Evaluation of a robotic technique for transrectal MRI-guided prostate biopsies

Martijn G. Schouten, Joyce G.R. Bomers[†], Derya Yakar[†], Henkjan Huisman[†], Dennis Bosboom[†], Tom W.J. Scheenen[†], Sarthak Misra[††] and Jurgen J. Fütterer[†]*

[†]Department of Radiology, Radboud University Nijmegen Medical Centre, Nijmegen, Netherlands. Geert Grooteplein 10, 6500 HB Nijmegen, the Netherlands.* M.Schouten@rad.umcn.nl
[††]MIRA-Institute of Biomedical Technology and Technical Medicine, University of Twente.

Introduction: The detection rate of magnetic resonance image (MRI)-guided biopsies after two or more negative transrectal ultrasound guided (TRUS)-guided biopsy sessions is 59%[1], demonstrating the potential role of MRI-guided biopsies. Unfortunately, this procedure is time consuming since needle guide positioning is a precise work. Furthermore, during manipulation of the needle guide the target may have moved. For these reasons an in-house pneumatically actuated MR-compatible robotic technique was developed where needle guide direction can be controlled from inside the control room[2]. It is thought that this robotic technique will improve procedure time and enhance needle guide positioning. Thus, the purpose of our study was to evaluate the accuracy and speed of a novel pneumatically controlled magnetic field compatible manipulator as an aid to perform magnetic resonance image (MRI)-guided biopsies on patients with cancerous lesions in the prostate.

Methods: A pneumatic controlled manipulator with 5 degrees of freedom constructed of plastic to achieve magnetic field compatibility was developed in-house to guide biopsies under real-time imaging[4]. The targeting and biopsy accuracy of the new robotic technique and the existing commercially available manual device (Invivo, Schwerin, Germany) to sample a predefined target were measured. In total, 13 biopsy procedures (8 procedures using the robotic technique) were performed on a 3 Tesla whole body closed bore MR system. A target displacement vector was determined for each needle position by evaluating the shift of anatomical landmarks around the cancerous lesions. This in order to determine distance and direction of target displacement. The time needed for both procedures was recorded to evaluate manipulation and procedure time.

Results: Both the robotic and manual techniques demonstrated comparable results regarding mean targeting error (5.7 vs 5.8 mm, respectively) and mean target displacement (6.6 vs 6.0 mm, respectively). The mean biopsy error was larger (6.5 vs 4.4 mm) when using the robotic technique, however not significant. Most of the target displacement was in the direction of the needle trajectory. The mean procedure time was 76 minutes using the robotic technique and 61 minutes with the manual technique. Mean manipulation time to move from target to target was 6 minutes with the robotic technique and 8 minutes with the manual technique. Manipulation time and procedure time were not significant different when comparing the robotic and manual techniques.

Conclusion: Currently, the robotic technique for transrectal real-time MR-guided prostate biopsies did not outperform the manual technique. Furthermore, this study provided insight into reasons for target motion during a biopsy procedure. Our results suggest that most target displacement is caused by needle insertion.

1. T. Hambrocket al. "Magnetic resonance imaging guided prostate biopsy in men with repeat negative biopsies and increased prostate specific antigen," J.Urol. **183**, 520-527 (2010).
2. M.G. Schouten et al. "The accuracy and safety aspects of a novel robotic needle guide manipulator to perform transrectal prostate biopsies," Med.Phys. **37**, 4744-4750 (2010).