

Scientific Article

Utilization Patterns of Single-Fraction and Short-Course Radiotherapeutic Schedules in the Management of Bone Metastases



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Abstract

Purpose: Bone metastases are common, occurring in 60% to 70% of patients with advanced malignancies. Historically, bone-directed radiation therapy regimens of 30 Gy over 10 fractions were used. However, prospective randomized data suggest equivalent pain relief with shorter-course regimens. The American Society for Radiation Oncology Choosing Wisely Campaign encourages clinicians to consider shorter-course palliative regimens in patients with limited prognosis. A retrospective analysis was performed to assess patterns of short-course and single-fraction radiation therapy during the past 5 years.

Methods and Materials: We queried our electronic medical record (MOSAIC) from 2016 to 2020 for patients with bone metastases who received palliative radiation therapy. Patients receiving >10 fractions or Medicare-approved palliative courses of radiation (30 Gy/10 fractions, 24 Gy/6 fractions, 20 Gy/5 fractions, 8 Gy/1 fraction) were included. Treatment department was defined as academic (n = 2) versus community (n = 12). Short-course treatment was defined as <6 fractions, whereas long-course included patients receiving >10 fractions. Patients were subdivided based on age and disease site. Physicians were grouped according to their year of residency completion. Multivariable logistic regression analysis identified predictors of short-course and single-fraction treatment.

Results: We identified 1004 patients with 1768 bony metastases meeting inclusion criteria. The spine was the most common site, followed by pelvis/hip, extremity, and other site. Use of short-course treatment increased from 40% in 2016 to 50% in 2020. Single-fraction treatment increased from 7% in 2016 to 11% in 2020. Predictors of shorter courses included treatment at academic centers, more recent treatment, patient age >76 years, and nonspine anatomic site. Predictors of single-fraction treatment included treatment at academic centers, treating physician residency completion after 2010, patient age >76 years, and treatment to extremity or other site.

Conclusions: Rates of short-course and single-fraction bone-directed radiation therapy increased within our health system over time. Treatment receipt at academic centers was associated with both short-course and single-fraction regimens. Physicians completing residency after 2010 were more likely to deliver single-fraction therapy.

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Data are under restricted access. It is Allegheny Health Network's institutional review board policy to not share data from clinical studies as a matter of security.

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Introduction

Affecting nearly 350,000 patients with cancer each year in the United States, bone metastases are a significant contributor to cancer-related morbidity nationwide. Symptomatic bone metastases are often managed with

radiation therapy, with reported response rates of 65% to 80%.¹ Historically, external beam fractionation schemes have ranged from single-fraction treatment to more protracted courses extending over 10 fractions.² A prospective phase 3 randomized trial was conducted by the Radiation Therapy Oncology Group (RTOG 97-14) in an effort to compare short-course (8 Gy in 1 fraction) versus long-course (30 Gy in 10 fractions) radiation treatment schedules.² In this study, there was no statistically significant difference in response rates between the shorter and longer treatment courses; however, there was increased acute toxicity and lower rates of retreatment associated with the longer-course regimen.

Based on these findings, American Society for Radiation Oncology (ASTRO) consensus guidelines were updated in 2016 to suggest dose fractionations of 8 Gy in a single fraction, 20 Gy in 5 fractions, 24 Gy in 6 fractions, or 30 Gy in 10 fractions for palliative treatment of bone metastases. More recently, the ASTRO Choosing Wisely campaign has endorsed avoidance of more protracted treatment courses in the setting of uncomplicated painful bone metastases considering the comparable rates of pain response, less acute toxicity, and greater patient convenience associated with shorter courses. Additionally, shorter courses of treatment can also help mitigate rising health care costs and save time in departments with a high volume of metastatic cases.³ Furthermore, in light of the new precautions associated with the COVID-19 pandemic, shorter treatment courses may also reduce the number of unnecessary health care facility exposures.

As such, utilization of single-fraction treatments has increased over recent years but still accounts for <10% of palliative courses.⁴ For example, one study explored single- versus multiple-fraction radiation treatments for bone metastasis secondary to prostate cancer and found that single-fraction treatments constituted only 3.3% of treatments in their study population despite comparable pain relief for either treatment.⁵ Other such studies have explored dose fractionation schedules as an opportunity for improvement, but few have identified patient or physician-related characteristics that may predict for shorter treatment courses. This study aimed to compare utilization trends and predictors of abbreviated treatment courses for patients with bone metastases treated across a large integrated health care delivery network.

