


SHORT COMMUNICATION

Preliminary outcomes of stereotactic body radiotherapy in bladder cancer: An initial institutional experience

Trinanjana Basu^{1*}, Jay Prakash Sahu¹, Shounak J. Kamat¹, Rohith R. Menon¹, Ashay Karpe², Vivek Venkatramani³, and Sachin Gawde⁴¹Department of Radiation Oncology, HCG Cancer Centre, Mumbai, Maharashtra, India²Department of Medical Oncology, HCG Cancer Centre, Mumbai, Maharashtra, India³Department of Urology, HCG Cancer Centre, Mumbai, Maharashtra, India⁴Department of Nuclear Medicine, HCG Cancer Centre, Mumbai, Maharashtra, India**Abstract**

Muscle-invasive bladder cancer (MIBC) is commonly managed with radical cystectomy, with systemic therapy when indicated, or with bladder-preserving chemotherapy after maximal transurethral resection of the bladder tumor. However, some patients are not candidates for radical chemoradiotherapy because of comorbidities, poor performance status, or anticipated treatment-related toxicity. MIBC can cause severe hematuria, pain, irritative or obstructive bladder symptoms, and local or systemic disease progression. Stereotactic body radiotherapy (SBRT) has emerged as a curative-intent option in selected disease sites and has gained increasing use in oligometastatic disease. Bladder SBRT, delivered over a shorter treatment course, may improve treatment feasibility and symptom control in selected patients, although published evidence remains limited. We report the preliminary outcomes of our institutional series of SBRT in patients with MIBC and oligometastatic bladder cancer. The initial five patients treated with bladder SBRT included four with MIBC and one with oligometastatic bladder cancer. Treatment was feasible and generally well tolerated, with symptomatic improvement observed in all patients. However, a long follow-up is required to assess the durability of local control and late toxicity.

***Corresponding author:**Trinanjana Basu
(trinanjana.doctor@gmail.com)

Citation: Basu T, Sahu JP, Kamat SJ. *et al.* Preliminary outcomes of stereotactic body radiotherapy in bladder cancer: An initial institutional experience. *Adv Radiother Nucl Med.* 2026;4(2):025290034. doi: 10.36922/ARNM025290034

Received: July 14, 2025**Revised:** August 11, 2025**Accepted:** October 28, 2025**Published online:** May 12, 2026

Copyright: © 2026 Author(s). This is an Open-Access article distributed under the terms of the Creative Commons Attribution License, permitting distribution, and reproduction in any medium, provided the original work is properly cited.

Publisher's Note: AccScience Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Keywords: Bladder cancer; Muscle-invasive bladder cancer; Stereotactic body radiotherapy; Oligometastatic; Image-guided radiation therapy

1. Introduction

Stereotactic body radiotherapy (SBRT) has proven clinically effective in several cancers as a curative modality for early-stage lung, liver, and prostate cancers and as an effective palliative modality for brain or spine metastases over the past decade.¹ Its indications also expanded to the oligometastatic setting, supported by randomized clinical data such as SABR-COMET.² The clinical application of SBRT in bladder cancer, especially non-metastatic muscle-invasive bladder cancer (MIBC), has been slow to develop. Challenges associated with bladder preservation as an alternative to radical cystectomy, together with misconceptions regarding non-surgical approaches, have limited its wider acceptance.³ However, palliative radiotherapy (RT) has long been established as effective

for symptom control. Bladder radiosensitivity, bowel toxicity, and limitations in techniques for safe delivery have hindered the clinical application of SBRT in MIBC and oligometastatic bladder cancer (OMBC). The whole bladder is conventionally considered the target volume because of difficulties in tumor localization, limitations in treatment delivery accuracy, and the multifocal nature of bladder cancer.⁴ Once-weekly delivery has allowed recovery from acute toxicity without deleterious effects on outcomes.⁵ In an Italian series, SBRT for limited-volume OMBC showed promising results with a low rate of acute toxicity.⁶ We report preliminary outcomes from the first five cases in our institutional bladder SBRT series.

