Phantom Study of a novel Stereotactic Prostate Biopsy System Integrating Preinterventional MRI and Live US fusion

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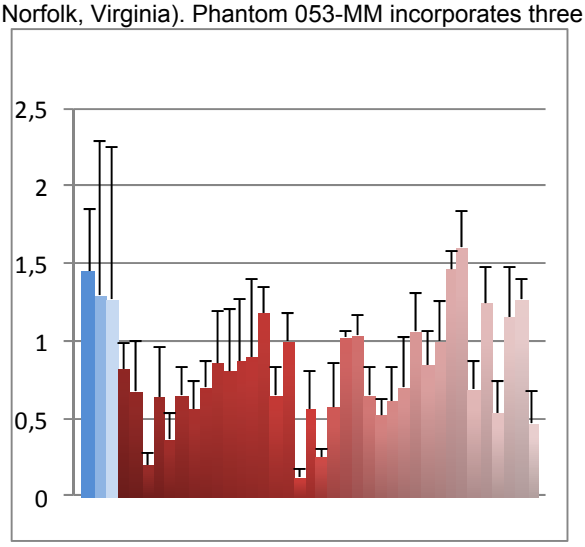
INTRODUCTION

With the widespread introduction of the PSA testing, the characteristics of prostate cancer (PCa) have changed dramatically within the last fifteen years. The common procedure in patients with elevated PSA is a transrectal ultrasound guided (TRUS) biopsy taking 10 to 14 cores. However, repeated prostate biopsies in individuals with elevated PSA levels and negative findings can be frustrating for both the urologist and the patient because of the lack of definitive exclusion / detection of PCa. In the past years, multiparametric MRI of the prostate increased detection of smaller carcinomas[1,2]. Thus, aim of recent technical developments was to integrate information provided by MRI into TRUS-guided transperineal or transrectal prostate biopsy devices[3]. Purpose of this study was to determine the targeting error of a novel stereotactic prostate biopsy system (BiopSee®, MedCom, Germany), which integrates pre-interventional MRI with peri-interventional ultrasound for transperineal navigated prostate biopsies.

MATERIALS & METHODS

We performed stereotactic biopsies on five prostate multimodality phantoms (one CIRS 053-MM and four CIRS 066, CIRS Inc., Norfolk, Virginia). Phantom 053-MM incorporates three MRI- and TRUS-visible lesions, while lesions within phantom 066 are only detectable on MRI. In both phantoms the 0.5cc volume lesions are randomly placed. The phantoms were examined by 3T-MRI preinterventionally. Then, three stereotactic biopsies from one lesion in phantom 053-MM and from all ultrasound-invisible lesions in the 066 phantoms were taken under live-fusion-imaging guidance. During the intervention, a mix of blue ink and gadobutrol was injected into each biopsy channel. Afterwards 3T-MRI was obtained again. These MRI images were then fused again with the intraoperative TRUS data to measure the targeting error (TE) between the planned and performed biopsy. Additionally, the procedural targeting error (PTE) between the virtually planned biopsy trajectory and the manually registered three-dimensional needle position of every single biopsy core taken was calculated.



RESULTS

Overall targeting error (TE) of the 39 biopsy-cores taken was 0.83mm (SD: 0.48mm) with the highest TE in the sagittal plane (1.09±0.54mm), followed by the coronal (0.72±0.43mm) and axial (0.69±0.34mm) planes. The procedural targeting error, which is provided intraoperatively, was 0.26mm in average (SD: 0.46mm). Comparing PTE and TE, there was no statistically significant difference (p=0.39).

Fig.1: Average targeting error ([mm] of X, Y and Z plane) in each biopsy (blue = CIRS MM-053, red = CIRS 066)

CONCLUSION

The targeting error of stereotactic biopsies using our novel perineal prostate biopsy system is below 1mm and can be estimated in vivo by the automatically calculated procedural targeting error. Stereotactic prostate biopsies guided by the combination of MRI and ultrasound allow effective and precise evaluation of suspicious lesions detected by MRI of the prostate.

FIGURES

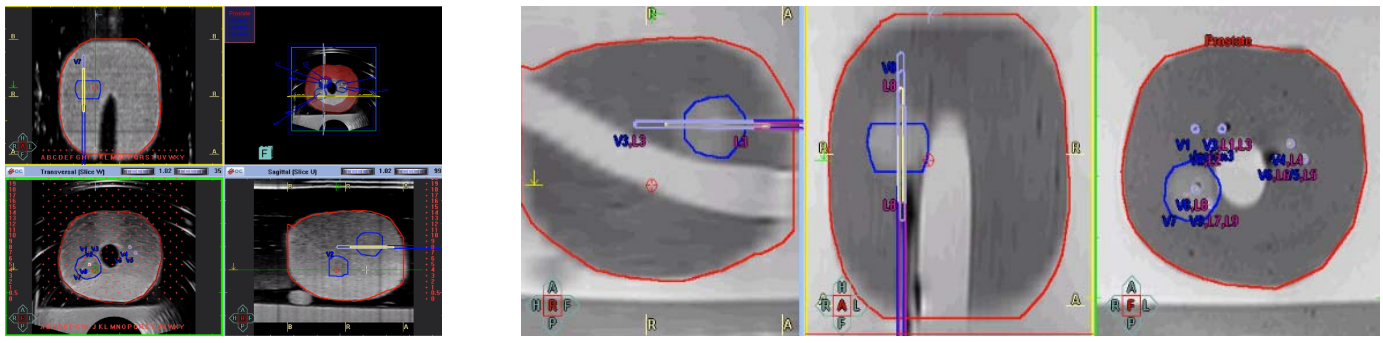


Fig. 2: Left:: planning of biopsies in iso-echoic, MRI-only visible lesions in a CIRS 066 phantom; right: post-interventional MRI matched with the intra-interventional contours and registered biopsy trajectories.

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