Importance of Post-Treatment Delay for the Evaluation of the Response to MRIgFUS

A. Khiat[1], D. Gianfelice[1], M. Amara[1], A. Belblidia[1], Y. Boulanger[1]

[1]Radiology, Hôpital Saint-Luc du CHUM, Montréal, PQ, Canada

INTRODUCTION

The ability to determine noninvasively the extent of residual tumor following magnetic resonance imaging-guided focused ultrasound surgery (MRIgFUS) of breast tumors is essential for the validity of the technique. Evaluation of the response by clinical examination is confounded by necrosis and fibrosis often being intermixed with residual tumor and breast edema. In our previous work, parameters from dynamic contrast enhanced MRI (DCE-MRI) were demonstrated to be promising to monitor the effects of MRIgFUS treatment of breast cancer (1). In this study, a refined analysis has been performed on a larger number of patients which highlights the importance of the time interval between treatment and evaluation.

METHODS

Twenty-one patients aged between 48 and 78 years (average: 59.0 years) with small breast tumors (0.11 to 8.8 cm^3) were treated with MRIgFUS (1,2). DCE-MRI data were acquired 3-21 days after initial treatment of the breast lesion by MRIgFUS and before patients underwent standard surgical lumpectomy. Dynamic MR images were acquired using fast spoiled gradient echo (FSPGR) images (TR = 6.4 ms; TE = 2.4 ms, preparation time = 22 ms; flip angle = 10º; slice thickness = 4 mm, no gap; 256 x 128) following injection of the MR contrast agent gadopentetate dimeglumine (0.1 mmol/kg body weight). Following routine segmental resection, a complete three-dimensional macroscopic and microscopic histopathologic analysis was performed to evaluate the percentage of residual cancer. DCE-MR images were analyzed using a locally developed program which calculates the most enhancing pixel within the entire tumor and signal intensity vs time curves at this pixel. Response to treatment was assessed semi-quantitatively by calculating several DCE-MRI parameters. These parameters were calculated for all patients (21 patients) and for the patients who had their evaluation at least seven days after MRIgFUS treatment (17 patients). DCE-MRI parameters were evaluated using the FUNCTOOL program (GE Medical Systems).

RESULTS

A strong correlation between several DCE-MRI parameters and % of residual tumor was found, and when four patients who had their evaluation only three days after MRIgFUS treatment were excluded from the analysis, the correlation was much stronger. As an example, the correlation coefficient for the percentage increase in signal intensity (ISI) parameter was 0.81 and 0.93 (Graphs 1A, 1B), respectively, for all patients and for patients analyzed after seven days. For the positive enhancement integral (PEI) parameter, values were 0.68 and 0.84, respectively (Graphs 2A, 2B). For the four patients whose evaluation was performed three days after MRIgFUS treatment, signal intensity vs time curves continued to exhibit abnormal enhancement in comparison with the patients who had their evaluation at least seven days after treatment. This is a probably due to post-treatment effects like inflammation and edema. In the absence of residual cancer, the shape of the enhancement curves was typical of a benign lesion, supporting this possibility.

Graph 1   **Graph 2**

% Residual viable cancer
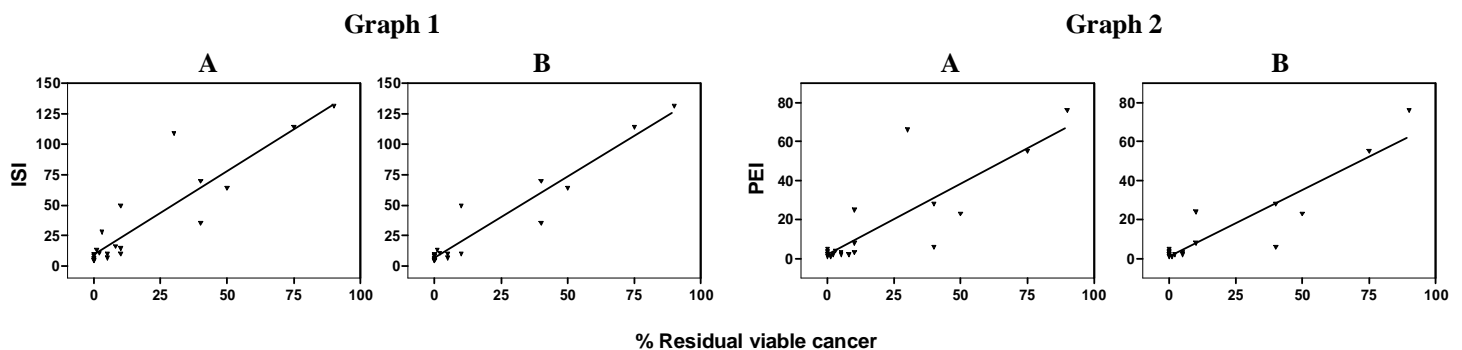
DISCUSSION

Quantification of DCE-MRI parameters appears to be very useful to assess residual tumor after MRIgFUS treatment of breast tumors, but the accuracy of the results is strongly enhanced when the DCE-MRI data are recorded at least seven days after treatment. The shapes of the enhancement curves support this conclusion but must be explored in further detail.

1. Gianfelice, D., Khiat, A., Amara, M., Belblidia, A. & Boulanger, Y. - MR imaging-guided focused ultrasound surgery of breast cancer: correlation of dynamic contrast-enhanced MRI with histopathologic findings. **Breast Cancer Res. Treat.** (in press).
2. Gianfelice, D., Khiat, A., Amara, M., Belblidia, A. & Boulanger, Y. - MR imaging-guided focused ultrasound surgery of breast cancer : Histopathologic assessment of efficacy – Initial experience. **Radiology,** 227, 849-855, 2003.