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Impact of small prostate size on postimplant prostate dosimetry: Analysis of a large community database

Al V. Taira[1], Gregory S. Merrick[2,*], Peter Grimm[3], Wayne M. Butler[2], Jonathan H. Lief[2], Mallory Morris[2], Abbey Bennett[2]

[1]Dorothy Schneider Cancer Center, Mills Peninsula Hospital, San Mateo, CA
[2]Schiffler Cancer Center, Wheeling Jesuit University, Wheeling, WV
[3]Prostate Cancer Center of Seattle, Seattle, WA

ABSTRACT

PURPOSE: Achieving high-quality permanent interstitial brachytherapy in smaller prostates is thought to be more difficult than in larger glands. This study evaluates 4547 implants in a large community database to test this hypothesis.

METHODS AND MATERIALS: From January 2003 to October 2010, 4547 prostate brachytherapy implants from a large community database were analyzed. The cohort was divided into three groups based on size, namely smaller (<30 cm^3, $n = 1301$), medium (30–40 cm^3, $n = 1861$), and large (>40 cm^3, $n = 1385$). Postimplant dosimetry, including D_{90}, V_{100}, and V_{100} by prostate sector, was performed for each implant. Comparison of mean V_{100} among small, medium, and larger prostate volume cohorts was performed using a one-way analysis of variance test.

RESULTS: For the overall cohort, the D_{90} was 105% and 104% for monotherapy and boost, respectively. Mean D_{90} for small prostates was 106% and 104% for monotherapy and boost, respectively. Mean V_{100} for small prostates was 91.1% and 90.0%, respectively. Coverage for small prostates was as good or slightly better than larger glands. V_{100} by prostate sector revealed that there were no sectors for which smaller glands had significantly inferior coverage compared with larger glands.

CONCLUSION: Although smaller prostates may in some respects be more technically difficult to implant than larger glands, a review of community-based brachytherapists reveals that with current implant techniques, good quality implants are readily achievable in men with smaller glands.

Keywords: Prostate brachytherapy; Prostate size; Dosimetry; ProQura

Introduction

For men treated with permanent interstitial prostate brachytherapy, a substantial body of literature has documented the link between key dosimetric measures, specifically D_{90} and V_{100}, and treatment outcomes. Men with high-quality implants by these measures have been shown to have better biochemical progression-free survival, metastasis free-survival, and overall survival (1–3). Many factors can make it challenging to achieve high-quality implants. Smaller prostates, in particular, are thought to be technically more difficult to implant (4).

Several studies have reported that men with smaller prostates tend to have poorer quality implants (5–7). However, more recent single institutional studies have found that high-quality implants can be routinely achieved in men with smaller prostates (8, 9). When men with small prostates receive high-quality implants, outcomes have been excellent (9).

This study examines the ProQura (Seattle, WA) database, which consists of 129 brachytherapists. The purpose is to determine whether men with smaller prostates receive the same quality as men with medium or larger prostates.

Methods and materials

The current analyzed ProQura database consists of post-implant CT scans of 4547 patients implanted by 129

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Conflict of Interest: Dr. Grimm is the founder of ProQura.

* Corresponding author. Schiffler Cancer Center, Wheeling Hospital, 1 Medical Park, Wheeling, WV 26003-6300. Tel.: +1-304-243-3490; fax: +1-304-243-5047.

E-mail address: gmerrick@urologicresearchinstitute.org (G.S. Merrick).

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Table 1
Treatment and summary dosimetric data for the 4547 cases in the study population stratified by prostate volume tertile

Parameters	Implant type	Overall $n = 4547$	p-Value[a]	Small (<30 cm^3) $n = 1301$	p-Value[a]	Medium (30–40 cm^3) $n = 1861$	p-Value[a]	Large (>40 cm^3) $n = 1385$	p-Value[a]	p-Value[b]
Volume (cm^3)	Monotherapy	36.7 ± 10	<0.001	25.1 ± 3.6	<0.001	34.8 ± 2.9	0.006	48.2 ± 7.7	0.550	<0.001
	Boost	33.6 ± 10		24.2 ± 4.2		34.3 ± 2.9		47.8 ± 6.1		<0.001
Monotherapy or boost	Monotherapy	78.9		72.3		79.5		84.3		<0.001
	Boost	21.1		27.7		20.5		15.7		
Radionuclide	^{125}I	68.0		56.3		68.7		78.1		<0.001
	^{103}Pd	31.6		43.2		30.8		21.8		
	^{131}Cs	0.40		0.50		0.50		0.10		
Number of seeds	Monotherapy	99.3 ± 19	<0.001	82.4 ± 12	<0.001	97.2 ± 13	<0.001	115 ± 17	0.001	<0.001
	Boost	91.7 ± 18		78.3 ± 13		93.1 ± 12		112 ± 15		
Prostate V_{100} (% vol)	Monotherapy	90.7 (7.5)	0.003	91.1 (7.5)	0.025	91.3 (6.9)	0.101	89.7 (8.1)	0.032	<0.001
	Boost	89.9 (8.8)		90.0 (9.0)		90.6 (8.1)		88.4 (9.3)		0.012
Prostate D_{90} (% Rx)	Monotherapy	105 (15)	0.006	106 (16)	0.028	106 (14)	0.078	103 (14)	0.047	<0.001
	Boost	104 (15)		104 (15)		105 (15)		101 (15)		0.003

