Int. J. Radiation Oncology Biol. Phys., Vol. 81, No. 3, pp. e143–e149, 2011

0360-3016/$ - see front matter

doi:10.1016/j.ijrobp.2010.12.057

CLINICAL INVESTIGATION **Prostate**

DELINEATION OF THE POSTPROSTATECTOMY PROSTATE BED USING COMPUTED TOMOGRAPHY: INTEROBSERVER VARIABILITY FOLLOWING THE EORTC DELINEATION GUIDELINES

Piet Ost, M.D.,* Gert De Meerleer, M.D., Ph.D.,* Tom Vercauteren, MSc.,* Werner De Gersem, Ir., Ph.D.,* Liv Veldeman, M.D.,* Katrien Vandecasteele, M.D.,* Valérie Fonteyne, M.D., Ph.D.,* and Geert Villeirs, M.D., Ph.D.†

*Department of Radiotherapy and †Department of Radiology, Ghent University Hospital, Ghent, Belgium

Purpose: **The present study aims to assess the interobserver agreement of prostate bed delineation after radical prostatectomy using CT alone as proposed by the European Organization for Research and Treatment of Cancer (EORTC) guidelines.**
Methods and Materials: **Six observers delineated the postoperative prostate bed (PB) and the original seminal vesicle position or remnants (SV) of 10 patients according to the EORTC guidelines. Contours were then compared for agreement between observers (the apparent volume overlap and generalized kappa statistics). Standard deviations were also calculated to measure the variability of the position of the outer margins.**
Results: **The mean volume of 100% agreement (±1 standard deviation, SD) was only 5.0 (±3.3) ml for the PB and 0.9 (±1.5) ml for the SV, whereas the mean union of all contours (±1 SD) was 41.1 (±11.8) ml and 25.3 (±13.4) ml, respectively. The mean overall agreement corrected for chance was moderate for both the PB (mean kappa, 0.49; range, 0.35–0.62) and SV (mean kappa, 0.42; range, 0.22–0.59). The overall SD of the outer margins of the PB ranged from 4.6 to 7.0 mm**
Conclusion: **The delineation of the postprostatectomy bed using CT shows only a moderate observer agreement when following the EORTC guidelines.** **© 2011 Elsevier Inc.**

Prostate, Postoperative, Adjuvant, Radiotherapy, Delineation.

INTRODUCTION

Postoperative radiotherapy after radical prostatectomy (RP) is indicated in the adjuvant setting for patients with high-risk pathological features (1) or in the salvage setting at prostate-specific antigen (PSA) relapse or when the PSA is persistently elevated after RP (2). In both settings, the tumor burden is often microscopic, which renders it invisible for anatomic imaging. This results in a large interobserver variability of the radiotherapy target volume (3, 4). Therefore, the European Organization for Research and Treatment of Cancer (EORTC) Radiation Oncology Group developed a guideline for the delineation of the postoperative prostate bed (PB) based on the areas at greatest risk for relapse (5). This guideline suggests soft tissue anatomical boundaries for delineation of the postoperative prostate bed using computed tomography (CT) alone (5). However, most of these soft tissue structures are difficult to discriminate on CT (5), which might lead to interobserver variability, resulting in systematic errors. As a consequence, an underdosage of the target and/or an overdosage of the normal tissues might arise.

The present study aims to assess the accuracy of prostate bed delineation using CT alone as proposed by the EORTC guideline (5).

METHODS AND MATERIALS

Ten patients referred to our department for postoperative radiotherapy, treated in 2009, were randomly selected for retrospective delineation of the PB according to the EORTC guideline (5) (Table 1). We did not take the additional 5-mm expansion (microscopical extensions) from the PB to the clinical target volume into account as proposed by the EORTC, because this would not influence the delineation as such and is not observer dependent. The observers did not have access to the pathological specimen results, because these results should not influence the delineation of the PB and would only influence CTV expansions (5). Next, the observers were also instructed to delineate a separate volume including the original seminal vesicle (SV) position and/or remnants as proposed in case of SV invasion.

Reprint requests to: Piet Ost, M.D., Department of Radiotherapy, Ghent University Hospital, De Pintelaan 185, B-9000, Gent, Belgium. Tel: 0032 9 332 24 11; Fax: 0032 9 332 30 40; E-mail: piet.ost@ugent.be

Conflict of interest: none.
Received July 19, 2010, and in revised form Dec 5, 2010. Accepted for publication Dec 29, 2010.

Table 1. EORTC definition of the prostate bed harboring the areas at greatest risk for relapse after prostatectomy (5)

Position	Anatomical border
Centrally	Urethra-vesical anastomosis
Cranially	Bladder neck, up to the base of the seminal vesicles
Posteriorly	Up to but not including the outer rectal wall, cranially including the most posterior part of the bladder
Caudally	Including the apex (15 mm cranially from the penile bulb)
Laterally	Up to the neurovascular bundles (if removed up to the ilio-obturatic muscles)
Anteriorly	Including the anastomosis and the urethral axis

Six observers (5 radiation oncologists and 1 radiologist) took part in the delineation process. Each observer had to interpret the guidelines of the EORTC by himself and was blinded from the delineation of the other observers. Two observers had a limited experience with fewer than 10 postoperative prostate bed delineations in the past. The 4 other observers were more experienced, with more than 100 previous prostate bed delineations. The CT acquisition protocol was previously described in detail (6), with the exception that the slice thickness was 2 mm for all patients.

