APT-CEST imaging in the distinction between radionecrosis & tumor recurrence in brain metastasis

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Introduction

This case report shows the potential added value of Amide Proton Transfer (APT) contrast in the discrimination between radio-induced toxicity lesions and tumor progression in brain metastatic disease.

Baseline

During the routine follow-up of a 47-year-old woman with breast cancer, 3T brain MRI revealed two intra-axial contrast enhancing lesions, one in the head of the right caudate nucleus and the other in the inferior frontal/ anterior insular region, consistent with breast cancer metastasis (Figure 1). Due to the small size of the lesions, they were both treated with Gamma Knife Stereotactic Radiosurgery in a single-session.

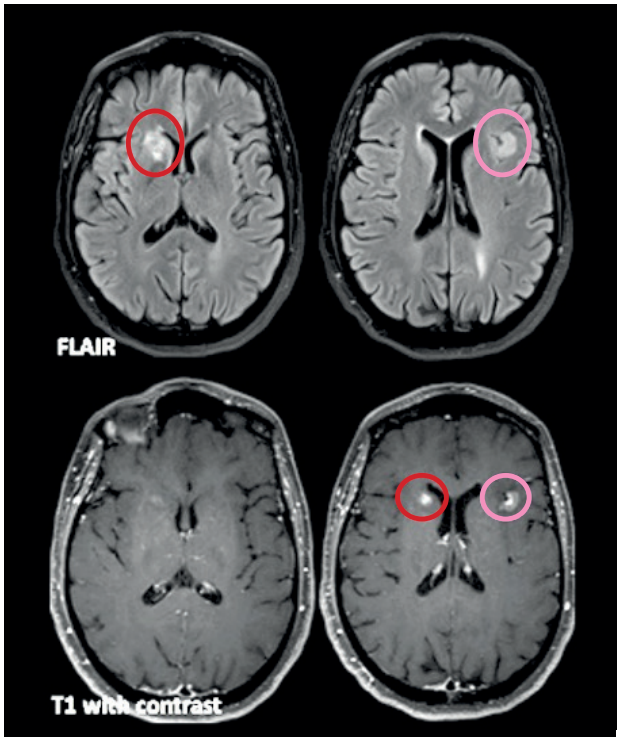


Figure 1 MRI scan at baseline: two contrast- enhancing lesions in the right caudate nucleus (red circle) and the inferior frontal / anterior insular region (pink circle).

Two months' follow-up

Two months after Stereotactic Radiotherapy, lesions volumes were markedly decreased both on FLAIR and T1 post-contrast imaging, demonstrating a response to therapy (Figure 2).

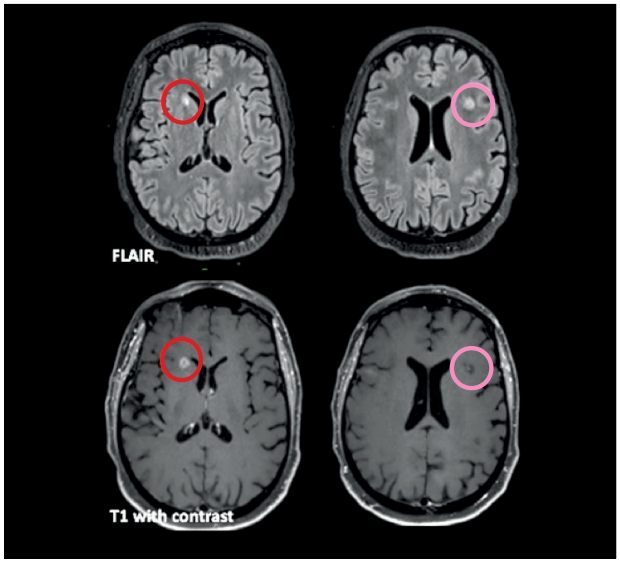


Figure 2 MRI scan two months after the radiotherapy: clear volume decrease of both treated metastases.

Twelve months' follow-up

One year after radiotherapy the caudate nucleus lesion (red circle) had increased slightly in size, while the second lesion was further reduced and showed no enhancement (pink circle) (Figure 3). Radiation-induced toxicity phenomena were suspected for the first lesion and advanced MRI examination with perfusion sequence was requested.

