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Favorable clinical outcomes of three-dimensional computer-optimized high-dose-rate prostate brachytherapy in the management of localized prostate cancer

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ABSTRACT

PURPOSE: To report PSA relapse-free survival and toxicity outcomes of prostate cancer patients who have undergone three-dimensional computer-optimized high-dose-rate (HDR) brachytherapy with external beam radiotherapy as definitive treatment.

METHODS AND MATERIALS: One hundred five patients consecutively treated between 1998 and 2004 are reported. All patients were treated with HDR boost with lr 192 (5.5–7.0 Gy), based upon postimplant CT three-dimensional treatment planning using an in-house treatment plan optimization algorithm. Three-dimensional conformal external beam radiotherapy (45–50.4 Gy) was also administered 3 weeks after the HDR procedure. Toxicity was measured using National Cancer Institutes Common Toxicity Criteria and International Prostate Symptom Score indices.

RESULTS: With a median followup of 44 months (8–79 months), the 5-year PSA relapse-free survival outcomes for low, intermediate and high-risk patients were 100%, 98%, and 92%, respectively, Median urinary toxicity, and 93% of patients denied rectal problems at the time of last followup.

Erectile dysfunction was noted in 47% patients at the time of last followup, but overall 80% were able to achieve vaginal penetration when those who responded to sildenafil were included.

CONCLUSION: Computer-optimized three-dimensional HDR prostate brachytherapy provides excellent disease control for even high risk localized prostate cancer. Significant toxicity has been minimal.

Keywords: High dose rate; Prostate brachytherapy; Computer optimized

Introduction

High-dose-rate (HDR) prostate brachytherapy in combination with external beam radiotherapy has been reported in several series with mature followup as a safe and highly effective therapy for localized adenocarcinoma of the prostate (1–6). The outcomes of HDR brachytherapy are particularly impressive compared to outcomes of external beam radiation alone for patients with tumors with higher risk features (7).

HDR brachytherapy techniques have evolved with progressive advancements in medical imaging technology and computer capabilities, allowing for continued improvements in disease control and reduction in treatment-related toxicity. We present the HDR experience of a single institution using careful computer-optimized three-dimensional brachytherapy treatment planning with particular attention to target volume and normal tissues in conjunction with highly conformal external beam radiotherapy in the management of localized prostate cancer.

Methods and materials

Patients with intermediate to high-risk prostate cancer were generally offered either low-dose-rate (LDR) brachytherapy or HDR brachytherapy with external beam

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radiotherapy (EBRT) or EBRT alone as definitive treatment for those with clinically localized adenocarcinoma of the prostate. Standard definitions of risk were made for each patient based upon pretreatment serum PSA, Gleason's scoring, and clinical stage as suggested by D'Amico *et al.* (7, 8) Patients who were classified as low risk but had ominous pathology features (i.e., >50% positive biopsy cores involved) were also offered HDR treatment. Provided there were no medical or other contraindication to brachytherapy (i.e. International Prostate Symptom Score (IPSS) >15 or prostate >60 cm^3), the decision to undergo HDR brachytherapy was made by the patient. HDR prostate brachytherapy was performed in three fractions at least 6 h apart in a single insertion, followed by external beam radiotherapy (EBRT). Brachytherapy was typically carried out under a general anesthetic using a transperineal approach with a template-based technique with real-time ultrasound guidance. The template is able to lock catheters in place to minimize caudal displacement of the catheters (Fig. 1). The prostatic apex was identified and marked with two inert gold marker seeds. Small trocars were initially placed transperineally through a locking perineal template via ultrasound guidance. Each trocar was replaced with a flexible plastic catheter. Each catheter was placed with a steel stylet in the lumen to give it the necessary rigidity for placement. This stylet was left inside the catheter between fractions of radiation to prevent kinking of the catheter. The template was then secured to the perineum with 2.0 silk sutures. At the end of the procedure, a flexible cystoscope was passed through the urethra and retroflexed in the bladder to ensure that no catheters had penetrated the urethra or the bladder mucosa, while confirming that each catheter tip caused tenting of the bladder mucosa. Typical anesthesia time was less than 75 min, and blood loss was minimal. A foley catheter was left in place after the procedure to mark the urethra position and provide bladder irrigation if necessary.

