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Using Machine Learning to Differentiate Between Radiation Necrosis and Tumor Progression in Brain Tumor Patients: A Systematic Review and Meta-Analysis

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ABSTRACT

Introduction: This Research has demonstrated that distinguishing between radiation necrosis (RN) and actual progression (TP) is essential for making informed clinical decisions. Multiple studies have investigated the use of machine learning (ML) to differentiate between RN and TP in patients with brain tumors. This specific study evaluated the effectiveness of ML in identifying RN and TP in brain tumor patients who have undergone radiation therapy.

Methods and Materials: This systematic review and meta-analysis followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. We searched PubMed, Embase, Scopus, and Web of Science databases from their inception until May 17, 2023, to identify relevant studies. The sensitivity and specificity of studies that used ML algorithms to distinguish between RN and TP in patients with brain tumors were pooled using a random-effects model. Statistical analysis was conducted using STATA v.17.

Results: Sixteen studies met the eligibility criteria. The pooled sensitivity was 0.84 (95% CI: 0.76-0.89), and the specificity was 0.87 (95% CI: 0.82-0.91). Specificity showed no significant heterogeneity, while sensitivity exhibited considerable heterogeneity. The pooled area under receiver operating characteristics curve was 0.89 (95% CI: 0.86-0.91). The positive and negative likelihood ratio were 6.47 (95% CI: 4.64-9.03) and 0.19, respectively. The pooled diagnostic score was 3.53 (95% CI: 2.91-4.15), and the diagnostic odds ratio was 34.19 (95% CI: 18.36-63.64).

Conclusion and Discussion: The findings indicate that ML can effectively differentiate between RN and TP. However, additional studies are required to validate these results. ML-driven imaging analysis has the potential to enhance diagnostic accuracy and patient management.

Keywords: Brain neoplasms, Radiation, Radiosurgery, Radiotherapy

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