Diagnostic performance of machine learning-based magnetic resonance algorithm vs conventional magnetic resonance imaging for predicting the likelihood of brain tumours

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Author (Name and year)	*TP*	*FN*	*FP*	*TN*	*Sensitivity (95% CI)*	*Specificity (95% CI)*
Gates et al (ML MRI HGG, 2020)	6	0	0	53	1.00(0.61,1.00)	1.00(0.93,1.00)
Gates et al (ML MRI LGG, 2020)	41	1	2	53	0.98(0.88,1.00)	0.96(0.88,0.99)
Jun et al (ML MRI per lesion, 2018)	56	1	1	7	0.98(0.91,1.00)	0.88(0.83,0.98)
Jun et al (ML MRI per patient,2018)	18	1	0	46	0.95(0.75,0.99)	1.00(0.92,1.00)
Gates et al (CMRI HGG, 2020)	4	3	0	52	0.57(0.25,0.84)	1.00(0.92,1.00)
Gates et al (CMRI LGG, 2020)	36	5	3	52	0.88(0.74,0.95)	0.95(0.85,0.98)
Dort et al (CMRI, 2001)	51	6	1	542	0.89(0.79,0.95)	1.00(0.99,1.00)
Pooled					0.93(0.88,0.95)	0.99(0.98,1.00)

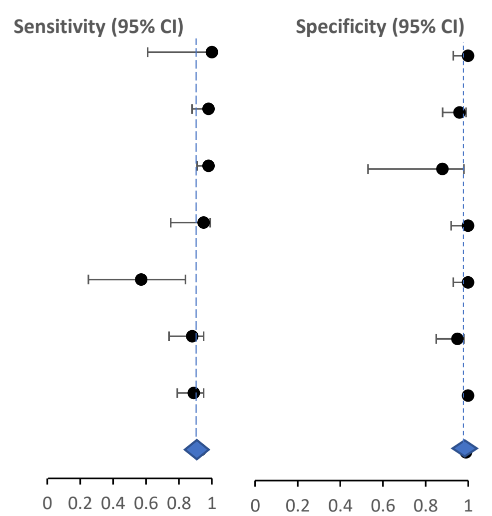

Fig 1. Forest plots for sensitivity and specificity.

Introduction

Magnetic resonance imaging (MRI) forms an imperative part of the diagnostic and treatment protocol for both primary brain tumours and metastasis. Though conventional T1 weighted MRI forms the basis for diagnosis at present, it faces several limitations. Machine learning algorithms require less expertise and provide better diagnostic accuracy.

Objective

This systematic review and meta-analysis aimed to compare the diagnostic performance of conventional MRI with machine learning (ML) algorithms for brain tumours.

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Materials and methods

A systematic review of PubMed, Google Scholar and Cochrane databases along with registries (World Health Organization International Clinical Trials Registry Platform and ClinicalTrials.gov) from 1980–2021 was done. Original articles in English evaluating conventional MRI or ML algorithms with/without usage of a reference standard were included. Data were extracted by two independent reviewers and meta-analysis was performed using a bivariate regression model.

Results

The study protocol was registered under PROSPERO (CRD42021289726). Twelve studies with 1,247 participants were included for systematic analysis and three studies for meta-analysis. ML algorithms had better aggregate sensitivity and specificity (80% and 83.14%, respectively) than conventional MRI (81.84% and 74.78%, respectively).The pooled sensitivity, specificity, diagnostic odds ratio (DOR) for the studies were 0.926 (95% confidence interval (CI) 0.840–0.926), 0.991 (95% CI

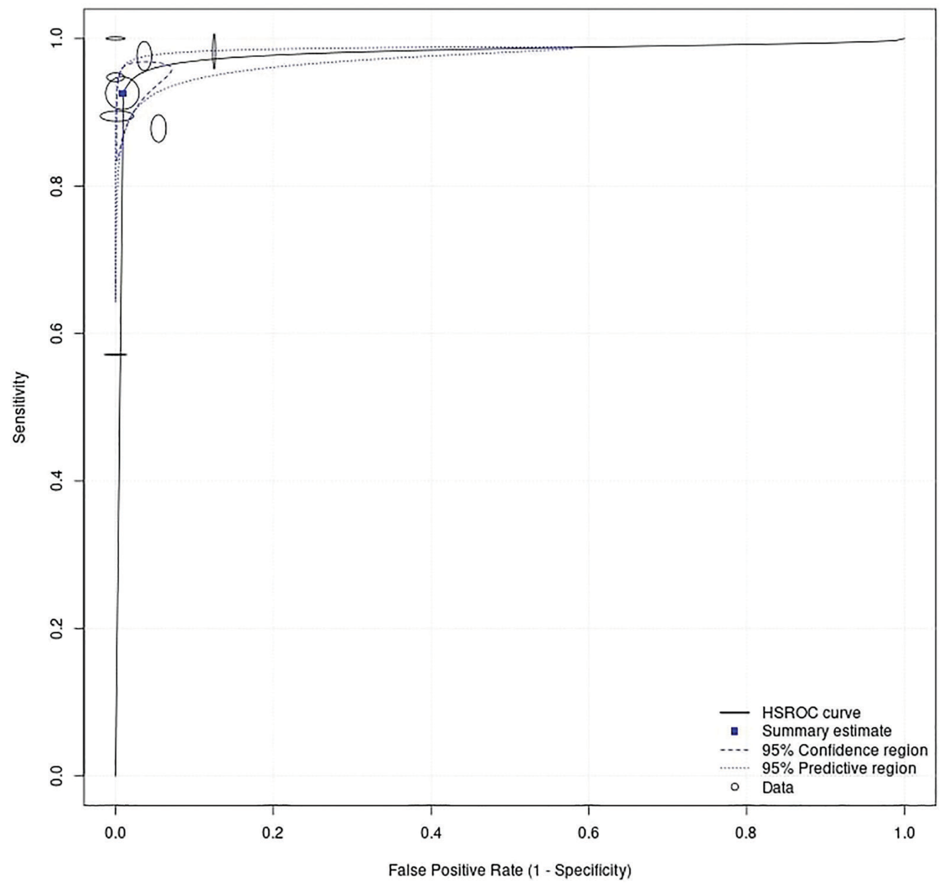

Fig 2. Summary receiver operating characteristic curve for brain tumour diagnosis (combined conventional magnetic resonance imaging and machine learning algorithm). AUC = 0.904.

0.955–0.998) and 1,446.946 (312.634–6,692.646), respectively, with area under the curve (AUC) 0.904 under hierarchical summary receiver operating characteristic (Figs 1 and 2). On subgroup analysis, MRS (100% and 100%) and random forest model (100% and 100%) had highest sensitivity and specificity, respectively; dynamic susceptibility contrast MRI and deep neural network (DNN) had highest AUC (0.98 and 0.986, respectively).

Conclusion

Machine learning algorithms have superior diagnostic performance and faster diagnostic capability once trained than conventional imaging for brain tumours. They have immense potential to be the standard of care in the future. ■