ANOVA = analysis of variance; SD = standard deviation.
Data are presented as mean ± SD or percentage.
[a] Independent samples t test for bivariate parameters or one-way ANOVA for radionuclide.
[b] χ^2 Test of distribution across volume tertiles.

brachytherapists from June 2003 to October 2010. Patients implanted at the authors' institutions are not part of the database. Monotherapy represented 78.9% of the cases, whereas 21.1% were implanted with a boost. ^{125}I was the most commonly used isotope (68%), whereas ^{103}Pd comprised 31.6% and ^{131}Cs comprised 0.4% of all cases (Table 1). All patients underwent postimplant CT dosimetry at a median of 30 days after brachytherapy.

Postimplant dosimetry was performed by a standard technique developed by ProQura (10). Overall prostate D_{90} was calculated for each implant. Adequacy of prostate coverage also was determined by assessing what percent of the overall prostate gland was covered by 100% of the prescription dose (V_{100}). In addition, each prostate was divided into 12 sectors to evaluate dosimetric coverage by sector. Sections included prostate apex, midgland, and base—each further subdivided into left, right, anterior, and posterior sectors.

The purpose of the study was to evaluate the impact of prostate size on postimplant dosimetric quality. The database was divided into cohorts of patients with small (<30 cm^3), medium (30–40 cm^3), and large (>40 cm^3) prostates. Using this categorization, 1301 men (28.6%) had small prostates, 1861 men (40.9%) had medium prostates, and 1385 men (30.5%) had large prostates (Fig. 1). Overall prostate dosimetry and dosimetry for each of the 12 prostate sectors was compared for men with small, medium, and large prostates. Quality of coverage by sector was considered minimal if V_{100} was lower than 80%, standard if V_{100} is 80% or higher, and excellent if V_{100} is 90% or higher.

Comparison of mean V_{100} and D_{90} between small, medium, and large prostate volume cohorts was performed using a one-way analysis of variance test. For all tests, a p-value of 0.05 or lower was considered significant. Statistical analyses were performed with SPSS Version 15.0 software (SPSS, Inc., Chicago, IL).

Results

Table 1 summarizes treatment and dosimetric data for the entire cohort. For the cohort overall, D_{90} was 105% for monotherapy and 104% for boost. V_{100} was 90.7% for monotherapy and 89.9% for boost. Men with small and medium prostates had modestly higher D_{90} and V_{100} than men with large prostates. Mean D_{90} was 106%, 106%, and 102% for small, medium, and large prostates, respectively ($p < 0.001$). Mean V_{100} was 90.8%, 91.2%, and 89.5% for small, medium, and large prostates, respectively ($p < 0.001$; Table 2).

Table 3 presents V_{100} by sector analysis for the overall cohort. In general, sector coverage was lower in anterior prostate and prostate base sectors. Median V_{100} was 92.8%, 95.2%, and 83.0% for all apex, midgland, and base sectors, respectively. Median V_{100} was 81.1%, 93.5%, and 90.3% for all anterior, lateral, and posterior sectors, respectively. For men with small prostates, Fig. 2 displays percent

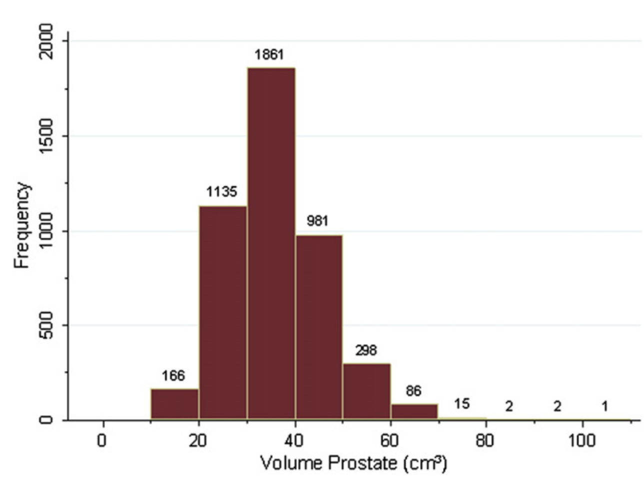

Fig. 1. Histogram of preimplant ultrasound prostate volumes.