Diagnostic accuracy and workflow of 240 experimental MR biopsies with a clinical navigation solution outside the bore

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Introduction/Purpose

Minimally invasive diagnostic and therapeutic procedures are often performed under image guidance. Despite some limitations, MRI is increasingly used as guiding modality [1], in particular with magnet designs that allow instrument manipulation with direct imaging control inside the bore [2]. With closed-bore scanners, the instrument typically needs to be operated outside the magnet, which requires more technical efforts and renders the guidance technique more prone to errors caused by patient and organ motion. On the other hand, access to the patient is very flexible outside, scanners are more common, and their performance is superior, which would explain the continued use of these scanners for interventional purposes. Recently, an add-on solution for real-time navigation outside the bore has been presented and clinically deployed (Fig. 1). Given the technical challenges and potential workflow issues of such an approach, the purpose of this work was to thoroughly evaluate the diagnostic accuracy, usability, and workflow on a total of 240 experimental MR-guided biopsies.

Materials and Methods

The navigation technique has been described elsewhere [3]. In short, it allows virtually any device to be tracked optically from arbitrary camera and MR table positions. Automatic registration is established by a one-time, fast 3D localization of table-mounted MR reference markers (Fig. 1). In this experimental study, we have used a large plastic cylinder filled with opaque glaze as phantom tissue. Twenty-four operators were assigned to three groups with different radiological experience (attending radiologists AR, radiology residents RR, and medical students MS). A 6-minute video instruction was presented to each operator immediately before the biopsies. Each operator performed 10 successive biopsy cycles in the same order. A biopsy was counted as a diagnostic success if the biopsy sample clearly contained green material from the pea samples were directly taken with a fully automatic biopsy gun (Invivo).

Results and Discussion

The average diagnostic success rates were 93% (AR: 9-10 hits), 88% (RR: 7-10 hits), 81% (MS: 6-10 hits) and overall not significantly different (Cochran p=0.104). In contrast, the mean times for a complete biopsy cycle in minutes (AR: 4:13, RR: 4:42, MS: 5:06) were significantly different (p<0.001) (Fig. 3). The largest individual time difference was observed for the navigation step (AR: 1:16, RR: 1:25, MS: 1:48, p<0.001), the time difference of the puncture step was significant (p<0.05) but negligible (<3.5 s), all other time differences were insignificant. None of the item ratings were significantly influenced by the factor group (experience). The rounded Likert scores over all items were 4.4 (AR), 4.2 (RR), 4.2 (MS), and 4.2 (all). The majority (9/13) of average item scores showed significant (p<0.001) differences between groups, mainly due to the navigation step.

Conclusion

For an in-vitro setting, this study demonstrated good diagnostic accuracy, usability, and workflow of an "in-and-out" navigation solution for closed-bore scanners. Taking some precautions, we believe that this approach is a feasible option for dedicated procedures. While the clinical performance can only be assessed on real patients, this work provides valuable results for a large number of biopsies and different operators.

References