RESEARCH ARTICLE

Feedback on Baseline Use of Staging Images is Important to Improve Image Overuse with Newly Diagnosed Prostate Cancer Patients

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Abstract

Background: The objective of this study was to evaluate baseline use and positive rates of staging images (bone scan, CT) in newly diagnosed patients with prostate cancer (PCa) and to improve staging image overuse. Materials and Methods: This retrospective study covered a consecutive series of patients with PCa who underwent stage imaging at our institution between 2006 and 2011. Various clinical and pathological variables (age, PSA, biopsy Gleason score, clinical T stage, positive biopsy core rate) were evaluated by multivariate logistic regression analysis for their ability to predict a positive staging image. All patients were stratified according to the NCCN risk stratification and positive rates were compared in each risk group. Results: 410 patients (100%) underwent a bone scan and 315 patients (76.8%) underwent a CT scan. Some 51 patients (12.4%) had a positive bone scan, clinical T3 and T4 being significant independent predictors. Positive bone scan rates for low-, intermediate-, high-, and very high-risk groups were 0%, 0%, 8.25%, and 56.6%. Some 59 (18.7%) patients had a positive CT scan, with elevated PSA and clinical T3, T4 as significant independent predictors. Low-, intermediate-, high- and very high-risk group rates were 0%, 0%, 13.8% and 80.0%. Conclusions: The incidences of positive staging image in low- and intermediate- risk group were reasonably low. Following feedback on these results, staging in low- and intermediate- risk groups could be omitted.

Keywords: Prostate cancer - staging image - baseline use - feedback - risk stratification

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Introduction

Incidence rates of prostate cancer (PCa) in Japan have increased and are estimated to increase in the future. The number of patients with newly diagnosed PCa will be 78,468 in 2020, which will be the second highest male cancer following lung cancer (Ito et al., 2008).

More than 90% of PCa patients are diagnosed with a clinically localized disease (Lavery et al., 2011). For many years, there existed routine imaging (CT, bone scan) for staging purposes in all patients with newly diagnosed PCa, regardless of risk stratification (Borin, 2011). Despite the publication of international evidence-based guidelines, imaging overuse remains an issue (Borin, 2011; Lavery et al., 2011). This may place the patient at increased risk from radiation or contrast exposure and places an unnecessary financial burden on the patient and health care system (Lavery et al., 2011).

The Urological Surgery Quality Collaborative (USQC) project was performed to improve the use of radiographic staging in men with newly diagnosed PCa and accomplished a reduction in the use of staging image by collaborative feedback on baseline use and review of clinical guideline. Especially, there was a significant reduction in patients with low- and intermediate- risk cancer (Miller et al., 2011).

In this study, we evaluated the baseline use and positive rate of staging image (CT, bone scan) in a consecutive series of patients with PCa at our institution. We investigated the relevance of a positive staging image and various clinical and pathological variables (age, PSA, biopsy Gleason score, clinical T stage, positive biopsy core rate) and assessed the incidence of positive staging image across prostate cancer risk strata.

Materials and Methods

Between 2006 and 2011, the consecutive 410 newly diagnosed prostate cancer patients were treated at our institution. For a metastatic evaluation, a bone scan using

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technetium (Tc) 99m methylene diphosphonate (Tc 99m MDP) and a CT scan of chest, abdomen and pelvis were performed. All bone scans were classified as positive or negative for evidence of bone metastasis. If the diagnosis of bone metastases was suspected, then additional imaging studies with CT scan or magnetic resonance imaging (MRI) were undertaken to confirm the final diagnosis. All CT scans were classified as positive or negative for evidence of lymph node metastasis and distant metastasis. The results of CT and bone scans were obtained from the official radiology reports by one expert full-time radiologist (H.K.).

We retrospectively studied the baseline use and positive rate of staging image (bone scan, CT). The proportion of a positive staging image was evaluated by age distribution, PSA level at diagnosis, biopsy Gleason score (bGS), clinical T stage, and positive biopsy core rate (%). All patients underwent transrectal systemic biopsies for diagnosis of the disease. In the biopsy, three to five cores from each prostatic lobe with a total six to ten cores were taken and served for diagnosis. The positive biopsy core rate was determined by the following formula: the number of positive cores/the number of total biopsy cores. Clinical T stage was determined by digital rectal examination (DRE), transrectal ultrasonography and pre-biopsy MRI (1.5T, pelvic phased array). A 2002 UICC TNM staging system was used for clinical T stage classification. The bGS was assigned by the Gleason grading system of the 2005 International Society of Urological Pathology (ISUP) Consensus Conference.

Fisher's probability exact test was used to compare the categorical parameters. Mann-Whitney's U-test was used to compare the continuous parameters. Univariate and multivariate logistic regression analyses were performed to access the predictors of patients with a positive staging image (CT, bone scan).

