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Original article

Patient characterization and usage trends of proton beam therapy for localized prostate cancer in the United States: A study of the National Cancer Database

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Abstract

Purpose: To evaluate usage trends and identify factors associated with proton beam therapy (PBT) compared to alternative forms of external beam radiation therapy (RT) (EBRT) for localized prostate cancer.

Patients and Methods: The National Cancer Database was queried for men with localized (N0, M0) prostate cancer diagnosed between 2004 and 2013, treated with EBRT, with available data on EBRT modality (photon vs. PBT). Binary multiple logistic regression identified variables associated with EBRT modality.

Results: In total, 143,702 patients were evaluated with relatively few men receiving PBT (5,709 [4.0%]). Significant differences in patient and clinical characteristics were identified between those men treated with PBT compared to those treated with photon (odds ratio [OR]; 95% CI). Patients treated with PBT were generally younger (OR = 0.73; CI: 0.67–0.82), National Comprehensive Cancer Network low-risk compared to intermediate (0.71; 0.65–0.78) or high (0.44; 0.38–0.5) risk, white vs. black race (0.66; 0.58–0.77), with less comorbidity (Charlson-Deyo 0 vs. 2+; 0.70; 0.50–0.98), live in higher income counties (1.55; 1.36–1.78), and live in metropolitan areas compared to urban (0.21; 0.18–0.23) or rural (0.14; 0.10–0.19) areas. Most patients treated with PBT travelled more than 100 miles to the treatment facility. Annual PBT utilization significantly increased in both total number and percentage of EBRT over time (2.7%–5.6%; $P < 0.001$). PBT utilization increased mostly in men classified as National Comprehensive Cancer Network low-risk (4%–10.2%).

Conclusion: PBT for men with localized prostate cancer significantly increased in the United States from 2004 to 2013. Significant demographic and prognostic differences between those men treated with photons and protons were identified. © 2017 Elsevier Inc. All rights reserved.

Keywords: Prostate cancer; Protons; Photons; Patterns of care; Utilization; National Cancer Database (NCDB)

1. Introduction

Definitive external beam radiation therapy (RT) (EBRT) is a curative treatment for localized prostate cancer and the treatment of choice for many men. Technologic advances, such as development of intensity-modulated photon therapy (IMRT) and proton beam therapy (PBT), facilitated radiation dose escalation to the prostate, which in turn improved cancer control rates without a parallel increase in toxicity [1–3]. Owing to unique dose deposition characteristics, PBT was an original method for prostate radiation dose escalation while minimizing dose deposition to nearby sensitive organs [4,5]. Although several institutional series have demonstrated favorable cancer-specific outcomes and low toxicity rates using PBT for prostate cancer compared to historical results with photons (X-rays) [6,7], large public database analyses have suggested discordant results, with some concern for higher gastrointestinal toxicity with PBT [8]. In addition, with reimbursement changes taking place, PBT may not be the

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most cost-effective treatment approach for prostate cancer; Yu et al. [9] reported median Medicare reimbursements of $32,428 for proton therapy compared to $18,575 for IMRT.

Despite the absence of high-quality comparative effectiveness research to support superiority or equivalency, PBT, historically limited in application by the small number of facilities equipped with such technology, has become increasingly available in the United States over the past decade. There are currently 24 operating proton facilities in the United States with another 11 facilities currently under construction [10]. With increased advertisement and electronic access via the Internet, more patients are inquiring about PBT for prostate cancer [11], and medical systems with PBT capability have increasingly focused on direct service marketing to men with localized prostate cancer [12].

Demographic and prognostic differences between PBT and photon-based EBRT have been appreciated by analyses of other large national databases demonstrating higher usage in young, affluent white males [9,13]. There are relatively limited data available evaluating disease risk factors and geographic patterns of usage for PBT using national datasets. In this population-based analysis, we queried the National Cancer Database (NCDB) to evaluate the use of PBT for localized prostate cancer since 2004 and sought to identify patient, clinical, and geographical factors associated with PBT vs. photon therapy use.

