

Stereotactic brain biopsy under real-time MR-imaging. A feasibility study

Uwe Spetzger MD, PhD; Gerd Winkler; Andrej von Schilling; Thomas Remmele; Sebastian Arnold

Department of Neurosurgery, Klinikum Karlsruhe, Karlsruhe, Germany

Faculty of Computer Sciences, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

Innomedic GmbH, Herxheim, Germany

Introduction

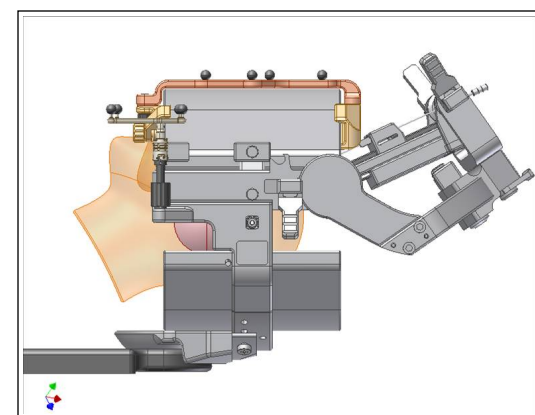
Stereotactic biopsy of cerebral lesions is a routine procedure. At present, the concept of intra-operative MR-imaging is realized in different sites, allowing visualization of neurosurgical procedures under radiological control. The overall idea is to bring the whole stereotactic setup into a conventional MR suite and perform real-time MR-imaging of frame-based stereotaxy.

The set-up of the navigation system (BrainLab) and the whole procedure of registration and planning and navigation was out of the 5 Gauss line (0.5 mT), also the burr hole was made outside of this area. The xyz-coordinates and the trajectory were adjusted as usual at the stereotactic frame and the MR-compatible biopsy needle was mounted in the slide.

Results

Initial tests, a phantom study as well as a feasibility study and accuracy evaluation of the biopsy (mean: 0.5 mm) in a cadaver head are described. The phantom studies demonstrate an adequate workflow, a perfect time management, a perfect time management with a low procedure time, as well as a high precision of the procedure.

The biopsy in the cadaver head was performed inside of the MR scanner. In this setup (initial release), the needle was moved manually to the target under continuous image data acquisition (MR cine-mode). The MR-imaging of the insertion and removal of the biopsy needle to the target deep into the brainstem is demonstrated in the video sequence.



The constructed stereotactic frame (Innoguide) with integrated headcoil (PEEK)

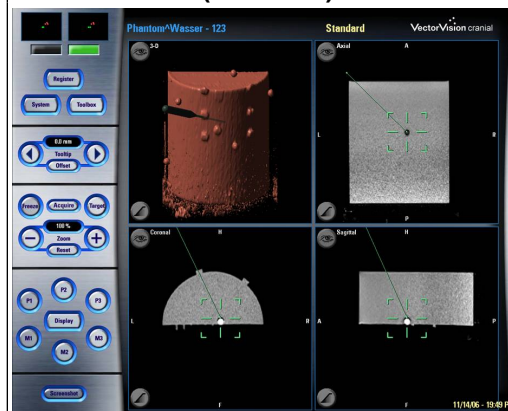


Registration and planning in the phantom model in front of the MR

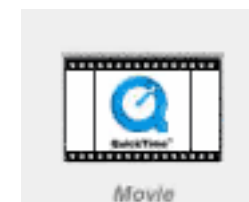
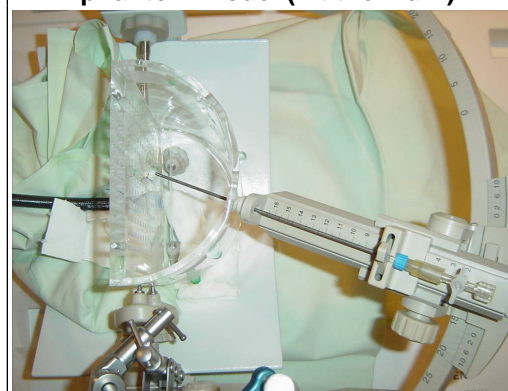


Then the whole equipment was moved with the table inside of the MR to perform the biopsy.

Intraoperative planning of the target using a conventional navigation system (BrainLab)



Confirmation of the target in the phantom model (hit the mark)



Conclusions

The studies confirm that stereotactic biopsies are practicable within a conventional MR-machine using a standard navigation system for pre- and intraoperative planning and this new developed stereotactic PEEK-frame. The modern concept of the planning and the intraoperative real-time MR-imaging of stereotactic biopsies within the MR-scanner will improve the whole workflow of the procedure and will also enhance the precision and the safety of a stereotactic biopsy.

Methods

In a scientific collaboration a fully MR-compatible stereotactic frame (PEEK) was developed. All components of the frame and materials fit into the bore of a conventional 1.5 T scanner (diameter of 60 cm).

The movement to the target, the final positioning of the needle and the biopsy itself, is visible in real-time MRI, due to ongoing image acquisition during surgery. The planning, development and final construction of the MR-compatible stereotactic frame is demonstrated, as well as the initial testing in phantom and cadaver head studies.