

Heterogeneity in the Treatment of Bone Metastases: A Contemporary Statewide Practice Pattern Analysis

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PURPOSE / OBJECTIVE(S)

Palliative radiotherapy for bone metastases is often viewed as a single entity, despite national guidelines providing input principally only for painful bone metastases. Data surrounding the treatment of bone metastases is often gleaned from questionnaires of what providers would theoretically do in practice or population-based data lacking critical granular information. Herein to investigate the "real-world" radiotherapeutic treatment of bone metastases, we used the statewide Michigan Radiation Oncology Quality Consortium (MROQC) to examine contemporary practice patterns among radiation oncologists across a broad range of practices in the state of Michigan.

MATERIAL & METHODS

Twenty diverse institutions from this statewide Radiation Oncology Quality Consortium had data extracted on their 10 most recent cases of radiotherapy delivered for the treatment of bone metastases at their institution between January and February of 2017 using Case Review forms. Uni- and multivariable binary logistic regression were used to assess use of single fraction (8 Gy x 1) radiotherapy.

Figure 1. Heterogeneity in dose fraction schedules. (A) Scatter plot of dose per fraction and number of fractions for all 196 cases. Size of the sphere correlates to frequency. (B) Stacked bar chart of the biologically equivalent dose using an α/β of 10 according to treatment planning technique used.

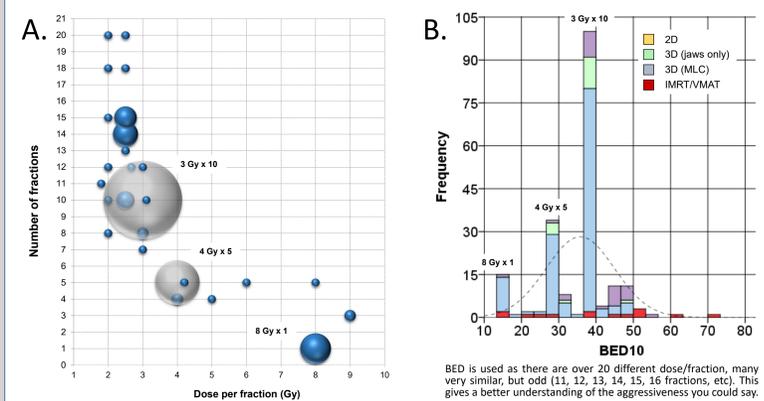


Figure 3. Distribution of IMRT and single fraction (SF) use stratified by institution.

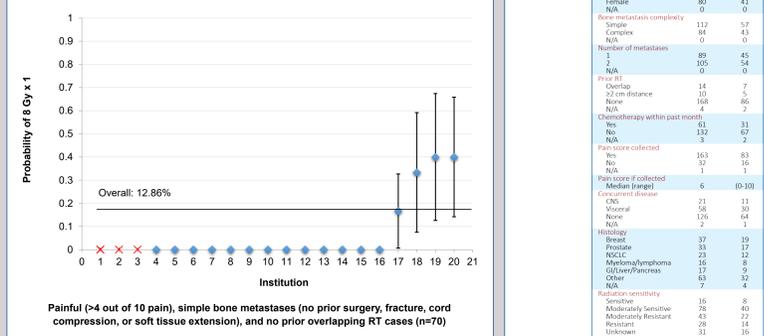


Figure 2. Heterogeneity in use of single fraction radiation therapy (8 Gy x 1) stratified by institution among all cases (n = 196). (A) Cumulative probability of single fraction radiation therapy use stratified by institution for only painful bone metastases (pain score >4 of 10) and no previous overlapping radiation therapy, soft tissue extension, spinal cord compression, pathologic fracture, or surgery (n = 70).

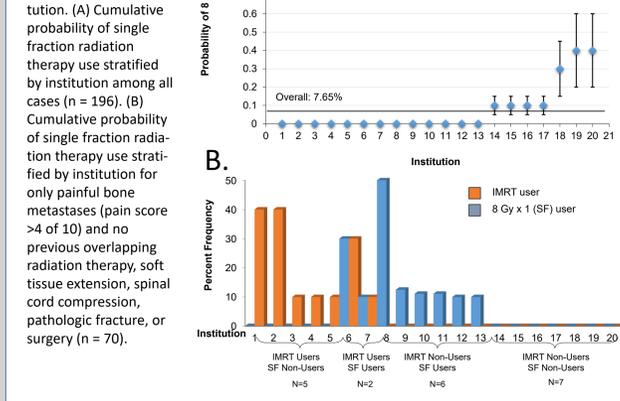


Table 2. Single fraction (8 Gyx1) use: Uni- and multivariable analysis.