2. Cases and methods

Five cases of primary bladder cancer (MIBC, $n = 4$; OMBC, $n = 1$) were treated with SBRT. There were four male and one female patients. All had biopsy-proven transitional cell carcinoma. Patients were referred for SBRT because they were either ineligible for chemotherapy, not candidates for bladder-preservation chemoradiotherapy (CTRT), or were treated in the setting of OMBC. Age was also considered for SBRT. Details are provided in [Table 1](#). All five patients had symptoms including bleeding, pain, or obstructive urinary symptoms.

After multidisciplinary evaluation, SBRT was considered an appropriate treatment option, and informed consent was obtained from all patients before treatment. RT planning scans with an empty bladder were obtained, and the whole bladder was defined as the clinical target volume. The planning target volume (PTV) was generated using a plan-of-the-day approach with two margin

expansions. The SBRT dose was 30–36 Gy in 5–6 fractions, delivered once weekly. On treatment days, after patient setup, a pre-treatment cone-beam CT scan was acquired on the linear accelerator, registered to the planning CT, and used to verify target position before treatment delivery with volumetric modulated arc therapy using 2–3 arcs. Treatment time was 3–4 minutes, depending on the number of arcs. A rectal preparation protocol was followed, including stool softeners and flatus tube insertion in cases of gaseous distension.

Patients were followed up once weekly during SBRT and again two weeks after completion of SBRT for acute toxicity assessment. Thereafter, they were followed up on every three months. Routine blood tests, urine microscopy, and whole-body positron emission tomography/computed tomography (PET/CT) were obtained at three months.

3. Results

The patients ranged in age from 54 to 89 years. All patients presented with hematuria, and some required blood transfusion. Two patients also had obstructive urinary symptoms associated with pain. SBRT was generally well tolerated, with mostly grade 2 symptoms (cystitis) managed conservatively. All patients experienced a reduction in hematuria, and by two weeks after SBRT, bleeding had completely stopped in all cases. At six months after SBRT, one patient with OMBC developed grade 3 hematuria requiring hospital admission and bladder irrigation. The patient subsequently died of systemic disease progression. Among the other four patients with MIBC, clinical response was observed after SBRT, although imaging-based evaluation was still pending at the time of manuscript

Table 1. Initial institutional experience with bladder SBRT

Patient number	Case scenario	Dose/fractionation	Symptom control	Reported toxicity	Response/Tumor control
1	MIBC, 89-year-old man	36 Gy/6 fractions/once weekly	Hematuria, 90% improvement	Grade 2 cystitis; Grade 2 lower GI toxicity	Not reported
2	OMBC, 64-year-old woman	30 Gy/5 fractions/once weekly	Hematuria, 60% improvement; pain, 50% improvement	Grade 3 GU toxicity (hematuria) at 6 months after SBRT	Died 9 months after SBRT due to metastatic progression
3	MIBC, 88-year-old man	36 Gy/6 fractions/once weekly	Hematuria, 90% improvement; dysuria/frequency, 70% improvement	Grade 2 GI/GU toxicity	No evidence of disease at 3 months after SBRT
4	MIBC, 54-year-old man	36 Gy/6 fractions/once weekly	Hematuria, 50% improvement	Grade 2 cystitis; Grade 2 diarrhea	Clinically controlled at 2 months after SBRT
5	MIBC, 85-year-old man	30 Gy/5 fractions/once weekly	Hematuria, 90% improvement	Grade 1 cystitis	Clinically controlled at 1 month after SBRT

Abbreviations: GI: Gastrointestinal; GU: Genitourinary; MIBC: Muscle-invasive bladder cancer; OMBC: Oligometastatic bladder cancer; SBRT: Stereotactic body radiotherapy.

submission. Local bladder control was reported at the last available assessment, although formal radiologic response evaluation was incomplete in some patients.

The first patient was an 89-year-old man with MIBC who presented with recurrent hematuria requiring frequent blood transfusions. In view of his age and unsuitability for chemotherapy, we selected a once-weekly SBRT schedule. The planned dose was 36 Gy in 6 fractions. Hematuria stopped after the first fraction of SBRT. The patient completed treatment and developed grade 2 cystitis, which was managed conservatively.