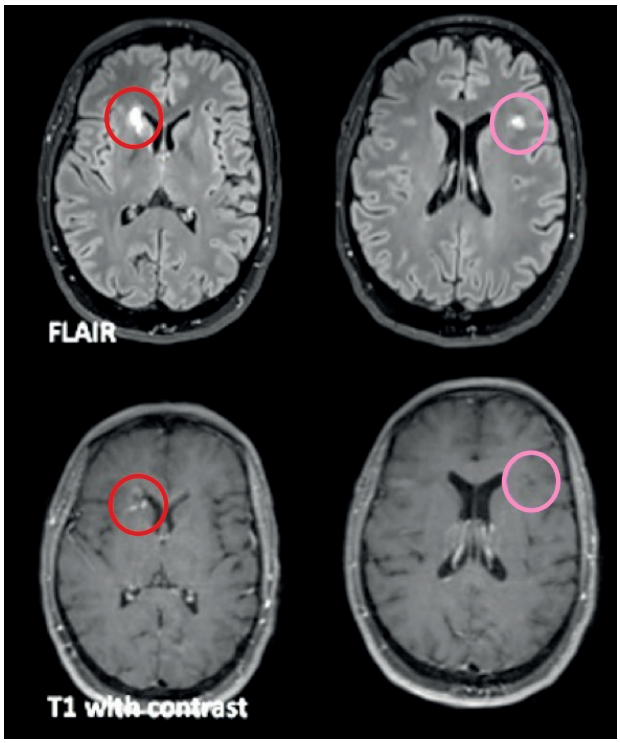
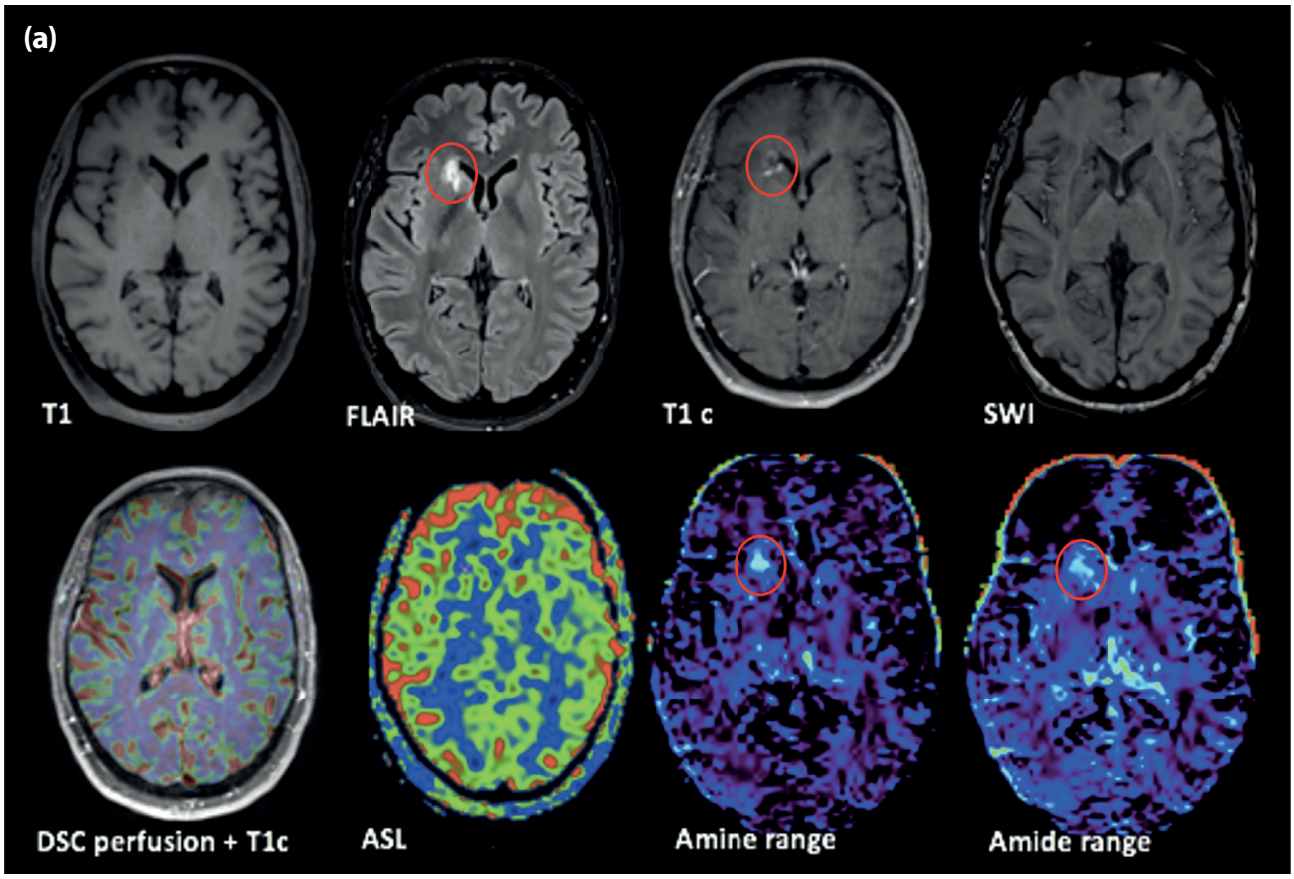


Figure 3 MRI scan performed twelve months after radiotherapy: the metastasis in the right caudate nucleus enlarged and maintained contrast enhancement (red circle) while the second metastasis continued to decrease and showed no enhancement (pink circle).

