# Application of simultaneously acquired T1 & T2* dynamic perfusion study using Gd-DTPA in breast tumors of the rat

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**Introduction**

Dual dynamic contrast-perfusion MR imaging method that combines both T1 and T2*(ΔR2*) imaging had been used to evaluation of tumor perfusion and to eliminate the T1 effect for the elimination of underestimation of regional blood volume. To get the ΔR2* correction, we applied dynamic T1/T2* dual gradient echo sequence and underwent post-processing works. The purpose of this study is to test the application of simultaneously acquired T1 & T2* dynamic perfusion study using Gd-DTPA in breast tumors of the rat and to test the differential diagnosis between benign breast tumor and malignant tumor using vascular permeability and corrected T2* perfusion with histological correlation.

**Materials and Methods**

Ethyl-N-nitrosourea (45, 180mg/kg) was inoculated intra-pertoneally at 30-day-old female Sprague-Dawley rats. About 3-4months later, benign fibroadenoma and malignant carcinoma were developed in rat breast. In each tumor the perfusion and vascular permeability were measured by using Gd-DTPA at a dose of 0.2mmol/kg. The MRI study protocol consisted of T2-weighted anatomic imaging, T1, T2, and rho map (TR/IR/TE=1448/1848/20,40,60,80,100,120,140,160, matrix=256x192, slice thickness/gap=5mm/1mm, 5 slices, TSE factor=8, acquisition time=8 min 27 sec), single slice dynamic T1/T2* gradient dual echo sequence (1000 phases, TR/TE1/TE2/α=10/2/8msec/30°; temporal resolution=1.28 sec; FOV=20cm; slice thickness=5mm; matrix size=128×128), post-contrast T1-weighted, fat-suppressed imaging. T1, T2, and rho map has selected a plane through the mid portion of the tumor based on T2-weighted imaging, and single section was evaluated in the center of the map imaging in dual dynamic T1/T2* sequence. By using dynamic T1/T2* gradient dual echo sequence, both T2* shortening and T1 shortening effects were simultaneously obtained after a single bolus injection. The correction of ΔR2* was obtained by the separations of T1 and T2* values in PC work station. The corrected ΔR2*-curve was plotted as a function of time using tumor ROI method. High vascular area of the tumor in vascular volume map image was selected. Vascular permeability (K1, K2) was calculated at each tumor. After the imaging studies had been completed, the tumor was removed and the tissue were fixed in 10% buffered formalin, embedded in paraffin, sectioned and stained with hematoxylin and eosin. The Scarff-Bloom-Richardson(SBR) method was applied for tumor grading, range from 3 to 9 points. Special stain using CD31 for the evaluation of microvessel density (MVD) was also acquired. MVD was counted in 20 400X fields in areas of highest MVD, range from 56 to 318.

**Results**

10 rats developed mammary tumors, 2 fibroadenoma, 5 low grade carcinoma, 1 intermediate grade carcinoma, 2 high grade carcinoma. K1 and K2 was not correlated with SBR and MVD. Dynamic curve pattern of ΔR2* was different between benign and malignant breast tumor. Corrected ΔR2* curve in breast carcinomas showed rapid rise and fall and steady state, whereas fibroadenomas showed gradual rise and gradual decrease.

**Conclusions**

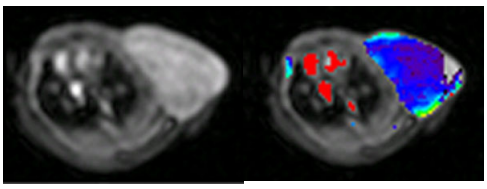
The method to correct ΔR2* using simultaneous T1/T2* gradient dual echo sequence could differentiate between benign breast tumor and malignant breast carcinoma in rat tumor model. Vascular permeability using Gd-DTPA could not differentiate between benign breast tumor and malignant breast carcinoma.

**Reference**

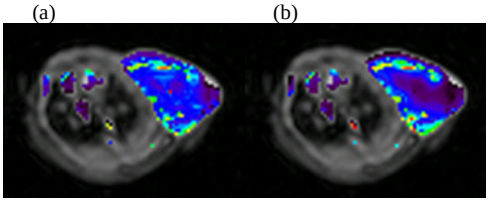
1. Su et al. JMRI 1999;9:177-186
2. Miyati et al. JMRI 1997;7:230-235

Fig 1. The breast carcinoma. (a) Postcontrast dynamic dual echo image images showed a solid mass. (b) Vascular volume map. (c) K1 map. (d) K2 map.
Fig 2. High grade breast carcinoma. Top graph showed T1, middle showed T2*, bottom showed ΔR2*. ΔR2* showed rapid rise and rapid decrease.
Fig 3. Benign fibroadenoma. Top graph showed T1, middle showed T2*, bottom showed ΔR2*. ΔR2* showed relatively gradual rise than carcinoma and gradual decrease.

Fig 1



(a) (b)



(c) (d)

Fig 2.

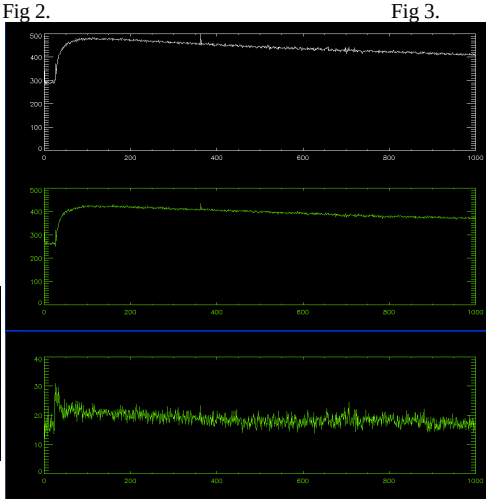


Fig 3.