Diagnostic accuracy and procedure times for 37 navigated liver biopsies in a closed-bore MRI environment

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Introduction/Purpose

MRI is the method of choice for the detection of suspicious liver lesions that are barely or not seen with ultrasound or CT imaging [1]. A definite diagnosis, however, often requires the histological analysis of proper biopsy samples. In a standard 60-cm bore MRI, the remaining space is practically too small to guide and insert a biopsy instrument inside the scanner. Free-hand biopsies can be performed outside the bore and controlled by intermediate scans but are often time consuming and less accurate. The aim of this work is to analyze the workflow and diagnostic results of 37 liver biopsies using a previously described concept [2] where the needle is navigated under virtual real-time guidance outside the bore and control imaging can be rapidly performed at any time.

Materials and Methods

Computer-assisted biopsies have been performed in 35 patients with liver lesions that were not adequately discernible on CT. A previously described, flexible add-on system was used for navigational assistance (iMRI Navigator, Localite, St. Augustin, Germany) [3]. The study was approved by the institutional ethic committee and written informed consent was obtained from all patients. The interventional specialist 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 instrument holder. An overview of the clinical setup with the patient and add-on components in place is shown in Fig. 1. Immediately before the procedure, every patient underwent a short breath-hold training to establish a reproducible level of inspiration between roadmap acquisition and needle insertion and minimize navigation errors. After preparation and positioning, the patient is moved inside the magnet to acquire the marker data 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 approximate 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 using fast intermediate scans for control. Biopsies were taken with coaxial 18G true-cut systems (Invivo, Würzburg, Germany and Somatex, Teltow, Germany).

Fig. 1: All patients were placed in a prone position, sedation and analgesia were performed with lorazepam and piritramide. A large loop coil (Ø=19 cm, underneath the drape) and an integrated spine array coil were used for imaging. A large in-room screen (SCR) allows proper guidance of the device (DEV), which is virtually displayed onto the MR dataset by tracking (CAM) its relative position with respect to a reference marker set (REF).

Results

37 liver biopsies were successfully performed in 35 patients (15 female, 20 male, BMI=18-40 kg/m²) without any major complication. Lesion depths varied between 47 and 135 mm and the needle trajectory was double oblique in 33 of 37 cases. A sample screenshot of the navigation scene is shown in Fig. 2. Biopsy cores were true positive in 23 cases, true negative in 10 cases, false negative in 3 cases and non-diagnostic in one case, resulting in a diagnostic accuracy of 89%. Patient preparation and access planning required an average of 10 and 13 min, respectively. The mean intervention time from needle insertion to final control image was 21 min resulting in a mean total time of 44 min (25-80 min). On average, three intermediate control steps were performed. After an initial training phase (assumed for the first 15 biopsies) the mean table time was reduced to 37 minutes.

Discussion and Conclusion

The presented add-on solution allows for 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. Average table times around 35 min and an intuitive navigation appear to be acceptable in clinical practice. In comparison with other stereotactic or robotic approaches for closed-bore scanners, the presented setup is relatively compact and will also allow interventions in more overweight patients. A specific breath-hold protocol was required to accomplish these interventions in a moving organ like the liver relying on a tolerable number of control steps. In conclusion, the presented navigation solution can be successfully used for MR-guided punctures in a closed-bore scanner environment.

References