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## Impacts of radiation therapy on quality of life and pain relief in patients with bone metastases

Armin Hoveidaei, Mehdi Karimi, Vida Khalafi, Patrick Fazeli, Amir Human Hoveidaei

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### Abstract

Bone metastases (BM) are a common complication in advanced cancer patients, significantly contributing to morbidity and mortality due to their ability to cause pain, fractures, and spinal cord compression. Radiation therapy (RT) is vital in managing these complications by targeting metastatic lesions to ease pain, improve mobility, and reduce the risk of skeletal-related events such as fractures. Evidence supports the effectiveness of RT in pain relief, showing its ability to provide significant palliation and lessen the need for opioid painkillers, thereby enhancing the overall quality of life (QoL) for patients with BM. However, optimizing RT outcomes involves considerations such as the choice of radiation technique, dose fractionation schedules, and the integration of supportive care measures to mitigate treatment-related side effects like fatigue and skin reactions. These factors highlight the importance of personalized treatment planning tailored to individual patient needs and tumor characteristics. This mini-review aims to provide comprehensive insights into the multifaceted impacts of RT on pain management and QoL enhancement in BM patients, with implications for refining clinical practices and advancing patient care through the synthesis of findings from various studies.

**Key Words:** Radiation therapy; Radiotherapy; Quality of life; Pain relief; Bone metastases; Bone cancer

**Core Tip:** Radiation therapy (RT) significantly alleviates pain and improves quality of life in patients with bone metastases. Optimizing RT effectiveness involves personalized treatment approaches and supportive care measures to manage side effects, enhancing overall well-being and symptom control.

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## INTRODUCTION

### **Brief overview of bone metastasis and its impact on quality of life**

Cancers are a significant global problem and may lead to severe complications like bone metastasis (BM), which can cause pain and mobility issues[1,2]. Additionally, the psychological impact of cancer can be profound, resulting in anxiety and depression for many patients[3]. Metastatic bone cancer, or secondary bone cancer, denotes the proliferation of tumors originating from other tissues and disseminating (metastasizing) to bone sites[4]. According to the American Cancer Society, about 400000 new malignant BM cases are diagnosed annually[5]. The incidence rate of BM in the United States is still unknown, with estimates varying from 21000 to 400000 per annum[6]. BM ranks as the third most prevalent site for metastatic malignancies[7]. Notably, bone represents a common locus for metastases, often signaling a short prognosis for cancer patients. Indeed, BM surpasses primary bone cancers in occurrence, particularly among adults[8]. Among cancers, prostate cancer poses the highest risk for bone metastases, trailed by lung, renal, or breast cancers. The rich arterial supply to bone predisposes it to metastatic dissemination[9,10]. Generally, the presence of BM in patients predicts a poor prognosis, with median survival ranging from 6 months to 4 years, depending on the primary cancer type [8]. It can significantly impact the quality of life (QoL), causing severe pain, impaired mobility, pathological fractures, spinal cord compression, and other complications[8,11]. It negatively affects multiple domains of QoL, including physical, emotional, social, and functional well-being[11]. Pain is a significant factor impacting QoL, but other issues like reduced activities of daily living also play an essential role[11,12]. Treatment aims to relieve pain, prevent complications, and improve overall QoL. Options include pain medications, radiation therapy (RT), surgery, and bone-targeted agents like bisphosphonates[12]. In general, a multidisciplinary approach involving oncologists, pain specialists, radiologists, orthopedic surgeons, and others is recommended for optimal management[8,12].

### **Introduction to radiotherapy as a treatment option for bone metastasis**

RT is the predominant therapeutic approach for addressing painful bone metastases in the spine and non-spine regions. Initially, conventional low-dose external beam RT was employed for this purpose; however, stereotactic body radiotherapy (SBRT) is increasingly utilized for such cases[13]. The SBRT technique employed by Correia *et al*[14] involved a variable dosing regimen (range 24-42Gy) administered in 2 to 7 separate fractions. Other studies utilized SBRT using variable dosing regimens, ranging from 15-24 Gy in a single fraction to 24 to 50 Gy delivered over 3 to 5 fractions. These studies reported local control rates of approximately 90% with a decreased incidence of adverse effects[15]. The principal aim of RT in managing BM is to alleviate pain and enhance the QoL for patients[16]. This treatment modality assumes critical importance due to the array of challenges posed by bone metastatic disease, encompassing pain, fractures, spinal cord compression, and neurological deficits[16]. Notably, RT assumes a pivotal role in pain management and overall QoL enhancement for individuals with BM[16]. In uncomplicated bone metastases, defined by the absence of pathological fractures, evidence of cord compression, or previous surgical interventions, RT has demonstrated notable efficacy, with improvements or complete pain relief observed in up to 60% of cases. Moreover, there appears to be no discernible difference in effectiveness between single or multiple-fraction RT regimens[17].

### **Purpose of the mini-review**

Our purpose in this mini-review study was to offer a thorough investigation of the effects of RT on pain alleviation and QoL among patients with bone metastases. This involved synthesizing available evidence concerning the effectiveness of RT in managing pain associated with BM and its influence on various aspects of patient's QoL. Ultimately, our goal was to provide clinicians and researchers with valuable insights to improve the application of RT in treating bone metastases, focusing on enhancing overall well-being and symptom control for patients (Figure 1).

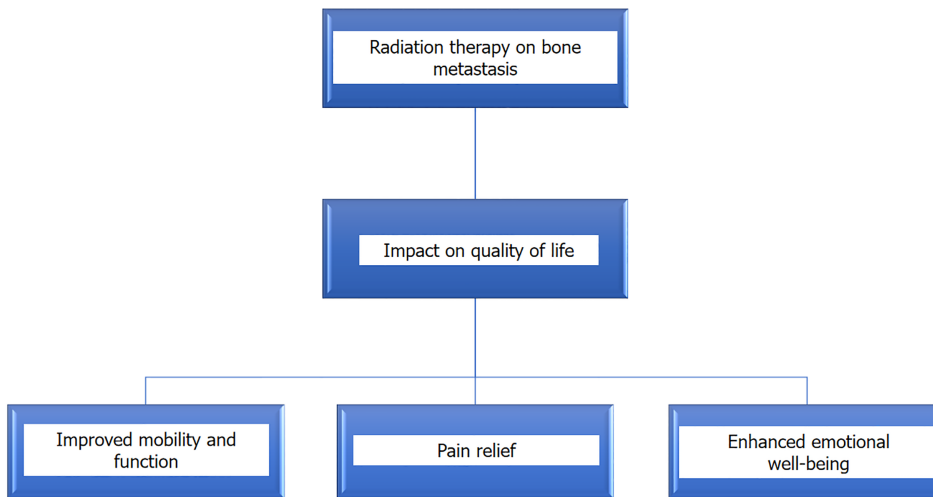


Figure 1 The impact of radiation therapy in bone metastasis patients on the quality of life.

