Bayesian transit-time modelling enhances GRE-DSC MRI perfusion metrics compared with standard deconvolution algorithms in untreated IDH-wild-type glioblastoma

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Objectives

To test whether a Bayesian transit-time model (BTM) that fits voxel-wise capillary transit-time distributions yields higher perfusion metrics in untreated *IDH*-wild-type glioblastoma compared with standard deconvolution algorithms for gradient-echo dynamic-susceptibility-contrast (GRE-DSC) MRI.

Materials and Methods

In this retrospective, single-centre cohort, 89 patients with glioblastoma underwent pre-therapeutic GRE-DSC MRI at 1.5 T (n = 15) or 3 T (n = 74). CBF, CBV and MTT maps were generated with the BTM (gamma-distributed residue, leakage correction) and two vendor pipelines. Using co-registered T1-post-contrast and T2/FLAIR images, two neuroradiologists independently performed region-of-interest analyses within visually identified tomour hotspots and contralateral normal-appearing white matter for quantification. Inter-rater agreement was evaluated with two-way intraclass correlation coefficients (ICC); paired Wilcoxon and Mann-Whitney U tests assessed intra- and inter-algorithm differences.

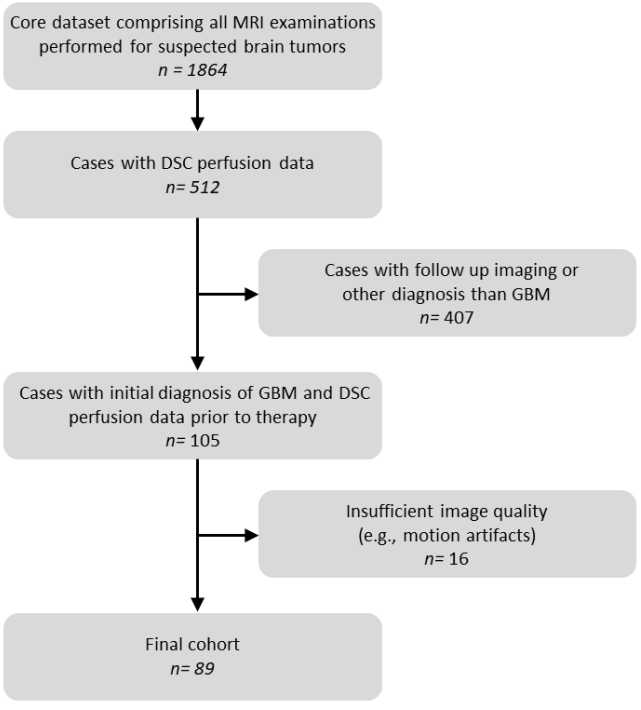

Figure 1. Flowchart of the patient selection process for this retrospective study.

Results

Inter-observer reliability was excellent (ICC = 0.86–0.94). BTM yielded significantly higher normalised perfusion ratios (median nCBF 5.4 vs 3.9, nCBV 4.8 vs 3.1, nMTT 2.2 vs 1.6; all $p < 0.001$). At 3 Tesla, BTM-derived nCBV exceeded 1.5 T values (5.0 vs 3.8, $p = 0.008$), whereas nCBF and nMTT were field-strength independent. Scanner-specific discrepancies disappeared after BTM processing.

