Are we ready for routine interventional 1.5 Tesla MRI? Experience from 370 MR-guided percutaneous interventions.φ

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Objective

Within the last 4 years at our clinic 142 patients received 370 MR-guided percutaneous interventions at 1.5 Tesla. We would like to share the experiences with this non-irradiating image-guided therapy modality method and hope to provide valuable insight for safer and faster percutaneous MR-guided procedures.

Material and methods

Our interventions ranged from drainages and spinal pain therapies to arthrographies and intra articular therapies. They were carried out in two 1.5 Tesla MRI's (Symphony, Espree, Siemens, Germany). Most of the procedures were performed with the flexible loop coil in conjunction with the table mounted spine coils. Depending on the intervention, the patient was positioned prone or supine. A 15cm foam role was positioned under the knees in supine and below the ankles in prone position. A big pillow helped the patient to keep the position when he was positioned prone. A nitro capsule was fixed as a reference point in the area of the expected needle entry point. In most of the cases we acquired a set of optimized TSE-images in axial, sagittal and coronal orientations without angulations. The images of this first measurement served as the basis for the placement of slices of the second measurement. All interventions were performed with needle-guidance in nonangulated transaxial slices. Using the laser projection of the magnet, the therapy slice was marked on the skin of the patient. The distance of the nitro marker to the needle entry point was measured and marked as well. All interventions were prepared by taping a sterile aperture drape to the patient. After vigorous disinfection the first centimeter of the needle was inserted. The needle angle was estimated from the planned needle path on the monitor. Advancing the needle to the target was done with repeated axial control scans. Before drug injection, diluted Gadolinium contrast agent or pure physiological saline solution (PSS) was applied to monitor drug distribution. The mechanical properties and the representation of two types of needles were compared with and without stylet:

1. Titanium needle 22G, 50mm, 100mm, with steel stylet (Invivo, Schwerin, Germany)
2. Carbon fiber needle 21G with Nitinol stylet (Radimed, Bochum, Germany)

In intraarticular and intraspinal therapies or arthrographies contrast media were injected to ensure that the needle lumen actually entered the target cavity. We used a mixture of PSS with Gd-DTPA or pure PSS as contrast agent. Optimization of the dilution degree of Gd-DTPA in PSS was performed with fast T1-weigted GE and TSE sequences. We used a slice thickness of three millimeters and a maximum acquisition time of 60 seconds. T1, T2 and PD sequences were optimized for the display of anatomy, needles and fluids. The influence of the BLADE sequence (compare to table 1) for spinal and intraarticular iMRI was evaluated.

Results

No infections or complications occurred. Nevertheless all interventions could be performed successfully in both 1.5 Tesla MRI's. For the success of the treatment it was crucial that the patient was in a stable and comfortable position. A nitro capsule as a reference point, together with the magnets line-projection facilitated the determination of the needle entry point, but the accurate transfer of the exact image information into therapeutic action is still challenging. The precision of entry point, puncture angle and the procedure time are highly dependent on the experience of the team. Training and optimization of sequences and procedures shortened the treatment time from 45 minutes to about 20 minutes. Needle positioning and subsequent contrast medium dilution application inside the MRI-scanner for MRI-arthrography is feasible.

Comparison of needles showed a clearly superior rigidity of the carbon fiber needle The relatively large distance between the lumen and the tip of this needle proved to be a challenge in intraarticular therapies, because the tip often reached the bone before the lumen had completely entered the joint capsule. For this reason intra articular injections were not possible in some rare cases. Without stylet the slim soft tip of the titanium needle was easily deformed by bone contact.

For imaging, the stylets of the titanium needles had to be removed to reduce the size of the artifact. The carbon fiber needle with stylet had different representations depending on the sequences. We identified a mixed ratio of 200 parts of PSS to one part of Gd-DTPA as an ideal degree of dilution to be displayed in fast T1-weighted sequences. Using PSS as contrast medium is feasible but sometimes discrimination to body fluids and fat was difficult. Acquisition of the T2-sequence before and after application of PSS facilitated the detection.

The following sequences proved to be well-suited for iMRI:

Sequence	TR/ ms	TE/ ms	TA/ s	Matrix
HASTE	850	110	27	320x512i
T2-TSE	4630	126	34	320x512i
BLADE	3450	109	36	256x256
T1-FLASH	137	4	30	210x320
PD-TSE	1980	18	32	288x384

BLADE improved the image quality for spinal interventions but not for intraarticular therapies.

Conclusion

Various CT- or fluoroscopy-guided percutaneous procedures can be performed in a 1.5 Tesla MRI with high precision in a similar time frame after a training phase. It is desirable that more patients are treated without X-ray-exposure, but currently only exceptional cases are reimbursed by health insurances.

To reduce costs, a significant decrease of treatment time is required. This should be possible through improved receiver coils, faster sequences and automated auxiliaries for precise needle placement in the near future.