

## Variability in the point to which single direct field irradiation is prescribed for spinal bone metastases: a survey of practice patterns in Japan

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Direct single fields are commonly used in radiotherapy for spinal bone metastases, and it is crucial to define the point for which the dose is prescribed. According to the guidelines from the International Bone Metastases Consensus Working Party (IBMCWP) updated in 2010, different opinions exist on whether this therapy should be prescribed to the mid-vertebral or anterior vertebral body. To our knowledge, no previous studies have surveyed practice patterns regarding this discrepancy. Therefore, we performed an Internet-based survey of members of the Japanese Radiation Oncology Study Group (JROSG) to investigate the current practice patterns in Japan. The respondents mentioned the point to which they prescribed radiotherapy for a single direct field. A total of 52 radiation oncologists from 50 institutions (36% of JROSG institutions) responded. Respondent prescription for radiotherapy varied widely. Only 21% and 6% of respondents prescribed irradiation to the mid-vertebral body and anterior vertebral body, respectively. A larger proportion of respondents (27%) prescribed irradiation to the spinal cord (center of the spinal canal). Still another group of respondents (27%) stated that they never use a single direct field. In conclusion, the point to which irradiation dosages are prescribed varies widely for a single direct field in cases of spinal bone metastases. This variation may lead some radiation oncologists to misunderstand the tolerance dosage of the spinal cord, especially in cases of re-irradiation. Thus, careful consideration is required before any prescriptions are made.

**Keywords:** radiotherapy; bone metastases; spine; patterns of care study; prescription point

## INTRODUCTION

Direct single fields are commonly used in radiotherapy for thoracic and lumbar spinal bone metastases [1]. It is crucial to define the point to which the dose is prescribed. Variations of the point cause changes in doses for the tumor and organs at risk, particularly for the spinal cord, which may lead to variations in the efficacy and safety of radiotherapy for spinal bone metastases [2]. According to the guidelines from the International Bone Metastases Consensus Working Party (IBMCWP) updated in 2010, different opinions exist on whether this therapy should be prescribed to the mid-vertebral or anterior vertebral body [3]. However, to our knowledge, no previous studies have surveyed practice patterns regarding this discrepancy. Therefore, we investigated the current practice patterns in Japan.

## MATERIALS AND METHODS

Members of the Japanese Radiation Oncology Study Group (JROSG), all of whom were radiation oncologists, completed an Internet-based survey from December 2010 to January 2011. Respondents were asked to define the point to which the dose is prescribed for a single direct field in a case of spinal bone metastases, in addition to the radiotherapy dose fractionation they would recommend for hypothetical cases describing patients with painful bone metastases [4]. As a reference for the variability of irradiated dose, we calculated monitor unit ratios for each point at which respondents prescribed radiotherapy compared to cases prescribed for the

mid-vertebral body, using 40 simulation CT scans involving patients previously treated for thoraco-lumbar spinal bone metastases.

## RESULTS

A total of 52 radiation oncologists from 50 institutions (36% of JROSG institutions) responded. Of those, 32 respondents (62%) work at university hospitals or cancer centers, 15 (29%) at public hospitals, and 5 (10%) at private hospitals.

Respondent prescription for radiotherapy for a single direct field for spinal bone metastases varied widely (Table 1). Monitor unit ratios ranged from 0.76–1.10 relative to that prescribed for the mid-vertebral body. Only 21% and 6% of respondents prescribed irradiation to the mid-vertebral body and anterior vertebral body, respectively. A larger proportion of respondents (27%) prescribed irradiation to the spinal cord (center of the spinal canal). Still another group of respondents (27%) stated that they never use a single direct field.

## DISCUSSION

Large variations were found amongst respondents prescribing radiotherapy for a single direct field. These variations cause changes in doses for the tumor and organs at risk, which may lead to variations in the efficacy and safety [2]. Furthermore, the variations may make it difficult to clarify the tolerance dose of the spinal cord in cases of re-irradiation. While recurrent pain in spinal bones can be successfully alleviated with external beam radiotherapy re-treatment, optimal dosage and fractionation are still under investigation [5]. Nieder *et al.* collected data from 40 individual patients who received re-irradiation of the spinal cord, published in eight different reports, and mentioned that the risk of radiation-induced myelopathy appears to be small after cumulative doses of  $\leq 135.5 \text{ Gy}_2$  when the interval is not less than 6 months and the dose of each course is  $\leq 98 \text{ Gy}_2$  [6]. However, the cumulative dose was calculated from prescribed doses without the absolute correctness of the doses to the spinal cord.