2. Materials and methods

2.1. Data source and patient selection

The NCDB is a joint project of the Commission on Cancer of the American College of Surgeons and the American Cancer Society. It is a hospital-based registry that represents 70% of all cancer cases in the United States, drawing data from more than 1,500 commission-accredited cancer programs. The NCDB contains detailed information on disease stage, risk factors specific to prostate cancer, and receipt of treatment including radiation dose, modality, treatment site, and receipt of androgen deprivation therapy (ADT) [14]. The data used in this analysis are derived from a publically accessible de-identified NCDB file. The American College of Surgeons and the Commission on Cancer have not verified and are not responsible for the analytical or statistical methodology employed, or the conclusions drawn from these data by the investigator.

We initially identified 196,266 patients, age ≥ 18 years, who were diagnosed with a first diagnosis of prostate adenocarcinoma (International Classification of Disease for Oncology [third edition] histology code 8140) from 2004 to 2013, with no evidence of nodal or metastatic involvement and treated with RT. All patients initially queried had complete information on Gleason score (GS), prostate-specific antigen (PSA), tumor staging, and receipt of EBRT. The following patients were excluded: patients treated surgically or with prostate brachytherapy, patients with unknown vital status or follow-up, patients treated with palliative intent, patients treated with stereotactic body RT, patients with unknown EBRT modality, and patients with missing data on facility type, race, insurance status, median county income, residence, distance to the treatment facility, or receipt of ADT. This resulted in a total of 143,702 patients for analysis (Fig. 1).

2.2. Patient demographics and treatment variables

Potentially relevant patient and treatment characteristics were included. Race was categorized as White, African American, and "Other." Distance from treatment center was recorded in miles. The NCDB groups' treatment facility

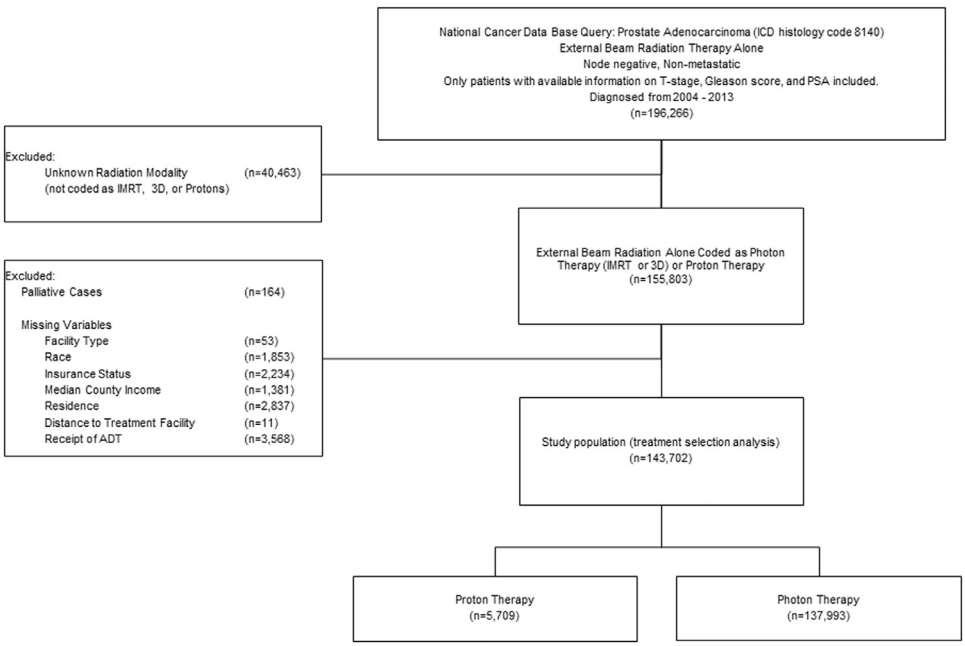

Fig. 1. Flow diagram detailing patient inclusion and exclusion for determining the analysis groups.

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