Complementary multiparametric MRI protocol included Dynamic Susceptibility Contrast (DSC) perfusion, Arterial Spin Labeling (ASL), axial diffusion, Susceptibility-Weighted Imaging (SWI) and Amide Proton Transfer (APT) Chemical Exchange Saturation Transfer (CEST) sequences. The lesion in the right caudate nucleus had some hemosiderin deposits on SWI, without spontaneous hyperintense T1 signal (Figure 4).

It did not present any neovascularization (red circle), neither on DSC perfusion nor ASL perfusion. In contrast, the signal in APT-weighted maps (computed in Amine and Amide range) increased in this area, thus leading to a suspicion of tumor progression. A complementary (18)F-fluorodeoxyglucose Proton Emission Tomography (PET) was also done, showing no pathological hypermetabolism for the caudal lesion.



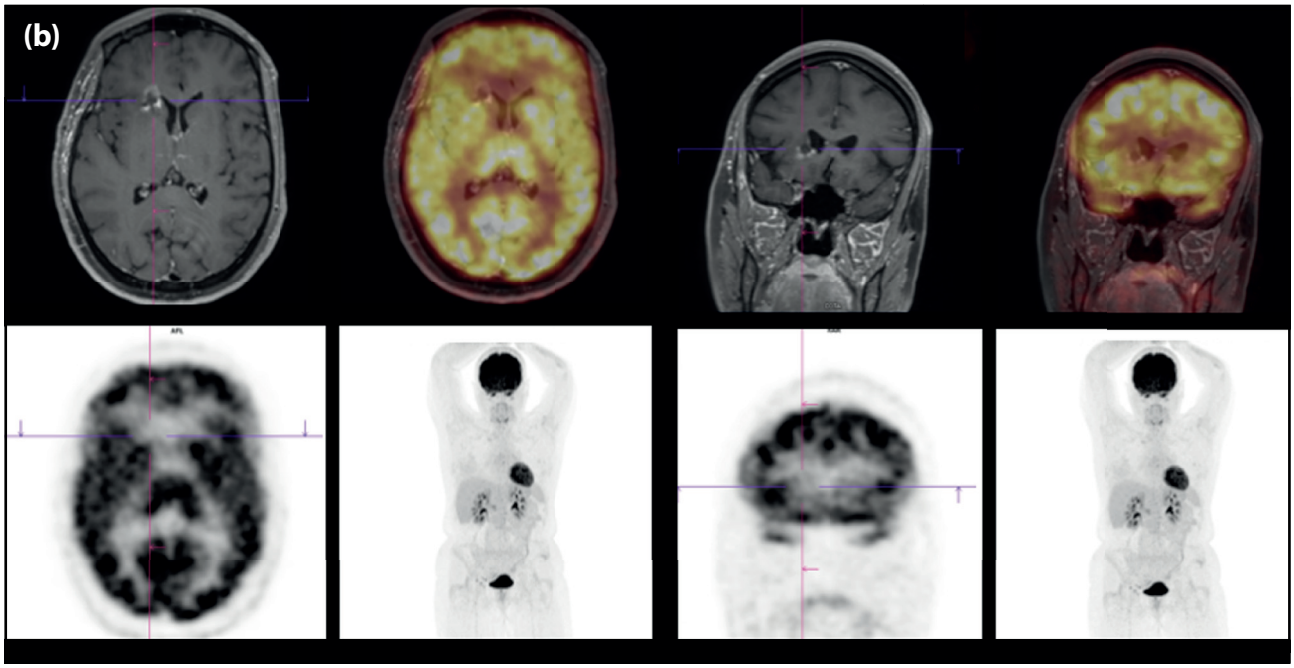


Figure 4 3T Multiparametric MRI after twelve months focused on the first lesion:

(a) MRI examination. APTw maps computed in amine and amide range with fluid suppression to suppress possible hemosiderin components on APT contrast showed an increase signal in the lesion of the right caudate nucleus (red circle, bottom right maps). None of the perfusion maps (DSC + ASL) showed neo-vascularization in this area (bottom left maps).

