

Task Group/Practice Parameter

The American College of Radiology and the American Brachytherapy Society practice parameter for transperineal permanent brachytherapy of prostate cancer

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ABSTRACT

Transperineal permanent brachytherapy is a safe and effective treatment option for patients with organ-confined prostate cancer. Careful adherence to established brachytherapy standards has been shown to improve the likelihood of procedural success and reduce the incidence of treatment-related morbidity. A collaborative effort of the American College of Radiology (ACR) and the American Brachytherapy Society (ABS) has produced practice parameters for LDR prostate brachytherapy. These practice parameters define the qualifications and responsibilities of all the involved personnel, including the radiation oncologist, physicist and dosimetrist. Factors with respect to patient selection and appropriate use of supplemental treatment modalities such as external beam radiation and androgen suppression therapy are discussed. Logistics with respect to the brachytherapy implant procedure, the importance of dosimetric guidelines, and attention to radiation safety procedures and documentation are presented. Adherence to these parameters can be part of ensuring quality and safety in a successful prostate brachytherapy program. © 2016 American Brachytherapy Society and American College of Radiology. Published by Elsevier Inc. All rights reserved.

Keywords:

Prostate cancer; Brachytherapy; Quality assurance; Safety; Dosimetry

Preamble

This document is an educational tool designed to assist practitioners in providing appropriate radiation oncology care for patients. Practice Parameters and Technical Standards are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care¹. For these reasons and those set forth below, the American College of Radiology and our collaborating medical specialty societies caution against the use of these documents in litigation in which the clinical decisions of a practitioner are called into question.

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The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the practitioner in light of all the circumstances presented. Thus, an approach that differs from the guidance in this document, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt

¹ Iowa Medical Society and Iowa Society of Anesthesiologists v. Iowa Board of Nursing, ___ N.W.2d ___ (Iowa 2013) Iowa Supreme Court refuses to find that the *ACR Technical Standard for Management of the Use of Radiation in Fluoroscopic Procedures* (Revised 2008) sets a national standard for who may perform fluoroscopic procedures in light of the standard's stated purpose that ACR standards are educational tools and not intended to establish a legal standard of care. See also, *Stanley v. McCarver*, 63 P.3d 1076 (Ariz. App. 2003) where in a concurring opinion the Court stated that "published standards or guidelines of specialty medical organizations are useful in determining the duty owed or the standard of care applicable in a given situation" even though ACR standards themselves do not establish the standard of care.

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Each practice parameter and technical standard, representing a policy statement by the College, has undergone a thorough consensus process in which it has been subjected to extensive review and approval. The practice parameters and technical standards recognize that the safe and effective use of diagnostic and therapeutic radiology requires specific training, skills, and techniques, as described in each document. Reproduction or modification of the published practice parameter and technical standard by those entities not providing these services is not authorized.

Amended 2015 (CSC/BOC)**

** As of May 2010, all radiation oncology collaborative parameters are approved by the ACR Council Steering Committee and the ACR Board of Chancellors and will not go through the ACR Council (ACR Resolution 8, 2010). The effective date is displayed below: Development Chronology for this Practice Parameter, 2000 (Resolution 19), Revised 2005 (Resolution 19), Amended 2006 (Resolution 16g, 36), Revised 2010 (Resolution 2), Amended 2014 (Resolution 39), Amended 2015 (CSC/BOC).

a course of action different from that set forth in this document when, in the reasonable judgment of the practitioner, such course of action is indicated by the condition of the patient, limitations of available resources, or advances in knowledge or technology subsequent to publication of this document. However, a practitioner who employs an approach substantially different from the guidance in this document is advised to document in the patient record information sufficient to explain the approach taken.

The practice of medicine involves not only the science, but also the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to

always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment. Therefore, it should be recognized that adherence to the guidance in this document will not assure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The sole purpose of this document is to assist practitioners in achieving this objective.

Introduction

This practice parameter was revised collaboratively by the American College of Radiology (ACR) and the American Brachytherapy Society (ABS).

