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Efficacy and safety of intraoperative MRI in glioma surgery: a systematic review and meta-analysis of prospective randomized controlled trials

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Abstract

Objective: Maximum extent of resection in glioma yields enhanced survival outcomes. The contemporary literature presents contradictory results regarding the benefit of intraoperative MRI (iMRI). This meta-analysis aimed to investigate the efficacy and safety of iMRI-guided surgery.

Methods: The authors searched the PubMed, Embase, and Cochrane Reviews databases for eligible prospective randomized controlled trials through the end of February 2024. Endpoints were extent of resection, progression-free survival (PFS), overall survival, neurological functioning, and surgical complications. Individual patient data regarding PFS were reconstructed using the R package IPDfromKM.

Results: From 1923 identified results, 3 randomized controlled trials with 384 patients met the inclusion criteria. Extended resections after iMRI were performed in 29.2% of the iMRI cases. Intraoperative MRI-guided glioma surgery (OR 5.40, 95% CI 3.25-8.98; $p < 0.00001$) outperformed conventional navigation-guided surgery in attaining gross-total resection (GTR). In patients in whom a GTR was achieved, the median time to progression was 16.0 months (95% CI 12.3-19.7 months), while the median PFS in patients with a subtotal resection was 9.7 months (95% CI 6.9-12.5 months) ($p < 0.001$). Despite increased GTR rates, postoperative neurological deterioration was equal among the iMRI and control groups (OR 1.0, 95% CI 0.6-1.7; $p = 0.91$, $I^2 = 0\%$). Intraoperative MRI use prolongs surgery by 42 minutes on average (95% CI 3.3-80.7 minutes; $p = 0.03$, $I^2 = 56\%$). The risk of postoperative intracranial hemorrhage (OR 1.9, 95% CI 0.2-16.9; $p = 0.55$, $I^2 = 0\%$) was not increased, while in one study significantly increased infections were observed in the iMRI arm.

Conclusions: Intraoperative MRI outperforms conventional surgery in achieving complete glioma resections of all contrast-enhancing tumor portions, enhancing PFS without added risk. Intraoperative MRI is a tool that facilitates these aims without reducing safety in terms of neurological deficits and surgical complications.

Keywords: glioma surgery; gross-total resection; intraoperative MRI; meta-analysis; progression-free survival; randomized trials; tumor.

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