T1-mapping and OE-MRI of patients treated with radiotherapy for breast cancer

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T1-mapping and OE-MRI of patients treated with radiotherapy for breast cancer

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Purpose: Radiotherapy (RT) of breast cancer has been shown to result in decreased performance in pulmonary function tests (PFT) up to ten years post-irradiation (Erven et al. 2012). However, PFT only provide global evaluation and cannot visualize regional differences in lung function. The purpose of this study is to investigate whether oxygen enhanced (OE) -MRI and T1-mapping can be used to detect chronic regional changes in lung function after breast radiotherapy.

Subjects and Methods: In this pilot study, five women (52 – 60 years) who received RT of either left or right breast > 10 years ago, and for which treatment plans were available, were included. Seven healthy volunteers (42 – 64 years) were recruited as controls. Baseline T1-quantification and OE-MRI of a coronal slice was performed with the Snapshot FLASH pulse squence (Arnold et al. 2004) on a SIEMENS Avanto Fit (Siemens Medical, Erlangen, Germany). Measurements were made during light inspiratory breath hold, with each T1-map being collected in 3 seconds. Medical air and oxygen was supplied by a Hans Rudolph V2-mask 7450 (Hans Rudolph Co., Kansas City, MO). The average of nine coronal T1-maps was used for baseline and OE measurements. For RT-patients, a ROI was drawn in the apical part of the lung where the treatment plan indicated a dose > 30 Gray. For the non-irradiated side and controls, a ROI was drawn encompassing the upper lung, down to the level of the aortic arch. The mean T1-value of the entire ROI was used. The OE effect was quantified as the change in transversal relaxation rate ΔR1=R1(o2)-R1(air). The T1 and ΔR1 of the three groups (right RT, left RT and controls) were tested with multiple comparisons ANOVA. All subjects performed PFT which was compared with Student's T-test (all RT vs. controls).