## EFFECTS OF RADIOTHERAPY ON PAIN RELIEF

### **Summary of studies demonstrating the efficacy of radiotherapy in reducing pain in patients with bone metastasis**

Prior research has shown that conventional RT alleviates pain in approximately 60% of people suffering from painful bone metastases, with total pain reduction in about 30% of cases[18,19]. On the other hand, SBRT is a more precise RT technique delivering high doses of radiation in few fractions, primarily used for extra-cranial lesions like lung, liver, and prostate, offering enhanced accuracy compared to conventional radiotherapy (cRT)[20]. SBRT also demonstrated a pain relief rate reaching up to 50%[21]. In a study conducted by Wang *et al*[22] they revealed that patients undergoing SBRT had better pain alleviation three months after radiation than those undergoing cRT, with no increase in adverse event occurrence. Moreover, in a study on palliative RT fractionation for bone metastases, Rich *et al*[23] discovered that both single and multiple-fraction radiation treatment regimens consistently result in similar pain management and side effects. However, patients who receive single-fraction treatment are more likely to require re-treatment.

### **Discussion of the mechanisms by which radiotherapy alleviates pain**

The exact mechanism underlying radiation-induced pain alleviation remains unexplained. Radiation's analgesic impact is thought to be due to a variety of causes, including ossification stimulation, osteoclast activity inhibition within the bone microenvironment, and cancer cell elimination, all of which lead to decreased osteolysis and, as a result, tumor burden reduction[24,25]. Some patients have immediate pain relief that lasts longer than 24 hours, indicating a decrease in inflammatory cell activity and the concentration of chemical pain mediators in the radiation-exposed area. These characteristics help to increase the analgesic efficacy of RT[26]. The fractionation regimen of RT used on individuals with BM impacts the degree of mineralization, bone density, and re-calcification at the treated location, which correlates with pain response[27,28].

### **Impact of pain relief on quality of life in patients with bone metastasis**

Patients with bone pain frequently face increasing difficulties completing daily activities, which is accompanied by severe distress and a reduction in QoL. Despite this, few studies provide complete QoL assessments. Furthermore, existing research provides mixed results, and some show an improvement in QoL among patients who respond well to RT treatment[29-33]. Others suggest that RT's impact on QoL across various domains is inconsistent[34-36]. Nevertheless, a recent study conducted by Mendez *et al*[34] discovered that patients over 75 significantly improved overall activity, mood, and interpersonal interactions more than their younger counterparts. Furthermore, their patients experienced pain relief as early as four weeks after getting RT. This finding was associated with a statistically significant improvement in QoL across all dimensions of functional interference, except sleeping quality, consistent with Zeng *et al*[37] results. On the other hand, Khan *et al*[38] claimed that sleeping improves in the second and third month after the treatment in patients responding positively to the RT.

## EFFECTS OF RADIOTHERAPY ON PHYSICAL FUNCTIONING

### **Review of research on how radiotherapy affects physical functioning in patients with bone metastasis**

Studies have demonstrated the substantial impact of RT on the physical functioning and QoL of individuals with BM[15]. The primary goal of RT in this context is to alleviate pain and prevent skeletal-related events such as fractures, which can severely impact a patient's mobility and daily activities. While RT is beneficial for pain management and may contribute to improved physical functioning, a comprehensive approach considering all influencing factors is necessary for optimal

patient care[39].

A prospective, single-institutional study showed that RT significantly improved nine domains of QoL in patients with BM, with pain management the most notable improvement. This study underscored the effectiveness of RT in palliating painful BM and enhancing QoL[40]. Patients with bone metastases receiving palliative radiotherapy have reported improvements in their physical functioning, including general activities of daily living[11,41]. A study found that gender, performance status, and primary histology affect health-related QoL in patients with BM[42].

### **Discussion of improvements in mobility, daily activities, and overall physical well-being following radiotherapy**

RT, particularly when integrated with complementary therapeutic modalities, enhances daily functioning, mobility, and overall physical well-being among patients with BM[43]. Its pivotal role in managing BM chiefly revolves around pain alleviation, indirectly fostering improved mobility, daily activities, and overall physical wellness. RT exhibits efficacy in providing pain relief for patients with BM originating from diverse primary cancers, including lung, breast, colon, and prostate, among others[44-48]. Augmenting RT with adjunctive interventions like Poly methyl methacrylate acetabuloplasty or pharmacological approaches such as calcitonin can increase these outcomes[49]. This body of research underscores the necessity of adopting a multidisciplinary approach to managing BM to optimize physical function and enhance the QoL for affected patients[49].

### **Consideration of the long-term effects on physical functioning**

Although there is no investigation to provide specific results on the long-term impact of RT on physical functioning, studies suggest that by effectively managing symptoms and complications related to BM through RT and supportive care, patients may experience maintenance or improvement in physical functioning and overall QoL[41]. A primary consideration associated with RT for BM revolves around the possibility of long-term bone impairment and heightened fracture susceptibility. Radiation exposure can induce bone demineralization and debilitation, particularly within irradiated regions, consequently elevating the likelihood of pathological fractures. Such fractures can exacerbate limitations in physical functioning and mobility[50].

Combining RT with bone-targeted therapies may help mitigate the adverse effects on bone health[50]. RT may precipitate enduring musculoskeletal complications, encompassing muscle weakness, joint stiffness, and diminished range of motion. Such effects can be further compounded by the presence of underlying BM and the accompanying pain and immobility[51]. Physical activity and exercise, when possible, may help preserve musculoskeletal function and mitigate some of the adverse effects of RT and BM[51].

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## **EFFECTS OF RADIOTHERAPY ON EMOTIONAL WELL-BEING**

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### **Examination of the psychological impact of bone metastasis and associated pain**

Patients with BM usually experience psychological distress marked by anxiety, depression, and fear[52,53]. The associated pain, disability, and loss of independence often induce feelings of helplessness, social isolation, and apprehension regarding the future and end-of-life[52,54]. Studies demonstrated that BM exerts a more profound negative impact on psychological well-being compared to other metastatic sites. Multivariate logistic regression indicated that older age, female sex, malignancy, higher numeric rating scale scores, and a lower Barthel Index were associated with increased risk for psychological distress[53]. Weng Hong *et al*[55] did a study among orthopedic oncology patients and reported that 29.8% had anxiety, 16.2% had depression, and 15.2% had mixed anxiety and depression.

