents to diffuse midline gliomas or medulloblastomas.

Conclusions: This review highlights the growing interest in expanding transcranial FUS to pediatric neurosurgical patients. In parallel to ongoing work in the adult neurosurgical community, pediatric neurosurgical applications of this novel technology will continue to expand, but will require conscious and intentional efforts to optimize its use given the unique features of the pediatric population.

Keywords: Brain; DMG; Focused ultrasound; Neurosurgery; Pediatrics; Tumor.