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Focused ultrasound blood-brain barrier disruption in high-grade gliomas: Scoping review of clinical studies

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Abstract

Background: This scoping review aims to comprehensively review the available literature on the safety and efficacy of focused ultrasound (FUS) for blood-brain barrier disruption (BBBD) in patients with high-grade gliomas, including glioblastoma (GBM). High-grade gliomas pose significant challenges in neuro-oncology due to their aggressiveness and intricate location, often limiting the efficacy of traditional treatments. FUS offers a promising approach by transiently disrupting the blood-brain barrier, thereby facilitating enhanced drug delivery to tumor cells while minimizing systemic side effects.

Methods: A scoping review adhering to PRISMA guidelines was conducted to explore the literature on FUS-induced BBBD in glioma patients. PubMed and Embase databases were searched from inception to April 2024 using defined keywords. Original clinical studies focusing on FUS for BBBD in gliomas were included. Two reviewers independently screened records, with conflicts resolved by a third reviewer. Data extraction and quality assessment were performed accordingly.

Results: A total of 1,310 studies were initially identified, resulting in nine eligible studies after screening and selection. These studies, published between 2016 and 2024, included 106 patients (39.6 % female) with ages ranging from 29 to 80 years. Recurrent GBM was the most common diagnosis (100 patients), with other diagnoses including anaplastic astrocytoma, diffuse infiltrating glioma, and oligodendroglioma. Various FUS devices and microbubble contrast agents were employed across the studies. Safety and efficacy were assessed in both experimental and clinical settings, with no significant adverse events reported during BBBD procedures. Notably, BBBD facilitated enhanced drug delivery to tumor tissue, demonstrating potential therapeutic benefits.

Conclusion: Studies investigating BBBD using FUS demonstrate promising outcomes in experimental and clinical settings. BBBD procedures in patients with malignant gliomas and recurrent GBM show safety and successful enhancement of drug delivery potential. Overall, FUS-mediated BBBD emerges as a safe and feasible approach for improving therapeutic outcomes in brain tumor patients, warranting further clinical exploration and optimization.

Keywords: Blood-Brain Barrier Disruption; Focused Ultrasound; Glioblastoma; Glioma; Pulsating Ultrasound.