

Seminar article
**Benchmarks achieved in the delivery of radiation therapy for
muscle-invasive bladder cancer**

John J. Coen, M.D.^a, Anthony L. Zietman, M.D.^a, Donald S. Kaufman, M.D.^b,
William U. Shipley, M.D.^{a,*}

^a Department of Radiation Oncology, Harvard Medical School, Massachusetts General Hospital, Boston, MA 02114, USA

^b Department of Medical Oncology, Harvard Medical School, Massachusetts General Hospital, Boston, MA 02114, USA

Abstract :

Radiation therapy has a multifaceted role in the treatment of muscle-invasive bladder cancer, from being a component of bladder sparing regimens to adjuvant therapy for patients after partial cystectomy, to palliative treatment in patients with metastatic disease. Here, we review the techniques currently used and the settings in which these techniques are applied. Advances in imaging and radiation delivery have allowed for definition of more precise treatment volumes, permitting the delivery of higher tumor doses and lesser doses to critical targets. Better tumor control, fewer therapeutic complications, and better quality of life outcomes are anticipated. In the United States, the most rapidly growing use of radiation in the treatment of bladder cancer is as a component of selective bladder conservation. It uses trimodality therapy, consisting of a maximal transurethral resection followed by concurrent chemotherapy and radiation. Careful cystoscopic surveillance by an experienced urologist ensures a prompt cystectomy at the first sign of treatment failure. The majority of patients retain a well-functioning bladder with no survival decrement. Radiation therapy is also used as adjuvant therapy after partial cystectomy in select patients. In this setting, it decreases the risk of local or incisional recurrence. It is also used in patients with pelvic recurrences after cystectomy, often combined with concurrent chemotherapy. Radiation is a very effective palliative agent for patients with locally advanced or metastatic disease. It can palliate bleeding and pain for patients with local progression or alleviate pain from bony metastases. © 2007 Elsevier Inc. All rights reserved.

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Introduction

Radiation therapy plays a variety of roles in the treatment of muscle-invasive bladder cancer. It serves as an important component of organ-sparing therapy, as adjuvant therapy after surgical treatment, or as an effective palliative measure for locally recurrent or metastatic disease. Here, we will review the indications for radiation and the techniques used in these various settings.

Radiation techniques

Radical radiation is frequently used in the curative treatment of muscle-invasive bladder cancer, either as a component of selective bladder preserving trimodality therapy in medically fit patients or alone after maximal

transurethral resection in patients who cannot tolerate chemotherapy. In either setting, the planning techniques and treatment volumes are similar. The treatment volumes of interest can be described as pelvic, bladder, and bladder tumor volumes.

Pelvic volume

Cystectomy series have suggested a therapeutic advantage to extended as opposed to more limited lymphadenectomy [1]. Similarly, the radiation oncologist covers the regional lymph nodes in addition to the local target when treating bladder cancer. The initial pelvic volumes include the internal and external iliac lymph nodes in addition to the whole bladder, bladder tumor volume, proximal urethra, and, in male patients, the prostate and prostatic urethra. Historically, this volume was covered using a 4-field arrangement, consisting of opposed anterior and posterior fields and opposed laterals based primarily on bony landmarks (Fig. 1). When de-

* Corresponding author. Tel.: +1-617-726-8650; fax: +1-617-726-3603.

E-mail address: jcoen@partners.org (J.J. Coen).

