

MR Image Overlay Adjustable Plane System for Percutaneous Musculoskeletal Interventions

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Purpose

The 2D MR image overlay system (IOS) concept and its clinical feasibility have been evaluated and successfully proved in MSK procedures. However, IOS image plane is vertical, limiting the insertion at the scanner axial plane. In many cases of MSK procedures, such as joint arthrography and facet joint injections, the optimal access to target requires an oblique insertion plane. To overcome such problems, we have developed the *MR image overlay adjustable plane system (IOAPS)*. The challenges remain due to the strong magnetic field and confined operating space.

Methods

MR image overlay adjustable plane system (IOAPS) is an advanced version of the IOS. It has 4 degrees of freedom of motion (two translations and two rotations), manually actuated. These motions are indicated by calibrated encoders attached to the moving joints. The IOAPS consists of two main units; 1) *out-of-room unit* consisting of an interconnection box, a power control box, and a laptop and 2) *in-room unit* placed next to the MRI scanner and consisting of a fully MR-compatible monitor, linear and rotary motion encoders, a sensor control box, a transverse plane laser, an MRI-compatible keyboard, a semi-transparent mirror, and a supporting aluminum frame. The aluminum frame carries the weight of all devices and provides the motion of ± 100 mm (in X-Y directions) and $\pm 25^\circ$ (around X-Y axes). The MR-compatible monitor (18-inch, RF shielded LCD monitor, Siemens Corp) allows the operator to work within 60 cm from the bore, thus minimizing table translation. The system was designed to allow for sufficient working space to execute multiple oblique needle insertions. A system workflow and calibration processes were designed.

Results

The IOAPS has been successfully designed and built. The new system calibration is more challenging compared to IOS. Modules of the in-room unit have been tested. Technical validation of the IOAPS is currently in progress.

Conclusions

We report the design and implementation of an MR image overlay system with adjustable imaging plane, with the objective of assisting the interventionalist in performing MR-guided needle insertion in oblique planes.