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Multisector prostate dosimetric quality: Analysis of a large community database

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ABSTRACT

PURPOSE: To evaluate multi-institutional prostate brachytherapy dosimetric quality using multisector analysis.

METHODS AND MATERIALS: In the database, 4547 patients underwent brachytherapy (3094 for ^{125}I, 1437 for ^{103}Pd, and 16 for ^{131}Cs). The original prostate postimplant dosimetry was reported using the maximum dose covering 90% of the prostate volume (D_{90}) and the percentage of the prostate volume covered by the prescription dose (V_{100}). Retrospectively, the dosimetry of all implants was recalculated after segmenting the prostate into 12 sectors (anterior, left and right lateral and posterior, about the center of gravity, and subdivided lengthwise into three—base, midgland, and apex). The dosimetric quality of each sector and combinations of sectors was compared across radionuclides.

RESULTS: For each radionuclide, there was no significant difference between monotherapy and boost in terms of V_{100} or D_{90}. When classified as excellent ($V_{100} \geq 90\%$), standard ($V_{100} \geq 80\%$), or minimal ($V_{100} < 80\%$), 33.0%, 4.6%, and 10.5% of all base, midgland, and apical sectors, respectively, were of minimal quality. Specifically, 59.2% of the anterior base and 30.3% of the posterior base sectors were minimal. At the anterior midgland and apex, 22% and 19% of sectors were minimal. Excellent quality was observed in more than 90% of lateral and posterior midgland sectors and in >70% of lateral and posterior sectors. When stratified by ^{103}Pd vs. ^{125}I, sector analysis did not result in clinically significant dosimetric differences.

CONCLUSIONS: Coverage of base sectors was inferior to midgland and apical sectors, and coverage of anterior sectors was notably inferior to lateral and posterior sectors. Further critique of brachytherapy planning and intraoperative technique is necessary for brachytherapists to minimize these dosimetric differences.

Keywords: Prostate cancer; Brachytherapy; Implant quality; Dosimetry

Introduction

Prostate brachytherapy is a highly efficacious treatment for clinically localized prostate cancer with multiple studies demonstrating a relationship between dosimetric quality, biochemical control rates, and complications (1–3). To provide community-based prostate brachytherapists with feedback and guidance, Pro-Qura was established as a quality initiative to provide preplanning and dosimetry guidance to include written instructions, standardize pre- and postimplant dosimetry, and facilitate dosimetric comparisons across institutional and community practices (4). It was presumed that consistent external dosimetric feedback would produce continuous improvements in implant quality with resultant community-wide improvements in biochemical control and decreases in brachytherapy-related morbidity.

Previously, we evaluated the Pro-Qura database to evaluate the impact of case volume on postimplant dosimetric

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Conflict of interest: PG is an owner of Pro-Qura.

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quality (5). In this study, the highest volume brachytherapists were most likely to obtain excellent dosimetric coverage of the prostate gland compared with lower volume brachytherapists. However, only 25.6% of brachytherapists with sufficient case volume (21/82) demonstrated the quality improvement over time. It is conceivable that certain regions of the prostate gland were more susceptible to underdosage than others, and the identification of these regions could lead to improvement in intraoperative technique to minimize such differences. The concept of sector analysis was first reported by Bice *et al.* (6) in 2001, and single-institutional studies have demonstrated disparities in geometric dose distributions throughout the gland (7). In this study, the Pro-Qura database was used to evaluate postimplant dosimetry using a multisector analysis to determine a dosimetric quality for each sector and combinations of such.

Methods and materials

From August 1999 to December 2008, 4547 postimplant CT scans stored in the Pro-Qura database were available for additional analysis. These CT scans originated from the 129 Pro-Qura participating brachytherapists. The original postimplant prostate dosimetry was reported in terms of a V_{100} (the percentage of the prostate volume covered by the prescription dose) and D_{90} (the maximum dose covering 90% of the prostate volume) using the previously described Pro-Qura approach (4). Patients implanted at the authors' institutions were not part of the Pro-Qura database.