Methods and Materials

We queried the network-wide radiation oncology electronic medical record MOSAIQ, version 2.83 (Elekta, Inc) using MOSAIQ Oncology Analytics for patients with a diagnosis of bone metastases who received radiation therapy between the years 2016 and 2020 using the International Classification of Diseases, 10th Revision (ICD-10) code (C79.51). Baseline patient characteristics, such as

age, race, sex, and disease site, were tabulated (Table 1). Patients were treated across an integrated health care delivery network in one state across 15 cancer centers. Cancer centers were grouped as community/nonacademic satellites (13 sites) versus academic (2 sites). The year of residency graduation and age of the treating radiation oncologist were also recorded.

Fractionation schemes were grouped according to the Medicare-approved palliative courses: 8 Gy in 1 fraction, 20 to 24 Gy in 5 to 6 fractions, 30 Gy in 10 fractions, or any number of Gray in >10 fractions.¹ “Short course” was defined as 6 or fewer treatments. We conducted a multivariable logistic regression to identify variables predictive of short-course and/or single-fraction treatment receipt. This study was reviewed and approved by our institutional review board.

Results

A total of 1004 patients with 1768 bony metastatic lesions were identified as meeting inclusion criteria. The median age for the patient population was 68 with a range of 11–101. The most commonly treated site was the spine (46%) followed by the pelvis/hip (26%), extremity (15%), and other (13%) (Table 1). Shorter treatment courses (6 fractions or less) became more frequent as time

Table 1 Patient characteristics

Variable	No. (%)
Age, y	
Q1 (<61)	466 (23.5)
Q2 (61–68)	487 (24.5)
Q3 (68–76)	514 (25.9)
Q4 (>76)	520 (26.1)
Sex	
Male	1117 (56.2)
Female	870 (43.8)
Site of treatment	
Spine	912 (45.9)
Hip/pelvis	492 (24.8)
Extremity	289 (14.5)
Other	247 (12.4)
Race	
White	1767 (88.9)
Black	173 (8.7)
Other	47 (2.4)
Baseline patient characteristics show that they were of comparable age distribution. A majority of patients were White and a majority were treated for bone metastases in the spine.	

Table 2 Likelihood of short-course versus long-course radiation

Variable	OR (95% CI)	P value
Age, y		
Q1 (<61)	Reference	
Q2 (61-68)	0.96 (0.72-1.29)	.81
Q3 (68-76)	1.19 (0.90-1.59)	.22
Q4 (>76)	1.54 (1.17-2.04)	.0023
Department		
Academic	Reference	
Nonacademic	0.32 (0.25-0.40)	<.0001
Graduation year		
Before 2010	Reference	
After 2010	1.09 (0.85-1.41)	.48
Site		
Spine	Reference	
Hip	1.84 (1.44-2.35)	<.0001
Extremity	2.95 (2.19-3.98)	<.0001
Other	2.05 (1.50-2.80)	<.0001
Race		
White	Reference	
Black	1.11 (0.75-1.63)	.60
Other	0.43 (0.23-0.82)	.01
Year of treatment		
2016	Reference	
2017	1.38 (0.98-1.93)	.06
2018	1.12 (0.81-1.57)	.49
2019	2.01 (1.46-2.78)	<.0001
2020	1.65 (1.20-2.26)	.0022

Abbreviations: CI = confidence interval; OR = odds ratio. The table compares short-course versus long-course treatments; “short course” is defined as 6 or fewer fractions. The results show that patients older than age 76 are more likely to get treated with a shorter course of radiation (OR, 1.55; 95% CI, 1.17-2.04). Patients treated at an academic center also were more likely to get a shorter-course treatment (OR, 3.16; 95% CI, 2.52-3.97). The pelvis, extremities, and “other” sites were more likely to be treated with short-course treatments compared with treatments of the spine. Finally, treatments delivered in a more recent year (2019 and 2020) were more likely to get shorter-course treatments.

progressed, consisting of 40% of treatment plans in 2016 and 50% of treatment plans by 2020. Single fraction treatment also increased in frequency, composing 7% of plans in 2016 and 11% of plans by 2020.

Predictors of shorter treatment courses identified on multivariable logistic regression included: receipt of treatment at an academic center, more recent treatment year, patient age > 76, and non-spine anatomic site (Table 2).

Table 3 Single-fraction versus nonsingle fraction

Variable	OR (95% CI)	P value
Age, y		
Q1 (<61)	Reference	
Q2 (61-68)	1.43 (0.81-2.50)	.21
Q3 (68-76)	1.12 (0.63-1.99)	.71
Q4 (>76)	2.18 (1.27-3.74)	.0048
Department		
Academic	Reference	
Nonacademic	0.30 (0.20-0.45)	<.0001
Graduation year		
Before 2010	Reference	
After 2010	0.55 (0.36-0.83)	.0044
Site		
Spine	Reference	
Hip	1.47 (0.89-2.43)	.13
Extremity	2.99 (1.81-4.95)	<.0001
Other	2.79 (1.66-4.71)	.0001
Race		
White	Reference	
Black	1.20 (0.68-2.13)	.53
Other	0.49 (0.14-1.68)	.25
Year of treatment (compared with data from 2016)		
2016	Reference	
2017	0.91 (0.47-1.74)	.77
2018	0.53 (0.26-1.06)	.07
2019	1.00 (0.54-1.83)	.99
2020	1.51 (0.85-2.68)	.16

