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Cleveland Clinic

Bone Marrow and Kidney Doses from Lu-177 Radiopharmaceutical Therapy

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PURPOSE

Purpose: To evaluate the doses to the bone marrow and kidneys from Lu-177 radiopharmaceutical therapy (RPT), as affected by radiopharmaceutical type, cycle of administration, and tumor volume.

Innovation/Impact: Radiopharmaceutical therapy (RPT) is a rapidly growing method of treating metastatic cancer with targeted radiation. Pluvicto and Lutathera are FDA-approved treatments for prostate and neuroendocrine cancer, respectively. Two main organs at risk for RPT are bone marrow and the kidneys. This study demonstrates a method of RPT dosimetry for kidneys and bone marrow based on post-injection quantitative SPECT, and evaluates how the dose changes with cycle number, radiopharmaceutical type, and tumor burden.

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INTRODUCTION

Radiopharmaceutical therapy (RPT) targets cancer cells while minimizing dose to healthy tissue. However, nearby organs at risk will still receive some dose from RTP, which might depend on the organ and the RTP administered. We evaluated doses to kidney and bone marrow for a simplified clinical protocol.

METHODS AND MATERIALS

32 patients treated with RPT (22 with Pluvicto, 10 with Lutathera) were chosen for this retrospective study. Following the institutional imaging protocol (Pluvicto: cycles 1, 2, and 4 of 6, Lutathera: cycles 1 and 3 of 4), 12 of 22 Pluvicto patients had cycle 1 and 2 imaging, and 4 had cycles 1, 2 and 4. 4 of the 10 Lutathera patients had cycle 3 imaging. A quantitative SPECT/CT was acquired approxi mately 24 hours post injection. 3D dosimetry was performed bas ed on the quantitative SPECT using commercialsoftware (MIM SurePlanMRT v7.4.4) and the Hänscheid Single-Time-Point formulism. Mean doses to kidneys and bone marrow were calculated from AI-derived contours (MIM Protégé). For marrow dosimetry, the whole skeleton was separated into 9 skeletal components, excluding tumor activities by thresholding and then expanding the regions by 1 cm. Marrow mean dose was a weighted average of the mean doses to skeletal components, with weightings defined by published active bone marrow concentration in adult skeletons.

RESULTS

Across all patients, average dose to bone marrow from the first cycle of Pluvicto (0.238 ± 0.217 Gy) was comparable with Lutathera (0.187 ± 0.065 Gy), with p = 0.316, and the average dose to the kidneys from Pluvicto (2.167 ± 0.701 Gy) was comparable with Lutathera (2.375 ± 0.463 Gy), with p = 0.329. Comparing cycle 2 with cycle 1 for Pluvicto patients, marrow mean dose decreased by 11.0% and kidneys mean dose decreased by 11.3%. From cycle 2 to cycle 4, marrow mean dose increased by 6.2% and kidneys mean dose increased by 18.8%. Marrow dose from Pluvicto increases with increasing total tumor volume (p = 0.02). Dose to kidneys from Lutathera decreased with increasing tumor volume (p = 0.0001).

Table 1. *Published data from Ellis [2] on the distribution of active bone marrow in the adult skeleton used for calculating bone marrow dose. Upper Limb Girdle includes humeral heads, scapulae, and clavicles, and Lower Limb Girdle includes femoral heads and the pelvic bone.*

Skeletal Structure	Skull	Cervical Spine	Thoracic Spine	Lumbar Spine	Sacrum	Upper Limb Girdle	Lower Limb Girdle	Sternum	Ribs
Marrow Distribution (%)	13.1	3.4	14.1	10.9	13.9	8.3	26.1	2.3	7.9

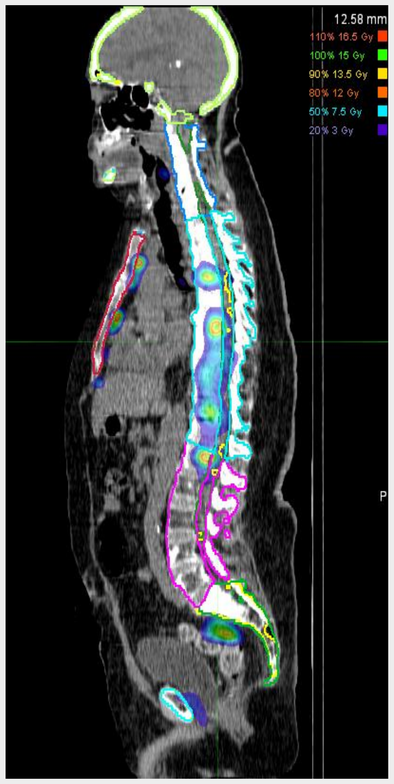
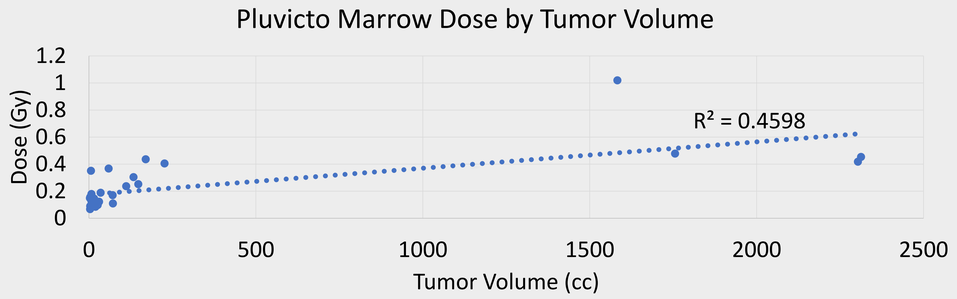


Figure 1. Sagittal image showing a sample patient with the calculated dose distribution overlaid on the skeletal structure contours.



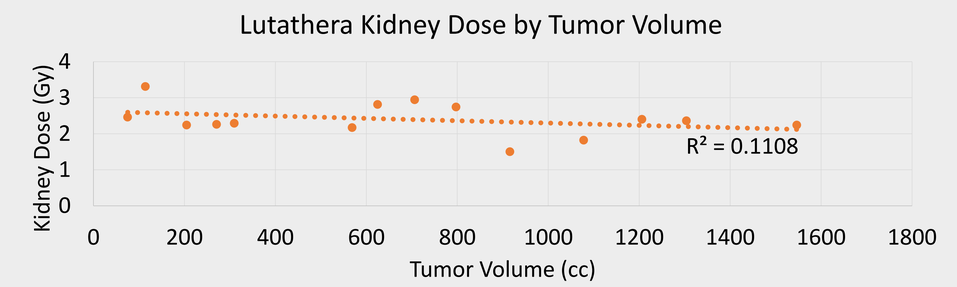


Table 1. *Table showing the differences in average bone marrow dose and kidney dose across the first cycle of all patients for Pluvicto and Lutathera.*

	Patients	Mean Total Tumor Volume (cc)	Mean Bone Marrow Dose (Gy)	Mean Kidney Dose (Gy)
Pluvicto	22	306.3 ± 684.4	0.235 ± 0.197	2.091 ± 0.646
Lutathera	10	694.5 ± 470.2	0.184 ± 0.059	2.396 ± 0.455

CONCLUSIONS

Pluvicto shows decreasing bone marrow and kidney dose in later cycles, as well as higher marrow dose but comparable kidney dose compared with Lutathera. The strongest correlation with marrow and kidney dose was with tumor volume.

REFERENCES

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