Radical prostatectomy, external beam radiotherapy, and permanent prostate brachytherapy all represent well-established options for the treatment of prostate cancer (1–3). There is emerging data to suggest that cryoablation and high-intensity focused ultrasound (HIFU) may also be effective as primary therapy for organ-confined prostate cancer, though neither represent the current standard of care (4, 5). Active surveillance can and should be considered in appropriately selected patients with low-risk disease (6).

Patients with clinically localized prostate cancer can be treated with radical prostatectomy, external beam radiotherapy, or prostate brachytherapy. The patient requires an understanding of the risks and benefits of each option in order to make an informed decision. It is suggested that all patients with localized prostate cancer have a radiation oncology consultation in order to receive information to make an informed decision on treatment.

A literature search was performed and reviewed to identify published articles regarding practice parameters and technical standards in brachytherapy of prostate cancer. Review of the recent scientific literature regarding permanent transperineal prostate seed implantation reveals significant variation in patient selection, brachytherapy techniques, and medical physics and dosimetric conventions. Despite this range of different procedural practices, interstitial low-dose-rate (LDR) brachytherapy has consistently been shown to be an effective component in the treatment of all prostate cancer risk strata, either as monotherapy or as part of a multi-modality regimen (7–10).

Qualifications and responsibilities of personnel

Radiation oncologist

1. Certification in Radiology by the American Board of Radiology to a physician who confines his/her professional practice to radiation oncology, or certification in Radiation Oncology or Therapeutic Radiology by the American Board of Radiology, the American Osteopathic Board of Radiology, the Royal College

of Physicians and Surgeons of Canada, or the Collège des Médecins du Québec may be considered proof of adequate qualification.

or

2. Satisfactory completion of a residency program in radiation oncology approved by the Accreditation Council for Graduate Medical Education (ACGME), the Royal College of Physicians and Surgeons of Canada (RCPSC), the Collège des Médecins du Québec, or the American Osteopathic Association (AOA).
3. The radiation oncologist should have formal training in prostate brachytherapy. If this training was not obtained during an ACGME-approved residency or fellowship program the radiation oncologist should comply with the following requirements:
 - a. Appropriate training in transrectal ultrasound (TRUS), computed tomography (CT), or magnetic resonance imaging (MRI) guided prostate brachytherapy.
 - b. Additional training by participating in hands-on workshops on the subject or through proctored cases with a minimum of five cases required. The proctoring physician should be an experienced prostate brachytherapist with the proficiency to perform the mechanics of the implant procedure and critically assess the dosimetric quality of the implant. He/she should have delineated hospital privileges for performing this procedure. These workshops must provide the radiation oncologist with personal supervised experience with seed placement and implant evaluation.

Qualified Medical Physicist

For the qualifications of the Qualified Medical Physicist, see the ACR–AAPM Technical Standard for the Performance of High-Dose-Rate Brachytherapy Physics or the ACR–AAPM Technical Standard for the Performance of Low-Dose-Rate Brachytherapy Physics (11, 12).

Radiation therapist

The radiation therapist must fulfill state licensing requirements and be certified in radiation therapy by American Registry of Radiologic Technologists (ARRT).

Dosimetrist

Certification by the Medical Dosimetrist Certification Board is recommended.

Patient support staff

Individuals involved in the nursing care of patients should have education or experience in the care of radiation therapy patients.

Patient selection criteria

Candidates for treatment with prostate seed implant alone, as monotherapy, include those for whom there is a significant likelihood that their prostate cancer could be encompassed by the dose distribution from permanent prostate seed implant alone. Patients with a significant risk of disease outside of the implant volume may benefit from the addition of external beam irradiation and/or androgen deprivation therapy (ADT). Specific treatment schemas are evolving, as there are conflicting data regarding the efficacy of combined therapies relative to monotherapy. Consequently, it is suggested that each facility establish and follow its own practice parameters. Ongoing clinical trials will help to better define indications.

