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Comparison of low and intermediate source strengths for ^{125}I prostate brachytherapy implants

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ABSTRACT

PURPOSE: To compare the implant quality and clinical outcomes for patients treated with low and intermediate strength ^{125}I seeds in prostate brachytherapy implants.

METHODS AND MATERIALS: This retrospective review included 390 consecutive patients treated with prostate brachytherapy from 1999 to 2006. The first 142 patients were implanted with source strengths lower than 0.415 U (0.327 mCi), with the subsequent 248 patients implanted with source strengths higher than 0.493 U (0.388 mCi). Clinical, dosimetric, toxicity, and outcome data were compared between these two cohorts of patients.

RESULTS: Despite having similar prostate volumes, fewer sources (median, 95 vs. 113; $p < 0.0001$) and fewer needles (median, 23 vs. 29; $p < 0.0001$) were implanted in the intermediate strength cohort. The postimplant dosimetry demonstrated better quality implants in patients treated with intermediate strength sources (median D_{90}, 160.0 Gy vs. 139.6 Gy; $p < 0.0001$), with greater dose inhomogeneity identified in the intermediate strength cohort of patients. A higher incidence of late rectal toxicity was identified in patients treated with intermediate strength sources despite lower rectal doses in this cohort. The biochemical relapse-free survival, prostate cancer survival, and overall survival were not significantly different between the two cohorts.

CONCLUSIONS: The transition from low to intermediate strength sources has led to fewer resources being used and improved postoperative dosimetry. Although there were more rectal complications identified in the intermediate strength cohort of patients in this analysis, there were no other significantly worse clinical or biochemical outcomes for patients implanted with intermediate strength sources.

Keywords: Brachytherapy; Source strength; Prostate cancer; Toxicity; Outcomes

Introduction

The last two decades have seen a dramatic rise in the utilization of prostate brachytherapy implants for men with localized prostate cancer (1, 2). A survey of clinical practices identified a range of source strengths that are used by different institutions (3). Proponents of low strength sources point to the improved dose homogeneity and greater error tolerance, as source placement errors or loss of sources have a lower impact on the postoperative dosimetry (4). In contrast, advocates of higher strength sources emphasize the lessened surgical trauma and cost savings that can be achieved with this approach because of the lower cost of sources and shorter implanting time (5). As a result, there is no practitioner consensus on an optimal source strength for permanent prostate brachytherapy implants (6).

With these issues in mind, our group performed planning studies to determine if a preferred source strength exists for permanent prostate brachytherapy implants (7). This study

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demonstrated that higher strength sources can provide better dose coverage and improved organ sparing compared with lower strength sources, with 0.5–0.6 U (U = unit of air kerma strength = 1 $cGy \cdot cm^2 \cdot h^{-1}$) sources emerging as optimal source strengths. A subsequent study by our group compared the postoperative dosimetry of two groups of patients with different source strengths and confirmed that the D_{90} was significantly better for patients implanted with higher strength sources (8). Other studies have also compared implants of different source strengths (9, 10), but there are few comparisons of clinical outcomes of patients treated with different source strengths (11), particularly long-term outcomes. This study reports the dosimetry, toxicity, and outcomes of two consecutive cohorts of patients implanted with either low or intermediate strength sources. The purpose of this study was to confirm that the clinical outcomes of patients treated with intermediate strength sources were not compromised in comparison with patients implanted with low strength sources.

Methods and materials

Study cohort

This study included 390 consecutive patients treated with permanent prostate brachytherapy implants at the Cross Cancer Institute, Edmonton, Alberta, Canada between May 4, 1999 and December 19, 2006. The cutoff date was chosen to allow a minimum potential followup of 5 years. The institutional research ethics committee approved this study.

Men eligible for brachytherapy included those with low-risk disease (defined as clinical stage of T2 or lower, Gleason score of 6 or less, and pretreatment prostate-specific antigen [PSA] level of 10 ng/mL or lower) and low-tier intermediate-risk disease (defined as organ-confined disease and either Gleason score of 7 and PSA of 10 ng/mL or lower or PSA of 10–15 ng/mL and Gleason score of 6 or lower).

Treatment characteristics

Patients were treated with ^{125}I sources (model 6711; Oncura, Arlington Heights, IL and model MED3631-AM; North American Scientific, Chatsworth, CA) using an implant technique that our group has previously described (7). Briefly, a transrectal planning ultrasound was performed by a radiation oncologist before implantation with aerated gel in the urethra. The planning target volume was defined as the prostate gland with a 3-mm margin anteriorly and laterally, 0-mm margin posteriorly and superiorly, and a 5-mm margin inferiorly. A modified peripheral loading pattern delivered a minimum peripheral dose of 145 Gy to the planning target volume. A transrectal ultrasound-guided transperineal technique under general or spinal anesthesia was used to deliver the sources. Aerated gel was used to visualize the urethra during the procedure.

Each patient underwent a CT scan approximately 28 days after the initial implantation, using 3-mm thick slices to assess postoperative dosimetry. The CT scans were acquired using a Philips PQ-5000 (Philips Healthcare, Picker, Cleveland, OH) scanner and imported into the VariSeed treatment planning system (Varian Medical Systems, Palo Alto, CA) for postoperative dosimetry. The prostate, bladder neck, and complete rectum (all slices containing sources) were contoured by a radiation oncologist, whereas a medical physicist identified the source coordinates using a combination of manual selection and automated seed finding, including redundancy checks available in Variseed. The dosimetric values calculated included the postoperative D_{90} (defined as the minimum dose covering 90% of the postimplantation CT prostate volume) and the V_{100}, V_{150}, and V_{200} (percentage of the postimplantation CT prostate volume covered by 100%, 150%, and 200% of the prescription dose, respectively).

The first 142 patients (low strength cohort) were treated with a median source strength of 0.398 U (0.313 mCi; range, 0.387–0.414 U [0.305–0.326 mCi]). Following a planning exercise that demonstrated improved dose coverage and urethra protection with higher strength sources (7, 8), the source strength was increased (intermediate strength cohort) to a median strength of 0.494 U (0.389 mCi; range, 0.494–0.572 U [0.389–0.450 mCi]) for the following 248 patients. Variability in the source strength was owing to a lack of availability of desired source strength or by the postponing of a patient's treatment. In addition, it should be noted that our institution transitioned from loose sources to stranded sources in July 2001 (patient number 125), with subsequent implants using RapidStrands (Oncura, Arlington Heights, IL) for all sources except the periurethral sources.

Followup

The day of the brachytherapy implant was considered Day 0 for followup. The followup of these patients consisted of assessments at 4 weeks, then semiannually for 2 years, and then annually. The toxicity and PSA outcomes were retrospectively entered into a database. A large proportion of patients at our institution travel from out of town for their treatment and are discharged from followup at our institution, with guidelines provided to family physicians for followup including physical examinations, toxicity, and PSA assessments. To capture information on patients discharged from our followup, the Alberta electronic medical record was reviewed to capture toxicities and biochemical information for patients. In the province of Alberta, patients' electronic medical records contain all PSA measurements performed in the province, with procedure notes, operative notes, and hospitalizations also available for patients suffering complications. It should also