

# In vitro and in vivo evaluation of MR fluoroscopy-guided injection therapy for low back pain in open high-field MRI

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## Introduction:

Percutaneous spinal infiltrations are usually conducted under fluoroscopy or computed tomography (1,2). Since these procedures are often performed on young individuals of fertile age in serial therapeutic regimes the repeated exposure to ionizing radiation is troublesome. Only few studies on MR-guided therapeutic spinal injections have been conducted in open low-field scanners. (3,4). The purpose of this study is to evaluate the feasibility of open high-field MRI for MR fluoroscopy-guided infiltration therapy of lumbosacral nerve roots, facet- and sacroiliac joints.

## Methods and Materials:

In a CuSO<sub>4</sub> phantom and cadaveric specimen, fluoroscopy TSE and GRE sequences (Table 1) were evaluated with respect to artifacts and image quality in an open high-field MRI (1.0 T, Panorama HFO, Philips, Netherlands) using a MR-compatible 20-G needle (MReye Chiba, Cook, Denmark). Artifacts were analysed with respect to needle orientation to B0 (0°-100°) and phase encoding direction. Image quality was described with SNR and CNR. Subsequently, a total of 122 MR-guided infiltrations were performed in 52 patients suffering from lumbosacral pain. 32 patients underwent periradicular therapy, 12 facet- and 8 sacroiliac joint injections. An in-room monitor, wireless MR-mouse (custom-made) for operator-controlled sequence initiation and multiplanar navigation and a flexible surface coil were used. The clinical outcome was quantified by regular clinical follow-up and questionnaire using a visual analog scale (VAS).

## Results and Discussion:

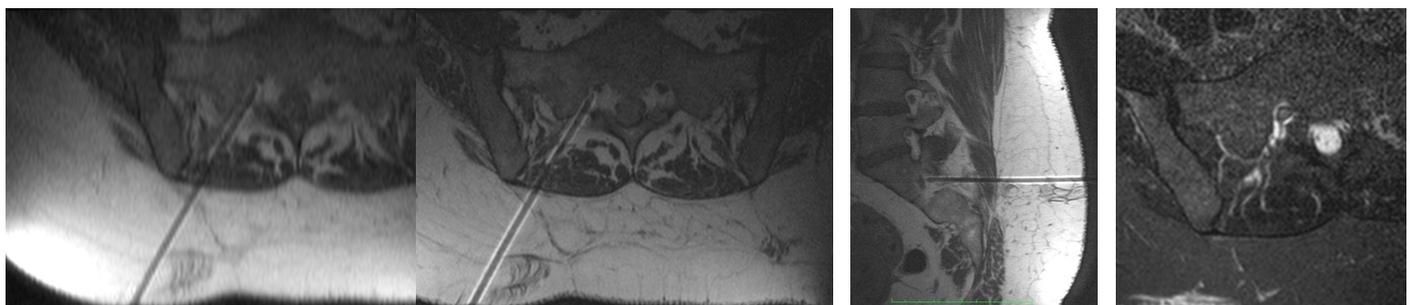
In vitro, PD-w TSE yielded superior image quality with the best needle-tissue contrast (Table 1) (CNR=45, 18, 15, 9 for fat, muscle, spinal root, bone), adequate artifact sizes (<5mm) with an optimal infiltration angle of 45° to B0. Artifact sizes were found to generally correlate with needle orientation to B0 (Fig. 1). There was no significant influence on the artifact when changing the phase encoding direction. The acquisition time (2 s) was adequate, facilitating adequate near real-time MR imaging guidance. In vivo, the PD-w TSE sequence confirmed to have superior image quality. Needle placement was successful in all cases (Fig. 2a,b,c). No complications occurred. The dispersion of the injected medication was reliably visualized in all cases by a strongly T2-w SPIR sequence (Fig. 2d). Preliminary clinical outcome was evaluated up to 1–7 months (mean 4.1 months) after the procedure and was comparable to that of other studies using fluoroscopy or CT guidance.

## Conclusion:

MR fluoroscopy-guided lumbosacral injection therapy in an open high-field MRI is feasible and safe and may further increase accuracy of image guided spinal pain therapy.

Fluoroscopy Sequences	TR (ms)	TE (ms)	Flip angle (°)	scan time (s)	CNR fat-needle	CNR muscle-needle	CNR root-needle	CNR bone-needle
PDW TSE	600	10	90	2,4	45.2±2.9	18.2±0.8	15.4±1.7	8.9±2.3
T1W TSE	200	8	90	4,0	16.4±2.1	13.6±0.9	13.9±1.1	11.3±1.8
T2W TSE	1600	90	90	1,6	14.2±1.7	5.7±2.0	1.2±0.8	2.7±1.3
bSSFP	6,1	3	60	2,4	18.6±1.7	13.7±0.4	-	10.5±1.4
T1W GRE	14	6,8	25	3,6	31.1±1.8	15.9±1.3	11.3±1.3	9.0±1.0
T2W GRE	22	6,4	15	2,3	8.0±0.3	6.2±0.4	-	2.0±0.3

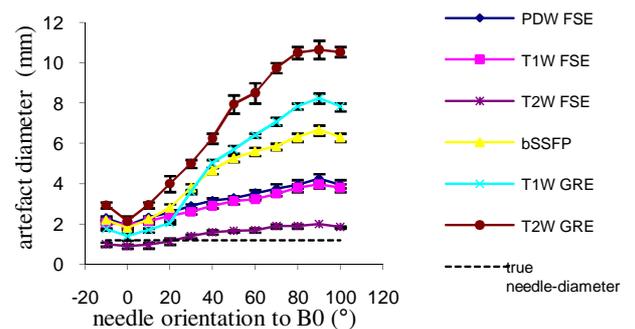
**Table 1:** Comparison of fluoroscopy sequences for their capability in guidance of percutaneous spinal infiltrations in an open high-field MRI (FOV/voxel size =150x150mm/1x1x3mm). PD-w TSE proved to display an optimal needle artifact within the anatomic structures with adequate temporal and spatial resolution.



**Fig 2:** MR Fluoroscopy-guided periradicular nerve root infiltration using PD-w TSE (a). Final position of the needle tip. Needle trajectory in dorsolateral approach yielding an excellent needle artifact due to the 45° orientation to B0. (b-c) Comparison of real-time PD-w TSE with a diagnostic PD-w sequence for verification shows similarly adequate image quality in display of needle and target lesion. Note the benefit of multiplanar navigation in a sagittal plane as seen in (c). (d) A T2-w TSE SPIR confirmed the accurate deposition of the medication, typically appearing as a hyperintensity in the periradicular space, without the need of contrast agent.

## References:

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**Fig 1:** Graph showing needle artifact diameter of the a 20 G MR puncture needle in dependence to the orientation to B0 in each fluoroscopy sequence in relation to the true needle size (dashed).