### **Review of studies showing the positive effects of radiotherapy on emotional well-being and quality of life**

Few studies have looked into the psychological effects of RT. For instance, Cañón *et al*[41] revealed that responders to RT significantly improved functional psychosocial aspects (such as relations with others and life enjoyment) compared with nonresponders. These findings were consistent with McDonald *et al*[33], Westhoff *et al*[35], and Caissie *et al*[56] evaluated the emotional functioning of the patients by asking them about feeling tense or depressed, and they found that RT responders had an improvement in emotional functioning together with a decrease in symptoms such as insomnia at month 1.

### **Discussion of the role of psycho-social support in improving emotional outcomes**

Providing psycho-social support for individuals coping with BM is crucial for enhancing their overall well-being and QoL. According to some studies, prognostic awareness correlates with decreased QoL and mood among patients recently diagnosed with incurable cancer[57-60]. Furthermore, some studies show that patients who go through palliative therapy along with their treatment have better outcomes than patients undergoing oncology treatment alone[61,62]. However, specific coping strategies have been examined for their potential to enhance patients' mood and QoL. For instance, acceptance has been shown to positively influence patients' psychological and emotional well-being, diverging from the adverse effects associated with denial and self-blame[63]. This insight could guide the patient's support system, including their family and medical caregivers, in creating the best environment to assist the patient in overcoming this challenge.

## FACTORS INFLUENCING QUALITY OF LIFE OUTCOMES

### **Exploration of factors that may influence the effectiveness of radiotherapy on quality of life in patients with bone metastasis, for instance, the coronavirus disease 2019 lockdown effects on the outcomes**

The pandemic of the coronavirus disease 2019 (COVID-19) challenges medical professionals to treat patients with advanced cancers, especially with RT[64]. Cancer patients are known to be fragile, so it is critical to treat patients safely and reduce the transmission risk of COVID-19[64]. Oncologists must re-organize how they approach treatment to reduce pain and improve palliation of patients[64,65]. Palliative RT can dramatically maximize the QoL of patients, even during the COVID-19 pandemic[66]. As such, guidelines recommend that patients with BM receive the 8Gy single-fraction RT during a single hospital visit[64,67]. Hypofractionated regimens for radiation are recommended to reduce the frequency of transport, the number of sessions, and complicated treatments[64].

### **Consideration of patient characteristics, treatment regimen, and supportive care services**

Numerous factors, such as patient characteristics, treatment regimen, and supportive care services, can influence QoL outcomes[31]. Responding patients with painful BM have higher QoL scores than nonresponders after RT[31]. Elderly cancer patients show a worse QoL, including appetite and physical functioning, after RT for BM than younger patients [31,68,69]. Patients with younger ages report significant QoL[68]. More women report clinically better improvement in enjoyment of life and mood after radiation for relieving bone pain[68]. High bone pain scores are associated with poor performance status, influencing functional QoL after RT[35]. Combined hyperthermia and RT significantly improve the QoL and ease bone pain in patients with BM[70]. Nurse-led education reduces pain intensity and improves patient empowerment in cancer patients with BM undergoing RT[71].

### **Implications for personalized treatment approaches**

Treatment recommendations for palliative RT for BM should be personalized based on individual patient characteristics to optimize patient outcomes[72-74]. Considering the patient's life expectancy, overall health, tumor progression, tumor biology, comorbidities, and clinical condition allows for the development of personalized treatment plans[72-74].

## FUTURE DIRECTIONS AND CLINICAL IMPLICATIONS

### **Summary of key findings regarding the effects of radiotherapy on quality of life in patients with bone metastasis**

BM significantly impacts patients' physical, functional, and psychosocial QoL[75]. New therapies and interventions have improved patient's QoL and extended life expectancy. RT is the primary therapeutic approach for managing painful bone metastases, playing a crucial role in pain management and improving the overall QoL for individuals with BM[13,16,76].

Studies have shown the efficacy of both cRT and SBRT in relieving pain for patients with BM[22,23]. They indicated that patients undergoing SBRT experienced more pain relief three months after radiation than those undergoing cRT[22]. Radiation's impact is due to multiple factors, including ossification stimulation, osteoclast activity inhibition within the bone microenvironment, and cancer cell elimination[24,25]. These mechanisms lead to decreased osteolysis and reduced tumor burden[24,25]. Pain relief was associated with a statistically significant enhancement in QoL across various aspects of functional interference, except sleeping quality[41]. The main goal of RT is to alleviate pain and prevent skeletal-related events that can severely affect a patient's mobility and daily functioning[39]. RT is valuable for pain management and may positively enhance physical functioning[39]. Integrating RT with complementary therapeutic approaches improves physical well-being, mobility, and daily functioning in patients with BM[43]. RT can cause long-term musculoskeletal complications, including muscle weakness, joint stiffness, and limited movement, compounded by bone metastases, the accompanying pain, and immobility[51]. Research demonstrated that BM has a more profound negative impact on psychological well-being than other sites of metastasis[53]. Cañón *et al*[41] revealed that individuals who responded positively to RT experienced more improvements in their relationships with others and enjoyment of life than nonresponders.

### **Discussion of potential areas for further research and improvements in treatment strategies**

BM, which is a severe complication of cancer, demands immediate attention as it is indicative of a limited prognosis in individuals with cancer[77,78]. Despite our knowledge being enhanced in the metastatic process, several questions remain unanswered that necessitate further research to comprehend the skeletal consequences of metastasis[78]. Future research directions in RT for BM include several critical areas[79]. These comprise response definitions, refining eligibility criteria, reirradiation, systemic therapy changes, radiation techniques, follow-up parameters, and assessment timing[79]. for instance, SBRT may improve local control and pain relief in non-spine BM individuals. However, further research is essential in areas such as volume delineation, MRI, ideal doses, and fractionation[15].

