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Efficacy and safety of gamma knife radiosurgery in the management of pediatric gliomas: a systematic review and meta-analysis

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Abstract

Background: Pediatric gliomas pose significant treatment challenges due to their location in eloquent areas and the vulnerability of the developing brain to toxicity. Gamma knife radiosurgery (GKRS) has emerged as a minimally invasive alternative aimed at maximizing local control while sparing healthy tissue. This systematic review and meta-analysis evaluated the efficacy and safety profile of GKRS in the management of pediatric gliomas.

Methods: A comprehensive search was conducted across PubMed, Embase, and Web of Science databases for studies published between January 1994 and September 2024, adhering to PRISMA guidelines. Eligible studies included at least four patients and reported on tumor regression, control rates, or safety outcomes. Data were pooled using a random-effects model with single proportion analysis.

Results: Eleven studies encompassing 203 patients were included in the quantitative synthesis. The pooled analysis demonstrated a complete tumor regression rate of 17% (95% CI 10-28%) and a partial regression rate of 47% (95% CI 34-60%). Favorable neurological outcomes were achieved in nearly all evaluated patients - 100% (95% CI 95-100%). Regarding safety, procedure-related mortality was 0%. The overall mortality rate was 9% (95% CI 4-18%), with significantly lower mortality observed in pilocytic astrocytomas (2%) compared to other tumor types (15%). Major and minor complications occurred in 3% and 6% of patients, respectively, while adverse radiation effects were noted in 11%.

Conclusions: GKRS is a safe and effective treatment modality for pediatric gliomas, offering high rates of tumor regression and excellent neurological preservation. The procedure is associated with minimal morbidity and zero procedure-related mortality, supporting its utility as a reliable therapeutic option for selected pediatric patients.

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