The second case involved OMBC (para-aortic nodes) after multiple lines of chemotherapy. The patient was a 64-year-old woman with frequent intensive care unit admissions due to chemotherapy-induced hematological toxicities and infections. After informed consent, bladder SBRT of 30 Gy in 5 fractions was planned on a once-weekly schedule. The patient experienced relief of hematuria and urinary pain, but developed grade 3 hematuria six months after SBRT, requiring bladder irrigation. She subsequently developed systemic disease progression and died approximately nine months after SBRT.

The third case was an 88-year-old man with MIBC who presented with recurrent hematuria and dysuria. In view of his age, SBRT was considered the most suitable option. He tolerated treatment well, with no grade 3 adverse events, and achieved marked symptomatic improvement.

The fourth case was a 54-year-old, otherwise fit, man with non-metastatic MIBC. He was offered primary immunotherapy instead of surgery or radical chemoradiation. After one year of immunotherapy, his blood counts declined, requiring frequent transfusions or growth factor administration. Repeat whole-body PET/CT showed a small bladder-limited area of uptake. He was then planned for SBRT at 36 Gy in 6 fractions, delivered once weekly, and his symptoms had settled at two months after treatment.

The fifth case was an 88-year-old man who presented with recurrent hematuria requiring frequent blood transfusions. We planned SBRT of 30 Gy in 5 fractions, delivered once weekly, because he was not fit for systemic therapy. He tolerated treatment well and had no hematuria until the last follow-up.

The contouring and planning images are shown in [Figure 1](#).

4. Discussion

Stereotactic body radiotherapy in bladder cancer may be considered in two clinical scenarios: chemotherapy-unsuitable MIBC and OMBC. OMBC has been categorized

according to the timing of metastatic presentation relative to primary diagnosis, prior local treatment, and systemic therapy exposure, with commonly used categories including synchronous disease, oligorecurrence, and oligoprogression.⁷ Data on the use of SBRT in MIBC remain limited. Traditionally, patients with MIBC who opt for a non-surgical approach receive long-course chemoradiation or moderately hypofractionated RT with chemotherapy.^{8,9} At present, bladder SBRT is not established in the AUA/ASCO/SUO guidelines, and RT alone, including SBRT, is generally not considered a standard alternative to bladder-preservation chemotherapy.⁸ The available literature on hypofractionated RT schedules is listed in [Table 2](#).¹⁰ Two series from Italy reported once-weekly SBRT schedules with acceptable toxicity. Symptom control was high, and these studies helped inform future protocol development.^{11,12}

With the advent of immunotherapy, new trials are evaluating the combination of SBRT with immunotherapy. A trimodality strategy in which long-course external beam RT is replaced by SBRT, and chemotherapy is replaced by immunotherapy has been explored, and Kundu *et al.*¹³ reported safety data at the ASCO GU 2022 meeting. In that protocol, SBRT at 33 Gy in 5 fractions was delivered between the first and second cycles of dual immunotherapy with durvalumab and tremelimumab. In a cohort of 10 patients, the reported local control rate was 90%. These findings may help guide future evaluation of bladder SBRT. The potential immunomodulatory synergy between SBRT and immunotherapy is promising, although the lack of phase III data remains a barrier to the routine clinical application of bladder SBRT.

Hafeez *et al.*¹⁴ reported their phase II data in patients with MIBC unsuitable for long-course CRT or radical cystectomy. A plan-of-the-day approach was used, and image-guidance protocols were maintained. A regimen of 36 Gy in 6 once-weekly fractions was delivered to the empty whole bladder. With a median patient age of 86 years, this protocol was associated with acute grade 3 genitourinary and gastrointestinal toxicity rates of 18% and 4%, respectively. The one-year local progression rate was 7%.¹⁴ The study also suggested that older patients, who are often considered unsuitable for radical treatment, may still be candidates for bladder SBRT. Daily image guidance and a plan-of-the-day approach may help reduce genitourinary and gastrointestinal toxicity. Similarly, Alati *et al.*¹⁵ reported outcomes in older patients with MIBC treated with trimodality therapy using twice-daily hypofractionated RT. The study reported 70% five-year survival with bladder preservation, challenging the assumption that radical treatment is unsuitable in older patients. Future studies should compare this regimen with SBRT in MIBC. More recently, Marvaso *et al.*¹⁶ also

