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Bone metastases

Efficacy of postoperative radiation treatment for bone metastases in the extremities

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ABSTRACT

Background and purpose: Impending or pathological fractures due to bone metastases may require surgical fixation. Postoperative radiation is often recommended to reduce local progression and prevent prosthesis displacement, hence reducing the need for second surgery. The objectives of this study were to investigate the need for second surgery, and to report on rates of re-irradiation, tumor progression and prosthesis displacement following postoperative radiation.

Materials and methods: Data were collected from 65 patients who received postoperative radiation to 74 sites in the extremities in a palliative radiation clinic between January 2009 and January 2017. Descriptive statistical analyses were performed.

Results: Only 2 patients required a second surgery (2.7%) at 9 and 10 months after postoperative radiation. Increase in pain requiring re-irradiation was reported in 7 patients (9.5%), at a median time of 9.3 months after the delivery of radiation. Of the 47 patients who had radiological imaging available post-radiation, local progression of bone metastases was seen in 8 patients (17.0%) and displacement of the prosthesis in 1 patient (2.1%).

Conclusion: Rates of prosthesis displacement and progression of bone metastases at site of surgery were low after postoperative radiation. There were few incidences of second surgery and re-irradiation observed in the cohort. These findings provide support for the benefit of postoperative radiation.

Bone metastases are present in approximately 70% of patients with metastatic disease [1–4]. Development of bone metastases can result in pain and complications such as pathologic fractures, which are seen in approximately 10% of patients with bone metastases [1,5,6]. Surgical interventions are often required to stabilize the bones either in a prophylactic manner if a fracture is impending, or as soon as possible after the fracture occurs with the goal of providing pain relief and restoring functional status [7]. Clinical practice often involves treatment with radiation following orthopedic stabilization surgery, as it is believed to slow down further local progression of metastases and promote bony growth at the site. This could help lessen pain and decrease displacement of surgical hardware, thereby reducing the need for a second surgical procedure. Postoperative radiation may help improve quality of life through restoration of functional status [7–12].

However, there is a lack of clinical evidence in the actual effectiveness of postoperative radiation [1]. Many clinicians base their recommendation of postoperative radiation to the extremities on a single retrospective cohort study by Townsend et al. published in 1995 [5]. A recent systematic review by Willeumier et al. [1] highlighted the need for further clinical investigation into the effectiveness of postoperative radiation in patients with bone metastases.

The present study aimed to investigate the benefit of postoperative radiation treatment in patients with bone metastases and (impending) pathological fractures in the extremities.

Materials and methods

A retrospective study was conducted in patients who were referred for postoperative radiation to the extremities between January 2009 and January 2017 in the Rapid Response Radiother-

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apy Program at the Sunnybrook Odette Cancer Centre. Patients were included if they had received: (1) surgical fixation of impending or pathologic fractures in the extremities due to bone metastases; and (2) postoperative radiation treatment. Demographic information, radiation treatment plans, and details regarding the surgical procedures were extracted from the prospective database and medical records. Study approval from the Sunnybrook Research Ethics Board was obtained. All data recorded were analyzed using descriptive statistics.

The primary objective of this study was to evaluate the need for second surgery following postoperative radiation. Operative reports from the medical records of each patient were analyzed. Information including the date, type, and site of procedure were extracted, and surgical details were recorded.

The secondary objectives in this study were to assess the need for re-irradiation and the radiological changes at the treatment site over time. In cases of re-irradiation, treatment characteristics including dosage, fractionation, date and site of treatment were recorded. Any imaging of the surgical site performed post radiation was reviewed and analyzed to determine frequencies of tumor progression and prosthesis displacement at treatment sites.

Time to specified outcome (second surgery, re-irradiation, local progression of bone metastases, displacement of prosthesis, or follow-up) was calculated from the date of first fraction of postoperative radiation.

Results

Demographics

Sixty-five patients received radiation to 74 sites at a median time of 24 days (range 6 to 127 days) following orthopedic surgery (Table 1). The median age was 74 years old (range 52–100), and median Karnofsky Performance Status (KPS) score was 50 (range 20–90) at the time of consultation for postoperative radiation. The most common primary cancer sites were lung (29.2%), breast (27.7%), prostate (15.4%) and renal cell (13.8%).

Table 1
Patient demographics.

Demographic	*n* (%) *N* = 65
Age (years)	
50–59	10 (15.4%)
60–69	15 (23.1%)
70–79	25 (38.5%)
80–89	14 (21.5%)
90–99	0 (0%)
≥100	1 (1.5%)
Gender	
Female	31 (47.7%)
Male	34 (52.3%)
Primary cancer site	
Lung	19 (29.2%)
Breast	18 (27.7%)
Prostate	10 (15.4%)
Renal Cell	9 (13.8%)
Others	5 (7.7%)
Unknown	4 (6.2%)
KPS score	
20	1 (1.5%)
30	5 (7.7%)
40	12 (18.5%)
50	15 (23.1%)
60	19 (29.2%)
70	7 (10.8%)
80	3 (4.6%)
90	3 (4.6%)

Karnofsky Performance Status, KPS.

Treatment information

All patients were treated with a two-beam opposed pair arrangement. The radiation fields covered the entire prosthesis in 72 (97.3%) treatment sites. Neither of the 2 prostheses that had partial coverage by the radiation field required a subsequent intervention or showed radiological local progression at the site. Most treatment sites (81.1%) received 20 Gy in 5 fractions (Table 2). The majority of surgeries and postoperative radiation treatments were performed at the hip or femur (79.7%). All patients received postoperative radiation within 3 months, with the exception of one whose radiation was performed 172 days after surgery. This delay was due to the presence of 2 treatment sites of which the latest was operated on 5 months following the first, with the patient receiving postoperative radiation to both sites only after the second treatment site was surgically fixed. Despite the delay, the patient did not have radiological evidence of local progression in either treatment site.

Need for second surgery

Out of the 74 treatment sites, 2 (2.7%) required a second surgery to the same site following postoperative radiation (Table 2). The first treatment site belonged to a 73 year-old woman with lung cancer and metastases to her femur; she required a second surgery 9 months following postoperative radiation (20 Gy in 5 fractions) due to tumor progression resulting in a fracture and concomitant pain. Time to radiological bone metastases progression was 27 days.

The second treatment site was from a 78-year-old man with prostate cancer and metastases to the hip. This patient required a second surgery 10 months following initial postoperative radiation (20 Gy in 5 fractions) due to prosthesis displacement.

Need for re-irradiation

There were 7 treatment sites (9.5%) that required re-irradiation, administered a median time of 9.3 months after initial postoperative radiation treatment (Table 3). One patient did not have radiological imaging available. Of the 6 evaluable treatment sites, 2 showed local progression in the bone. All of these patients reported increased pain at the site.

Assessment of radiological changes

A total of 47 treatment sites had radiological imaging post radiation that enabled assessment of local progression and prosthesis

Table 2
Surgical and radiation treatment information.

	n (%) *N* = 74
Site of surgery/radiation	
Hip or femur	59 (79.7%)
Humerus	10 (13.5%)
Knee or tibia	5 (6.8%)
Dosage of radiation	
20 Gy/5	60 (81.1%)
30 Gy/10	5 (6.8%)
8 Gy/1	4 (5.4%)
Other	5 (6.8%)

Gy, Gray.