All patients were stratified according to the NCCN (v.3.2012) risk stratification (http://www.nccn.org/professionals/physician_gls/PDF/prostate.pdf). In NCCN risk stratification, the risk groups are defined as follows: low risk group, clinical T stage T1-T2a and bGS2-6, and PSA<10 ng/mL; intermediate risk group, stage T2b-T2c or bGS 7 or PSA 10-20 ng/mL; high risk group, stage T3a or bGS≥8 or PSA>20 ng/mL; very high risk; T3b-T4. We compared the baseline use and positive rate of staging image (CT, bone scan) in each risk group.

All statistical analyses were performed using IBM SPSS Statistics ver.19.0. All P values<0.05 were considered as statistically significant.

Results

For staging, 410 patients (100%) underwent a bone scan and 315 patients (76.8%) underwent a CT scan. Of 410 patients, 51 (12.4%) were diagnosed with positive bone scan (bone metastasis). Patient backgrounds including age, PSA , bGS, clinical T stage and positive biopsy core rate (%) are summarized in Table 1. PSA, clinical T stage, bGS and positive biopsy core rate were significantly higher than those without positive bone scan (PSA<0.001, clinical stage<0.001, bGS<0.001, positive biopsy core rate<0.001). In Table 2, the univariate logistic regression analyses of each parameter to predict positive bone scan demonstrated that PSA, clinical T3, T4, bGS 8-10 and positive biopsy core rate were independent predictors. The multivaritate logistic regression analyses of each parameter to predict positive bone scan demonstrated that

Table 2. Univariate and Multivariate Logistic Regression Analyses to Predict a Bone Metastasis

	Univariate analyses		Multivariate analyses	
	Odds ratio	p value	Odds ratio	p value
Age (years)		0.12	0.958	0.104
PSA (ng/ml)		<0.001	1	0.162
Clinical stage				
T3 *vs* T2	74	<0.001	58.41	<0.001
T4 *vs* T2	251	<0.001	142.4	<0.001
biopsy Gleason score				
3+4 *vs* 3+3	7.8	0.08	0.987	0.992
4+3 *vs* 3+3	5.0	0.39	1.172	0.909
8-10 *vs* 3+3	19.8	<0.001	1.263	0.843
Positive biopsy core rate		<0.001	1.011	0.128

Table 1. 410 Patients Who Underwent a Bone Scan (Patients' Background)

	All patients	Patients without bone mets	Patients with bone mets	p value
No. of patients	410	359	51	
Age mean (median)	72.2 (73)	72.0 (73)	73.8 (75)	0.12
Clinical stage No.				<0.001
T1c	102	102	0	
T2a/T2b/T2c	83/34/56	83/34/55	0/0/1	
T3a/T3b	71/32	55/17	16/15	
T4	32	13	19	
PSA, ng/ml mean (median)	205 (11.5)	84.6 (9.99)	1052.8 (293)	<0.001
PSA, ng/ml, No.				<0.001
0-4.0	10	10	0	
4.01-10.0	171	170	1	
10.01-20.0	94	94	0	
>20	135	85	50	
Biopsy Gleason score, No.				
6	87	86	1	
3+4/4+3	60/34	55/32	5/2	
≥8	229	186	43	
Positive biopsy core rate (%) mean (median)	45.5 (40)	40.8 (30)	78.6 (90)	<0.001

Table 3. 316 Patients Who Underwent a CT Scan (patient's background)

	All patients	Patients without positive CT scan	Patients with positive CT scan	p value
No.	315	256	59	
Age mean (median)	72.6 (73)	72.4 (73)	73.2 (74)	0.36
PSA, ng/ml mean (median)	192.5 (11.5)	20.1 (9.0)	940.4 (225)	<0.001
Clinical stage No.				<0.001
T1c	84	83	1	
T2a/2b/2c	61/28/43	59/28/43	2/0/0	
T3a/T3b	50/23	30/8	20/15	
T4	26	5	21	
PSA, ng/ml, No.				<0.001
0-4.0	7	7	0	
4.01-10.0	136	135	1	
10.01-20.0	71	69	2	
>20	101	45	56	
Biopsy Gleason sum, No.				
6	59	58	1	<0.001
3+4/4+3	42/25	38/24	4/1	
≥8	189	136	53	
Positive biopsy core rate(%) mean (median)	46.5 (40)	39.1 (30)	78.5 (90)	<0.001

clinical T3 and T4 were independent predictors.

Of 315 patients, 59 (18.7%) were diagnosed with positive CT scan (lymph node in 46, bone in 11, and lung in 2). All those with positive bone metastases evidenced on CT had positive bone scans. Patient backgrounds including age, PSA, bGS, clinical T stage and positive biopsy core rate (%) are summarized in Table 3. PSA, clinical T stage, bGS and positive biopsy core rate were significantly higher than those without positive CT scan (PSA<0.001, clinical stage<0.001, bGS<0.001, positive biopsy core rate<0.001). In Table 4, the univariate logistic regression analyses of each parameter to predict positive CT scan demonstrated that PSA, clinical T3, T4, bGS 8-10 and positive biopsy core rate were independent predictors. The multivaritate logistic regression analyses of each parameter to predict positive CT scan demonstrated that PSA and clinical T3, T4 were independent predictors.

