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ORIGINAL RESEARCH ARTICLE

SPECT/CT for medication-related osteonecrosis of the jaw with bone metastases of cancer: Maximum standardized uptake values comparison between jaw lesions and bone metastases

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ABSTRACT

Introduction: Medication-related osteonecrosis of the jaw (MRONJ) is a complication of medication for bone metastases patients. This study aimed to examine SPECT/CT for MRONJ with bone metastases of cancer, especially maximum standardized uptake values (SUVmax) comparison between the jaw lesions and bone metastases.

Methods: Thirty-one MRONJ patients with bone metastases of cancer underwent bone SPECT/CT, and the SUVmax were obtained with a workstation. The SUVmax of jaw lesions of MRONJ and bone metastases of cancer were compared in staging of MRONJ, location of MRONJ, primary cancer, location of bone metastases and medication for bone metastases.

Results: The SUVmax of bone metastases of cancer (33.3±27.2) were significantly higher than those of jaw lesions of MRONJ (17.6±10.0, p = 0.001). Furthermore, the SUVmax for stage 2, mandible, prostate cancer, vertebra and zoledronate were significantly different between the jaw lesions of MRONJ and bone metastases of cancer.

Conclusion: This study indicated the SUVmax with SPECT/CT was different between the jaw lesions and bone metastases, and the data could be effective for the management in MRONJ patients with bone metastases.

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INTRODUCTION

Medication-related osteonecrosis of the jaw (MRONJ) is a complication of medication for bone metastases patients [1, 2]. Bone scintigraphy can demonstrate physiologic changes in bone, and is useful for detecting MRONJ [3]. Recently, bone SPECT/CT plays an important role in assessing MRONJ [4, 5]. Furthermore, the SPECT/CT provide maximum standardized uptake value (SUVmax) for the quantitative diagnosis of MRONJ [6-12].

Prostate cancer is a common malignancy, and bone is the main location of distant metastases [13]. Bone scintigraphy is the most widely available imaging modality worldwide to detect bone metastases in patients with prostate cancer [14]. To date, there are little data available on the usage of quantitative measurement with SPECT/CT SUVmax in differential diagnosis of bone metastases [15, 16]. Furthermore, no reports for MRONJ with bone metastases of cancer have been published on SUVmax using SPECT/CT. This study aimed to examine SPECT/CT for MRONJ with bone metastases of cancer, especially SUVmax comparison between the jaw lesions and bone metastases.