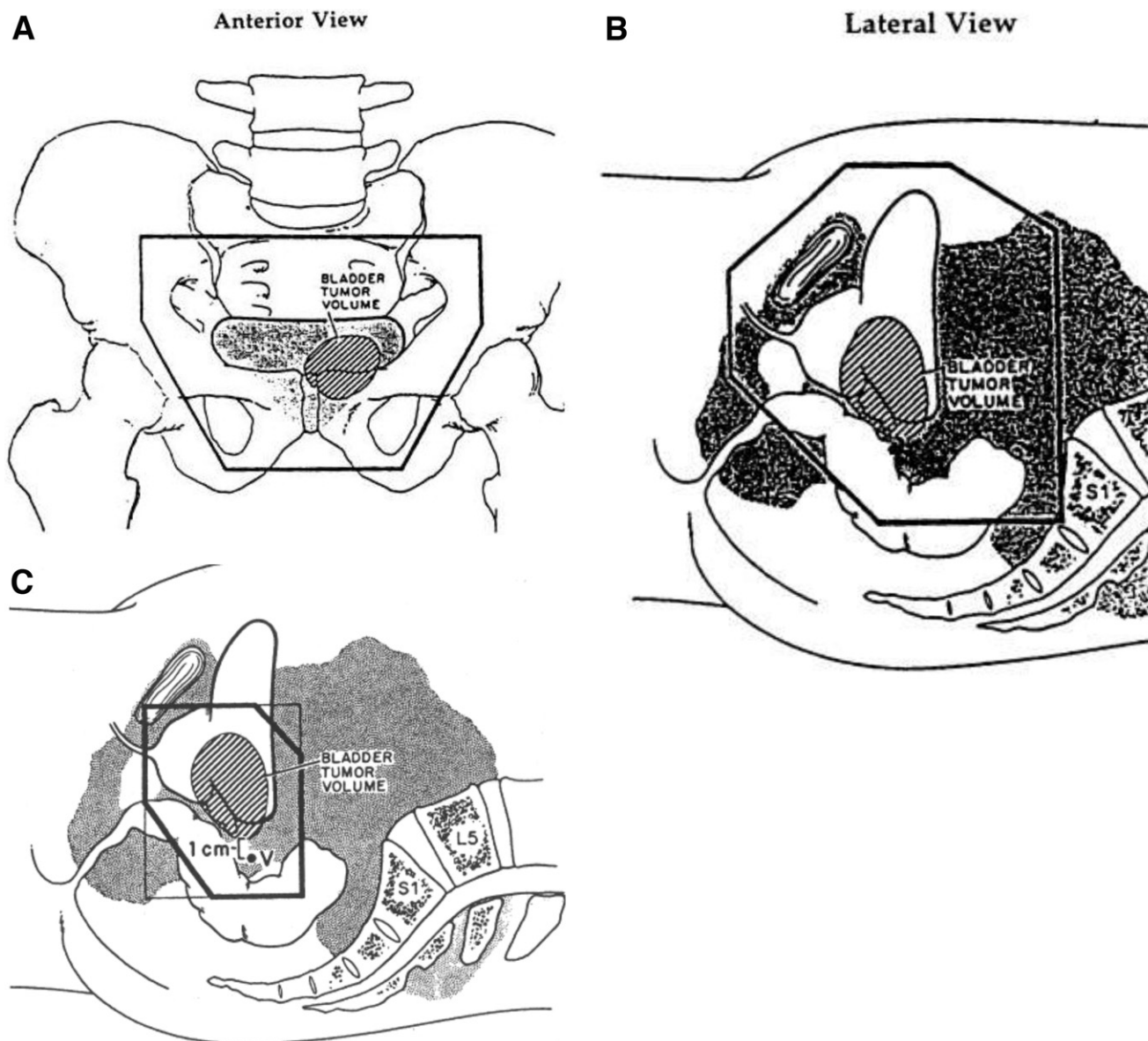


Fig. 1. (A and B) The 4-field arrangement used to treat the whole bladder, bladder tumor, and pelvic lymph nodes. (C) Partial bladder boost.

livered with concurrent chemotherapy, the most prominent acute toxicity is diarrhea resulting from incidental small bowel irradiation.

Pioneering work performed using nanoparticle magnetic resonance imaging to evaluate pelvic lymph nodes in genitourinary malignancies showed that lymph node volumes could be more precisely mapped using pelvic vascular anatomy than bony anatomy [2]. This process allows for 3-dimensional contouring of nodal volumes on computerized tomography (CT) images, paving the way for the use of intensity modulated radiation therapy to deliver therapeutic doses while minimizing small bowel irradiation. Both acute and late toxicity can be reduced with this technique. It will also allow for improved surgical outcomes in the minority of patients ultimately requiring salvage cystectomy because the small bowel

used for the creation of a urinary conduit would have been spared high doses of radiation.

Bladder volume

The bladder is treated to a higher dose than the pelvic volumes. This volume is defined using an air contrast cystogram visualized either fluoroscopically or on planning CT. Partial bladder boosts allow the delivery of a higher dose to the portion of the bladder at highest risk, while limiting the whole bladder dose. Some would argue against the use of a partial bladder boost for several reasons:

1. Bladder cancer is a field lesion such that the entire bladder mucosa must be considered the target volume.

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