All patients were given intraoperative prophylactic dexamethasone unless contraindicated. All patients also received antibiotics and an on-demand intravenous analgesia unit postoperatively (patient-controlled analgesia or PCA unit). All patients were put on antiembolus precautions. Patients were given a low-residue low-fiber diet and medically constipated until the catheters were removed. While catheters were in place, strict bedrest precautions were observed. The patient's lower extremities were placed on a special leg rest that allowed limited hip flexion and knee flexion with the patient supine and the template/catheter assembly to rest away from the mattress of the patient's bed (Fig. 2). The patient rested on a gelpad to minimize the risk of bedsore formation.

After recovery from anesthesia, patients underwent spiral CT scan of the pelvis for treatment planning. These simulation CT images were virtually reconstructed using an in-house software package. The clinical target volume (CTV) was defined as the prostate gland proper. Typically, a 5 mm margin around the CTV was identified on each relevant CT slice and defined as the planning target volume (PTV). The urethra (as identified by the catheter) and the rectum were also contoured. In cases of concern for extracapsular disease, the CTV was extended to areas of concern and the PTV was adjusted appropriately. Each brachytherapy catheter was identified on each slice to provide an exact three-dimensional model of the implant in relation to the PTV and with surrounding pelvic structures.

Particular attention was paid to the superior extent of the catheters to ensure that adequate coverage of the prostate base is possible. If necessary, selected catheters were repositioned at the time of CT simulation and rescanned to ensure proper positioning. It was usually necessary to reposition some of the catheters cranially at the time of simulation by 5–10 mm, typically the most anteriorly placed catheters. The depth of each catheter was marked on each catheter on the face of the template at the time of simulation and rechecked before administration of each fraction of radiation.

Initially, the first 10 patients underwent orthogonal x-rays of the implant to ascertain whether there was any

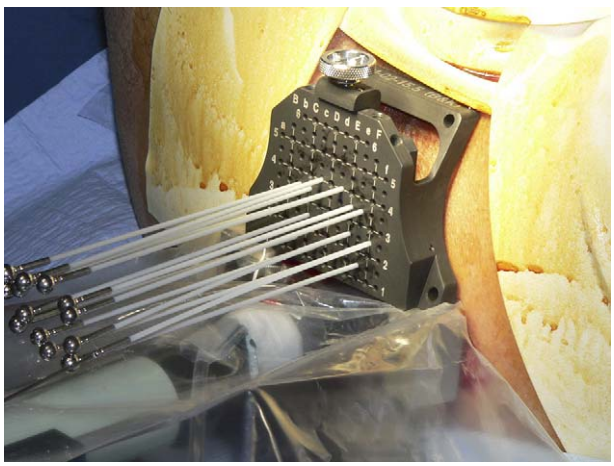

Fig. 1. Locking perineal template with catheters.

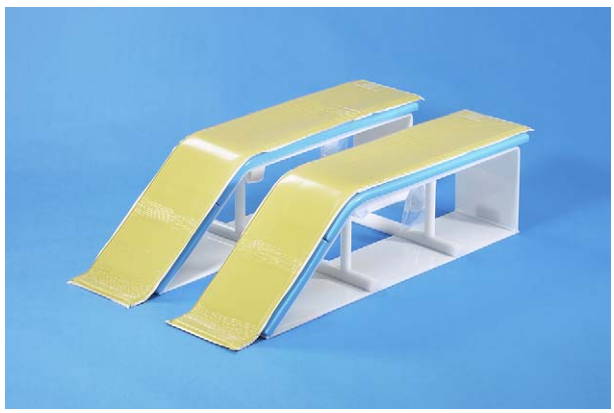

Fig. 2. Leg rest apparatus.