Abbreviations: CI = confidence interval; OR = odds ratio. Patients older than age 76 were more likely to receive a single fraction compared with patients younger than age 76 (OR, 2.18; 95% CI, 1.27-3.74). Patients in a nonacademic center were less likely to get a single fraction (OR, 0.30; 95% CI, 0.20-0.45). Bone metastases in the extremity (OR, 2.99; 95% CI, 1.81-4.95) or “other” site (OR, 2.79; 95% CI, 1.66-4.71) were more likely to receive single-fraction treatment compared with patients with metastases to the spine or pelvis/hip.

Predictors of a single fraction treatment included treatment at an academic center, treating physician residency completion after 2010, patient age > 76, and treatment to extremity or other site (Table 3).

About 78% of the physicians who participated in this study graduated prior to 2010. The majority of the participating physicians (63.5%) also work in non-academic centers. Approximately 51.4% of the physicians are younger than 50 years old and about 48.4% are older than 50 years old (Table 4).

Table 4 Physician characteristics

Variable	No. (%)
Attending age	
Q1 (30-40)	351 (17.9)
Q2 (41-50)	656 (33.5)
Q3 (51-60)	340 (17.4)
Q4 (>60)	611 (31.2)
Department	
Academic	726 (36.5)
Nonacademic	1261 (63.5)
Graduation year	
Before 2010	1550 (78.0)
After 2010	437 (22.0)
The table suggests that most of the prescribing attendings who participated in this study were nonacademic physicians (63.5%). The majority of the physicians who participated in this study had graduated before 2010 (78.0%).	

Discussion

The results of our study suggest shorter-course and single-fraction radiotherapeutic treatment schedules have been increasingly used in more recent years; both in community and academic settings. In addition, shorter-course and single-fraction treatments were more often used in older patients and at academic sites within our integrated network. Interestingly, use of single-fraction treatments was more common among physicians graduating residency in later years (ie, after 2010).

There are several potential advantages to more abbreviated treatment courses. Shorter treatment courses are beneficial for patients by decreasing the amount of time spent commuting to the hospital or treatment center. Additionally, shorter treatment courses help to decrease health care costs and optimize the time spent treating each patient.

These findings are consistent with previously reported findings. Bekelman et al⁵ found that patients receiving single-fraction treatment courses for prostate cancer-related bone metastases were more likely to be older and have poorer prognoses. This trend may suggest that single-fraction treatments are typically considered only for palliative treatment in later stage disease.

In recent years, ASTRO has been promoting the Choosing Wisely campaign, which was developed by the American Board of Internal Medicine Foundation. It aims to encourage a balanced conversation between physicians and their patients to provide evidence-based and personalized treatment that is both beneficial and free from harm. Considering the several treatment regimens

available for painful bone metastases, it is essential to involve patient preferences when determining their care.

Physicians graduating in later years and those working in nonacademic centers were found to be less likely to use short-course treatments. A possible explanation for this is that older physicians and those with less of an academic focus may not be familiar with the results of RTOG 97-14 (ie, similar efficacy with pain relief and less acute toxicity). In contrast, certain physicians may consider the higher retreatment rates reported in the single-fraction arm of RTOG 97-14 as rationale for longer treatment schedules. Oncologists may also overestimate the expected prognosis of their patients and in turn place undue emphasis on the potential for retreatment. Furthermore, financial incentives potentially related to longer treatment courses should also be considered as a potential factor affecting the duration of recommended treatment courses among providers although this is difficult to objectively assess.

There were a few limitations to this study. This study did not exclude patients who had spinal cord compression, another painful spinal condition that is also mitigated with radiation treatment. Furthermore, this was a retrospective study, which means some characteristics cannot be retroactively measured. There may be other confounding variables that are unaccounted for, such as the size of the lesions, soft tissue extension, or existence of pathologic fractures. Nonetheless, the study does provide meaningful data that demonstrates the highly beneficial qualities of shorter-course and/or single-fraction radiation treatments over longer ones.

Conclusion

To summarize, the rates of short-course and single-fraction bone-directed radiation therapy have increased among the patients within our integrated health system in the past few years. Treatment with shorter-course radiation treatments is highly associated with academic centers and is more common among physicians completing residency after 2010. Although there are some limitations to this study, there is evidence for believing that the findings of this study represent a shift in the culture of radiation therapy toward more personalized and less harmful ways of treatment.

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