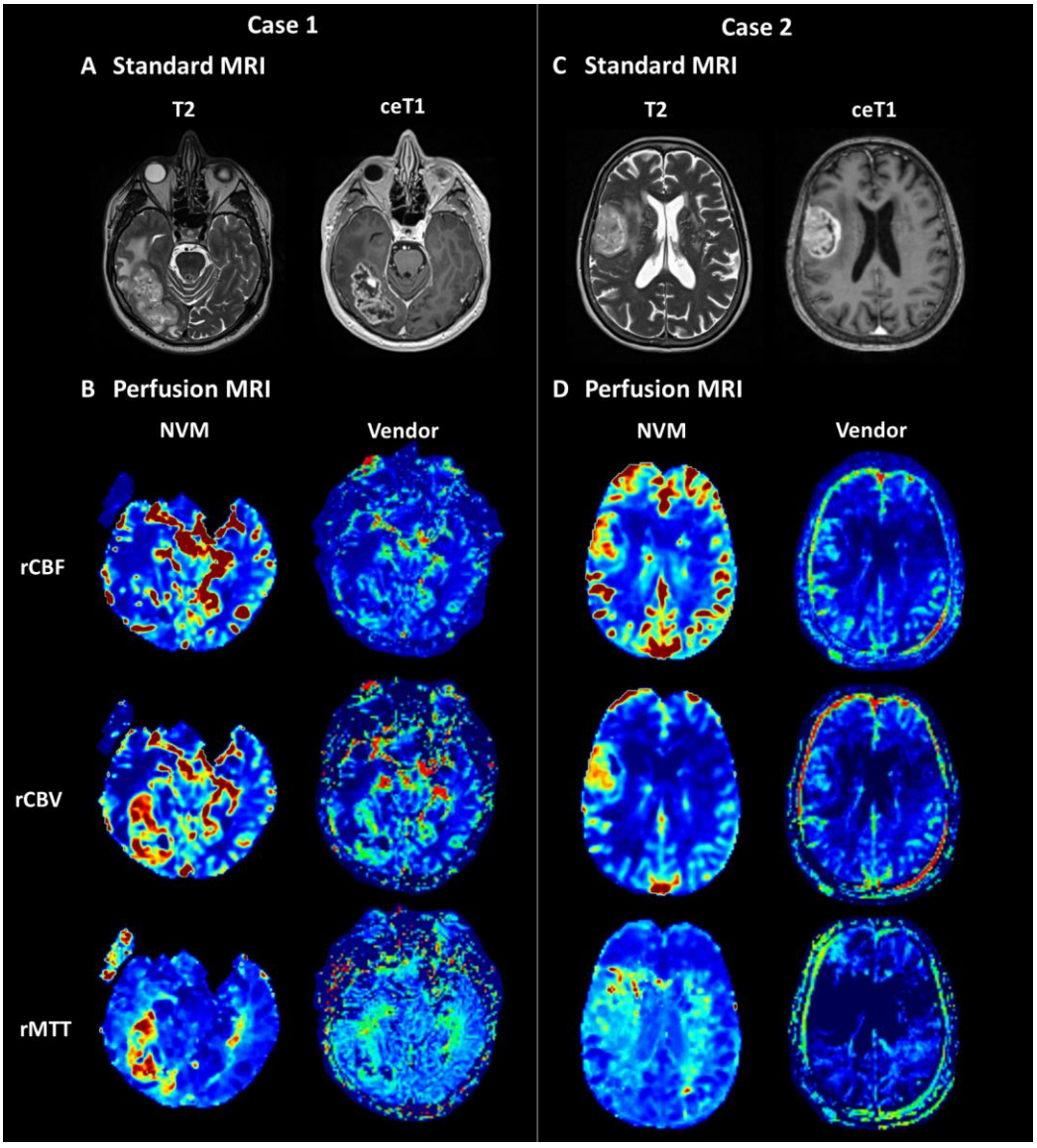

Figure 2. Illustrative DSC-MRI perfusion comparisons between the novel vascular model (NVM) and vendor algorithms in two glioblastoma cases.

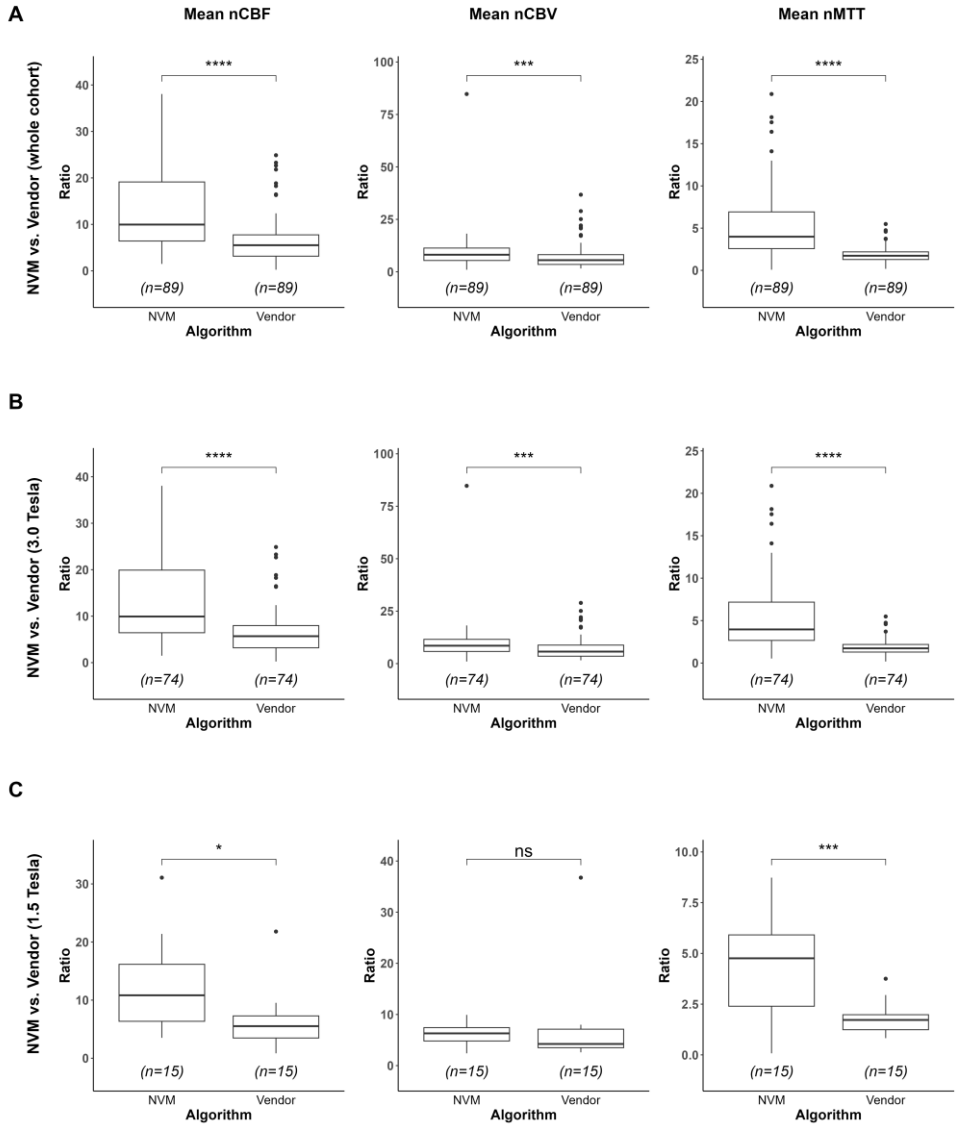

Figure 3. Illustrative DSC-MRI perfusion comparisons between the novel vascular model (NVM) and vendor algorithms in two glioblastoma cases.

Conclusion

BTM systematically increased GRE-DSC estimates of flow, volume and transit-time of hyperperfused hotspots in untreated glioblastoma, with the most pronounced effect at 3 T. Although these numerical gains imply improved detection of microvascular changes in glioblastoma, confirmation against histopathology is still required. Prospective multicentre trials should clarify whether BVM metrics translate into more accurate treatment monitoring and refined radiotherapy or surgical planning.