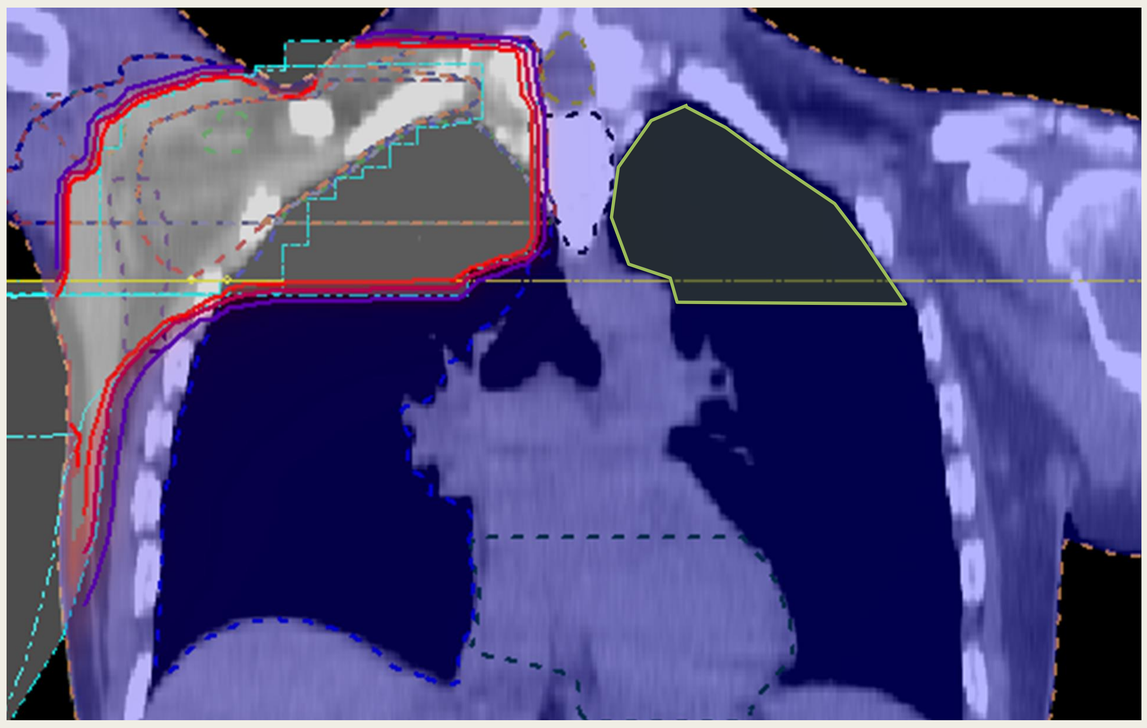

FIGURE 1: Representative dose plan for a right side RT patient. The ROI of the dependent side is the intersection of lung and >30 Gy isodose (red line). The ROI of the untreated side is the upper lung down to the level of the aortic arch (green line).

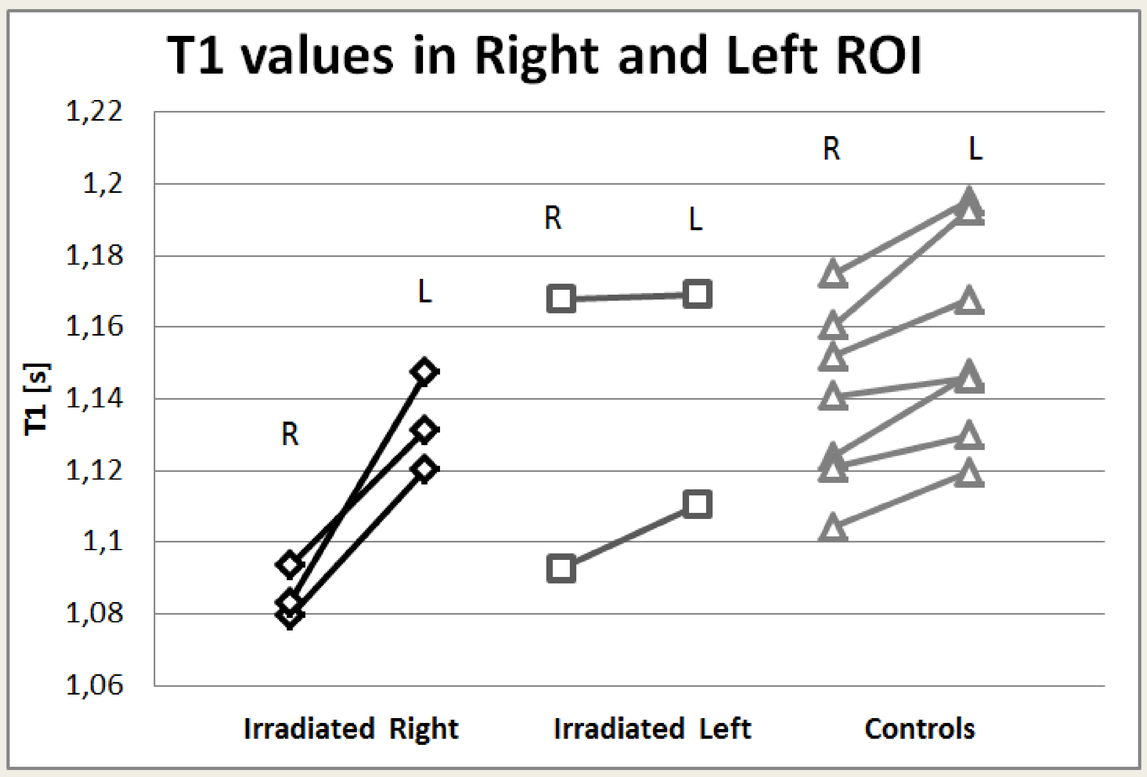

FIGURE 2: T1 values in right and left apical ROI for the three groups. The quotient or R/L T1 was lower ($p<0.05$) for the right treatment group.

