

Neuroradiology. 2024 Oct 21. doi: 10.1007/s00234-024-03489-7. Online ahead of print.

The utilisation of fMRI for pre-operative mapping in the paediatric population with central nervous system tumours: a systematic review

Hanani Abdul Manan ^{1 2}, Nur Shaheera Aidilla Sahrizan ³, Kamalanathan Palaniandy ⁴, Hamzaini Abdul Hamid ^{3 5}, Noorazrul Yahya ⁶

Affiliations

PMID: 39432073 DOI: [10.1007/s00234-024-03489-7](https://doi.org/10.1007/s00234-024-03489-7)

Abstract

Background: Functional MRI (fMRI) is a well-established tool for pre-operative planning, providing neurosurgeons with a roadmap of critical functional areas to preserve during surgery. Despite its increasing use, there is a need to compare task-based (tb-fMRI) and resting-state fMRI (rs-fMRI) in the paediatric population to comprehensively evaluate the existing literature on the use of fMRI for pre-operative mapping in pediatric patients, comparing tb-fMRI and rs-fMRI.

Methods: Two databases were searched for relevant studies published before July 2024 following the PRISMA guidelines. Eleven studies were selected and comprised 431 participants: 377 patients with different types and locations of brain tumours, and 54 healthy controls (HC).

Results: Results indicate that tb-fMRI could reliably locate the eloquent cortex with more than an 80% success rate. Furthermore, results were comparable with intraoperative mapping. Two studies reported that 68-81% of patients did not develop deficits in the postoperative period. Results also found that rs-fMRI can fill the gap in the situation of paediatric patients when other techniques do not apply to younger patients.

Conclusion: This study suggests that tb-fMRI is more effective for pre-operative mapping in pediatric patients, offering precise localisation of critical brain functions and enhancing surgical planning. Although rs-fMRI is less demanding and compatible with light sedation, it lacks the specificity needed for accurate identification of language, sensory, and motor areas, which limits its clinical relevance. rs-fMRI can aid in function-preserving treatments for brain tumour patients and reduce the need for invasive procedures. Combining tb-fMRI with intraoperative mapping optimizes precision and safety in pediatric-neurosurgery.

Keywords: Brain tumour; Intraoperative mapping; Pre-operative mapping; Resting-state fMRI; Task-based fMRI.

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