### **Recommendations for healthcare providers in optimizing quality of life outcomes for patients undergoing radiotherapy for bone metastasis**

Therapeutic interventions have the potential to improve pain control and function and the preservation of skeletal integrity in patients with BM[80]. The approach to treatment necessitates a multidisciplinary approach[80]. Achieving successful management of BM requires collaboration among healthcare professionals such as medical oncologists,



surgical oncologists, and radiation oncologists[80]. The judgment of expert radiation oncology physicians is crucial for optimizing outcomes of RT in treating painful BM[72]. Effective RT for BM requires a personalized approach that includes various factors, such as the individual's life expectancy and the progression of tumors in different sites[73].

## CONCLUSION

In conclusion, RT has been proven to be a crucial treatment for patients with BM. It significantly helps to relieve pain and improve overall QoL. This treatment approach reduces the intense discomfort often associated with metastatic bone lesions, allowing patients to experience a notable improvement in their daily functioning and well-being. While the primary goal of RT is to manage pain and control disease progression, it's equally important to consider the broader impact on patients' QoL. The physical side effects, psychological stress, and potential long-term consequences of treatment require a comprehensive and patient-centered approach. Healthcare providers should prioritize the clinical effectiveness of RT and the individual patient's experience, preferences, and overall QoL. By incorporating supportive care measures, personalized treatment plans, and ongoing assessment of QoL outcomes, we can optimize therapeutic regimens and ensure a holistic approach to caring for patients with bone metastases. Ultimately, recognizing and addressing these multifaceted needs will improve health outcomes and enhance QoL for patients undergoing RT.

## FOOTNOTES

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## REFERENCES

- 1 **AziziKia H**, Teymourzadeh A, Kouchaki H, Nakhostin-Ansari A, Jafari Doudaran P, Ahmadinejad I, Hoveidaei A, Roshandel G. Colorectal Cancer Incidence in Iran Based on Sex, Age, and Geographical Regions: A Study of 2014-2017 and Projected Rates to 2025. *Arch Iran Med* 2024; **27**: 174-182 [PMID: 38685843 DOI: 10.34172/aim.2024.26]
- 2 **Hoveidaei AH**, Ghaseminejad-Raeini A, Hosseini-Asl SH, Shrestha A, Hoveidaei A, Taghavi SP, Nwankwo BO, Khonji MS, Conway JD. Initiating chemotherapy in joint arthroplasty patients increases the risk of periprosthetic joint infections. *Arch Orthop Trauma Surg* 2024 [PMID: 38693289 DOI: 10.1007/s00402-024-05307-4]
- 3 **Hoveidaei A**, Fekri M, Hoveidaei AH. Depression, the severity of bone metastasis, and the number of radiotherapy episodes: are they interlinked? *Eastern J Med* 2021; **26**: 618-619 [DOI: 10.5505/ejm.2021.27167]
- 4 **Jayarangaiah A**, Kemp AK, Theetha Kariyanna P. Bone Metastasis. 2023 Jul 31. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan- [PMID: 29939688]
- 5 **Jiang W**, Rixiati Y, Zhao B, Li Y, Tang C, Liu J. Incidence, prevalence, and outcomes of systemic malignancy with bone metastases. *J Orthop Surg (Hong Kong)* 2020; **28**: 2309499020915989 [PMID: 32634071 DOI: 10.1177/2309499020915989]
- 6 **Huang JF**, Shen J, Li X, Rengan R, Silvestris N, Wang M, Derosa L, Zheng X, Belli A, Zhang XL, Li YM, Wu A. Incidence of patients with bone metastases at diagnosis of solid tumors in adults: a large population-based study. *Ann Transl Med* 2020; **8**: 482 [PMID: 32395526 DOI: 10.21037/atm.2020.03.55]
- 7 **Martiniakova M**, Mondockova V, Biro R, Kovacova V, Babikova M, Zemanova N, Ciernikova S, Omelka R. The link between bone-derived factors osteocalcin, fibroblast growth factor 23, sclerostin, lipocalin 2 and tumor bone metastasis. *Front Endocrinol (Lausanne)* 2023; **14**: 1113547 [PMID: 36926025 DOI: 10.3389/fendo.2023.1113547]
- 8 **Macedo F**, Ladeira K, Pinho F, Saraiva N, Bonito N, Pinto L, Goncalves F. Bone Metastases: An Overview. *Oncol Rev* 2017; **11**: 321 [PMID: 28584570 DOI: 10.4081/oncol.2017.321]
- 9 **Arakil N**, Akhund SA, Elaasser B, Mohammad KS. Intersecting Paths: Unraveling the Complex Journey of Cancer to Bone Metastasis. *Biomedicines* 2024; **12** [PMID: 38791037 DOI: 10.3390/biomedicines12051075]