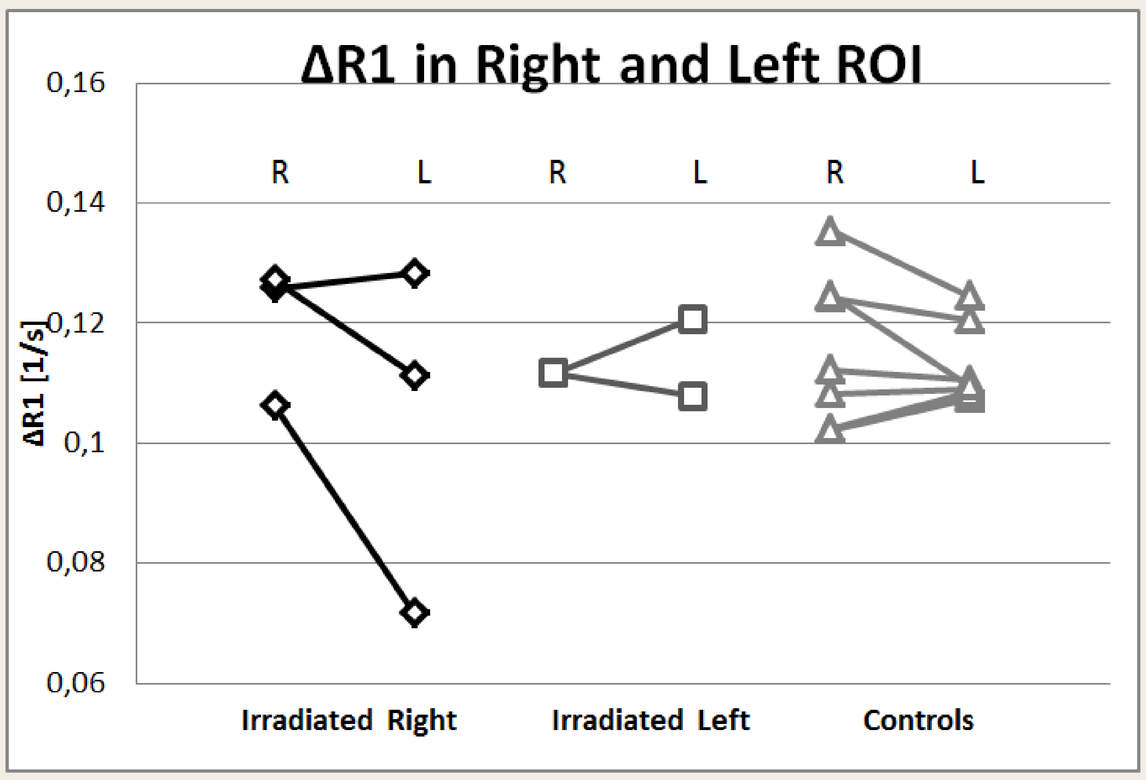

FIGURE 3: ΔR1 values in right and left apical ROI for the three groups. The quotient or R/L ΔR1 was not statistically different between groups.

Results & Discussion: No difference ($p<0.05$) between the RT group and controls were found for FEV, VC or DLCO. No difference ($p<0.05$) in R/L ΔR1 ratios was found between the left RT group and right RT group or controls. Baseline T1 values of the right and left ROI for all subjects are presented in the figure. The mean R/L T1-ratio of the right treatment group was significantly different from the other groups ($p=0.013$) with a mean of 0.96, compared to 0.99 (left treatment group) and 0.98 (controls). According to the treatment plans, the patients which received treatment of the right breast recieved > 30 Gy to 10-15 % of the lung volume, while treatment of the left breast resulted in > 30 Gy to 5 and 8 % of the lung.

References:

Erven, K. *et al.* Changes in pulmonary function up to 10 years after locoregional breast irradiation. *Int. J. Radiat. Oncol. Biol. Phys.* 82, 701–707 (2012).

Arnold, J. F. T. *et al.* Imaging lung function using rapid dynamic acquisition of T1-maps during oxygen enhancement. *MAGMA* 16, 246–53 (2004).

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