Statistical considerations

Volumes. After delineation, the contours were imported into the Computerized Environment for Radiation Research (CERR), an open-source Matlab-based radiation therapy planning analysis tool (7). Contours were then compared for agreement by using this Matlab statistical software package.

Several algorithms were used to measure the level of agreement between physicians. The commonly used apparent volume overlap was calculated as the average agreement probability by which a voxel is selected by the observers. This was corrected for agreement by chance by using generalized kappa statistics (8). Kappa statistics assume values between +1 (perfect agreement) and 0 (no agreement above chance) and –1 (complete disagreement). According to Landis and Koch criteria (9), a kappa value of 0 would indicate poor agreement, 0.01 to 0.20 slight agreement, 0.21 to 0.40 fair agreement, 0.41 to 0.60 moderate agreement, 0.61 to 0.80 substantial agreement, and 0.80 to 1.00 almost perfect agreement.

It was assumed that within the collection of delineated contours, a "true" PB existed that represented the areas at the greatest risk for relapse after prostatectomy. We applied an imputation method based on the expected maximum algorithms for simultaneous truth and performance level estimation to estimate the ''true'' PB contours (10). In this approach, the consensus contouring decisions at each image voxel are formulated as maximum-likelihood estimates from the observed investigator contours by optimizing sensitivity and specificity parameters of each observer's determination of anatomical sites that could harbor subclinical disease (3).

Dimensions. The variations in the position of the left, right, anterior, posterior, inferior, and superior margin of the prostate bed were assessed. First, the union volume was constructed, which corresponds with the largest volume assuming the outermost delineated contours. Next, the center of volume of this structure was seen as the reference point. Finally, the distance between the center of volume and the outermost delineated contour was assessed for every patient and observer in every direction. The standard deviations for these distances were calculated to measure the variability of the position of the margins.

Every patient underwent magnetic resonance imaging (MRI) of the pelvis before radiotherapy as part of the routine practice at our hospital for the delineation process in the postoperative setting (11, 12). For this study, the observers did not receive the MRI information. After the delineation process, the penile bulb was delineated on MRI. The superiority of MRI relative to CT to delineate the penile bulb is well documented (6, 13, 14). The distance between the penile bulb and the inferior border of the

Table 2. Summary of the prostate bed (PB) and seminal vesicle (SV) statistics

		Overall kappa	Min. volume	Max. volume	Mean volume ± SD	Total agreement volume	Union volume	Mean Sensitivity ± SD	Mean Specificity ± SD
Patient 1	PB	0.36	5.9	18.8	10.1 ± 5.0	1.5	30.0	0.58 ± 0.08	0.96 ± 0.04
	SV	0.47	4.4	14.7	9.6 ± 4.2	0.9	22.3	0.60 ± 0.21	0.98 ± 0.02
Patient 2	PB	0.60	15.2	33.6	24.3 ± 7.1	10.4	48.2	0.78 ± 0.12	0.96 ± 0.04
	SV	0.49	3.5	11.9	8.0 ± 2.9	1.2	19.0	0.66 ± 0.19	0.98 ± 0.02
Patient 3	PB	0.62	11.8	30.0	18.7 ± 6.3	9.3	38.9	0.78 ± 0.09	0.97 ± 0.03
	SV	0.40	4.6	18.6	11.6 ± 6.3	0.7	29.0	0.57 ± 0.26	0.98 ± 0.02
Patient 4	PB	0.42	7.5	33.7	16.2 ± 9.6	2.4	39.8	0.63 ± 0.22	0.96 ± 0.06
	SV	0.39	3.8	11.5	7.3 ± 2.9	0.2	18.9	0.55 ± 0.24	0.98 ± 0.02
Patient 5	PB	0.41	9.8	33.0	21.3 ± 9.6	2.4	64.1	0.56 ± 0.19	1.00 ± 0.01
	SV	0.42	9.6	18.4	13.0 ± 3.1	1.0	33.7	0.55 ± 0.13	0.99 ± 0.01
Patient 6	PB	0.57	11.8	29.8	20.9 ± 6.8	8.2	46.7	0.75 ± 0.11	0.97 ± 0.03
	SV	0.59	10.3	23.3	17.8 ± 5.1	3.8	30.8	0.70 ± 0.19	0.98 ± 0.02
Patient 7	PB	0.52	11.3	36.2	22.0 ± 9.9	6.5	49.8	0.75 ± 0.16	0.95 ± 0.06
	SV	0.35	2.5	12.9	7.2 ± 3.8	0.3	19.6	0.53 ± 0.24	0.97 ± 0.03
Patient 8	PB	0.44	7.0	20.7	13.8 ± 6.0	2.8	37.2	0.62 ± 0.13	0.97 ± 0.03
	SV	0.22	1.8	30.0	12.3 ± 10.8	0.1	46.9	0.46 ± 0.33	0.98 ± 0.03
Patient 9	PB	0.48	7.9	24.3	13.6 ± 6.1	3.8	34.5	0.70 ± 0.09	0.96 ± 0.05
	SV	0.46	4.4	10.8	7.6 ± 2.6	0.9	17.4	0.56 ± 0.15	0.99 ± 0.01
Patient 10	PB	0.52	5.5	12.6	9.0 ± 3.2	2.7	21.8	0.73 ± 0.10	0.97 ± 0.03
	SV	0.40	1.5	9.2	6.2 ± 2.9	0.1	15.2	0.53 ± 0.27	0.99 ± 0.01