- 10 **Arvelo F, Sojo F, Cotte C.** Cancer and the metastatic substrate. *Ecancermedicalscience* 2016; **10**: 701 [PMID: 28105072 DOI: 10.3332/ecancer.2016.701]
- 11 **Akezaki Y, Nakata E, Kikuuchi M, Sugihara S, Katayama Y, Katayama H, Hamada M, Ozaki T.** Factors Affecting the Quality of Life of Patients with Painful Spinal Bone Metastases. *Healthcare (Basel)* 2021; **9** [PMID: 34828545 DOI: 10.3390/healthcare9111499]
- 12 **von Moos R, Costa L, Ripamonti CI, Niepel D, Santini D.** Improving quality of life in patients with advanced cancer: Targeting metastatic bone pain. *Eur J Cancer* 2017; **71**: 80-94 [PMID: 27984770 DOI: 10.1016/j.ejca.2016.10.021]
- 13 **Burgess L, Nguyen E, Tseng CL, Guckenberger M, Lo SS, Zhang B, Nielsen M, Maralani P, Nguyen QN, Sahgal A.** Practice and principles of stereotactic body radiation therapy for spine and non-spine bone metastases. *Clin Transl Radiat Oncol* 2024; **45**: 100716 [PMID: 38226025 DOI: 10.1016/j.ctro.2023.100716]
- 14 **Correia D, Moullet B, Cullmann J, Heiss R, Ermiş E, Aebbersold DM, Hemmatazad H.** Response assessment after stereotactic body radiation therapy for spine and non-spine bone metastases: results from a single institutional study. *Radiat Oncol* 2022; **17**: 37 [PMID: 35189919 DOI: 10.1186/s13014-022-02004-7]
- 15 **De la Pinta C.** SBRT in non-spine bone metastases: a literature review. *Med Oncol* 2020; **37**: 119 [PMID: 33221952 DOI: 10.1007/s12032-020-01442-1]
- 16 **De Felice F, Piccioli A, Musio D, Tombolini V.** The role of radiation therapy in bone metastases management. *Oncotarget* 2017; **8**: 25691-25699 [PMID: 28148890 DOI: 10.18632/oncotarget.14823]
- 17 **Tseng YD.** Radiation Therapy for Painful Bone Metastases: Fractionation, Recalcification, and Symptom Control. *Semin Radiat Oncol* 2023; **33**: 139-147 [PMID: 36990631 DOI: 10.1016/j.semradonc.2022.11.004]
- 18 **Chow E, Harris K, Fan G, Tsao M, Sze WM.** Palliative radiotherapy trials for bone metastases: a systematic review. *J Clin Oncol* 2007; **25**: 1423-1436 [PMID: 17416863 DOI: 10.1200/JCO.2006.09.5281]
- 19 **Lutz S, Berk L, Chang E, Chow E, Hahn C, Hoskin P, Howell D, Koniski A, Kachnic L, Lo S, Sahgal A, Silverman L, von Gunten C, Mendel E, Vassil A, Bruner DW, Hartsell W; American Society for Radiation Oncology (ASTRO).** Palliative radiotherapy for bone metastases: an ASTRO evidence-based guideline. *Int J Radiat Oncol Biol Phys* 2011; **79**: 965-976 [PMID: 21277118 DOI: 10.1016/j.ijrobp.2010.11.026]
- 20 **Lartigau E.** Stereotactic body radiotherapy. *BMJ* 2011; **343**: d4286 [PMID: 21816739 DOI: 10.1136/bmj.d4286]
- 21 **Chang EL, Shiu AS, Mendel E, Mathews LA, Mahajan A, Allen PK, Weinberg JS, Brown BW, Wang XS, Woo SY, Cleeland C, Maor MH, Rhines LD.** Phase I/II study of stereotactic body radiotherapy for spinal metastasis and its pattern of failure. *J Neurosurg Spine* 2007; **7**: 151-160 [PMID: 17688054 DOI: 10.3171/SPI-07/08/151]
- 22 **Wang Z, Li L, Yang X, Teng H, Wu X, Chen Z, Wang Z, Chen G.** Efficacy and safety of stereotactic body radiotherapy for painful bone metastases: Evidence from randomized controlled trials. *Front Oncol* 2022; **12**: 979201 [PMID: 36338685 DOI: 10.3389/fonc.2022.979201]
- 23 **Rich SE, Chow R, Raman S, Liang Zeng K, Lutz S, Lam H, Silva MF, Chow E.** Update of the systematic review of palliative radiation therapy fractionation for bone metastases. *Radiother Oncol* 2018; **126**: 547-557 [PMID: 29397209 DOI: 10.1016/j.radonc.2018.01.003]
- 24 **Goblirsch MJ, Zwolak PP, Clohisy DR.** Biology of bone cancer pain. *Clin Cancer Res* 2006; **12**: 6231s-6235s [PMID: 17062706 DOI: 10.1158/1078-0432.CCR-06-0682]
- 25 **Goblirsch M, Mathews W, Lynch C, Alaei P, Gerbi BJ, Mantyh PW, Clohisy DR.** Radiation treatment decreases bone cancer pain, osteolysis and tumor size. *Radiat Res* 2004; **161**: 228-234 [PMID: 14731066 DOI: 10.1667/rr3108]
