Fast Real-Time Tracking Using a POCC Algorithm for 3T MR-Guided Transrectal Prostate Biopsy: A Feasibility Study.

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Introduction

MR guided prostate biopsies revealed in several studies promising results in terms of high tumor detection rates in the patients with previous negative ultrasound guided biopsies [1,2]. However, the procedure time for an MR-guided biopsy is substantial longer than for a TRUS-guided biopsy (range 20 - 76 vs 10 - 25 minutes) [3,4] which limits the availability of the procedure in the clinical routine. Consequently, the need for biopsy techniques allowing shorter procedure time is highly desirable. A fast real-time tracking sequence using phase-only cross correlation (POCC) algorithm was recently developed and showed promising results in terms of accuracy in phantom and animal experiments [5,6]. This sequence is able to track a needle guide automatically in real-time allowing "ultrasound like" fast handling of the needle guide during the guidance process. The time reduction of the guidance process may result in reduction of the time needed for the whole procedure. The aim of this study was to assess the feasibility of using the real-time POCC based sequence for automatic needle-guide tracking in transrectal 3T magnetic resonance (MR)-guided prostate biopsies.

Methods

Ten consecutive patients with a PSA level of 4 ng/mL or higher and a history of at least one previous negative TRUS-guided prostate biopsy session were enrolled in the study. All patients had cancer suspicious regions (CSRs) identified on a diagnostic 3T multi-parametric MRI, consisting of T2w, DWI/ADC and dynamic contrast enhanced (DCE) MRI using a 3T MR system (Siemens Skyra; Siemens Healthcare, Erlangen, Germany). In a subsequent MR-guided biopsy session, the CSRs were re-located and targeted using a real-time POCC based automatic passive tracking sequence as follows: a manually adjustable MR-compatible biopsy instrument holder (Invivo, Schwerin, Germany) and a passive marker (Invivo GmbH, Schwerin, Germany) were used to perform the procedure. After positioning of the patient in prone position, the passive marker was inserted into the rectum. After a short diagnostic protocol consisting of T2- weighted TSE and DWI/ADC sequences for assessing the position of the marker and re-locating of the CSRs within the prostate (under the knowledge of the prior diagnostic MRI, Fig. 1 a and b) the targeting was started. During the targeting process, the marker was manually moved within the rectum using the T2 weighted real-time guidance sequence in transversal or sagittal image orientation (balanced steady state free precision (bSSFP) sequence; TR/TE/FA = 4.0ms/1.9ms/70°, resolution 1.2x1.2x5.0 mm³, 1.0 s/slice). The sequence automatically aligned the imaging plane parallel with the axis of the endorectal marker. The real-time images were projected into the MR-room using a beamer. Targeting was stopped when the displayed axis trajectory (shown as a green line in the image, Fig. 1 c and d) was aligned with the CSR. After fixing of the marker a core biopsy was performed. The position of the biopsy needle in the target was documented using a fast bSSFP sequence (Fig. 1 e and f). In case of additional CSRs the guidance was repeated. All biopsy specimens underwent histological examination.

Results

A total of 23 CSRs were identified in 10 patients and total of 34 biopsy samples were taken. All identified CSRs were sampled. There were no clinical complications during or after the biopsy. The mean time needed for the entire biopsy procedure (guidance and sampling) was 34 minutes (range 18-48 minutes). The mean time for guidance per target (movement of the endorectal marker between two CSR) was 1.5 minutes (range: 0.73–6 minutes). Mean manipulation time to take a biopsy (guidance and sampling) per CSR was 13 minutes (range 5-22 minutes). Seven patients received a diagnosis of prostate cancer (detection rate of 70 %). 17 of 34 (50%) core biopsy samples contained prostate cancer.

Discussion

In this feasibility study a safe, easy and precise instrument guidance using the POCC based sequence for automatic needle-guide tracking in transrectal 3T MR-guided prostate biopsies was demonstrated. All CSRs could be followed during the targeting process and biopsies could be performed. The combination of very easy handling, good tumor detection rates comparable with other MR-guided prostate biopsy techniques, use of standard, commercial available devices and short procedure times is promising and makes this approach attractive for clinical routine. However, further clinical studies with statistically higher number of patients are needed to confirm the positive properties of this approach, particularly in terms of further reduction of the procedure time.

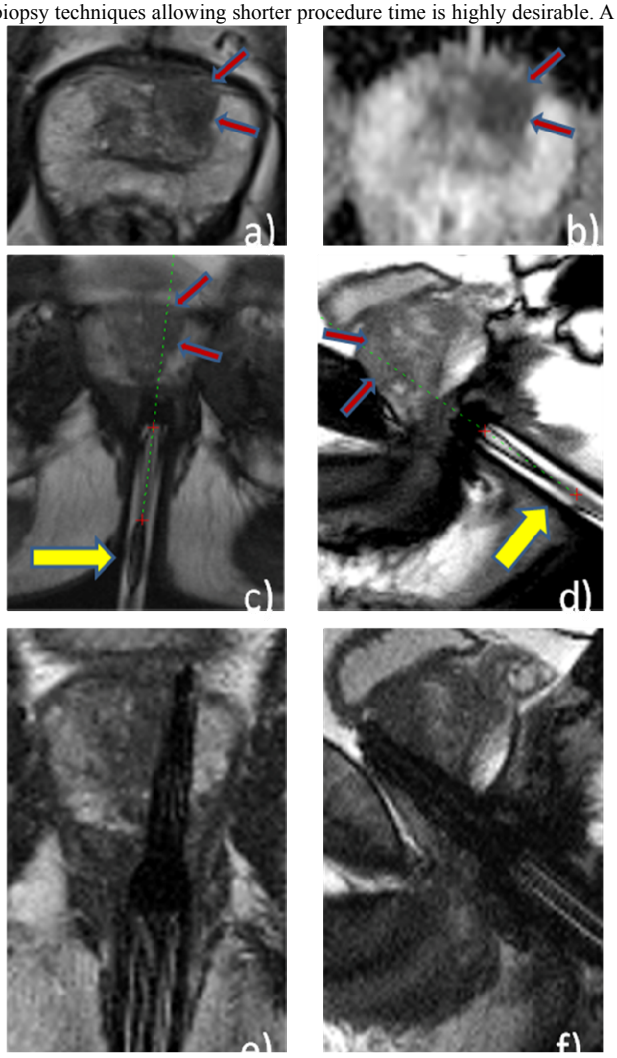

Fig.1 Patient with prostate cancer (Gleason 4+4=8) in the left ventral apical part of the central gland (red arrows):
a) transversal diagnostic T2 TSE; b) transversal diagnostic ADC map;
transversal c) and sagittal d) image of POCC based bSSFP sequence during the targeting: yellow arrow point to the endorectal marker, clearly visible is the green spotted line showing the axis (direction) of the endorectal marker i.e. the trajectory of the biopsy needle. The images e) and f) show the position of the biopsy needle in the suspect lesion (confirmation scan).

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