According to the guideline from the IBMCWP, updated in 2010, opinion was split between prescribing to the mid-vertebral body or anterior vertebral body [3]. However, only 21 and 6% of respondents prescribed irradiation to the mid-vertebral body and anterior vertebral body, respectively. Japanese radiation oncologists may be concerned that prescribing irradiation to the mid-vertebral body or anterior vertebral body may cause too high a dose to the spinal cord.

A larger proportion of respondents prescribed irradiation to the spinal canal (center of the spinal canal). A recent large multi-institutional randomized controlled trial (RCT) prescribed irradiation to the posterior edge of the vertebral body [7] (Table 2). The monitor units we calculated were similar

**Table 1.** Points where respondents prescribed radiotherapy for a single direct field for spinal bone metastases ( $n = 52$ )

Points	Monitor Unit ratio <sup>a</sup>	Number (%)
Anterior vertebral body	1.10	3 (6%)
Mid-vertebral body	1 (referent)	11 (21%)
Posterior vertebral body	0.92	2 (4%)
Spinal cord (center of the spinal canal)	0.89	14 (27%)
3-cm depth	0.81	1 (2%)
6-cm depth	0.94	4 (8%)
Maximum dose point	0.76	1 (2%)
Center of the gross tumor volume	0.94	1 (2%)
Adjust the point, considering dose distribution		1 (2%)
Never use a single direct field		14 (27%)

<sup>a</sup>Forty simulation CT scans previously treated for thoraco-lumbar spinal bone metastases were used for the calculation.

**Table 2.** The point to which single direct irradiation was prescribed for spinal bone metastases in large multi-institutional randomized controlled trials

Author	Country	Year published	Treatment arms	Point
Price, <i>et al.</i> [8]	UK	1986	8 Gy single vs 30 Gy/10 fractions	5-cm depth
Gaze, <i>et al.</i> [9]	UK	1997	10 Gy single vs 22.5 Gy/5 fractions	appropriate depth
Nielsen, <i>et al.</i> [10]	Denmark and UK	1998	8 Gy single vs 20 Gy/5 fractions	maximum absorbed dose
Bone Pain Trial Working Party [11]	UK and New Zealand	1999	8 Gy single vs 20 Gy/5 fractions or 30 Gy/10 fractions	5-cm depth
Steenland, <i>et al.</i> [12]	The Netherlands	1999	8 Gy single vs 24 Gy/6 fractions	no guidelines
Hartsell, <i>et al.</i> [13]	US	2005	8 Gy single vs 30 Gy/10 fractions	middle of the vertebral body
Roos, <i>et al.</i> [14]	Australia, New Zealand, and UK	2005	8 Gy single vs 20 Gy/5 fractions	5-cm depth
Kaasa, <i>et al.</i> [7]	Norway and Sweden	2006	8 Gy single vs 30 Gy/10 fractions	posterior edge of the vertebral corpora

between the prescription to the posterior vertebral body and to the spinal cord. Furthermore, some RCTs prescribed to a 5-cm depth, which was probably close to the spinal canal. Therefore, it seems to be reasonable to prescribe irradiation to the spinal canal if we do not consider the guideline of the IBMCWP [1].

Although the efficacy and safety of radiotherapy using a single direct field for spinal bone metastases have been proven through numerous clinical trials for both single- and multi-fraction radiotherapy [7–15], a large number of respondents stated that they never use a single direct field for spinal bone metastases. Those who never use a single direct field may prefer to use parallel opposing fields or highly conformal radiotherapy. Parallel opposed fields give a more homogenous dose distribution, which can avoid overdosing the spinal cord or underdosing the tumor. Stereotactic body radiotherapy (SBRT) is a technology that delivers high doses to spinal metastases with a steep dose gradient, which might allow superior sparing of the adjacent organs at risk, including the spinal cord. However, the efficacy and safety of SBRT have not been fully evaluated yet, and the ASTRO evidence-based guideline published in 2011 strongly suggests that SBRT should only be used within clinical trials [16].

Our study has certain limitations. Due to the relatively low response rate (36%) and small absolute sample size ( $n = 52$ ), our results might not accurately represent the practice of radiation oncologists in Japan. Furthermore, those willing to participate might have been more knowledgeable than those unwilling to participate.

In conclusion, the point to which irradiation dosages are prescribed varies widely for a single direct field in cases of spinal bone metastases. This variation may lead some radiation oncologists to misunderstand the tolerance dosage of the spinal cord, especially in cases of re-irradiation. Thus, careful consideration is required before any prescriptions are made.

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