A Comparison of Quantitative Dynamic Contrast-Enhanced CT and MRI in Musculoskeletal Tumors

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Introduction: Musculoskeletal (MSK) tumors are uncommon but have a poor prognosis, often afflicting young people. Standard clinical imaging somewhat poorly predicts the biological aggressiveness of these tumors, complicating management of the individual patient (1). Measurement of tracer kinetic parameters via dynamic contrast-enhanced (DCE) MRI is a promising technique for evaluating tumor aggressiveness (2). Standardization and validation studies for DCE-MRI in MSK tumors have been lacking, however (3-5). This is important considering the rarity, diversity (75+ sub-types), and variable body location of these tumors.

Purpose: Validate DCE-MRI in MSK tumors by comparing to DCE-computed tomography (CT) in the same patients.

Methods: For 6 MSK tumor patients, DCE-MRI (3T Siemens Trio) was performed with 3D FLASH: TR=6.3 ms, TE=1.6 & 3.9 ms, FA=25°, 18-36 slices, matrix=128x96, Δz=5 mm, 65 dynamic images, Δt=3.3-6.3 s, 0.1 mmol/kg Magnevist (Bayer Schering Pharma). Phase images were saved for estimation of Gd concentration-vs-time in major feeding arteries (6-7). T1 maps were obtained pre- and post- DCE using a variable flip angle technique (TR=20 ms, FA=4, 25°) (8), for estimation of Gd conc.-vs-time in tumor (9). Low-radiation-dose DCE-CT (Toshiba Aquilion One) was performed within 4 days of MRI: kVp=80-100, 13-40 slices, matrix=512x512, Δz=3 mm, 20-68 dynamic images, Δt=2.0-15.0 s (variable sampling), 50-100 ml Isovue 370 (Bracco), total effective dose=1.2-10.0 mSv (avg 3 mSv). DCE-MRI and CT data were analyzed with NordicICE (Nordic Neuro Lab) to obtain parametric maps of Ktrans (min^{-1}), blood volume (BV) (%), and distribution volume (ve) (%) (10-12). Mean whole-tumor-volume values were computed. Paired Wilcoxon (p-value), Lin's concordance coefficient, and Bland-Altman were used to compare CT vs MRI estimates.

Results: Pathological diagnoses of the tumors were: giant cell tumor (GCT) of bone (wrist, Fig. 1), undifferenciated pleomorphic soft tissue sarcoma (thigh), metastatic renal cell carcinoma (thigh), Ewing's sarcoma (forearm), diffuse large B- cell lymphoma (lower abdomen), and high-grade myxofibrosarcoma (upper arm). The agreement between CT and MRI was good for Ktrans and moderate for BV and ve (Table 1).

Discussion: Considering the variety of tumors and body locations studied, as well as major differences between the two imaging modalities (e.g. coverage, image orientation, spatial resolution, type and volume of contrast agent) the agreement obtained between CT and MRI was gratifying. Although the number of patients in this pilot study is small, the results are encouraging.

Conclusion: In six musculoskeletal tumors, we observed reasonable agreement in tracer kinetic parameters measured with CT and MRI. In particular, Ktrans had very similar mean values and showed good correlation on a case-by-case basis. This represents an important step forward for quantification of DCE-MRI for these tumors.

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a) Ktrans CT   b) Ktrans MR

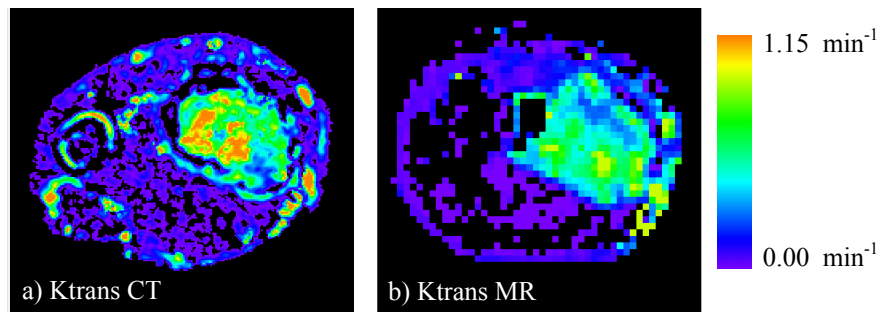1.15 min^{-1}

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Fig. 1 (above): Ktrans maps of GCT in the wrist, obtained by a) DCE CT and b) DCE MRI in the same patient. Table 1 (below): CT vs MRI for all patients.

Patient #	Ktrans CT	Ktrans MRI	BV CT	BV MRI	ve CT	ve MRI
1	0.59	0.48	6.8	4.6	30.2	25.6
2	0.18	0.19	5.9	3.3	23.4	36.6
3	0.16	0.12	6.1	7.7	7.5	31.4
4	0.16	0.07	3.6	2.8	17.4	18.3
5	0.10	0.15	5.3	2.2	20.4	31.3
6	0.11	0.21	2.8	1.5	17.5	28.3
Mean	**0.22**	**0.20**	**5.1**	**3.7**	**19.4**	**28.6**
Std.dev.	**0.18**	**0.14**	**1.5**	**2.2**	**7.5**	**6.2**
Wlcx. p	**0.84**		**0.16**		**0.09**	
c. coeff.	**0.87**		**0.47**		**-0.02**	
B.A.bias	**0.01**		**0.8**		**-9.2**	
B.A. 2σ	**0.16**		**1.8**		**19.6**	