- 26 **Wu JS, Wong RK, Lloyd NS, Johnston M, Bezjak A, Whelan T; Supportive Care Guidelines Group of Cancer Care Ontario.** Radiotherapy fractionation for the palliation of uncomplicated painful bone metastases - an evidence-based practice guideline. *BMC Cancer* 2004; **4**: 71 [PMID: 15461823 DOI: 10.1186/1471-2407-4-71]
- 27 **Sprave T, Verma V, Förster R, Schlampp I, Hees K, Bruckner T, Bostel T, El Shafie RA, Welzel T, Nicolay NH, Debus J, Rief H.** Bone density and pain response following intensity-modulated radiotherapy versus three-dimensional conformal radiotherapy for vertebral metastases - secondary results of a randomized trial. *Radiat Oncol* 2018; **13**: 212 [PMID: 30376859 DOI: 10.1186/s13014-018-1161-4]
- 28 **Sierko E, Hempel D, Zuzda K, Wojtukiewicz MZ.** Personalized Radiation Therapy in Cancer Pain Management. *Cancers (Basel)* 2019; **11** [PMID: 30893954 DOI: 10.3390/cancers11030390]
- 29 **Wu JS, Monk G, Clark T, Robinson J, Eigl BJ, Hagen N.** Palliative radiotherapy improves pain and reduces functional interference in patients with painful bone metastases: a quality assurance study. *Clin Oncol (R Coll Radiol)* 2006; **18**: 539-544 [PMID: 16969984 DOI: 10.1016/j.clon.2006.05.003]
- 30 **Westhoff PG, de Graeff A, Reyners AK, Monnikhof EM, Rodenhuis CC, van Vulpen M, Leer JW, Marijnen CA, van der Linden YM; Dutch Bone Metastasis Study Group.** Effect of age on response to palliative radiotherapy and quality of life in patients with painful bone metastases. *Radiother Oncol* 2014; **111**: 264-269 [PMID: 24746581 DOI: 10.1016/j.radonc.2014.03.017]
- 31 **Westhoff PG, de Graeff A, Monnikhof EM, Pomp J, van Vulpen M, Leer JW, Marijnen CA, van der Linden YM; Dutch Bone Metastasis Study Group.** Quality of Life in Relation to Pain Response to Radiation Therapy for Painful Bone Metastases. *Int J Radiat Oncol Biol Phys* 2015; **93**: 694-701 [PMID: 26281825 DOI: 10.1016/j.ijrobp.2015.06.024]
- 32 **Zeng L, Chow E, Bedard G, Zhang L, Fairchild A, Vassiliou V, Alm El-Din MA, Jesus-Garcia R, Kumar A, Forges F, Tseng LM, Hou MF, Chie WC, Bottomley A.** Quality of life after palliative radiation therapy for patients with painful bone metastases: results of an international study validating the EORTC QLQ-BM22. *Int J Radiat Oncol Biol Phys* 2012; **84**: e337-e342 [PMID: 22763028 DOI: 10.1016/j.ijrobp.2012.05.028]
- 33 **McDonald R, Ding K, Brundage M, Meyer RM, Nabid A, Chabot P, Coulombe G, Ahmed S, Kuk J, Dar AR, Mahmud A, Fairchild A, Wilson CF, Wu JSY, Dennis K, DeAngelis C, Wong RKS, Zhu L, Chan S, Chow E.** Effect of Radiotherapy on Painful Bone Metastases: A Secondary Analysis of the NCI Clinical Trials Group Symptom Control Trial SC.23. *JAMA Oncol* 2017; **3**: 953-959 [PMID: 28196208 DOI: 10.1001/jamaoncol.2016.6770]
- 34 **Mendez LC, Raman S, Wan BA, da Silva JLP, Moraes FY, Lima KMLB, Silva MF, Diz MDPE, Chow E, Marta GN.** Quality of life in responders after palliative radiation therapy for painful bone metastases using EORTC QLQ-C30 and EORTC QLQ-BM22: results of a Brazilian cohort. *Ann Palliat Med* 2017; **6**: S65-S70 [PMID: 28595442 DOI: 10.21037/apm.2017.04.06]
- 35 **Westhoff PG, Verdam MGE, Oort FJ, Jobsen JJ, van Vulpen M, Leer JWH, Marijnen CAM, de Graeff A, van der Linden YM; Dutch Bone Metastasis Study Group.** Course of Quality of Life After Radiation Therapy for Painful Bone Metastases: A Detailed Analysis From the Dutch Bone Metastasis Study. *Int J Radiat Oncol Biol Phys* 2016; **95**: 1391-1398 [PMID: 27315664 DOI: 10.1016/j.ijrobp.2016.03.032]
- 36 **Weinfurt KP, Li Y, Castel LD, Saad F, Timbie JW, Glendenning GA, Schulman KA.** The significance of skeletal-related events for the health-related quality of life of patients with metastatic prostate cancer. *Ann Oncol* 2005; **16**: 579-584 [PMID: 15734776 DOI: 10.1093/annonc/mdi122]