A number of different risk stratification systems exist. The majority of these systems divide prostate cancer patients into low-risk, intermediate-risk, and high-risk groups according to pretreatment PSA level, Gleason score, and clinical stage (13, 14). The volume of cancer on the prostate biopsy specimen also has been shown to affect biochemical outcome and may prove to be useful in further subdividing the established risk categories (15, 16). The National Comprehensive Cancer Network (NCCN) risk criteria are perhaps the most commonly cited and represent the standard for most modern clinical trials (17). Monotherapy is sufficient treatment for low-risk prostate cancer patients. Assuming good implant quality, there are emerging data that intermediate-risk patients may also be adequately treated with monotherapy, although this remains an area of active investigation (18–21). At the present time, most high-risk brachytherapy protocols include supplemental external beam with or without androgen suppression (22).

External beam treatment volume and the role of androgen suppression are areas of controversy. Extrapolation from external beam radiation therapy data suggests that there may be a potential role for androgen suppression in patients with factors that place them at high risk of metastasis (23–25). However, the role and duration of androgen suppression therapy in intermediate risk and high risk patients treated with brachytherapy have not been established.

When supplemental external beam radiation therapy is used the optimal treatment volume has not been established. Some investigators advocate the treatment of a whole pelvic field in higher risk patients. Other investigators believe an involved field around the prostate and immediately adjacent structures is appropriate (22, 26–28).

Androgen suppression should not be routinely given for low-risk patients. It could be given to certain patients with large glands if required for volume reduction for those utilizing a technique that requires prostate downsizing (29).

The following are potential exclusion criteria for permanent seed brachytherapy:

1. Life expectancy of less than 10 years in the setting of low-risk prostate cancer.

2. Unacceptable operative risk
3. Poor anatomy which in the opinion of the radiation oncologist could lead to a suboptimal implant (e.g., large or poorly healed transurethral resection of the prostate (TURP) defect, large median lobe, large gland size).
4. Pathologically positive lymph nodes
5. Significant obstructive uropathy
6. Distant metastases

Specifications of the procedure

Implant treatment planning

Dosimetric planning should be performed in all patients prior to or during seed implantation. TRUS, CT scanning, or MRI should be used to aid in the treatment planning process (30–36).

Intraoperative procedure

A transperineal approach under transrectal ultrasound guidance is recommended for seed implantation. Ideally, the full definition of the prostate in both longitudinal and transverse planes should be available. Typically, a 5.0–12.0 MHz probe is used for the TRUS. It is recommended to use a high-resolution biplanar ultrasound probe with dedicated prostate brachytherapy software.

There are several acceptable methods for seed insertion. These include, but are not limited to:

1. Using a preloaded needle technique
 - a. The preloaded technique is performed based on a pre-plan and can be used in conjunction with intraoperative planning. Needles can be placed one at a time, all at once, by row, or based on peripheral and central locations.
 - b. Seeds can be “stranded,” “linked,” or “loose” within each needle (37).
2. Using a free seed technique
 - a. A Mick applicator or similar device is used to load the seeds into the prostate.
 - b. Free seed loading can be based on a preplan or an intraoperative plan.
 - c. Needles can be placed one at a time, all at once, by row, or based on peripheral and central locations.

For dose calculations, the AAPM Task Group No. 43 Report (TG-43) (38, 39) and its successors should be adopted. The precise radiation dose necessary for eradicating prostate cancer by brachytherapy is not absolutely defined. Based on available data the following recommendations are made for dose prescriptions. For patients with low risk or favorable disease treated by monotherapy, the prescription dose ranges from 110 to 125 Gy for palladium-103 and 140 to 160 Gy for iodine-125 (40–42).

In recent years there has been experience with cesium-131, and if that isotope is used, reference to current literature is advised. The currently recommended dose is 115 Gy if cesium-131 is used as monotherapy. Doses of approximately 85 Gy are being investigated when combined with external beam radiation therapy (43). With external beam plus brachytherapy the recommended external beam dose to the prostate and periprostatic area is in the range of 20–50.4 Gy (44).

