MRI-guided Breast Biopsy Using an Active Marker

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Introduction

MRI is the most sensitive method for the detection of breast lesions. However, suspicious findings frequently turn out to be benign. Histological verification of the detected lesion is therefore mandatory for the diagnosis of breast cancer. Current breast biopsy procedures are usually carried out under ultrasound or mammography control. These imaging techniques are far less sensitive than MRI: They fail to visualise up to 70% of the lesions originally detected by MRI[1]. If feasible procedures had been established, MRI would have been the preferred modality for the guidance of breast biopsies. Several methods have been presented in the literature. Even the most systematically evaluated method[1] has not yet gained broader impact on patient treatment apart from some specialised centres. Reasons include the considerable expert knowledge and the long duration of more than one hour required. We present a new concept that uses active marker technology for biopsy planning and automated control scans.

Materials and Methods

Active markers consist of a micro-coil filled with a small liquid container as signal source. They have been used for various applications including catheter or field-of-view tracking[2]. An active marker has been attached to the needle insertion guideway of a conventional breast biopsy device with an appendant breast array coil (MRI Devices). A gelatine phantom was placed between the compression plates of the biopsy device. A 2 mm diameter titanium corpus mimicked a lesion. The whole setup is shown in Figure 1. MR Imaging (Philips Intera 1.5 T) included a dedicated tracking sequence to measure the marker's position and a standard breast imaging sequence. Image data and position data of the marker was transferred to a separate PC. A custom IDL software (RSI Inc.) visualised image data in three orthogonal views. The position of the lesion was marked in the image and an applicable angle for needle insertion was entered manually. The software then calculated the necessary adjustment of the needle guideway as well as the needle insertion depth. The biopsy needle was inserted strictly according to the software output. Correctness of needle positioning was inspected visually and by an additional MRI scan. A whole biopsy procedure from patient positioning to final tissue extraction was simulated with the phantom. The potential workflow optimisation by consequently exploiting the active marker technology was analysed.

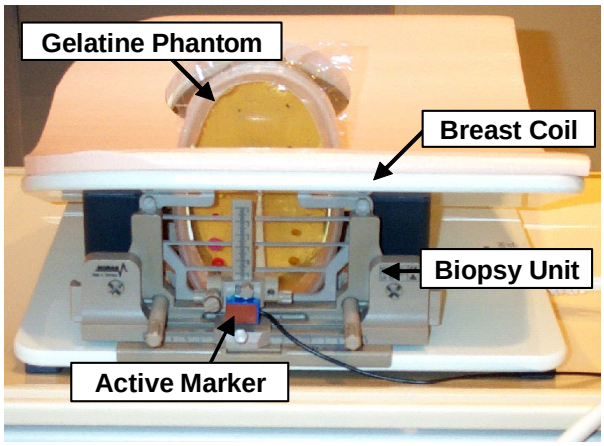

Fig. 1) Setup for the phantom measurements.

Results and Discussion

In the phantom tests, the biopsy needle was positioned successfully in the proximity of the target. Achievable accuracy seems to be sufficient for successfully targeting lesions with 5 mm diameter or less under clinical conditions. The automated localisation of the needle guideway led to a very easy biopsy planning process which basically requires a single mouse click for entering the lesion position only. Further room for improvement was found in the opportunity to perform automated control scans to validate the user's adjustment of the needle guideway and the final needle position: Field-of-view tracking would enable the acquisition of two orthogonal slices along the planned needle pathway by pressing a single button. Integration of these techniques is expected to significantly reduce the examination duration: Planning of the needle pathway (including calculation of the required adjustments of the needle guideway based on the diagnostic images, actual adjustments, and automated control scan) can easily be completed within six minutes, the actual biopsy including an intermediate control of the inserted coaxial needle within eight minutes. The whole procedure takes approximately 30 minutes. The procedure is regarded as much less error-prone than conventional techniques, because manual user interaction is minimised and the automated control scans provide an effective double-check of the most critical steps.

Conclusion

The concept shows great promise for an optimised biopsy procedure. Potential improvements include facilitated handling, increased safety, time savings of up to 50%, and a more precise targeting of smaller lesions. Altogether, these improvements may enable a more widespread application of MR-guided breast biopsies. In addition, the concept can easily be transferred to other percutaneous procedures for relatively fixed or immobilised organs such as brain or prostate. A systematic evaluation of the achievable positioning accuracy is currently being performed.

Acknowledgements

This work was supported by the Federal Ministry of Education and Research (BMBF) as part of the CEMET-project, Kiel (FKZ 01 EZ 0103).

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