- 37 **Zeng L**, Chow E, Zhang L, Culleton S, Holden L, Jon F, Khan L, Tsao M, Barnes E, Danjoux C, Sahgal A. Comparison of pain response and functional interference outcomes between spinal and non-spinal bone metastases treated with palliative radiotherapy. *Support Care Cancer* 2012; **20**: 633-639 [PMID: 21476118 DOI: 10.1007/s00520-011-1144-6]
- 38 **Khan L**, Uy C, Nguyen J, Chow E, Zhang L, Zeng L, Salvo N, Culleton S, Jon F, Wong K, Danjoux C, Tsao M, Barnes E, Sahgal A, Holden L. Self-reported rates of sleep disturbance in patients with symptomatic bone metastases attending an outpatient radiotherapy clinic. *J Palliat Med* 2011; **14**: 708-714 [PMID: 21554034 DOI: 10.1089/jpm.2010.0491]
- 39 **Jamora KE**, Castillo MRL, Calaguas MJC. Assessment of the prevalence of pain, adequacy of pain management and influencing factors in patients undergoing radiotherapy. *Ecancermedicalscience* 2022; **16**: 1483 [PMID: 36819795 DOI: 10.3332/ecancer.2022.1483]
- 40 **Arias F**, Arrarás JJ, Asin G, Zarandona U, Mora I, Errasti M, Barrado M, Campo M, Visus I, Dominguez MA. To What Extent Does Radiotherapy Improve the Quality of Life of Patients With Bone Metastasis?: A Prospective, Single-Institutional Study. *Am J Clin Oncol* 2018; **41**: 163-166 [PMID: 26535991 DOI: 10.1097/COC.0000000000000249]
- 41 **Cañón V**, Gómez-Iturriga A, Casquero F, Rades D, Navarro A, Del Hoyo O, Morillo V, Willisch P, López-Guerra JL, Illescas-Vacas A, Ciervide R, Martínez-Indart L, Cacicedo J. Quality of life improvement in patients with bone metastases undergoing palliative radiotherapy. *Rep Pract Oncol Radiother* 2022; **27**: 428-439 [PMID: 36186707 DOI: 10.5603/RPOR.a2022.0048]
- 42 **Wong E**, Chow E, Zhang L, Bedard G, Lam K, Fairchild A, Vassiliou V, Alm El-Din MA, Jesus-Garcia R, Kumar A, Forges F, Tseng LM, Hou MF, Chie WC, Bottomley A. Factors influencing health related quality of life in cancer patients with bone metastases. *J Palliat Med* 2013; **16**: 915-921 [PMID: 23819731 DOI: 10.1089/jpm.2012.0623]
- 43 **Simon JM**. [Gross tumor volume and clinical target volume in radiotherapy: bone metastasis]. *Cancer Radiother* 2001; **5**: 704-710 [PMID: 11715322 DOI: 10.1016/s1278-3218(01)00128-7]
- 44 **Saito AI**, Hirai T, Inoue T, Hojo N, Kawai S, Kato Y, Ito K, Kato M, Ozawa Y, Shinjo H, Toda K, Yoshimura RI. Time to Pain Relapse After Palliative Radiotherapy for Bone Metastasis: A Prospective Multi-institutional Study. *Anticancer Res* 2023; **43**: 865-873 [PMID: 36697080 DOI: 10.21873/anticancerres.16229]
- 45 **Makita K**, Hamamoto Y, Kanzaki H, Nagasaki K, Kozuki T. Local control of bone metastasis treated with palliative radiotherapy in patients with lung cancer: An observational retrospective cohort study. *Oncol Lett* 2023; **26**: 303 [PMID: 37323814 DOI: 10.3892/ol.2023.13889]
- 46 **Jain PN**, Chatterjee A. A Randomized Placebo-Controlled Trial Evaluating the Analgesic Effect of Salmon Calcitonin in Refractory Bone Metastasis Pain. *Indian J Palliat Care* 2020; **26**: 4-8 [PMID: 32132775 DOI: 10.4103/IJPC.IJPC\_167\_19]
- 47 **Azmy AM**, Adel AM, Nagy AA, Ibrahim SA. Comparison between Single Fraction versus Multiple Fraction Radiotherapy in Terms of Pain Control and Prevention of Skeletal Related Events in Patients with Bone Metastasis Candidates for Radiotherapy. *QJM* 2020; **113** [DOI: 10.1093/qjmed/hcaa057]
- 48 **Dong ZF**, Qin YD, Wang XH. [Clinical Observation of Internal Radiotherapy with Strontium-89 and 99Tc-MDP in Treatment for Pain Relief of Lung Cancer Patients with Bone Metastasis]. *Biaoji Mianyi Fenxi Yu Linchuang* 2012; **19**: 197-200
- 49 **Shibata H**. Work-sharing between radiotherapy and chemotherapy for the treatment of bone metastasis. *Ann Oncol* 2019; **30**: vi7 [DOI: 10.1093/annonc/mdz304]
- 50 **Chen L**, Zhu W, Zhu S, Ding Q. Effects of alendronate combined with local radiotherapy on serum Akt/GSK3 $\beta$  and bone metabolism levels in patients with bone metastases from primary liver cancer. *Am J Transl Res* 2022; **14**: 6669-6677 [PMID: 36247307]
- 51 **Scorcelletti M**, Zange J, Böcker J, Sies W, Lau P, Mittag U, Reeves ND, Ireland A, Rittweger J. Associations between long-term exercise participation and lower limb joint and whole-bone geometry in young and older adults. *Front Physiol* 2023; **14**: 1150562 [PMID: 37250122 DOI: 10.3389/fphys.2023.1150562]
- 52 **Liu Y**, Cao X, Zhao X, Shi X, Lei M, Qin H. Quality of Life and Mental Health Status Among Cancer Patients With Metastatic Spinal Disease. *Front Public Health* 2022; **10**: 916004 [PMID: 35865242 DOI: 10.3389/fpubh.2022.916004]
- 53 **Ise M**, Nakata E, Katayama Y, Hamada M, Kunisada T, Fujiwara T, Nakahara R, Takihira S, Sato K, Akezaki Y, Senda M, Ozaki T. Prevalence of Psychological Distress and Its Risk Factors in Patients with Primary Bone and Soft Tissue Tumors. *Healthcare (Basel)* 2021; **9** [PMID: 34065006 DOI: 10.3390/healthcare9050566]
- 54 **Campbell KL**, Cormie P, Weller S, Alibhai SMH, Bolam KA, Campbell A, Cheville AL, Dalzell MA, Hart NH, Higano CS, Lane K, Mansfield S, McNeely ML, Newton RU, Quist M, Rauw J, Rosenberger F, Santa Mina D, Schmitz KH, Winters-Stone KM, Wiskemann J, Goulart J. Exercise Recommendation for People With Bone Metastases: Expert Consensus for Health Care Providers and Exercise Professionals. *JCO Oncol Pract* 2022; **18**: e697-e709 [PMID: 34990293 DOI: 10.1200/OP.21.00454]
- 55 **Weng Hong C**, Ajit Singh V, Amar Singh AK. Psychological disorders in patients with orthopaedic oncological diseases and their coping strategies. *J Orthop Surg (Hong Kong)* 2022; **30**: 10225536221093431 [PMID: 35410527 DOI: 10.1177/10225536221093431]
- 56 **Caissie A**, Zeng L, Nguyen J, Zhang L, Jon F, Dennis K, Holden L, Culleton S, Koo K, Tsao M, Barnes E, Danjoux C, Sahgal A, Simmons C, Chow E. Assessment of health-related quality of life with the European Organization for Research and Treatment of Cancer QLQ-C15-PAL after palliative radiotherapy of bone metastases. *Clin Oncol (R Coll Radiol)* 2012; **24**: 125-133 [PMID: 21917431 DOI: 10.1016/j.clon.2011.08.008]
- 57 **Nipp RD**, Greer JA, El-Jawahri A, Moran SM, Traeger L, Jacobs JM, Jacobsen JC, Gallagher ER, Park ER, Ryan DP, Jackson VA, Pirl WF, Temel JS. Coping and Prognostic Awareness in Patients With Advanced Cancer. *J Clin Oncol* 2017; **35**: 2551-2557 [PMID: 28574777 DOI: 10.1200/JCO.2016.71.3404]
- 58 **Epstein AS**, Prigerson HG, O'Reilly EM, Maciejewski PK. Discussions of Life Expectancy and Changes in Illness Understanding in Patients With Advanced Cancer. *J Clin Oncol* 2016; **34**: 2398-2403 [PMID: 27217454 DOI: 10.1200/JCO.2015.63.6696]
- 59 **Greer JA**, Pirl WF, Jackson VA, Muzikansky A, Lennes IT, Gallagher ER, Prigerson HG, Temel JS. Perceptions of health status and survival in patients with metastatic lung cancer. *J Pain Symptom Manage* 2014; **48**: 548-557 [PMID: 24680623 DOI: 10.1016/j.jpainsymman.2013.10.016]
- 60 **El-Jawahri A**, Traeger L, Park ER, Greer JA, Pirl WF, Lennes IT, Jackson VA, Gallagher ER, Temel JS. Associations among prognostic understanding, quality of life, and mood in patients with advanced cancer. *Cancer* 2014; **120**: 278-285 [PMID: 24122784 DOI: 10.1002/cncr.28369]
- 61 **Temel JS**, Greer JA, Muzikansky A, Gallagher ER, Admane S, Jackson VA, Dahlin CM, Blinderman CD, Jacobsen J, Pirl WF, Billings JA, Lynch TJ. Early palliative care for patients with metastatic non-small-cell lung cancer. *N Engl J Med* 2010; **363**: 733-742 [PMID: 20818875 DOI: 10.1056/NEJMoa1000678]
- 62 **Temel JS**, Greer JA, Admane S, Gallagher ER, Jackson VA, Lynch TJ, Lennes IT, Dahlin CM, Pirl WF. Longitudinal perceptions of prognosis and goals of therapy in patients with metastatic non-small-cell lung cancer: results of a randomized study of early palliative care. *J Clin Oncol*

