CLINICAL STUDY

Single-Center Experience in Prostate Fiducial Marker Placement: Technique and Midterm Follow-up

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ABSTRACT

Purpose: To describe the technique, technical success, and complications of prostate fiducial marker implantation using transrectal ultrasound (US) guidance in patients undergoing image-guided radiation therapy.

Materials and Methods: A retrospective review was performed of patients who underwent fiducial marker placement from January 2010–April 2013. In each case, gold markers were placed in the prostate using transrectal US guidance. Computed tomography (CT) was performed after the procedure and evaluated to confirm correct placement. Technical success, complications, and development of symptoms during radiotherapy were reviewed.

Results: Transrectal US–guided fiducial marker placement was performed on 75 patients (mean age, 62 y; range, 48–79 y) with a mean Gleason score of 7.25 (range, 6–10). Fiducial marker placement was confirmed in the intended location of the prostate or prostate bed for 297 of 300 markers (99%) on follow-up CT imaging. Two markers were placed just outside the prostate capsule, and one marker was lost. Complications included sepsis (n = 1; 1.3%), self-limiting perirectal or intraprostatic hemorrhage (n = 3; 4%), nausea (n = 1; 1.3%), transient hypotension (n = 1; 1.3%), epididymitis (n = 1; 1.3%), and urinary tract infection (n = 1; 1.3%). Complications were seen more frequently in patients with high tumor grade ($P = .001$) and in patients who developed metastatic disease ($P = .01$).

Conclusions: Transrectal US–guided implantation of fiducial markers is technically feasible, is well tolerated, and has a good safety profile.

ABBREVIATIONS

IGRT = image-guided radiation therapy, IMRT = intensity-modulated radiation therapy, IPSS = International Prostate Symptom Score

Multiple options exist for treating localized prostate cancer, including radical prostatectomy, intensity-modulated radiation therapy (IMRT), and brachytherapy. Image-guided radiation therapy (IGRT) involves delivering IMRT with daily positional confirmation by implanted fiducial markers. IGRT has been shown to be an effective treatment in selected patient populations (1). Dose escalation in external-beam radiotherapy for localized prostate cancer improves the outcome, with lower prostate-specific antigen recurrence rates and lower late urinary tract toxicities (2). Over the past few decades, advances have been made to increase the radiation dose to the prostate area, while limiting toxicities to adjacent organs such as the bladder and rectum (3). Day-to-day variations in rectal and bladder filling can lead to significant displacement of the prostate and alter the planned dose distribution (4). Placement of fiducial markers is an important option in radiation treatment planning as therapy evolves to deliver higher total doses with increased accuracy, safety, and efficacy (5,6). Multiple techniques have been described regarding fiducial marker placement, including transrectal ultrasound (US) guidance, transperineal approach with rectal US guidance, or placement through flexible endoscopic US (7,8). In the present study, we report the technique and experience with fiducial placement by interventional

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G.N. is a paid consultant for Biocompatibles International, AngioDynamics, Inc, and Boston Scientific Corporation. None of the other authors have identified a conflict of interest.

Table E1 is available online at *www.jvir.org*.

J Vasc Interv Radiol 2014; XX:▮▮▮–▮▮▮

http://dx.doi.org/10.1016/j.jvir.2014.03.017

radiologists using transrectal US guidance. It is hoped that this study serves as a guide for interventionalists incorporating this procedure into their practices.

MATERIALS AND METHODS

Patients

Institutional review board approval was obtained, and informed consent was waived for patients included in the study. A retrospective review was performed of 75 consecutive patients who underwent fiducial marker placement using transrectal US guidance from January 2010–April 2013. All patients who underwent fiducial marker placement during this time period were included. Mean patient age was 61.8 years (range, 48–79 y). The mean Gleason score was 7.25 (range, 6–10). Tumor extent ranged from T1c to T3b, excluding one patient with metastatic disease seeking IGRT to palliate severe urinary symptoms. One patient had previous cryoablation at an outside institution, and two patients had previously undergone radical prostatectomy. Before fiducial marker placement, all available imaging was reviewed to confirm the presence or absence of prostate tissue and to evaluate the size and symmetry of the gland. Prostate size was not specifically calculated, and an enlarged or absent prostate was not a contraindication to placement. Exclusion criteria included active infection in the prostate or colon; however, no patients were excluded from the study. Seven interventional radiologists with 2–18 years of experience (not including fellowships) performed the procedure. Mean follow-up was 1 year, 7 months (range, 6 mo–3 y, 9 mo). Data were collected via retrospective chart review. One patient was lost to follow-up, and one patient died 9 months after completing IGRT.

Technique

Patients self-administered an enema the morning of the procedure before arriving. Oral ciprofloxacin was given the day before the procedure and continued for 3 days. Patients were instructed to withhold anticoagulants and antiplatelet medications for 1 week before the intervention.

An endocavity US probe was used (GE Healthcare, Little Chalfont, United Kingdom) with an attached needle guide (CIVCO Medical Solutions, Kalona, Iowa) able to accommodate a 17-gauge × 20-cm needle (CIVCO Medical Solutions) (Fig 1). The tip of the needle came waxed, which served as a safety mechanism to prevent early deployment. The gold fiducial markers, 1.2 mm × 3 mm (CIVCO Medical Solutions), came preloaded within the tip of the needle.

If prior cross-sectional imaging was unavailable, the prostate or prostate bed was evaluated with US the day of the procedure. Abnormalities, such as calcifications, prominent vessels, or cysts, were identified in planning optimal placement. The base of the prostate was recognized by the seminal vesicles located at the posterior and superior surface of the gland bilaterally (Fig 2), and the apex was identified by locating the midline urethra, which exits the prostate anteriorly and caudally.

Figure 1. Sterile field containing the endorectal probe (black arrow) fitted with a needle guide secured with rubber bands, the 17-gauge × 20-cm needles preloaded with gold fiducial markers (gray arrow), and a 60-mL syringe with lidocaine hydrochloride 2% gel (white arrow). (Available in color online at www.jvir.org.)

Patients were placed in the left lateral decubitus position. Topical anesthesia (2% lidocaine hydrochloride gel) was instilled around the anal margin and distal rectum through a syringe and placed on the transducer before insertion. With the probe in position, the needle was advanced, and the prostate capsule was tented to confirm correct position before advancement into the gland. This phase also served to assess for adequate analgesia. When analgesia was deemed inadequate, intravenous midazolam (0.5 mg) and fentanyl (25 μg) were administered before proceeding. A qualified radiology nurse monitored the patients throughout the procedure. The needle was gently advanced under US guidance for a few centimeters. Four fiducial markers were placed in the prostate—one in each apex and base bilaterally. The procedure was initiated by deploying the fiducial markers in the right side, starting from the base of the gland. To move to the left prostatic quadrants simply required rotating the endorectal probe 180 degrees clockwise, which brought the left hemiprostate into adequate position on the monitor. In the two cases in which the patients had previously undergone radical prostatectomy,