Purpose: Glioblastoma is the most common primary brain tumor in adults and is rapidly fatal. Treatment monitoring of these patients has increased awareness that many patients have new areas of contrast enhancement without progressive clinical signs and symptoms. Although the enhancing areas mimic tumor progression, the lesions result from treatment effects and subsequently stabilize or improve without further treatment and are not correlated with poorer outcomes. This phenomenon has been termed pseudoprogression and is hypothesized to occur secondarily to edema and vessel permeability in the tumor area as a result of the combined effects of radiation and chemotherapy. Since the new enhancing lesions of pseudoprogression are indistinguishable from true disease progression, there is a need for a predictive model to distinguish the two phenomena.

Method: We developed a classification algorithm that combines perfusion and diffusion MRI imaging to effectively partition the cases as one exhibiting true or pseudo progression based on a vector of features containing T1, rCBV and ADC imaging. The multi-sequence classification algorithm uses an expectation maximization (EM) algorithm that learns from training cases with known clinical outcome to assigns each voxel to a type of tissue.

Results: A training set of 20 where the clinical outcome is known from biopsy or from long-term follow-up was used by EM algorithm to model typical imaging values within tissue of pseudo, tumor, edema, necrosis, vessels or brain anatomy to construct a database of expected values for each tissue type. When presented with a new case, the algorithm automatically classifies voxels by their geographical proximities and Mahalanobis distance to the pre-sampled values.

Conclusion: Usage of advanced classification techniques allows automated labeling of voxels into normal, pseudoprogression or tumoral tissue types. The technique allows for early detection of pseudo progression to spare patients from unnecessary surgery or toxic chemotherapy.