Quantitative assessment of procedure success in MR-guided breast biopsy exams

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Target Audience: Researchers/clinicians interested in MR-guided breast biopsies

Introduction: MRI-guided breast biopsies are lengthy, expensive procedures, whose accuracy and false negative rates are not perfect [1]. In current biopsy workflow, the breast to be biopsied is compressed between an immobilization plate and a coarse plastic grid. The first contrast-enhanced MR series enables lesion localization and the determination of the biopsy entry position and depth. The biopsy tool (stylet) is inserted into the breast at the computed entry point until it reaches the computed depth. Prior to tissue sampling, another scan is typically taken, in which the stylet is replaced with the obturator to confirm proper localization. At last, following the biopsy procedure, a confirmation post-biopsy scan is acquired for visual assessment of biopsy success. Tools and geometry of the procedure are shown in Figure 1. This workflow is quite challenging, because of the difficulty to accurately reach certain lesions (next to the chest wall or to a silicone implant, e.g.), and the fact that it is performed without real-time guidance. Moreover, the biopsy assessment is typically performed by *visually* inspecting the post-biopsy images, and comparing them to the pre-biopsy, contrast-enhanced images. Due to the fact that, by the end of the procedure, the contrast agent may have already washed out, the different image contrast in the two series, and the possible susceptibility induced artifacts existent in the post-contrast images (due to air trapped in the biopsy canal), this visual assessment can be inaccurate. In current clinical practice, there are no quantitative means to help the clinician decide if or how well the enhancing lesion region was sampled. In this work we develop a tool that enables quantitative assessment of the success of MR-guided breast biopsy procedure.

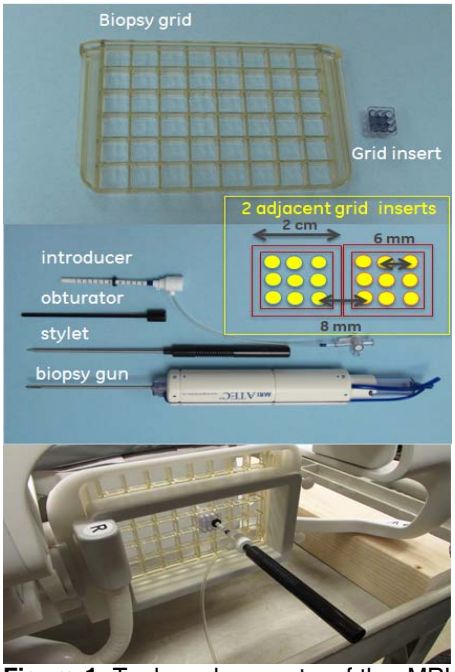

Figure 1: Tools and geometry of the MRI guided biopsies

Methods: Biopsy data from 4 patients, obtained at Memorial Sloan Kettering Cancer Center (MSKCC) on a 1.5T GE scanner, using a 16 channel Sentinelle coil, were included in this pilot study. Lesions were first semi-automatically segmented from the first, contrast-enhanced biopsy series. The biopsy volume was then semi-automatically segmented from the last confirmation series-- on the slices containing the lesion. The ratio between volume overlay of the enhanced lesion region and the removed tissue region was then computed for each case, and volume overlays were displayed for inspection.

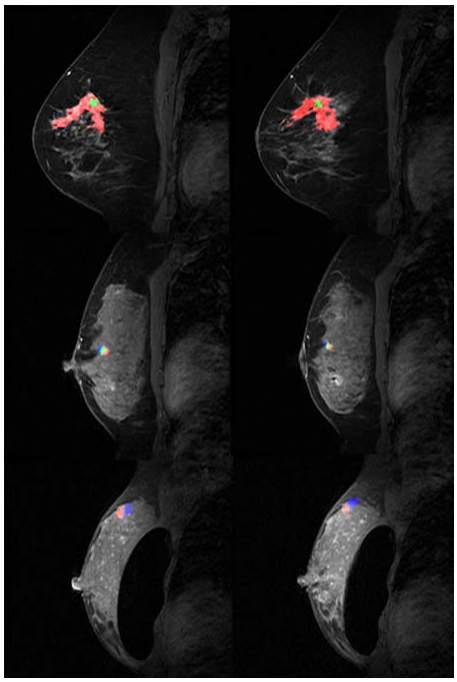

Figure 2: Data from 3 patients (different rows), containing the segmented tumors (red), biopsy volumes (purple) and overlap between the two (green)

Results: Figure 2 shows two slices (separate columns) from three separate patients (different rows). In these images, lesions are displayed in red, biopsy volume in purple, and lesion/biopsy volume overlap in green. Note that 3 separate scenarios exist: in the first patient (first row), a large lesion was adequately sampled. In the second patient (middle row), the location of a small lesion overlaps very well with the biopsy region. In the third one, however (bottom row), the overlap between lesion volume and biopsy volume was minimal. Should this graphic assessment have been available to the clinician at the end of the procedure, it would have likely prompted for additional tissue removal.

Quantitative assessment of the data from the 4 patients studied indicates that the ratio between volumes of the suspicious lesion and total tissue removed averaged to 52%, ranging from 4% to 99%.

Conclusions: We have developed a method to evaluate the accuracy of MRI-guided breast biopsies, based on the ratio of the volume overlap between the biopsy region and the suspicious lesion region. Results showed that, in the large lesion cases, MRI-guided procedures sampled the lesion regions very well. In the small lesion cases, it was possible for the biopsy to largely miss the lesion region. Should this information be available to the clinician prior to the completion of the procedure, it may prompt further lesion sampling. This method could serve as a quality control tool for MR-guided biopsy procedures.

Acknowledgement: This work was supported by NIH grant 1R01CA154433.

References: [1] Bahrs et al, Clin Radiol 2014;69(7):695-702.