Table 4. Univariate and Multivariate Logistic Regression Analyses to Predict a Positive CT Scan

	Univariate analyses		Multivariate analyses	
	Odds ratio	p value	Odds ratio	p value
Age (years)		0.39	0.949	0.117
PSA (ng/ml)		<0.001	1.007	0.01
Clinical stage				
T2 *vs* T1c	1.93	0.95	1.475	0.75
T3 *vs* T1c	76.4	<0.001	20.15	0.014
T4 *vs* T1c	348.6	<0.001	28.12	0.001
Biopsy Gleason score				
3+4 *vs* 3+3	6.1	0.18	0.978	0.99
4+3 *vs* 3+3	5	0.43	7.236	0.216
8-10 *vs* 3+3	22.6	<0.001	3.684	0.362
Positive biopsy core rate		<0.001	1.012	0.225

In Table 5, a positive staging image (CT, bone scan) was evaluated across the NCCN risk strata. To investigate a positive bone scan, 410 patients were stratified into four groups according to the NCCN risk stratification. The bone scan baseline use in each risk group was all 100%. The proportions of patients with positive bone scan of the low-, intermediate-, high-, and very high-risk groups in our cohorts were 0% (0/57), 0% (0/87), 8.25% (17/206), and 56.6% (34/60). The CT baseline use of low-, intermediate-, high- and very high-risk group were 68.4% (39/57), 74.7% (65/87), 80.5% (166/206) and 75.0% (45/60) . The proportion of patients with positive CT scan of the low-, intermediate-, high- and very high-risk groups in our cohorts were 0% (0/39), 0% (0/65), 13.8% (23/166) and 80.0% (36/45). In our study, the incidences of positive staging image (bone scan, CT) in low- and intermediate- risk group were reasonably low.

Discussion

Despite the publication of international evidence-based guidelines, imaging overuse remains an issue (Lavery et al., 2011; Broin, 2011). According to the guidelines, bone scan is indicated for patients with bone pain, PSA>20ng/ml, Gleason score 8 or greater, or stage cT3 or greater and CT is reserved primarily for patients with greater than 20% nomogram predicted lymph node involvement (Broin, 2011). But most clinicians have little or no empirical data regarding their own staging practice patterns. In addition, even when such data are available, many urologists are uncertain about how to implement appropriate staging

Table 5. The Proportion of Baseline Use and Positive Staging Image (CT, Bone Scan) in Patients Stratified Into Each Risk Groups

		Low risk	Intermediate risk	High risk	Very high risk
Patients with bone scan	baseline use	100% (57/57)	100% (87/87)	100% (206/206)	100% (60/60)
	positive bone mets	0% (0/57)	0% (0/87)	8.25% (17/206)	56.6% (34/60)
Patients with CT scan	baseline use	68.4% (39/57)	74.7% (65/87)	80.5% (166/206)	75.0% (45/60)
	positive CT	0% (0/39)	0% (0/65)	13.8% (23/166)	80.0% (36/45)

practices (Miller et al., 2011).

Miller et al. (2011) described findings from a Urological Surgery Quality Collaborative (USQC) project focused on improving the use of radiographic staging (CT, bone scan) in men with newly diagnosed prostate cancer. They collected clinical data such as PSA and clinical T stage, bGS, receipt of a bone scan and/or CT, bone scan and/or CT results. They assessed baseline practice patterns in the use of bone scan and CT. Following audit and feedback of baseline use pattern and clinical guideline dissemination, urologists in USQC practices ordered significantly fewer radiographic studies. This study demonstrated a significant reduction in the use of radiographic staging (CT, bone scan) in patients with low and intermediate risk cancer ($p<0.05$). This project accomplished a reduction in the use of staging image by collaborative feedback on baseline use and review of clinical guideline.

In our study, we evaluated the clinical data and practice patterns of staging image at our institution. In the multivaritate analyses, clinical T3 and T4 were significant independent predictors of a positive bone scan. PSA and clinical T3, T4 were significant independent predictors of a positive CT scan. These results were equivalent to guideline recommendations. Among patients with low risk tumor, 68.4%CT and 100% bone scan were performed, but a positive rate of CT, bone scan is 0%, 0%, respectively. Among patients with intermediate risk tumor, 74.7% CT and 100% bone scan were performed, but a positive rate ofCT, bone scan is 0%, 0%, respectively. Staging practices in low- and intermediate- risk cancer can be safely omitted, in line with earlier reports of overuse of imaging (Choi et al., 2011; Pavolgyi et al., 2011; Sanjaya et al., 2013). Following feedback of baseline use data and guideline recommendations, staging image overuse can be improved.

In conclusion, staging image overuse was seen at our institution. A positive rate of staging image (bone scan, CT) in low- and intermediate- risk tumor is reasonablely low. Feedback on baseline use data is important to improve staging image overuse in newly diagnosed patients with prostate cancer.

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