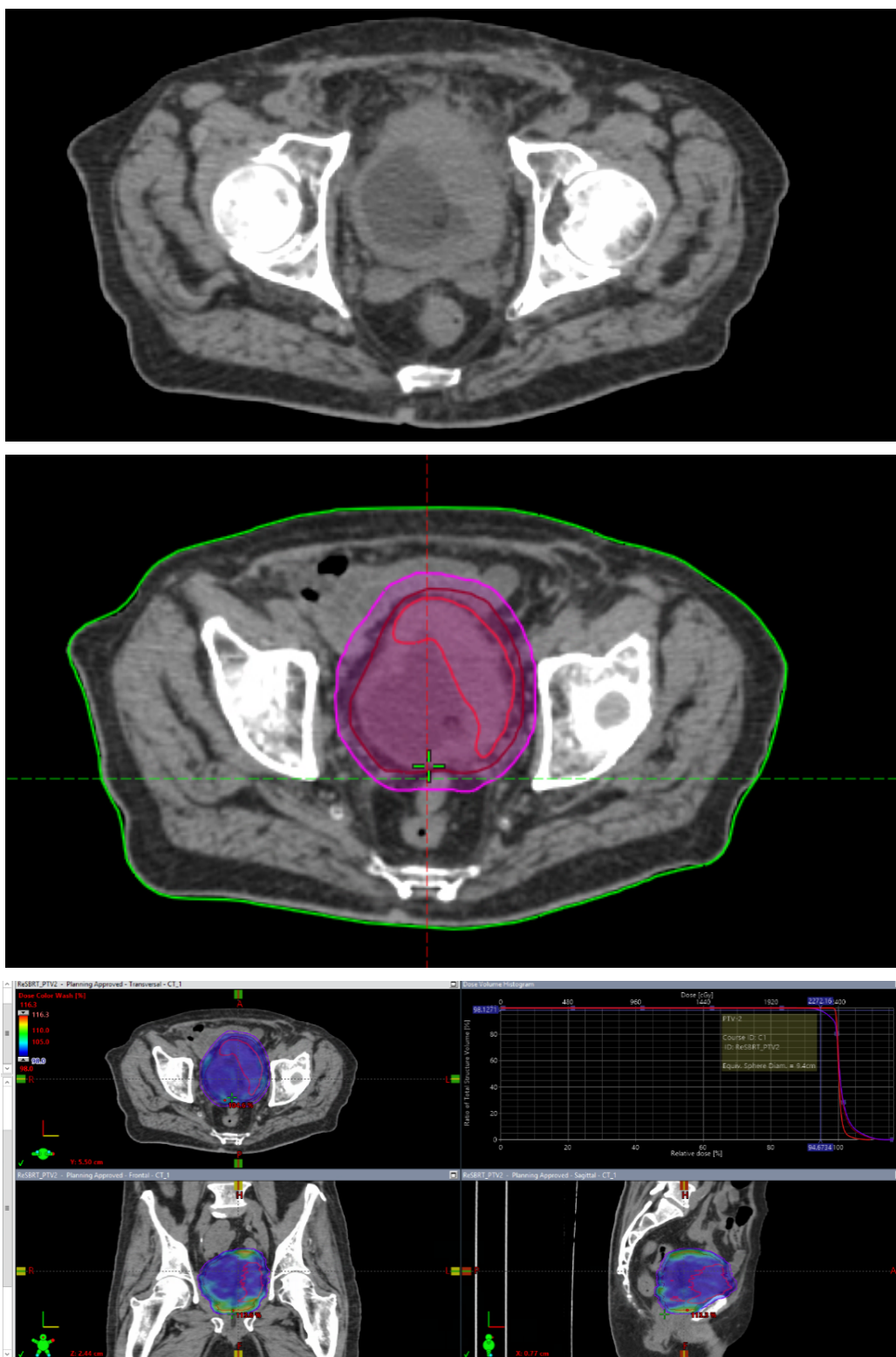


Figure 1. Bladder stereotactic body radiotherapy: contouring and planning images

Table 2. Hypofractionated bladder radiotherapy schedules

Study	Study design	Fractionation	Stage	Symptom control	Toxicity reported	Response/tumor control
Ali <i>et al.</i> ¹⁷	Retrospective	8 Gy in a single fraction to 30 Gy in 10 fractions	T1–T4, N1–N3, M0–M1	Hematuria, 54%; pain, 48%	NR	NR
Duchesne <i>et al.</i> ¹⁸	Randomized controlled trial	35 Gy in 10 fractions vs. 21 Gy in 7 fractions	T2–T4, N0–N1, M0–M1	Hematuria, 88%; pain, NR; dysuria/frequency, 70%	Bladder/bowel toxicity of grade 2 or higher, 30%	NR
McLaren <i>et al.</i> ¹⁹	Prospective	30–36 Gy in 6 fractions	T2–T4, N0–N1, M0–M1	Hematuria, 92%; dysuria/frequency, 52%	Urinary toxicity, 18%; bowel toxicity, 8% (greater than grade 2)	NR
Kouloulis <i>et al.</i> ¹¹	Prospective	36 Gy in 6 fractions	T1–T2, N0, M0	50–63% (details NR)	No toxicity greater than grade 2	NR
Dirix <i>et al.</i> ¹²	Prospective	34.5 Gy in 6 fractions	T1–T4, N1–N3, M0–M1	Hematuria, 90%	Bladder toxicity, 9% (greater than grade 2)	NR
Zygianni <i>et al.</i> ²⁰	Retrospective	36 Gy in 6 fractions	T2–T3, N0, M0	NR	Acute toxicity, 2.3%	NR
Hafeez <i>et al.</i> ¹⁴	Phase 2 prospective	36 Gy in 6 fractions	T2–T4a, N0–N2, M0–M1	Local control 92% on assessed patients	Acute grade 3 toxicity, 22%	2 years local control, 83%

Abbreviations: M: Metastasis; N: Lymph node; NR: Not reported; T: Tumor.

published preliminary data on bladder SBRT in elderly and frail patients, further supporting its feasibility and safety. [Table 2](#) highlights the available literature on bladder SBRT.

The technical aspects of SBRT for bladder cancer require careful planning and execution. Two important considerations are dose and PTV design in MIBC. As dose has been discussed above, the present discussion focuses on PTV design. Centers practicing bladder preservation should use daily image guidance, and a plan-of-the-day approach appears reasonable.^{14,21–22} PTV design depends on bladder filling during treatment delivery. The complexity of margin selection has been described by Murthy *et al.*²¹ over the past decade, as well as by Hafeez *et al.*¹⁴

