Irreversible Electroporation: First Patient Experience Focal Therapy of Prostate Cancer

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Introduction

Irreversible electroporation (IRE) is a new non-thermal ablation modality that uses short pulses of DC electric current to create irreversible pores in the cell membrane thus causing cell death. This method has been shown by Rubinsky et al. to have significant advantages in ablating prostatic tissue, such as rapid lesion creation, rapid lesion resolution, sparing of structures such as vessels, nerves and urethra, and uniform destruction throughout the IRE lesion (1). The underlying principles are well covered in other chapters in this book. This discussion will deal with the first human applications of IRE and whether its theoretical promises of improved clinical outcomes, have been delivered. For a number of reasons, including the ability to carry out extensive post operative biopsies to confirm the adequate ablation of cancer, the first human experience was carried out in the prostate.

The focal therapy of prostate cancer is gaining interest as a potentially new prostate cancer management strategy, falling between watchful waiting on the one hand and morbid whole gland treatments such as radical prostatectomy on the other. Onik et al. introduced the concept of using focal therapy for treating prostate cancer using cryo-ablation in 2002 (2). Other clinical series using cryo-ablation to focally treat prostate cancer have shown excellent cancer control rates with extremely low morbidity (3-5). Cryo-ablative lesions, however, have some distinct limitations, such as variable damage at the cryo lesion's margin, injury to adjacent structures such as rectum, urethra and neurovascular bundle (NVB), and long procedure time due to the need for multiple freeze thaw cycles. These characteristics could limit the widespread acceptance of this modality despite certain demonstrated advantages over the more traditional treatments of radiation and radical prostatectomy (6). Since these disadvantages of cryoablation are the theoretical strengths of IRE it seemed reasonable to explore the first human use of IRE in this setting.

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Methods

Patient Selection

Patients were considered for cancer targeted IRE ablation, if based on TRUS biopsies their cancer was localized and the maintenance of potency and/or continence was a major concern of the patient. All patients were restaged by a transperienal mapping biopsy biopsied under heavy sedation or general anesthesia. A brachytherapy grid was employed and biopsies were obtained every 5 mm's throughout the volume of the prostate under US guidance according to recently published guidelines for biopsy prior to focal therapy for prostate cancer (7). Each sample was sent separately, labeled as to its location and proximal segment of each core was inked to identify its orientation as to the base and apex of the prostate gland.

Procedure

Patients were placed in the dorsal lithotomy position, under sterile technique and general anesthesia (with paralysis to mitigate muscle contraction associated with the procedure) 18 gauge IRE electrodes were placed under TRUS guidance percutaneously through the perineum. IRE probes were placed to cover the known area of cancer location based on the patients mapping biopsy (Figure 1). Four probes were placed in a roughly square array, 1-1.5 cm apart, with the known area of cancer in the center of the array. Probes were placed to the capsule at the base and insulation was pulled back to expose enough electrode to affect the full length

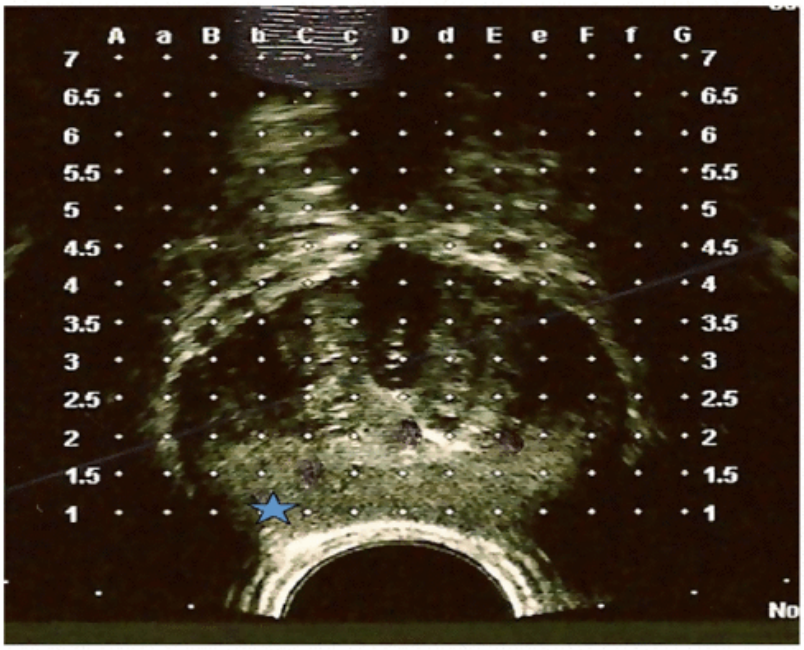

Fig. 1a. Ultrasound showing the brachytherapy grid overlay used during the 3D Prostate Mapping Biopsy. The star represents the area that was positive on this patient. Note that the positiveve area is in the region of the NVB.