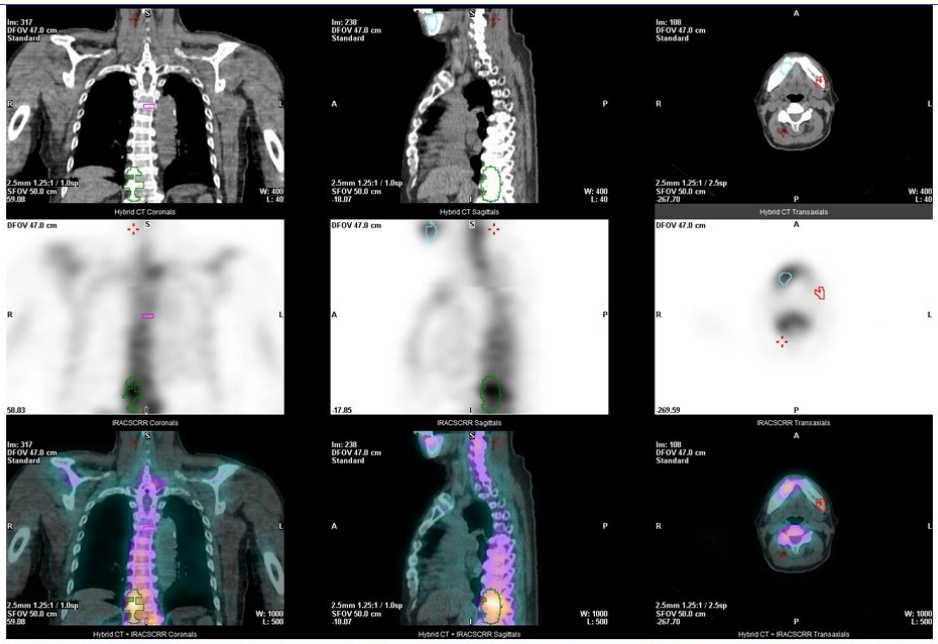
METHODS

Patients

The study was approved by the institutional review board of our university (approved no. ECNG-R-400), and informed consent was obtained from all individual participants included in the study. Thirty-one MRONJ patients with bone metastases of cancer (20 males and 11 females; mean age, 71.6 years (range, 48-85 years)) underwent bone SPECT/CT for the initial treatment at our institute from January 2020 to March 2025. This study excluded the patients for the follow-up and secondary treatment. Patients were diagnosed clinically as MRONJ by American Association of Oral and Maxillofacial Surgeons' position paper [2]. The patients with bone metastases were diagnosed and treated at other hospital.

Bone SPECT/CT

Bone SPECT/CT was underwent using a SPECT/CT unit (Optima NM/CT 640; GE Healthcare, Tokyo, Japan) acquisition at 4 h after intravenous injection of 740 MBq of Tc-99m hydroxymethylene diphosphonate (CLEARBONE Injection; Nihon Medi-Physics, Tokyo, Japan) [4], and the SUVmax of jaw lesions of MRONJ and bone metastases of cancer were obtained by a workstation (Xeleris 4DR and Q. Volumetrix MI; GE Healthcare, Tokyo, Japan) [10]. Volume of interest (VOI) on SPECT/CT was drawn over the lesions, and the SUVmax in a given VOI was evaluated (Figure 1). This study evaluated the maximum value of SUVmax of the jaw lesions and bone metastases as the SUVmax for each patient.



SPECT SUVbw [Quantification data]	Volume	Max	Mean	Total	% Injection dose	Min	Std.Dev.
r mromj	7.51	39.5	14.2	106.9	0.0668	1.03	8.61
l mandible	4.16	5.83	2.45	10.2	0.00637	0.892	1.37
vertebra meta	22.1	28.2	12.9	285.5	0.178	4.19	4.46
vertebra	3.36	9.13	6.15	20.6	0.0129	3.64	1.20

Figure 1. Medication-related osteonecrosis of the jaw of the right side of the mandible with bone metastases in vertebra from lung cancer in an 82-year-old male using a workstation. CT, SPECT and SPECT/CT were displayed on the workstation. Maximum SUV of jaw lesion (sky blue) and bone metastases in vertebra (green) using the workstation was 39.5 and 28.2, respectively

Statistical analysis

Statistical analyses for SUVmax between the jaw lesions and bone metastases were performed with Mann-Whitney U-test. Furthermore, box plot for SUVmax between the jaw lesions and bone metastases were also performed. The data were evaluated with a statistical package (IBM SPSS Statistics, Ver. 26; IBM Japan, Tokyo, Japan). A p-value less than 0.05 was considered to indicate statistical significance.

RESULTS

SPECT/CT data for MRONJ with bone metastases of cancer summarized in Table 1. The SUVmax for bone metastases of cancer (33.3 ± 27.2) were significantly higher than those for jaw lesions of MRONJ (17.6 ± 10.0, p = 0.001). Figure 2 showed the box plot for SUVmax between the jaw lesions and bone metastases. Furthermore, the SUVmax for stage 2 (p = 0.003), mandible (p = 0.002), prostate cancer (p = 0.003), vertebra (p = 0.016) and zoledronate (p = 0.009) were significantly different between the jaw lesions of MRONJ and bone metastases of cancer.

Figure 1 showed MRONJ of the right side of the mandible with bone metastases in vertebra from lung cancer in an 82-year-old male using a workstation. CT, SPECT and SPECT/CT were displayed on the workstation, and indicated maximum SUV of the jaw lesion (sky blue, 39.5) and bone metastases in vertebra (green, 28.2).

