Potential utility of early post-operative diffusion-weighted imaging and perfusion weighted imaging in differentiating between pseudo-progression and progression in patients with glioblastoma treated with temozolomide and radiotherapy

Xiang Liu[1], Wei Tian[1], Henry Wang[1], and Sven Ekholm[1]
[1]*Imaging Science, University of Rochester Medical Center, Rochester, NY, United States*

Purpose: Radiotherapy and concurrent/adjuvant temozolomide treatment is gold standard regimen for patients with newly diagnosed glioblastomas. However, this treatment protocol may induce up to 20-50% patients presenting pseudoprogression within 6 months after radiation/temozolomide treatment, which is difficult to be distinguished from true tumor progression on conventional MRI. Previous literatures reported that the restricted diffusion in the early post-operative MRI (<72 hours after operation) of such glioblastoma patients indicates the post-operative injuries, which subsequently transfer into pseudoprogression. Therefore, the purpose of this study is to differentiate between the pseudo-progression and true tumor progression based on early post-operative diffusion-weighted imaging and perfusion weighted imaging.

Materials and Method: A total of 41 cases of glioblastomas with dynamic susceptibility contrast perfusion weighted imaging and diffusion-weighted imaging acquired within post-operative 72 hours after resection were included in this study. Nine of the cases had to be excluded due to unacceptable imaging artifacts. Areas with visually detected low apparent diffusion coefficient (ADC) and increased relative cerebral blood volume (rCBV) in the peri-resection cavity regions were detected. Sequential MRI examinations at 1 month and 6 month after radiation/temozolomide treatment were performed to determine if these areas of enhancement represented pseudoprogression or true progression by means of the McDonald criteria. The difference of initial ADC and rCBV values in these pseudoprogression and tumor progression was evaluated with the Mann-Whitney U test.

Results: There were 48 post-operative peri-resection cavity regions with reduced ADC value, 33 among of them (68.8 %, mean ADC value 0.656±0.324; rCBV value 0.597±0.312), showed pseudoprogression on follow-up contrast enhancement T1WI, 15 areas (31.2 %, mean ADC value 0.597±0.268, p value=0.33; rCBV value 1.83±0.46, p<0.001) showed tumor progression. In addition, there were 12 true tumor progression regions with increased early post-operative rCBV value (1.61±0.27), but without reduced ADC value (1.13±0.35).

Discussion Our preliminary results showed that early postoperative restricted diffusion alone has limited value in differentiating between the pseudo-progression and true tumor progression. However, the areas with early postoperative high rCBV are prone to progress as true tumor progression.

Conclusions: Our findings suggest that early postoperative increased rCBV value may be a useful and novel imaging biomarker in differentiating between the pseudo-progression and true tumor progression in patients with glioblastomas treated with radiation and temozolomide.

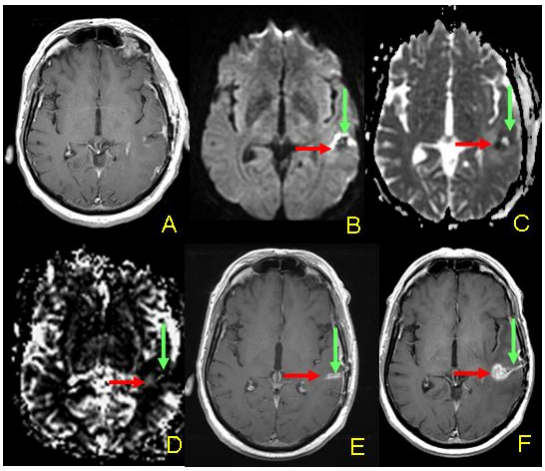
Reference:

Neurosurg Clin N Am. 2012 ;23:277-87,

Neurology. 2011;76:1918-24.

Am J Clin Oncol. 2012;35:284-9.

Neurology. 2006;67:1668-70.



A-D are post-contrast T1WI, DWI, ADC and rCBV map acquired within 24 hours after resection of glioblastoma. D and F are post-contrast T1WI image at 1 month and 6 moths after radiation and temozolomide. Both areas with red and blue arrow presented restricted diffusion. However, the area with blue arrow showed low rCBV, and its enhancement finally decreased (pseudo-progression). The red arrow area proved to be true tumor progression, with initial high rCBV,