Development of a training model for PTCD under MRI real-time guidance (MRI-PTCD)

I. R. van der Voort[1], I. S. Papanikolaou[1], J. Rump[2], C. Seebauer[2], R. Schilling[2], S. Chopra[2], B. Wiedenmann[1], U. Teichgräber[2], and T. Rosch[1]

[1]Department of Hepatology and Gastroenterology, Charité Universitätsmedizin Berlin, CVK, Berlin, Berlin, Germany, [2]Research Group for Engineering Instruments for the open MRI, Charité Universitätsmedizin Berlin, Berlin, Berlin, Germany

***Background*:** Percutaneous transhepatic cholangiodrainage (PTCD) performed under radiologic guidance is associated with a substantial morbidity and even mortality rate. PTCD under MRI real-time guidance (MRI-PTCD) could reduce the morbidity and mortality to be.

Aim: To establish a training model for MRI-PTCD and to compare procedure times of MRI and conventional radiologic guided PTCD.

***Methods*:** We developed an in-vitro model for MRI-guided and conventional PTCD, comprised of an animal endoscopy organ set including liver and bile ducts (BD), placed in an MRI-compatible box. The model was used in an open MRI scanner 1.0 Tesla Panorama (Philips Healthcare, Netherland). Prototype 18G MRI-compatible needles and guide-wires, standard guide-wires, dilatation bougies and drainages were used. MR visualization was achieved with a balanced steady state free precession real-time sequence (bSSFP: 0.75 frames/s, TR/TE [ms]: 7.2/3.6; flip angle: 45°; 200×200 matrix size; resolution: 1.3 x 1.3 mm, slice thickness: 7 mm) using a surface coil. MRI and radiologic control experiments were performed by physicians with limited PTCD experience. The success rates and time necessary for BD puncture by real-time MR-guidance as well as by conventional radiological methods using the same model were calculated. Time necessary for cannulation and drainage placement were also analyzed. Furthermore, the learning curve for the MRI was calculated.

***Results*:** Real-time MRI-guidance lead to rapid (mean: 43 s ± 2.0, range: 15-72 s) and successful puncture and cannulation in 96% (48/50) of the test-procedures. Median drainage placement-time for the successful cases was 321.5 s (range: 241-411 s). The learning curve of PTCD under MRI guidance was analyzed by comparing the first 15 with the last 15 puncture attempts; mean puncture times were significantly shorter in the last period (56 ± 2.4 vs. 28 ± 2.0 s, $p<0.001$; t-test; Figure 1). Subtracting these 15 initial procedures, the mean puncture time for the 35 subsequent attempts was a mean of 38 s ± 2.0. In the control group using the conventional radiologic approach (35 puncture attempts) mean procedure times until successful ductal puncture were a mean of 273 s (range 45-631) in the cases in which it could be successfully achieved (24/35). The success rate in the oMRI group was significantly higher as in the control group (96% vs. 69%; $p<0.002$, Fisher exact test). The puncture times (median: 43.5 s vs. 267 s) were significantly different between MRI (total n=50) and control group (n=35) ($p<0.001$, Mann-Whitney Rank Sum Test, Figure 2). The same was true when the MRI group after the learning period (n=35) was compared with the radiologic group (n=35) (median times: 39 s vs. 269 s, $p<0.001$; Mann-Whitney Rank Sum Test).

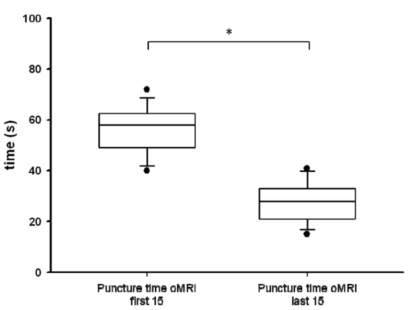

Figure 1: Learning curve of punctures in the oMRI experiment is shown by the puncture times of the first 15 and the last 15 punctures. * $p < 0.001$

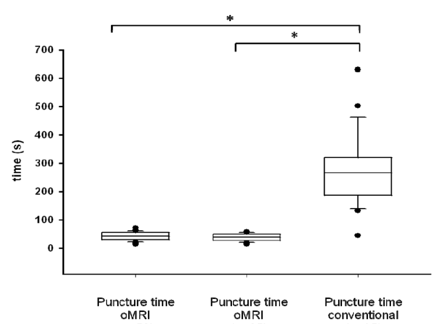

Figure 2: Puncture times of all 50 punctures in the oMRI experiment and of the last 35 punctures in the oMRI experiment compared to the punctures in the radiologic group. * $p < 0.001$

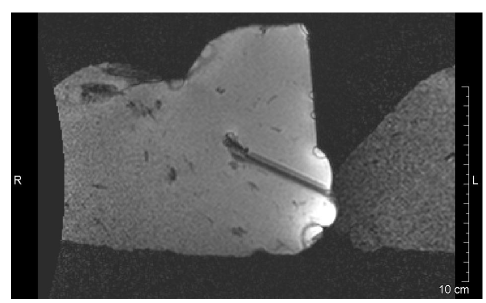

Figure 3: Example for the procedure under MRI guidance with puncture of the duct

***Conclusions*:** Initial in vitro experience shows that PTCD can be successfully and rapidly performed under real-time-MRI-guidance and may lead to optimized PTCD establishment compared to the conventional radiologic approach. This model can also be used as a training model for percutaneous interventions of the bile ducts.