Table 1. SPECT/CT for medication-related osteonecrosis of the jaw with bone metastases of cancer

Parameters		Maximum SUV: Mean ± standard deviation (Range)		
		Jaw lesions of MRONJ	Bone metastases of cancer	P-value
Total patients (n = 31)		17.6 ± 10.0 (7.5-45.4)	33.3 ± 27.2 (8.7-134.3)	0.001
Staging of MRONJ	Stage 2 (n = 22)	17.6 ± 9.6 (7.5-45.4)	37.2 ± 30.6 (8.7-134.3)	0.003
	Stage 3 (n = 9)	17.7 ± 11.6 (9.3-42.8)	23.7 ± 13.0 (10.6-48.7)	0.136
Location of MRONJ	Maxillsa (n =10)	18.2 ± 11.0 (7.8-45.4)	25.1 ± 14.5 (8.7-48.7)	0.353
	Mandible (n = 21)	17.3 ± 9.8 (7.5-42.8)	37.2 ± 31.1 (10.6-134.3)	0.002
Primary cancer	Prostate cancer (n = 13)	17.3 ± 10.0 (7.5-42.8)	41.7 ± 35.5 (12.3-134.3)	0.003
	Breast cancer (n = 9)	19.4 ± 11.2 (9.4-45.4)	25.5 ± 13.5 (10.6-45.2)	0.436
	Lung cancer (n = 4)	19.1 ± 14.5 (7.8-39.5)	35.2 ± 30.6 (8.7-79.3)	0.486
	Colorectal cancer (n = 2)	10.5 ± 1.7 (9.3-11.7)	37.9 ± 15.3 (27.0-48.7)	0.333
	Kidney cancer (n = 2)	18.8 ± 4.7 (15.5-22.1)	14.5 ± 3.8 (11.8-17.2)	0.667
	Thyroid cancer (n = 1)	12.5	14.2	1.000
Location of bone metastases	Vertebra (n = 17)	18.4 ± 9.9 (7.9-42.8)	35.7 ± 31.3 (11.5-134.3)	0.016
	Rib (n = 8)	15.1 ± 8.3 (7.5-27.4)	23.2 ± 12.7 (8.7-48.7)	0.161
	Pelvis (n = 6)	18.8 ± 13.3 (10.3-45.4)	39.9 ± 29.2 (10.6-90.6)	0.240
Medications	Denosumab (n = 20)	16.1 ± 8.1 (7.8-39.5)	24.8 ± 18.5 (8.7-79.3)	0.060
	Zoledronate (n = 10)	21.2 ± 13.2 (7.5-45.4)	50.9 ± 35.2 (14.9-134.3)	0.009
	Bevacizumab (n = 1)	11.7	27.0	1.000

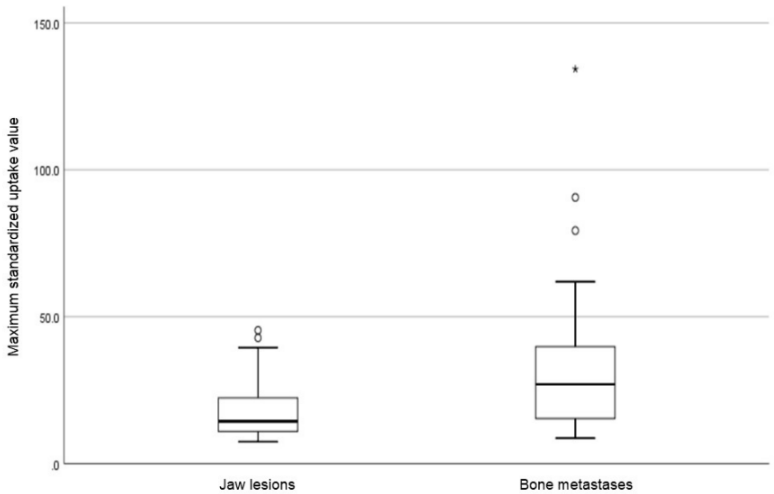


Figure 2. Box plots of maximum standardized uptake value between the jaw lesions and bone metastases

DISCUSSION

This study examined SPECT/CT for MRONJ with bone metastases of cancer, especially SUVmax comparison between the jaw lesions and bone metastases, and indicated the SUVmax with SPECT/CT was different between the jaw lesions and bone metastases.

