Dynamic Contrast Enhanced MRI of the Breast: Kinetic curve analysis to determine the optimal temporal resolution

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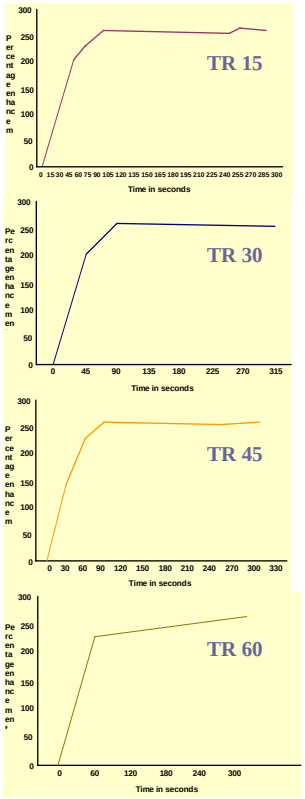
Purpose: MRI pulse sequences require a trade-off between spatial and temporal resolution for breast imaging. Because of this, clinical protocols frequently use a combinatio of dynamic imaging along with high spatial resolution sequences. However, the minimal temporal resolution to reliably reproduce the time-intensity curves remains poorl defined. The purpose of this study was to evaluate the required temporal resolution for dynamic contrast enhanced (DCE) magnetic resonance imaging (MRI) of the breast fc optimal characterization of breast lesions as benign versus malignant[1, 2].

Materials and Methods: Forty eight patients were evaluated using a 1.5 T system with a bilateral dedicated breast coil. All patients had single masses except one wit multicentric DCIS. MRI examination was performed that included DCE consisting of one pre- and at least 14 post-contrast series with 15 second temporal resolution pe acquisition. Post-processing of the DCE exam was performed with Computer Aided Detection (CAD) software using a four compartment modified Tofts model[3]. The 15 secon quantitative data from the kinetic curve was extracted and temporal resolution was systematically reduced to 30, 45 and 60 second temporal resolution per acquisition. Then, was in and washout slopes and washout percentage changes were calculated and the shapes of each curve (progressive, plateau and washout) were assessed separately at each tempora resolution. Logistic regression and probability cutoff were used to determine associations and significance. ROC analysis was performed to assess the diagnostic accuracy of eac parameter at each temporal resolution.

Results: Thirty eight patients (79%) had malignant lesions and 10 patients had benign lesions (21%). For wash-in slope, only the 45 second dataset predicted benign versu malignant diagnosis (p =0.049). For the washout slopes, 15 sec (p=0.006), the 30 second (p=0.006), 45 sec (p=0.012) and 60 sec (p=0.011) datasets predicted benign vs. malignar and 15 sec dataset had the greatest area under ROC curve (0.791). For the washout percentage, the 15 second (p=0.007), 45 sec (p=0.011) and 60 sec datasets (p=0.016) showe significant association with malignant versus benign diagnosis; again the 15 sec dataset showed the highest area under ROC curve (0.7813). The area under ROC was maximize by combining the wash-in and wash-out slopes (ROC = 0.866 for 15 second temporal resolution and 0.868 for 60 seconds). The shape classification of the kinetic curve wa affected by the choice of temporal resolution, with the 45 sec curves showing better correlation with biopsy results (odds ratio=7.03, p=0.002).

Temporal Resolution in seconds per acquisition	*Odds Ratio*	*P value*	*Confidence Interval*	*Probability Cut off*	*Corresponding sensitivity and specificity*	*Area under ROC*
			Wash in Slope			
15 sec	2.12	0.052	0.99-4.55	0.75	70%	0.73
30 sec	*2.08*	0.073	0.94-4.596	0.75	70%	0.69
45 sec	*1.88*	0.049	1.0 -3.45	0.8	55%	0.57
60 sec	2.07	0.072	0.94-4.6	0.75	70%	0.69
			Wash out Slope			
15 sec	*3.8e-06*	0.006	5.43e-10 – 0.03	0.75	80%	0.7912
30 sec	7.0e-06	0.006	1.49e-09 – 0.03	0.75	80%	0.7887
45 sec	0.000046	0.012	1.87e-08 – 0.1	0.75	80%	0.7641
60 sec	0.000065	0.011	3.95e-08 – 0.1	0.75	75%	0.7543
			Washout percent change			
15 sec	*1.047*	0.007	1.013 - 1.08	0.75	80%	0.7813
30 sec	*1.01*	0.194	0.99 - 1.02	0.75	80%	0.7518
45 sec	1.043	0.011	1.0098 - 1.077	0.75	80%	0.7715
60 sec	1.035	0.016	1.0065 - 1.064	0.75	75%	0.7424
			Type of the curve			
15 sec	*4.8*	0.008	1.51-15.3	. 85	75%	0.7711
30 sec	4.96	0.006	1.6-15.6	. 85	72%	0.7855
45 sec	7.02	0.002	2.0-4.7	0.88	75%	0.8197
60 sec	4.33	0.014	1.3-13.9	0.85	70%	0.7526

Table: The relationship between kinetic parameters and the final diagnosis of benign vs. malignant. The probability cutoff is shown as well as the corresponding sensitivity, specificity and area under the ROC curve for each parameter.



Figure; Kinetic curves drawn for one patient acquired at temporal resolution (TR) of 15 sec, and then systematically reduced to TR 30, 45 and 60 sec per acquisition. Note that the shape of the curve changes with changing temporal resolution. For example, at TR = 60 sec, the washout portion of the curve is progressive rather than plateau. Biopsy proved the tumor to be in-situ and infiltrating ductal carcinoma

Conclusion: DCE data with at least 45 second temporal resolution appears to be necessary to maximize the agreement between the DCE data and benign versus malignar diagnosis.

References:

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