Future bladder SBRT protocols should encompass the following key points:

- (i) Incorporation of daily image guidance and selection of the optimal plan.
- (ii) Motion-management strategies such as a PTV-based plan-of-the-day approach.
- (iii) Evaluation of once-weekly protocols.
- (iv) Consideration of partial-bladder SBRT.
- (v) Integration of immunotherapy with SBRT.
- (vi) Randomized comparisons between long-course image-guided RT and once-weekly SBRT.
- (vii) Incorporation of magnetic resonance imaging-guided treatment delivery with real-time adaptation.

With the evolving role of immunotherapy and RT in the management of MIBC and OMBC, the International Geriatric Radiotherapy Group guidelines provide a comprehensive overview of the literature on bladder preservation and available dose-fractionation approaches.²³ Bladder preservation using SBRT remains an area that is worth exploring.

Although our preliminary data are encouraging, large-scale documentation of outcomes and toxicity is needed. In the setting of geriatric MIBC and OMBC, bladder SBRT appears encouraging because of its short treatment schedule, acceptable toxicity profile, and potential for local control.

5. Conclusion

Our initial five cases of bladder SBRT for MIBC and OMBC hold promise. The treatment was well tolerated, with an acceptable toxicity profile. SBRT using modern image guidance and a plan-of-the-day approach, together with the incorporation of immunotherapy, may help address important questions regarding bladder SBRT. Further research is also needed to determine whether treatment should target the whole bladder or the tumor. Ultimately, careful clinical decision-making remains critical. The primary aim of reporting this initial experience was to highlight SBRT as a potential treatment option when CRT

is not feasible in MIBC or in OMBC, either for symptom control or for longer local control. This approach requires further evaluation against the standard of care. Until then, bladder SBRT remains a potential yet challenging treatment modality that should be practiced within a stringent multidisciplinary framework, and it cannot yet be considered ready for routine clinical use.

