Navigated liver biopsies in a closed-bore MR scanner: first clinical experience

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Introduction/Purpose

Most image-guided interventions such as biopsies or tumor ablations can be readily performed under CT or ultrasound guidance. MRI may be indicated whenever a suspect lesion can not reliably be visualized with these imaging modalities [1]. In a standard 1.5T MRI scanner, however, the remaining space is practically too small to handle an instrument inside the bore. Freehand biopsies outside the bore with intermediate control imaging are usually inaccurate and time consuming. Our concept combines an optical instrument tracking with an automatic patient registration [2] where the needle is manipulated outside the bore and control imaging can be performed at any time. For interventions in a moving organ (liver), a special respiratory training was evaluated. The goal of this work was to present a more reliable solution that may be flexibly added to a closed-bore scanner environment and to report on our first clinical experience in 15 patients with liver lesions.

Materials and Methods

Computer-assisted biopsies have been performed in 16 patients with liver lesions that were not adequately discernible on CT. A previously described, flexible add-on system was used for navigational assistance (Localite GmbH, St. Augustin, Germany) [3]. The interventionalist is guided by a real-time navigation scene that shows a virtual overlay of the tracked instrument onto properly reformatted MR images on a large in-room screen. Needle guidance is accomplished by a flexible custom-made (Leipzig University/Invivo Germany) instrument holder. An overview of the clinical setup with the patient and the add-on components in place is shown in Fig. 1. Before starting the procedure, a short breathhold training was performed with every patient. This is crucial to obtain the same level of inspiration for the planning images and during needle insertion to establish an accurate navigation. All patients were treated with sedation (lorazepam) and general analgesia (piritramid). After preparation and positioning, the patient is moved inside the magnet to acquire the marker data (used for patient registration) and anatomical roadmap data (fat saturated, T1-weighted VIBE and T2-weighted HASTE sequences with slice thicknesses between 3 and 8 mm). After a rough definition of entry point and needle orientation with an unsterile needle tracker, the access site was covered with a sterile drape. The exact trajectory was defined with a 16G, 120 mm-long coaxial needle properly inserted into the front-end of the instrument holder. Local anesthesia was administered (10 ml of a 1% lidocaine solution) along the trajectory. The needle was then inserted iteratively with fast intermediate control scans for which the patient had to moved back into the magnet. Biopsies were taken with coaxial 18G true-cut systems (Invivo, Würzburg, Germany and Somatex, Teltow, Germany). The study was approved by the institutional ethic committee and written informed consent was obtained from all patients.

Fig. 1: All patients were placed in a prone position, sedation and analgesia were performed with lorazepam and piritramide. A large loop (Ø=19 cm, underneath the drape) and an integrated spine array coil (1.5T Siemens Symphony) were used for imaging. Flexible add-on components allow proper needle guidance (arrow) and ensure proper patient registration.

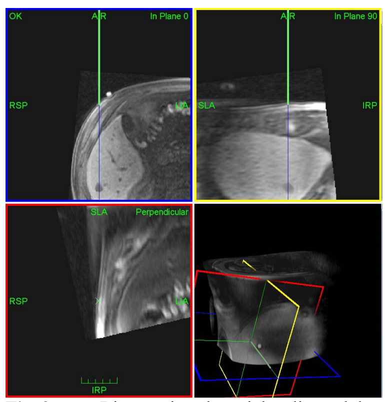

Fig. 2: Biopsy in the right liver lobe. Screenshot of the corresponding navigation scene showing three needle-related views and 3D rendering (T1w VIBE, TA=17 s) in the planning phase before needle insertion.

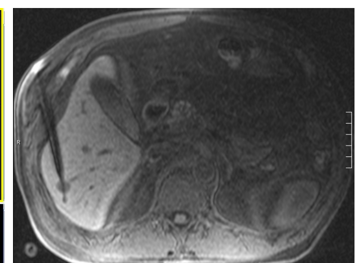

Fig. 3: Control image after needle insertion and prior to taking the biopsy using a VIBE sequence. Artifact of the true-cut needle tip indicates proper needle placement.

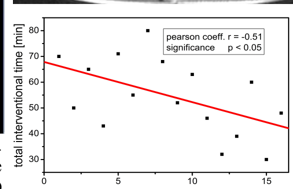

Fig. 4: Significant correlation of total intervention time with procedure number.

Fig. 5: Lesion could not be visualized with CT imaging.

Results

Sixteen liver biopsies in 15 patients (BMI=21-36 kg/m^2) have been successfully guided with the Localite system without any major complication. In 12 of 16 cases (lesion depths between 54 and 135 mm) the needle trajectory was double oblique. A screenshot of the navigation scene in instrument-related view is shown in Fig. 2. In most cases, T1-weighted sequences (VIBE and HASTE) were used to plan the intervention and control the actual needle position (Figs. 2 and 3). Patient preparation and access planning required an average time of 13 min each. The mean intervention time from needle insertion to final control image was 21 min resulting in a mean total time of 55 min (30-80 min). On average, three control steps were performed. A significant ($p<0.05$, negative) correlation was observed between total intervention time and number of intervention (Fig. 4). In 15 of 16 cases, the biopsies were diagnostic.

Discussion and Conclusion

The presented add-on solution allows a flexible navigation in a closed-bore scanner. Potential benefits are seen for interventions with a double oblique approach and for lesions with a difficult access path or at deeper locations. In comparison with a robotic manipulator for closed-bore scanners [4], the presented setup is more compact which would also allow interventions in overweight patients. A specific breathhold protocol was required to accomplish these interventions in a moving organ like the liver with a tolerable number of control steps. In conclusion, the presented navigation solution could be successfully used for MR-guided punctures in a closed-bore scanner.

References
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