Whole pelvic irradiation may be used in those cases at high risk for pelvic node metastases. The palladium-103 prescription boost dose is in the range of 80–110 Gy, and for iodine-125 the prescription boost dose is 100–110 Gy (34, 38, 39, 45). When brachytherapy is used in conjunction with external beam radiation, it is recommended that the treating clinician consider the biologically effective dose (BED) that results from the combination of these two modalities. Several formulas have been proposed to account for the different dose-fractionation schemas that exist for the external beam component of treatment and also the various isotopes that can be used in the brachytherapy implant (42, 46, 47). Given the known correlation between BED and treatment outcome, every effort should be made to attain a BED threshold that will maximize cure while minimizing treatment-related morbidity.

There are no recommendations regarding the choice of one radionuclide over another. One randomized trial examined differences between the two isotopes (palladium-103, iodine-125) and noted no significant differences in long term morbidity or PSA-based cancer control (48).

Postimplant procedures

Cystoscopy can be performed after the procedure. Cystoscopy allows for removal of blood clots and misplaced seeds in the bladder and/or urethra. Patients should be advised that there is a risk of seed migration to the lungs or other organs. Urinary anesthetics, antispasmodics, analgesics, perineal ice packs, and stool softeners may be added in symptomatic patients. Consideration should be given to the prophylactic use of alpha blockers before and after the procedure (49).

Documentation

Reporting and communication should be in accordance with the ACR–ASTRO Practice Parameter for Communication: Radiation Oncology (50).

Postimplant dosimetry

Postimplant dosimetry is mandatory for each patient. This information expresses the actual dose delivered and identifies variance from the original treatment plan. Although useful for seed counting, plain radiographs alone

are not adequate for dosimetric analysis. We recommend the use of image-based planning such as CT or MRI to evaluate the relationship of the seeds and the prostate, bladder, and rectum (51, 52).

The optimal timing for obtaining the postimplant CT and/or MRI is not known. Implant dosimetry will vary in a predictable fashion depending on when the imaging evaluation is performed. Imaging obtained within 24 h of the implant procedure will result in lower calculated doses to the prostate and anterior rectal wall, while day 30 imaging will predict higher doses to these respective structures (53–56). Some studies suggest an interval of 2–6 weeks postimplant (AAPM TG-64 and TG-137 Reports) (57, 58). Others have argued that dosimetric evaluation should be performed within 24 h of implant because this allows for immediate correction of dose deficiency and allows for implant assessment at the time maximal prostatic edema (59, 60). Regardless of convention, it is preferred that the timing of postimplant image acquisition be kept consistent within each practice. The TRUS volume study can be fused with the postimplant CT or MRI for the purposes of postimplant dosimetry (61).

Significant intraobserver variability in the contouring of prostate volumes and normal structures can be noted on post-implant CT scans, and this should be considered before drawing specific inferences regarding dosimetric parameters (62, 63).

The following parameters should be reported:

1. The prescribed (intended) dose.
2. The D90, defined as the minimum dose received by 90% of the target volume as delineated on the postimplant CT and the V100, defined as the percentage of the target volume delineated on the postimplant CT receiving 100% of the prescribed dose (64–66). A D90 of at least 90% of the prescription dose and a V100 that corresponds to at least 90% of the contoured prostate is recommended as the current standard of care, but this should be balanced with respect to the morbidity of the adjacent normal tissue doses (41, 42, 67–71). Reporting of the V150 and V200 (i.e., the percentage of prostate volume receiving 150% and 200% of prescribed dose, respectively) should also be considered (66).
3. Doses to organs at risk (OAR) including rectum and prostatic urethra (72–74). The dose to the rectum is commonly reported as the RV100 and RV150, the volumes in cubic centimeters of the rectal wall receiving 100% and 150% of the prescribed dose, respectively. The dose to the urethra is often reported as UrV150, which is the volume in cubic centimeters of the urethra receiving 150% of the prescribed dose (75). Dose to the penile bulb may be reported, but there are conflicting results regarding the clinical utility of this practice parameter (76, 77).