Acknowledgments

We acknowledge the contributions of the department staff at HCG Cancer Centre, Mumbai, India.

Funding

None.

Conflict of interest

The authors declare that they have no competing interests. There was no conflict of interest or any financial disclosures to be made.

Author contributions

Conceptualization: Trinanjan Basu, Jay Prakash Sahu, Shounak J. Kamat

Formal analysis: Trinanjan Basu, Ashay Karpe, Vivek Venkatramani, Sachin Gawde

Investigation: Trinanjan Basu, Jay Prakash Sahu, Shounak J Kamat, Rohith R. Menon

Methodology: Trinanjan Basu, Jay Prakash Sahu

Writing—original draft: Trinanjan Basu, Jay Prakash Sahu

Writing—review & editing: Trinanjan Basu, Jay Prakash Sahu

Ethics approval and consent to participate

This retrospective study was approved by HCG Cancer Centre, Mumbai, India (approval date: XXX). The analysis was a retrospective data collection, and formal consent for treatment was obtained from each patient.

Consent for publication

Not applicable. All images and patient data presented in this study have been deidentified.

Availability of data

The data supporting the findings of this study are not publicly available because they are contained in patient records and institutional electronic databases.

References

1. Alongi F, Arcangeli S, Filippi AR, Ricardi U, Scorsetti M. Review and Uses of Stereotactic Body Radiation Therapy for Oligometastases. *Oncologist*. 2012;17(8):1100-1107.

doi: 10.1634/theoncologist.2012-0092

2. Palma DA, Olson R, Harrow S, *et al*. Stereotactic Ablative Radiotherapy for the Comprehensive Treatment of Oligometastatic Cancers: Long-Term Results of the SABR-COMET Phase II Randomized Trial. *J Clin Oncol*. 2020;38(25):2830-2838.

doi: 10.1200/JCO.20.00818

3. Elumalai T, Joseph N, Choudhury A. Myths About Bladder Preservation in Muscle-Invasive Bladder Cancer. *Semin Radiat Oncol*. 2023;33(1):56-61.

doi: 10.1016/j.semradonc.2022.10.007

4. Jereczek-Fossa BA, Marvaso G. Palliative radiation therapy in bladder cancer: a matter of dose, techniques and patients' selection. *Ann Palliat Med*. 2019;8(5):786-789.

doi: 10.21037/apm.2019.11.02

5. Pos FJ, Hart G, Schneider C, Sminia P. Radical radiotherapy for invasive bladder cancer: What dose and fractionation schedule to choose? *Int J Radiat Oncol Biol Phys*. 2006;64(4):1168-1173.

doi: 10.1016/j.ijrobp.2005.09.023

6. Augugliaro M, Marvaso G, Ciardo D, *et al*. Recurrent oligometastatic transitional cell bladder carcinoma: is there room for radiotherapy? *Neoplasma*. 2019;66(01):160-165.

doi: 10.4149/neo_2018_180522N333

7. Bamias A, Stenzl A, Zagouri F, Andrikopoulou A, Hoskin P. Defining Oligometastatic Bladder Cancer: A Systematic Review. *Eur Urol Open Sci*. 2023;55:28-37.

doi: 10.1016/j.euro.2023.08.003

8. Holzbeierlein J, Bixler BR, Buckley DI, *et al*. Treatment of Non-Metastatic Muscle-Invasive Bladder Cancer: AUA/ASCO/SUO Guideline (2017; Amended 2020, 2024). *J Urol*. 2024;212(1):3-10.

doi: 10.1097/JU.0000000000003981

9. Hall E, Hussain SA, Porta N, *et al*. Chemoradiotherapy in Muscle-invasive Bladder Cancer: 10-yr Follow-up of the Phase 3 Randomised Controlled BC2001 Trial. *Eur Urol*. 2022;82(3):273-279.

doi: 10.1016/j.eururo.2022.04.017

10. Perera J, Hoskin P. The role of radiotherapy in metastatic bladder cancer. *J Cancer Metastasis Treat*. 2022;8:4.

doi: 10.20517/2394-4722.2021.167

11. Kouloulis V, Tolia M, Kolliarakis N, Siatelis A, Kelekis N. Evaluation of acute toxicity and symptoms palliation in a hypofractionated weekly schedule of external radiotherapy for elderly patients with muscular invasive bladder cancer. *Int Braz J Urol*. 2013;39(1):77-82.

