

## MR-guided focal cryoablation of prostate cancer recurrence following external beam radiation therapy: safety and feasibility

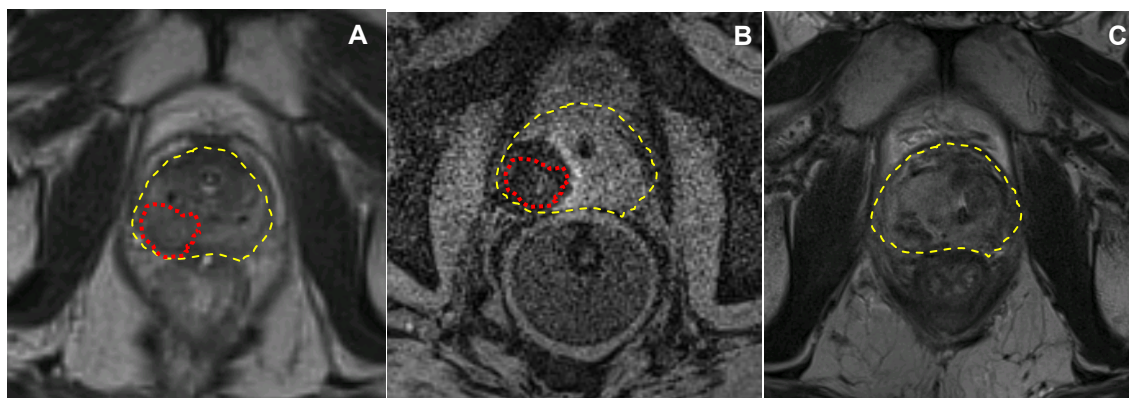
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**Objective:** Cryosurgery of prostate cancer (PCa) under ultrasound (US) guidance has been performed for several years for primary treatment as well as salvage treatment purposes. However, high complication rates (incontinence 4.3 – 39.6%, erectile dysfunction 57 – 77.8%, rectal fistula rate 0 – 3.4% [1 – 7]) are a familiar disadvantage. Magnetic resonance (MR) imaging guided cryosurgery of the prostate may reduce these high complication rates. The main advantages of MR imaging above US- or CT-image guidance are that MR imaging can be used to localize the tumor; to accurately place the cryoneedles in the target lesion and monitor and control the iceball growth with real-time MR imaging. Previous studies have shown that MR signal intensity is related to the temperature and that this relation consistently shows a signal intensity peak at 0°C for several different tissue types [8-10]. This means that exactly at the iceball-tissue transition a hyper-intense border can be seen on T1-weighted images. By carefully monitoring this edge, the critical temperature zone can be determined. In this way the tumor can be focally treated and nearby critical structures such as the urethra, the rectal wall and the neurovascular bundle can be avoided. Consequently, this may result in a decreased number of complications. The purpose of this study is to evaluate therapy success, complications and technical feasibility and safety of MR-guided focal cryoablation of recurrent prostate cancer.

**Materials and Methods:** Six patients with local recurrence of PCa without evidence for distant metastases were treated under general anesthesia in a closed-bore 1.5T MR system (MAGNETOM Avanto, Siemens, Erlangen, Germany). An urethral-warmer was inserted in the urethra. A transperineal plate, attached to a flexible arm was placed against the perineum. Cryoneedles (IceSeed or IceRod, Galil Medical, Yokneam, Israel) were inserted with real-time MR imaging in at least two directions (BEAT IRT axial: TR 465.92 ms TE 1.82 ms, flip angle 70°, resolution 2.7x2.7 mm, slice thickness 10 mm; coronal: TR 494.08 ms TE 1.93 ms, flip angle 70°, resolution 3.1x3.1 mm, slice thickness 4 mm). A rectal warmer was inserted in the rectum. Both warmers were constantly flushed with warm water to protect the urethra and the rectum from freezing. Iceball growth and -shaping was performed by adjusting the freezing capacity of the individual cryoneedles under real-time MR imaging using T1-weighted VIBE imaging (TR 4.81 ms TE 1.96 ms, flip angle 6°, resolution 1.3x1.3mm, slice thickness 2.5 mm). Two freeze- and thaw cycles were performed. Follow-up consisted of PSA-level measurement every three months and a multi-parametric prostate MR examination after 3, 6 and 12 months.

**Results:** Six patients with recurrent PCa were successfully treated with MR-guided focal cryoablation. In all patients the hyper intense ice ball rim was clearly visible and iceball growth and thus critical temperature zone were carefully monitored. Median number of cryoneedles used was 3 (range 2 – 4). In one patient the procedure was cancelled due to inability of insertion of the urethral warmer. In a second attempt, two months later the patient was successfully treated. Another patient had urine retention and was observed for 2 nights. All other patients went home one day after the procedure. No other complications were recorded. Follow-up is known for the first three patients. Their PSA level decreased severely and their multi-parametric MRI showed no presence of recurrent tumor.

**Conclusion:** Transperineal focal MR-guided cryoablation of recurrent PCa after external beam radiation therapy was technically feasible and safe. No major complications were recorded. After 3 months PSA level decreased and follow-up MRI showed no cancer. Initial results are promising and more patients have to be included.



**Figure 1** (A) Axial T2-weighted MR image of the prostate (yellow) and the tumor (red) (B) Axial T1-weighted image of the iceball (black signal void) with the hyper intense rim. Total tumor is covered with ice. (C) T2-weighted image of the prostate one day after ablation

**References:** [1] Pisters et al. J Urol 2008;180:559-563. [2] Eisenberg et al. Urology 2008;72:1315-1318. [3] Ismail et al. BJU Int 2007;100:760-764. [4] Ng et al. J Urol 2007;178:1253-1257. [5] Bahn et al. Clin Prostate Cancer 2003;2:111-114. [6] Donnelly et al. Prostate Cancer Prostatic Dis 2005;8:235-242. [7] Perotte et al. J Urol 1999;162:398-402. [8] Overduin et al. 2011 Unpublished data. [9] Wansapura et al. Acad Radiol 2005; 12:1080-1084, [10] Kaye et al. JMIR 2010; 31:719 – 724