Radiation safety and physics quality control

TRUS imaging system

The report of the AAPM Ultrasound Task Group 128 (78) for acceptance testing and quality assurance and the ACR Technical Standard for Diagnostic Medical Physics Performance Monitoring of Real Time Ultrasound Equipment (79) provide guidance for ultrasound imaging units. Physicists and physicians should pay attention to spatial resolution, grayscale contrast, geometric accuracy, and distance measurement. The correspondence between the electronic grid pattern on the ultrasound image and the template grid pattern should be verified.

Computerized planning system

The computerized planning system should be commissioned by the Qualified Medical Physicist prior to clinical use. The AAPM TG-40 (80) report should be followed. In addition, dose rate calculations from planning systems should be compared to the AAPM TG-43 (38, 39) report. The Qualified Medical Physicist and/or radiation oncologist should also be familiar with the AAPM TG-64 Report (58).

Brachytherapy source calibrations

The recommendations set forth by the AAPM TG-40 (80), TG-56 (45), and TG-64 (58) reports and the recommendations of AAPM Low Energy Brachytherapy Source Calibration Working Group (81) should be followed for calibrating brachytherapy sources.

Implantation procedure

The radiation oncologist will verify the position of the prostate gland relative to the template coordinates. The total number of seeds implanted should be verified at the end of the implant procedure. At the completion of the implant, a radiation survey of the patient and the room should be conducted with an appropriately calibrated survey instrument. Patient survey measurements should be performed at the surface of the patient and at 1 m from the patient. The room survey should include the vicinity of the implanted area, the floor, the waste fluids/materials, linens, and all applicators. Prior to the release of the patient, the Qualified Medical Physicist, or an appropriately trained member of the physics staff, and/or the radiation oncologist or radiation safety staff should review the postimplantation survey results to confirm that all pertinent federal and state regulations regarding the release of patients with radioactive sources have been followed.

Postimplant radiation safety considerations

Patients should be provided with written descriptions of the radiation protection guidelines, including, but not limited to, discussion of potential limitations of patient

contact with minors and pregnant women. This description should be in compliance with state and federal regulations. The radiation oncologist, the Qualified Medical Physicist, and the radiation safety officer should define the postimplant radiation safety guidelines for patients treated with permanent seed implantation.

Follow-up

Follow-up of definitively treated cancer patients is part of radiation oncology practice, as noted in the ACR–ASTRO Practice Parameter for Radiation Oncology (82). Postoperative follow-up should consist of sufficient visits within the first 3 months to assure patient safety and comfort and to minimize acute complications associated with the radiation therapy procedure. The frequency and sequence of subsequent visits may vary among the radiation oncologist, urologist, and other physicians involved in the care of the patient. The radiation oncologist should make an effort to obtain long term follow-up on patient status.

The best definition of biochemical PSA failure has yet to be determined for brachytherapy patients (83). The current ASTRO Phoenix PSA failure definition is most commonly used (84). PSA failure can also be defined according to an absolute threshold (i.e., PSA exceeding a certain level), but when using such a definition, adequate time should be allowed for the PSA to reach its nadir. Consideration should be given to the PSA bounce or spike phenomenon in cases of spurious PSA elevation following implantation (84–87). Although most spikes occur at 18 to 30 months, they can occur much later. Other clinical laboratory and radiologic studies may be performed when clinically indicated. If there is concern regarding recurrence, other treatment options can be considered.

Summary

Transperineal prostate brachytherapy is an effective modality for treating prostate cancer. Its safe and effective execution is a complex process that requires coordination between the radiation oncologist and other health professionals. Appropriate patient selection criteria and quality assurance procedures are important for a successful program.

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Collaborative Committee.

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