Development of Needle Guidance using an Optical Tracking System on the Skyra 3.0 T wide-bore system

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Purpose/Introduction:

In the recent years, MRI-guided breast biopsy has become a promising technique in the field of interventional MRI (iMRI). Frame-based stereotaxy is known to be effective in sampling and satisfying in diagnostic yield [1]. However, it is strongly limited by the set of fixed trajectories as well as co-registration errors [2, 3]. Furthermore, freehand techniques allow compensating for motion and compression of the target, and are able to reach any location within the breast [4]. The main disadvantage is the communication requirement between the operator, performing the biopsy inside the RF cabin, and the assistant in the control room.
The goal of this project was to assist MRI-guided biopsy using an optical *Moiré Phase Tracking* system, combining the advantages of the freehand technique with the accuracy of stereotactic guidance.

Subjects and Methods:

MRI-guided biopsy was developed and investigated on a 3.0 T wide-bore system (MAGNETOM Skyra) with an appropriate phantom, containing five embedded grapes.

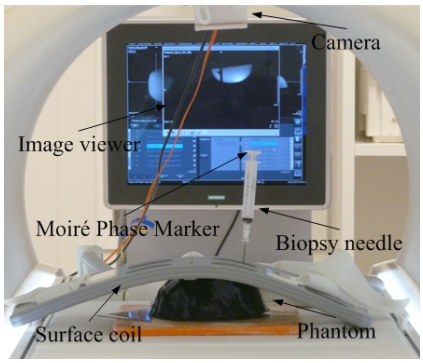

Figure 1 *Measurement arrangement*

A gradient echo sequence, capable of real-time position update by the Moiré Phase Tracking (MPT) system for motion correction, was modified to realize real time needle guidance. A Moiré Phase (MP) marker was attached at the back of the biopsy needle. Two intersecting scan planes perpendicular to each other were automatically aligned along the long axes of the biopsy instrument. Rotation and translation of the biopsy were utilized to update the position and orientation of the image planes every repetition, using the biopsy tool to interactively control slice position and navigate to the target. Five biopsies were simulated in the phantom.

Results:

The user was able to control the imaging planes interactively from the inside of the RF cabin by rotating or translating the needle. Deviations from the target trajectory could be corrected on the fly. Five biopsies were successfully performed with a mean performance time of only 3.49 min (SD=±0.46 min) total examination time including all localizers. The mean differences of the x, y, and z coordinates between the target center and the needle tip were 2.75 mm (SD=±1.09 mm), 3.32 mm (SD=±1.64 mm) and 2.95 mm (SD=±1.82 mm), respectively.

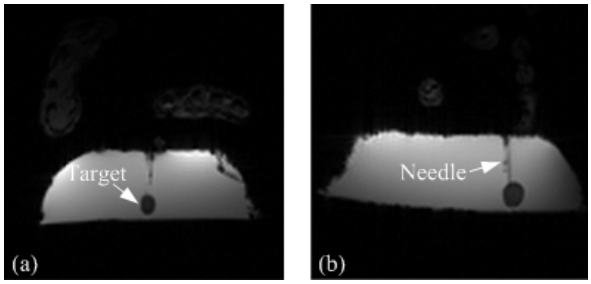

Figure 2 *Extract of the images obtained during MRI-guided biopsy with the MPT system: (a) sagittal and (b) transversal orientation relative to the biopsy needle*

Discussion/Conclusion:

MRI-guided biopsy with the Moiré Phase Tracking System demonstrated high accuracy and short procedure times. This technique improves, simplifies and expands the currently available MRI-guided breast biopsies.

References:

[1] Chen X et al., AJR 2004; 182:1075-80. [2] Weiss CR et al., JMRI 2008; 27(2):311-25. [3] Moche M et al., JMRI 2008; 27(2):276-91. [4] Fischbach F et al., Radiology 2012; 265(2):359-70.

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