Variable	Univariable analysis			Multivariable analysis		
	OR	95% CI	P value	AOR	95% CI	P value
Institution (continuous)	0.99	0.90-1.09	.81	-	-	-
Gender	0.50	0.15-1.64	.25	-	-	-
Age (continuous)	1.01	0.97-1.06	.57	-	-	-
Radioresensitivity	0.95	0.52-1.72	.87	-	-	-
Complexity (simple vs complex)	0.46	0.14-1.49	.2	-	-	-
No. of metastases (1-3 vs >3)	0.05	0.01-0.40	.005*	0.06	0.01-0.46	.008*
Concomitant CNS or visceral disease	0.26	0.06-1.20	.09*	0.84	0.15-4.55	.84
Chemotherapy in previous month	1.09	0.36-3.33	.88	-	-	-
Pain score (continuous)	1.08	0.89-1.28	.45	-	-	-
Previous RT	-	-	-	-	-	-
None	Reference	-	-	Reference	-	-
Overlap	3.85	0.94-16.67	.06*	5.88	1.00-35.71	.05*
>2 cm distance	1.59	0.18-14.29	.68	1.19	0.12-11.90	.89
Practice type (academic vs community)	0.12	0.02-0.93	.042*	0.09	0.01-0.89	.039*

Table 3. Details of cases using either IMRT and/or SBRT.

Case No.	Practice type	Age (y)	Histologic type	Bone metastasis complexity	Concurrent disease	Metastatic burden	Pain score (0-10)	Pain score RT	Previous treatment	planning technique	Total dose SBRT (Gy) (n)	Dose/Fx (Gy)	Image guidance			
1	Academic	57	RCC	Simple	No	Poly	No	No	IMRT	Yes	30	3	10	CBCT		
2	Community	70	NSCLC	Complex	Yes	Poly	No	No	IMRT	Yes	27	3	9	CBCT		
3	Academic	75	NSCLC	Complex	No	Oligo	Yes	5	No	IMRT	Yes	40	5	8	CBCT	
4	Academic	59	Prostate	Simple	No	Oligo	Yes	2	No	IMRT	Yes	27	3	9	CBCT	
5	Community	77	Breast	Simple	Yes	Poly	Yes	2	No	IMRT	Yes	18	1	18	CBCT	
6	Community	70	Penile	Complex	No	Oligo	Yes	4	No	IMRT	Yes	20	5	4	KV	
7	Community	70	Prostate	Complex	No	Oligo	No	Yes	IMRT	Yes	30	5	6	CBCT		
8	Academic	60	Unknown	Complex	Yes	Oligo	Yes	8	No	>2 cm distance	3D-CRT with MLCs	Yes	20	5	4	KV
9	Community	61	NSCLC	Complex	No	Poly	Yes	7	No	>2 cm distance	3D-CRT with MLCs	Yes	16	4	4	KV
10	Community	71	PACC	Simple	Yes	Oligo	No	No	IMRT	Yes	30	10	3	KV		
11	Academic	66	Unknown	Simple	Yes	Oligo	No	Yes	IMRT	Yes	16	4	4	CBCT		
12	Academic	63	Liver	Simple	Yes	Oligo	Yes	0	No	IMRT	No	50	20	2.5	CBCT	
13	Academic	48	Breast	Complex	No	Poly	Yes	9	Yes	IMRT	No	19.8	11	1.8	CBCT	
14	Community	68	Prostate	Simple	No	Oligo	Yes	10	No	IMRT	No	8	1	8	KV	
15	Community	55	GI	Complex	No	Poly	Yes	7	Yes	IMRT	No	30	10	3	KV	
16	Community	73	NSCLC	Simple	No	Oligo	Yes	1	No	IMRT	No	8	1	8	KV	
17	Community	64	Unknown	Complex	Yes	Poly	Yes	9	No	IMRT	No	36	15	2.4	CBCT	

Abbreviations: ACA = adenocarcinoma; CBCT = cone beam computed tomography; 3D-CRT = 3-dimensional conformal radiation therapy; Fx = fraction; IMRT = intensity modulated radiation therapy; MLCs = multileaf collimators; NSCLC = non-small cell lung cancer; Oligo = oligometastatic (1-3 metastases); PACC = parotid adenoid cystic carcinoma; Poly = polymetastatic (>3 metastases); RCC = renal cell carcinoma; SBRT = stereotactic body radiation therapy.

SUMMARY / CONCLUSION

To our knowledge, this is the most granular assessment of practice patterns for bone metastases performed to date. We demonstrate that bone metastases represent a heterogeneous disease, and the radiotherapeutic treatment of bone metastases is similarly diverse. Future work is needed to understand barrier to single fraction use, and clinical trials are necessary to establish appropriate guidelines for the breadth of this complex disease. Going forward, the Michigan Radiation Oncology Quality Consortium is expanding data collection efforts to better understand the barriers to adopting single fraction radiation therapy and to better understand and study the framework for the use of alternative dose fractionation schedules and advanced treatment techniques for diverse goals of care.

- 196 cases were eligible for inclusion. 28 different fractionation schedules were identified.
- Tremendous heterogeneity of the patients and treatment seen - 28 different fractionation schedules identified across the 20 reporting centers (Fig. 1A)
 - 3 Gy x 10 fractions (n = 100; 51.0%); 4 Gy x 5 fractions (n = 32; 16.3%); 8 Gy x 1 (n = 15; 7.7%)
 - 29 cases (14.8%) received >10 fractions (median 15, range 11-20)
 - IMRT or volumetric modulated arc therapy was used in 14 cases (7.1%; Fig. 1B), in 11 cases (5.6%).
 - The overall rate of single fraction use was low (7.7%), with no cases receiving 8 Gy x 1 in 13 institutions.
- On multivariable analysis (Table 2), significant variables associated with using single fraction radiation therapy were the presence of oligometastatic disease (P = .008), academic practice type (P = .039), and previous overlapping radiation therapy (P = .050)