- 2011; **29**: 2319-2326 [PMID: 21555700 DOI: 10.1200/JCO.2010.32.4459]
- 63 **Hagan TL**, Fishbein JN, Nipp RD, Jacobs JM, Traeger L, Irwin KE, Pirl WF, Greer JA, Park ER, Jackson VA, Temel JS. Coping in Patients With Incurable Lung and Gastrointestinal Cancers: A Validation Study of the Brief COPE. *J Pain Symptom Manage* 2017; **53**: 131-138 [PMID: 27725249 DOI: 10.1016/j.jpainsymman.2016.06.005]
- 64 **Thureau S**, Faivre JC, Assaker R, Biver E, Confavreux CB, Debiais F, Duterque-Coquillaud M, Giammarile F, Heymann D, Lecouvet FE, Morardet L, Paycha F, Body JJ, Vieillard MH. Adapting palliative radiation therapy for bone metastases during the Covid-19 pandemic: GEMO position paper. *J Bone Oncol* 2020; **22**: 100291 [PMID: 32292693 DOI: 10.1016/j.jbo.2020.100291]
- 65 **van de Haar J**, Hoes LR, Coles CE, Seamon K, Fröhling S, Jäger D, Valenza F, de Braud F, De Petris L, Bergh J, Ernberg I, Besse B, Barlesi F, Garralda E, Piris-Giménez A, Baumann M, Apolone G, Soria JC, Tabernero J, Caldas C, Voest EE. Caring for patients with cancer in the COVID-19 era. *Nat Med* 2020; **26**: 665-671 [PMID: 32405058 DOI: 10.1038/s41591-020-0874-8]
- 66 **Yerramilli D**, Xu AJ, Gillespie EF, Shepherd AF, Beal K, Gomez D, Yamada J, Tsai CJ, Yang TJ. Palliative Radiation Therapy for Oncologic Emergencies in the Setting of COVID-19: Approaches to Balancing Risks and Benefits. *Adv Radiat Oncol* 2020; **5**: 589-594 [PMID: 32363243 DOI: 10.1016/j.adro.2020.04.001]
- 67 **Arsenijević T**, Stepanović A, Milošević-Maračić B, Poparić-Bandjur B, Mišković I, Gavrilović D, Nikitović M. What did COVID-19 pandemics teach us about single-fraction radiotherapy for painful bone metastases-State of the art or undertreatment? *Cancer Med* 2023; **12**: 15912-15921 [PMID: 37317639 DOI: 10.1002/cam4.6231]
- 68 **Chow R**, Ding K, Ganesh V, Meyer RM, van der Linden YM, Roos D, Hartsell WF, Hoskin P, Wu JSY, Nabid A, van Acht M, Wanders R, Babington S, Demas WF, Wilson CF, Wong RKS, Brundage M, Zhu L, Chow E. Gender and age make no difference in the re-irradiation of painful bone metastases: A secondary analysis of the NCIC CTG SC.20 randomized trial. *Radiation Oncol* 2018; **126**: 541-546 [PMID: 29102263 DOI: 10.1016/j.radonc.2017.10.006]
- 69 **Koo K**, Zeng L, Chen E, Zhang L, Culleton S, Dennis K, Caissie A, Nguyen J, Holden L, Jon F, Tsao M, Barnes E, Danjoux C, Sahgal A, Chow E. Do elderly patients with metastatic cancer have worse quality of life scores? *Support Care Cancer* 2012; **20**: 2121-2127 [PMID: 22081058 DOI: 10.1007/s00520-011-1322-6]
- 70 **Ariyafar T**, Mahdavi SR, Geraily G, Fadavi P, Farhood B, Najafi M, Ashouri A, Khalafi L, Shirazi A. Evaluating the effectiveness of combined radiotherapy and hyperthermia for the treatment response of patients with painful bony metastases: A phase 2 clinical trial. *J Therm Biol* 2019; **84**: 129-135 [PMID: 31466745 DOI: 10.1016/j.jtherbio.2019.06.003]
- 71 **Geerling JI**, Raijmakers N, Mul VE, de Nijs EJ, Oudhof MA, de Bock GH, De Graeff A, van der Linden YM, Reyners AK. The effect of nurse-led pain education of patients with painful bone metastases on pain and quality of life: A multicenter randomized trial. *J Clin Oncol* 2017; **35**: 203-203 [DOI: 10.1200/jco.2017.35.31\_suppl.203]
- 72 **Lutz S**, Balboni T, Jones J, Lo S, Petit J, Rich SE, Wong R, Hahn C. Palliative radiation therapy for bone metastases: Update of an ASTRO Evidence-Based Guideline. *Pract Radiat Oncol* 2017; **7**: 4-12 [PMID: 27663933 DOI: 10.1016/j.prr.2016.08.001]
- 73 **Feyer PC**, Steingraeber M. Radiotherapy of Bone Metastasis in Breast Cancer Patients - Current Approaches. *Breast Care (Basel)* 2012; **7**: 108-112 [PMID: 22740796 DOI: 10.1159/000338724]
- 74 **Gutt R**, Dawson G, Cheuk AV, Fosmire H, Moghanaki D, Kelly M, Jolly S. Palliative Radiotherapy for the Management of Metastatic Cancer: Bone Metastases, Spinal Cord Compression, and Brain Metastases. *Fed Pract* 2015; **32** Suppl 4: 12S-16S [PMID: 30766118]
- 75 **Tharmalingam S**, Chow E, Harris K, Hird A, Sinclair E. Quality of life measurement in bone metastases: A literature review. *J Pain Res* 2008; **1**: 49-58 [PMID: 21197288 DOI: 10.2147/jpr.s4572]
- 76 **Colosia A**, Njue A, Bajwa Z, Dragon E, Robinson RL, Sheffield KM, Thakkar S, Richiemi SH. The Burden of Metastatic Cancer-Induced Bone Pain: A Narrative Review. *J Pain Res* 2022; **15**: 3399-3412 [PMID: 36317162 DOI: 10.2147/JPR.S371337]
- 77 **Selvaggi G**, Scagliotti GV. Management of bone metastases in cancer: a review. *Crit Rev Oncol Hematol* 2005; **56**: 365-378 [PMID: 15978828 DOI: 10.1016/j.critrevonc.2005.03.011]
- 78 **Vinay R**, KusumDevi V. Potential of targeted drug delivery system for the treatment of bone metastasis. *Drug Deliv* 2016; **23**: 21-29 [PMID: 24839990 DOI: 10.3109/10717544.2014.913325]
- 79 **Chow E**, Hoskin P, Mitera G, Zeng L, Lutz S, Roos D, Hahn C, van der Linden Y, Hartsell W, Kumar E; International Bone Metastases Consensus Working Party. Update of the international consensus on palliative radiotherapy endpoints for future clinical trials in bone metastases. *Int J Radiat Oncol Biol Phys* 2012; **82**: 1730-1737 [PMID: 21489705 DOI: 10.1016/j.ijrobp.2011.02.008]
- 80 **Lin A**, Ray ME. Targeted and systemic radiotherapy in the treatment of bone metastasis. *Cancer Metastasis Rev* 2006; **25**: 669-675 [PMID: 17160556 DOI: 10.1007/s10555-006-9025-z]



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