All implants were planned before the procedure. Of the 4547 patients, 3094 (68.0%) were implanted with ^{125}I, 1437 (31.6%) with ^{103}Pd, and 16 (0.4%) with ^{131}Cs. For ^{125}I, 84.3% of patients underwent monotherapy (144–145 Gy) and 15.7% a boost (110 Gy). For ^{103}Pd, 67.4% of patients underwent monotherapy (125 Gy) and 32.6% a boost (90–100 Gy). For ^{131}Cs, 62.5% of patients underwent monotherapy (115 Gy) and 37.5% a boost (84 Gy). All patients underwent postimplant CT dosimetry at a median of 30 days after brachytherapy.

The Pro-Qura technique for postimplant dosimetric analysis that superimposes the preimplant ultrasound and the postimplant CT has been described in detail (4). All postimplant CT dosimetry was physician reviewed, and the implanting brachytherapist was provided with a written critique. The summary implant quality standards, V_{100}

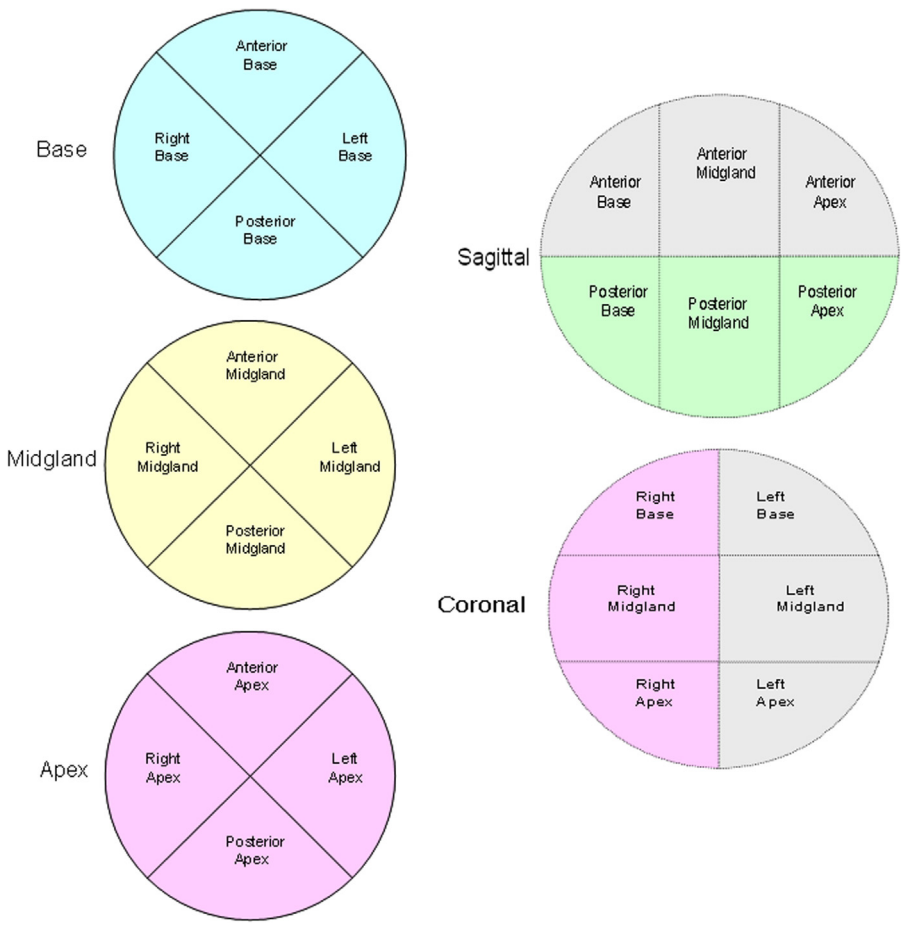

Fig. 1. Schematic distribution of the sectors analyzed in the 4547 patients. The 12 sectors were also combined for net dosimetric quality of base, midgland, and apex (four sectors each) and anterior, posterior, left lateral, and right lateral (three sectors each).