(b) 18F-FDG examination did not show pathological hypermetabolism in the right caudate lesion.

The second metastasis in the fronto-insular region did not show any increase in the APTw maps, nor on the rCBV or rCBF map, confirming no tumor viability of this lesion (Figure 5).

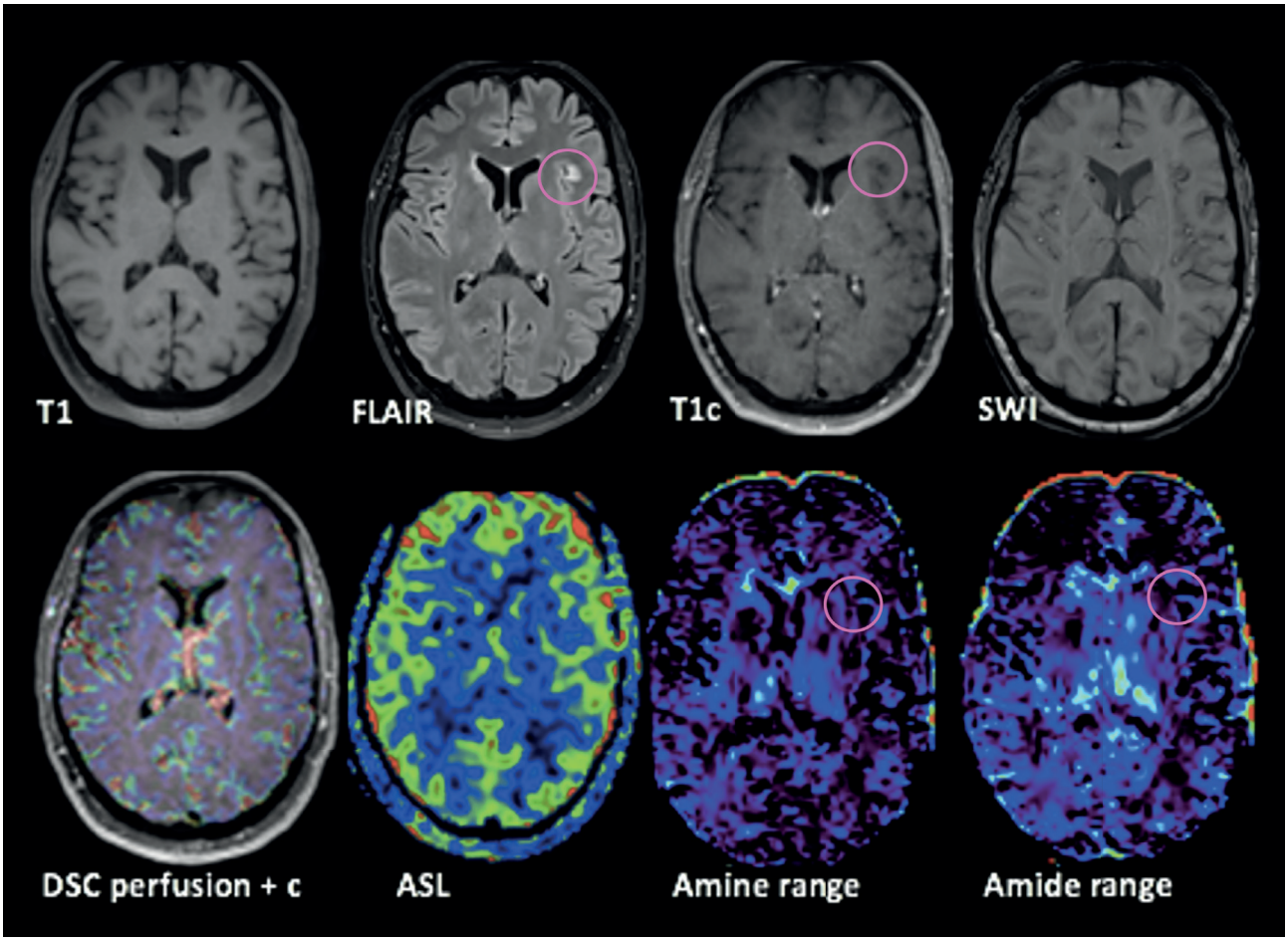


Figure 5 Multi parametric examination after 12 months focused on the second lesion: no contrast change was visible neither on APTw maps (computed in amine and amide range) nor on the DSC and ASL perfusion imaging in the lesion of the insular region (pink circle).

Fourteen months' follow-up

A further MRI follow-up after 2 months with DSC perfusion imaging showed the appearance of hyperperfusion suggesting neo-angiogenesis (relative CBV 3.5 higher than in contralateral white matter) in the right caudate lesion (red circle) confirming tumor progression (Figure 6).