doi: 10.1590/S1677-5538.IBJU.2013.01.10

12. Dirix P, Vingerhoedt S, Joniau S, Van Cleynenbreugel B,

- Haustermans K. Hypofractionated palliative radiotherapy for bladder cancer. *Support Care Cancer*. 2016;24(1):181-186.
doi: 10.1007/s00520-015-2765-y
13. Kundu P, Lee A, Drakaki A, *et al*. Safety lead-in of phase II SBRT and durvalumab with or without tremelimumab for unresectable and cisplatin-ineligible, locally advanced or metastatic bladder cancer. *JCO*. 2022;40(6_suppl):517-517.
doi: 10.1200/JCO.2022.40.6_suppl.517
14. Hafeez S, McDonald F, Lalondrelle S, *et al*. Clinical Outcomes of Image Guided Adaptive Hypofractionated Weekly Radiation Therapy for Bladder Cancer in Patients Unsuited for Radical Treatment. *Int J Radiat Oncol Biol Phys*. 2017;98(1):115-122.
doi: 10.1016/j.ijrobp.2017.01.239
15. Alati A, Fabiano E, Geiss R, *et al*. Bladder preservation in older adults with muscle-invasive bladder cancer: A retrospective study with concurrent chemotherapy and twice-daily hypofractionated radiotherapy schedule. *J Geriatr Oncol*. 2022;13(7):978-986.
doi: 10.1016/j.jgo.2022.05.014
16. Marvaso G, Vitullo A, Corrao G, *et al*. Muscle-invasive bladder cancer in elderly and frail people: Is hypofractionated radiotherapy a feasible approach when no other local options are available? *Tumori*. 2024;110(3):193-202.
doi: 10.1177/03008916241252326
17. Ali A, Song YP, Mehta S, *et al*. Palliative Radiation Therapy in Bladder Cancer—Importance of Patient Selection: A Retrospective Multicenter Study. *Int J Radiat Oncol Biol Phys*. 2019;105(2):389-393.
doi: 10.1016/j.ijrobp.2019.06.2541
18. Duchesne GM, Bolger JJ, Griffiths GO, *et al*. A randomized trial of hypofractionated schedules of palliative radiotherapy in the management of bladder carcinoma: results of medical research council trial BA09. *Int J Radiat Oncol Biol Phys*. 2000;47(2):379-88.
doi: 10.1016/s0360-3016(00)00430-2
19. McLaren DB, Morrey D, Mason MD. Hypofractionated radiotherapy for muscle invasive bladder cancer in the elderly. *Radiother Oncol*. 1997;43(2):171-174.
doi: 10.1016/s0167-8140(97)01943-9
20. Zygogianni A, Kouloulis V, Armpilia C, *et al*. A weekly hypofractionated radiotherapeutic schedule for bladder carcinoma in elderly patients: local response, acute and late toxicity, dosimetric parameters and pain relief. *J BUON*. 2013;18(2):407-412. Available from: <https://pubmed.ncbi.nlm.nih.gov/23818353/> [Last accessed on March 24, 2026].
21. Murthy V, Master Z, Adurkar P, *et al*. 'Plan of the day' adaptive radiotherapy for bladder cancer using helical tomotherapy. *Radiother Oncol*. 2011;99(1):55-60.
doi: 10.1016/j.radonc.2011.01.027
22. Krishnan A, Maitre P, Kashid S, *et al*. Online Adaptive Radiation Therapy for Bladder Preservation: Transitioning to Hypofractionation. *Int J Radiat Oncol Biol Phys*. 2025;122(4):995-1001.
doi: 10.1016/j.ijrobp.2025.03.018
23. Nguyen NP, Karlsson UL, Page BR, *et al*. Immunotherapy and radiotherapy for older patients with invasive bladder cancer unfit for surgery or chemotherapy: practical proposal by the international geriatric radiotherapy group. *Front Oncol*. 2024;14.
doi: 10.3389/fonc.2024.1371752