

Magnetic Resonance–Guided Thermal Therapy for Localized and Recurrent Prostate Cancer

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KEYWORDS

- MR imaging • Native prostate cancer • Recurrent prostate cancer • Laser ablation • Cryoablation • Focused ultrasound ablation

KEY POINTS

- Whole-gland and focal MR imaging–guided thermal ablative treatments for native and recurrent prostate cancer include cryoablation, laser, and focused ultrasonography ablation.
- Integrated clinical and imaging workup for the native and recurrent prostate cancer should include optimal multiparametric MR imaging of the prostate, careful mapping/targeted biopsy, and judicious selection of patients with appropriate cross-sectional imaging of the body to assess regional and distant disease.
- Multicenter, prospective clinical trials are critically needed to assess thermal ablative treatment efficacy for native and recurrent prostate cancer.

THE STATE OF THERAPIES FOR PROSTATE CANCER

The American Cancer Society estimates that 220,800 new cases of prostate cancer will be diagnosed in the United States in 2015. Prostate cancer is the most commonly diagnosed cancer in men. With an estimated 27,540 deaths in 2015, prostate cancer is the second-leading cause of cancer death in men.¹ Many men with prostate cancer are often managed with radiotherapy, surgery, or androgen deprivation.² No matter how expertly performed, these therapies carry significant risk and morbidity to the patient's health-related quality

of life, with potential impact on sexual, urinary, and bowel function.³ Active screening programs for prostate cancer have identified increasing numbers of low-risk prostate cancer and have encouraged regimens of active surveillance to delay treatment until cancer progression.⁴ Although active debate continues on the suitability of focal or regional therapy for these patients with low-risk prostate cancer, many unresolved issues remain, complicating this management approach, including prostate cancer multifocality, limitations of current biopsy strategies, suboptimal staging by accepted imaging modalities, and less than robust prediction models for indolent prostate

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cancers. Despite these restrictions, focal therapy continues to confront the current paradigm of therapy for low-risk disease.⁵ Furthermore, prostate cancer recurrence rates after established forms of therapy range from 20% to 60%.⁶ Advanced, locally recurrent, or metastatic disease has also become more amenable to treatment with new classes of medications and robotic surgical approaches. With such disease volume, the opportunities for treating advancement in early, recurrent, and metastatic disease are almost boundless. In this article, the use of MR imaging to direct focal therapy for native and recurrent prostate cancer is described.

IMPORTANCE OF MR IMAGING FOR PROSTATE CANCER IMAGING

Prostate cancer has traditionally been diagnosed by systematic but random sampling of the entire organ. The recent introduction of multiparametric MR imaging (mpMR imaging) now allows for imaging-based identification of prostate cancer, which may improve diagnostic accuracy for higher-risk tumors.⁷ Recently, a consensus panel agreed to PI-RADS v2 (Prostate Imaging-Reporting and Data System), which is designed to improve detection, localization, characterization, and risk stratification in patients with suspected cancer in treatment-naïve prostate glands.⁸ Targeted biopsy of suspected cancer lesions detected by MR imaging is associated with increased detection of high-risk prostate cancer and decreased detection of low-risk prostate cancer, particularly with the aid of MR imaging/ultrasonography (US) fusion platforms.⁹ The use of mpMR imaging has expanded beyond staging to detection, characterization, and monitoring for active surveillance for cases of suspected recurrence. The use of MR imaging for recurrent prostate cancer continues to evolve and has potential to evaluate both local recurrence and distant bony and nodal metastases.¹⁰ In 2013, a consensus panel chaired by Professor Michael Marberger endorsed using mpMR imaging to identify patients for focal therapy.¹¹ Multiparametric MR imaging is capable of localizing small tumors for focal therapy and is the technique of choice for follow-up of focal ablation. Although mpMR imaging plays an established, critical role in native and recurrent prostate cancer imaging, functional, metabolic imaging for prostate cancer is in its formative years. [¹¹C]Choline PET/computed tomography (CT) has an advantage in showing both local recurrent and distant metastatic prostate cancers. [¹¹C]Choline PET/CT had a sensitivity of 73%, a specificity of 88%, a positive predictive value of 92%, a negative predictive value

of 61%, and an accuracy of 78% for the detection of clinically suspected recurrent prostate cancer in postsurgical patients.¹² In a study of postprostatectomy patients with increasing prostate-specific antigen (PSA) levels, mpMR imaging was superior for the detection of local recurrence, [¹¹C]choline PET/CT superior for pelvic nodal metastasis, and both are equally excellent for pelvic bone metastasis. [¹¹C]Choline PET/CT and mpMR imaging are complementary for restaging prostatectomy patients with suspected recurrent disease.¹⁰ However, [¹¹C]choline PET/CT is not widely available.

With the limitations of US and PET/CT imaging, MR imaging remains preeminent for detection and staging of recurrent prostate tumors. MR imaging provides superior soft tissue contrast resolution, high spatial resolution, multiplanar imaging capabilities, and a large field of view.

If the focal treatment is intended for potential curative treatment, it is important to ensure that there is not distant disease with whole-body CT/MR imaging, bone scan, and [¹¹C]choline PET/CT. None of these imaging modalities is perfect, and appropriate selection of image staging is unique to each patient.

Native Prostate Cancer

In selecting the appropriate patient for focal therapy for the native prostate gland, it is critical to determine that the patient has localized low-risk disease. With low-risk disease, there is level 1 evidence that implies a lack of benefit from radical therapy.^{13–15} Patients are often targeted for cancer workup because of increasing PSA levels or nodule on digital rectal examination. Patients are further evaluated with a mapping biopsy or mpMR imaging with targeted biopsy. Patients are classified to have low or intermediate prostate cancer with a focal positive lesion on mpMR imaging, Gleason score 4 + 3 or lower, and PSA level less than 20 ng/mL. For consideration for focal therapy, the target lesion should be confined to 1 lobe of the prostate.¹⁶ Furthermore, the target should be visible with the imaging modality that will be used to guide the focal ablation treatment.

Focal Therapy Treatments for Native Prostate Cancer

Although radical prostatectomy and radiation therapy remain the preferred definitive therapy for choice for men with newly diagnosed prostate cancer and with a life expectancy greater than 10 years,^{17,18} there is increasing interest in less radical focal methodologies for treatment, especially in the watchful waiting population. For this population of patients with low-risk and

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