Regarding prostate cancer, bone is the main location of distant metastases [13-15]. Kuji et al [13] indicated SUVmax was 7.6 ± 2.4 for normal thoracic, 8.1 ± 12.2 for lumbar and 40.9 ± 33.5 for bone metastases in prostate cancer. Tabotta et al [14] indicated that SUVmax of prostate cancer bone metastases were 34.6 ± 24.6. Furthermore, SUVmax of spinal and pelvic osteoarthritic lesions were 14.2 ± 3.8 and 8.9 ± 2.2, respectively. Mohd Rohani et al [15] indicated that SUVmax for normal vertebra was 7.1 ± 2.0, 12.6 ± 9.0 for degenerative joint disease and 36.6 ± 24.8 for bone metastases in prostate cancer patients. Tezuka et al [17] indicated that SUVmax of vertebra, sternal body and parietal bone as normal structures in the head and neck were 8.1 ± 3.7, 5.2 ± 2.1 and 3.7 ± 1.6, respectively. In this study, SUVmax of prostate cancer bone metastases were 41.7 ± 35.5. Our observations are in agreement with previous publications reporting the SUVmax.

Kuji et al [13] concluded that SUV in quantitative SPECT/CT can be effective for the prognostication of bone osteoblastic metastatic burden in patients with prostate cancer. Tabotta et al [14] showed significantly different in uptake on bone scan between prostate cancer bone metastases and spinal and pelvic osteoarthritic changes based on quantitative data analysis, with significantly higher SUVmax in metastases. Mohd Rohani et al [15] concluded that SPECT SUVmax was significantly higher in bone metastases than degenerative joint disease. We also consider that SUVmax with bone SPECT/CT can be useful for the evaluation of prostate cancer bone metastases.

Zhang et al [16] showed that SUVmax of bone metastases of cancer was 20.7 ± 14.0. In this study, SUVmax of bone metastases of cancer was 33.3 ± 27.2. Furthermore, the SUVmax of vertebra, rib and pelvis in location of bone metastases were 35.7 ± 31.3, 23.2 ± 12.7 and 39.9 ± 29.2, respectively. We consider that quantitative measurement with bone SPECT/CT SUV may be useful for differential diagnosis of bone metastases.

In this study, the results showed that the SUVmax for bone metastases of cancer were significantly higher than those for jaw lesions of MRONJ, and the SUVmax for prostate cancer, vertebra, and zoledronate were significantly different for jaw lesions of MRONJ and bone metastases of cancer. We consider that characteristic of bone reaction may be different between jaw lesions of MRONJ and bone metastases of cancer, such as prostate cancer, vertebra and zoledronate. However, we evaluated the patients for the initial treatment, not the follow-up and secondary treatment. The time interval should be considered as a major confounding factor. As it is well known the intensity of radiotracer uptake in bone scan does necessarily not correlate with the disease severity. For example, many rapid growing bone metastases are dominantly lytic and less active on bone scan and also slow growing metastasis are sclerotic and intense on bone scan. Besides even the intensity is increased after effective therapy as we call it "flair phenomenon". The same findings are also noted in the course of benign lesions, and the intensity of radiotracer uptake is more depends on the disease course and healing process rather than the nature of the bone lesion. This is also applicable in the osteonecrosis of the jaw and other bones. The degree of uptake depends on the time interwall between necrosis development and imaging time. We consider that further research for the time interwall is essential.

There were several limitations of this study. The sample size was relatively small. Furthermore, this study evaluated the maximum value of SUVmax of the jaw lesions and bone metastases as the SUVmax for each patient. Therefore, further research is necessary to validate these results.

CONCLUSION

We assessed the SPECT/CT for MRONJ with bone metastases of cancer, especially SUVmax comparison between jaw lesions and bone metastases, and indicated the SUVmax with SPECT/CT was different between jaw lesions and bone metastases. The data could be effective for the management in MRONJ patients with bone metastases.

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