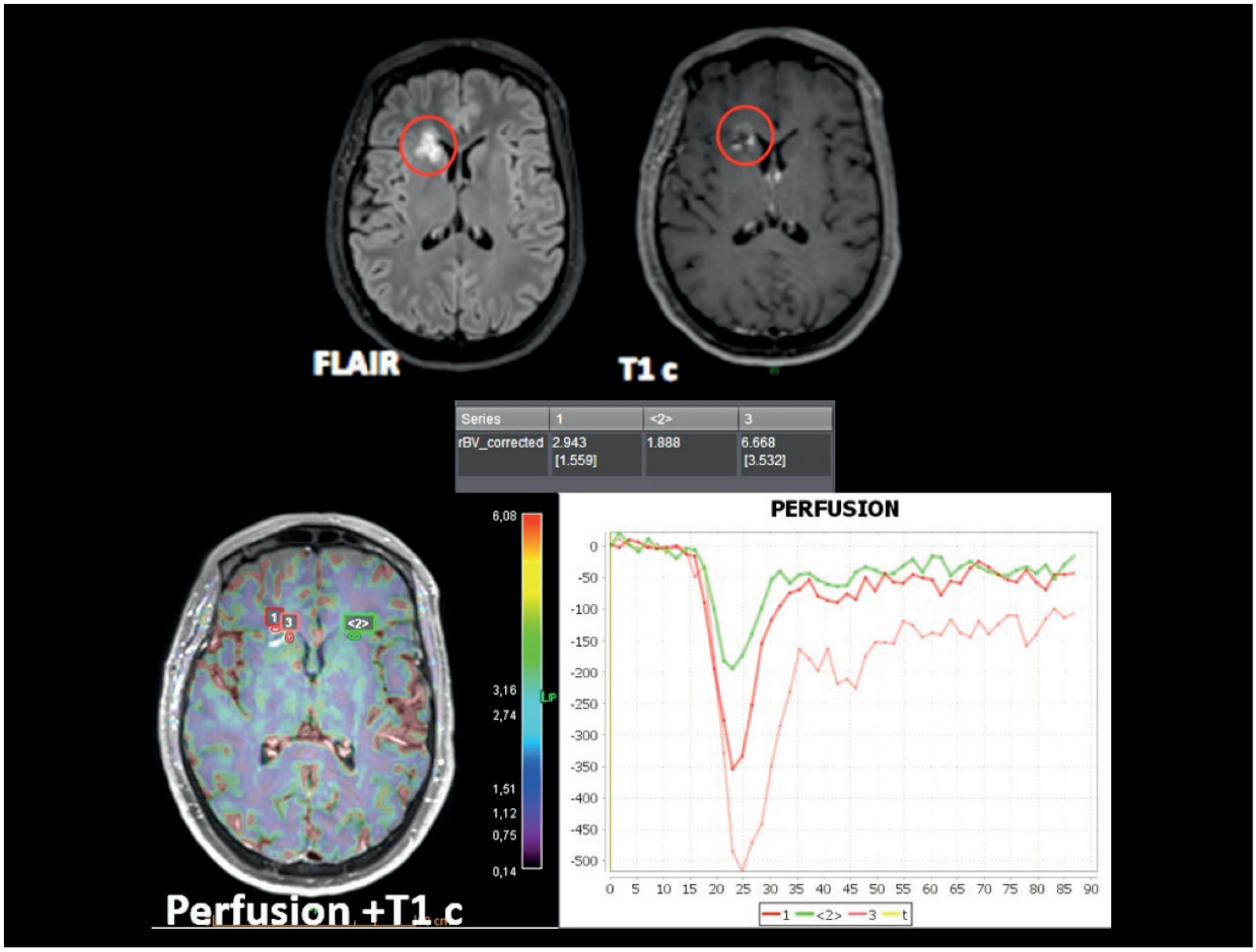


Figure 6 DSC perfusion imaging after 14 months follow-up focused on the first lesion: the lesion presented this time hyperperfusion suggesting neo-angiogenesis (relative CBV 3.5 higher than in the contralateral white matter).

Conclusion

In this patient APT-CEST predicted tumor progression two months before the appearance of neo-angiogenesis on DSC perfusion imaging. This case report suggests that APT imaging may detect tumor recurrence before perfusion and PET imaging and thus be useful in the therapeutic monitoring of brain metastasis, especially in the distinction between tumor progression and radiation-necrosis.
Although this finding clearly needs to be confirmed in a larger number of patients, it is in agreement with previous studies which suggested the interest of APT-CEST signal in the post-treatment evaluation of brain tumors.

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