JULY 12–16
2020 VIRTUAL
JOINT AAPM | COMP MEETING
EASTERN TIME [GMT-4]

Monte Carlo-Based Organ Dose Reconstruction for Wilms Tumor Patients During Cobalt-60 External Beam Therapy

J. DEMPSEY[1], M. PAULIAH[2], M. MILLE[3], M. GOPALAKRISHAN[2], J. JUNG[1], J. KALAPURAKAL[2], C. LEE[3]
[1]East Carolina University, Greenville, NC
[2]Northwestern University, Chicago, IL
[3]National Cancer Institute, Rockville, MD

ADD YOUR LOGOS HERE

INTRODUCTION

To estimate the secondary cancer risk accurately, the organ dose information is indispensable. The organ dose information for Wilms tumor patients treated with Co-60 machine is rarely reported for retrospective epidemiologic studies. We recently developed a new dose calculation method using Monte Carlo codes and realistic human model with organ contours, allowing us to use a more realistic anatomy to account for internal tissue heterogeneities and external body contour. We demonstrated the applicability of our new method to the systematic dose reconstruction.

AIM

To develop Monte Carlo based dosimetry methods to reconstruct organ doses of Wilms tumor patients receiving Co-60 external beam radiation therapy (EBRT) in the context of epidemiologic study of secondary cancer risk.

METHOD

- A Co-60 machine (Theratron, Nordion) consisting of a Co-60 source and collimation system was modeled using XVMC (X-Ray Voxel Monte Carlo) code by employing and adjusting a virtual source modelling[1].
- Percent depth dose (PDD) and off-axis profiles were calculated for in-field and out-of-field regions in a water tank. These profile calculations were compared to measured values from publication.
- Pediatric hybrid computational phantoms were employed to simulate 4 patients (3 males and 1 female). Beam plans were created in the Pinnacle Treatment Planning System (TPS), and the XVMC simulations were setup using data extracted from the DICOM-RT Plan files exported from the TPS.
- The organ doses from TPS calculation were compared with those from MC calculation.

RESULTS

A Co-60 machine was successfully simulated using water phantom with different beam field sizes and compared with measurement published (Figure 1). The PDD and off-axis profiles showed good agreement with measurement in all cases (differences <3%).

For the simulated patients, Table 1 shows comparison of TPS and MC organ doses. A right kidney within the treatment field was within 1% agreement between TPS and MC. Other right kidneys, hearts, and testes in out-of-field were within 0.4 Gy dose difference.

Table 1. Comparison of TPS and MC organ doses (Gy)

Patient#	Sex	NWTS RT prescription	Right Kidney		Heart		Ovary/Testes	
			TPS	MC	TPS	MC	TPS	MC
1	Female	LeftFlank 11Gy	0.91	1.03	0.32	0.29	<0.1	0.17
2	Male	RightFlank 20Gy	20.08	19.91	0.48	0.39	<0.1	0.11
3	Male	LeftFlank 10Gy	1.50	1.50	2.22	2.52	<0.1	0.12
4	Male	LeftFlank 10Gy	1.68	2.03	3.62	4.02	<0.1	0.11

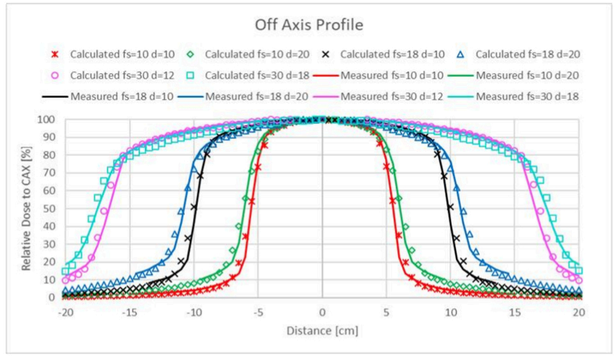
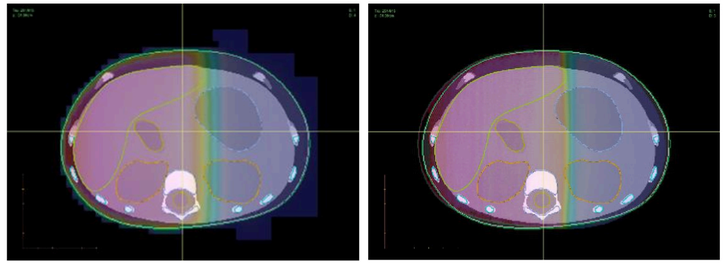


Figure 1. XVMC Profile Calculations vs Published Measurement Data[2].



(a) *(b)*

Figure 2. Comparison of dose profiles in an axial plane (a)TPS, (b) MC.

CONCLUSIONS

This study shows XVMC to be a viable method of dose reconstruction for patients receiving Cobalt-60 external beam radiation therapy.

REFERENCES

1 **Mille M et al**. Comparison of normal tissue dose calculation methods for epidemiological studies of radiotherapy patients. *J. Radiol. Prot. 2018; 38;: 775-792*
2 **Petroccia H et al**. A hybrid phantom Monte Carlo-based method for historical reconstruction of organ doses in patients treated with cobalt-60 for Hodgkin's lymphoma. *Phys. Med. Biol. 2017; 62;: 6261-6289*

ACKNOWLEDGEMENTS

This research was supported by the intramural research program of the NIH/NCI, Division of Cancer Epidemiology and Genetics and RO1CA219013.

CONTACT INFORMATION

Email: dempseyj18@students.ecu.edu