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Original Report

Postoperative radiation therapy for osseous metastasis: Outcomes and predictors of local failure

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Abstract

Purpose: To evaluate patterns and predictors of local failure in patients undergoing postoperative radiation therapy (RT) for osseous metastases.

Methods and materials: Patients undergoing postoperative RT for bone metastases between June 2008 and January 2012 were retrospectively reviewed. Patterns of local failure were assessed, and Fine and Gray's univariable and multivariable analyses (MVA) were used to evaluate factors associated with local progression, including dose intensity of RT (biological equivalent dose, BED, Gy_{10}) and percent coverage of the surgical hardware by the RT fields. Additional predictors were similarly assessed, including patient (eg, age, performance status), disease (eg, tumor type, metastasis site), and treatment (eg, interval from surgery to RT) characteristics.

Results: A total of 82 cases were followed for a median of 4.3 months (11.5 months among living patients) after treatment completion. Median BED was 39 Gy_{10} (range, 14-60), and RT fields covered an average of 71% (standard deviation, 26%) of the hardware. Fourteen cases (17%) experienced local progression. Although most (71%) failures occurred within the RT fields, 29% occurred marginally or out of field, but adjacent to surgical hardware. Increasing coverage of the surgical hardware by RT fields was associated with a reduced risk of local failure in MVA (hazard ratio [HR], 0.10; 95% confidence interval [CI], 0.012-0.82; $P = .03$), whereas a greater risk of failure was seen with increasing time between surgery and RT (HR, 1.03; 95% CI, 1.01-1.06; $P = .01$). Extremity rather than spinal site trended toward a greater risk of failure but did not reach significance (HR, 3.79; 95% CI, 0.96-14.89; $P = .057$). BED ≥ 39 Gy_{10} did not predict local failure ($P = .51$) in MVA.

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Conclusions: Current strategies achieve good outcomes after postoperative RT for osseous metastases. Greater coverage of the surgical hardware with RT fields and avoiding delays between surgery and postoperative RT should be considered to reduce recurrence risk for patients with bone metastases requiring surgical stabilization.

Introduction

Bone metastasis represents a frequent and severe complication of many cancers, occurring in up to 75% of patients with metastatic disease,[1] depending on site and stage of the primary disease. Bone metastases can be associated with pain, disability, and other clinical complications; carry a poor prognosis regardless of primary disease site[2-4]; and create significant challenges in effective coordination of care.[5] More than half of patients with bone metastases will experience a significant event (eg, fracture, spinal cord compression) related to that disease site in the course of their illness.[6] Current treatments for osseous metastatic disease include systemic chemotherapy, radiation therapy (RT), surgical stabilization, bisphosphonates, monoclonal antibodies, hormonal therapy, and pharmacologic pain management. The goals of these modalities include halting disease progression, preventing or healing disability, and palliation of symptoms. The specific treatment plan chosen for a patient can depend on the location (eg, long bone vs vertebral column), distribution, and extent of metastasis; patient functional status and symptoms; clinical urgency; previous therapies used; fracture risk; and goals of care/estimated prognosis.

Important subgroups of bone metastases necessitate operative management because of bony instability (ie, fracture, impending fracture) and/or the need for decompression of nearby structures, such as spinal cord. Several factors and algorithms are used to identify whether surgical stabilization is needed in these patients, including the Mirels scale,[7] both axial and cortical involvement of the bone metastasis,[8] and the Spinal Instability in Neoplasia score.[9] A single small series describing outcomes among patients who underwent surgical stabilization for bone metastases with and without postoperative RT showed improved patient functional status with RT.[10]

Optimal postoperative RT treatment protocols, particularly RT dose, amount of hardware coverage by RT fields, and timing of treatments, remain undefined. The limited available evidence suggests that significant heterogeneity in these protocols exists.[10] For these patients, inadequate data are available to define the optimal timing of RT, extent of hardware coverage by RT, dose intensity, and fractionation schema. Given the frequency of this clinical scenario, data are required to guide treatment and to develop evidence-based therapeutic strategies for these patients. In this study, we evaluated a cohort of patients undergoing palliative postoperative RT, specifically examining the relationship of RT dose intensity and hardware coverage to radiographic local disease progression. We also aimed to examine characteristics and frequency of local failure and acute treatment-related toxicities.

Methods and Materials

Sample

We analyzed all patients undergoing RT with palliative intent following surgical intervention for bone metastases from solid tumors, with or without placement of hardware, at the Dana-Farber Cancer Center/Brigham and Women's Hospital, Boston, Massachusetts, between July 2008 and January 2012. Patients were excluded if they were younger than 18 years old, were incorrectly listed as having been treated with palliative intent, or had nonmetastatic disease. Institutional review board approval of this research study was obtained before data collection.

The charts of all patients were assessed for multiple covariates, including location of treated bone metastases, presence of impending or pathological fracture before surgery, surgical type and location, days from surgery to first fraction of RT, and RT dose and fractionation. Records were also examined for acute toxicity, defined as any toxicity at the treated site within 12 weeks of completion of RT. Dose intensity of RT was assessed by calculating the biological equivalent dose (BED), assuming an α/β of 10 for tumor, based on the equation, $BED = nd(1 + {}^{d}/_{\alpha/\beta})$, in which n is the number of fractions of RT and d is the dose per fraction. Based on RT treatment films, the extent of hardware coverage by RT was assessed, with the percent of hardware covered by RT quantified by dividing the length of hardware within the RT field by the total length of hardware. If all hardware was covered by the RT fields plus additional bone/soft tissue beyond the hardware, this was categorized as 100% coverage. Other variables assessed were sex, primary tumor type, age, and Eastern Cooperative Oncology Group performance status at time of consultation with the radiation oncologist, duration of time between metastatic cancer diagnosis and treatment, and duration of time between surgery and postoperative RT. The primary outcome was local progression of the bone metastasis at the treated site, assessed by radiographic imaging with the attending radiologist report of progression on these studies. Imaging