Mariel Lewis B.S.RT(T)
Grand Valley State University
lewism8@mail.gvsu.edu

A Dosimetric Comparison of 6MV and 10MV Beam Energies for Adrenal SBRT

Introduction

Adrenal metastases are common with advanced cancers. Due to their anatomical location, they can be challenging to treat. With stereotactic body radiation therapy (SBRT) there is now an effective non-invasive treatment option for these lesions that minimizes dose to the surrounding normal healthy tissue.

Optimizing the choice of beam energy can be critical for maximizing tumor control while minimizing dose to surrounding organs at risk (OARs). Flattening filter free energies are usually preferred but not all radiation treatment centers have access to them. There is limited research comparing the dosimetric impact of different filtered photon beam energies, particularly 6MV and 10MV, in adrenal SBRT. 10MV is a newer beam energy which also limits the research on the subject.

This dosimetric comparison study provides valuable insight into the best choice for treating adrenal SBRT cases with a beam selection of 6MV and 10MV energies. The selection of beam energies is a vital component for finding the most effective therapeutic ratio.

Methods

This retrospective study compared 10 previously treated adrenal SBRT cases using both 6MV and 10MV energies.

All 10 subjects had metastatic adrenal cancer resulting from primary cancers of the lung, breast, prostate or kidney. The subjects included both smokers and non-smokers. The median age was 74. Inclusion criteria included tumors smaller than 5cm in size and no prior radiation exposure to the adrenal region.

Patients underwent four-dimensional computed tomography imaging to account for respiratory motion. Those scans were imported to the Treatment Planning System in Eclipse Version 16. The anatomy was contoured using RTOG atlas guidelines and tumor volumes were defined by the radiation oncologist.

SBRT plans were generated with a prescription dose of 50Gy delivered in 5 fractions. Using volumetric modulated arc therapy, 6MV and 10MV plans were generated. Plans were optimized to ensure 95% of the PTV received 95% of prescription dose and to minimize dose exposure to OARs. Efficiency, target coverage and OAR sparing were evaluated as parameters.

Normality could not be assumed so sign tests were conducted to compare the dosimetric parameters between the two energies with a significance threshold of $p < 0.05$. Although, the data was paired, the sign test was a more conservative choice since normality could not be verified, or the population size was too small to assume normality.

Results

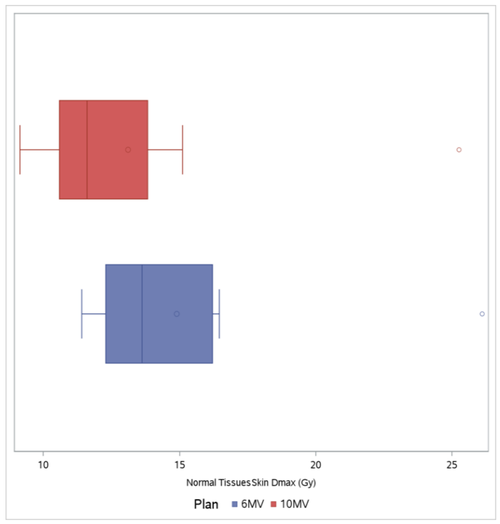

Fig. 1. A boxplot representing the difference in maximum dose to the skin for both 6MV and 10MV beam energies. The dose to skin ranged from 9.14 to 26.11 Gy.

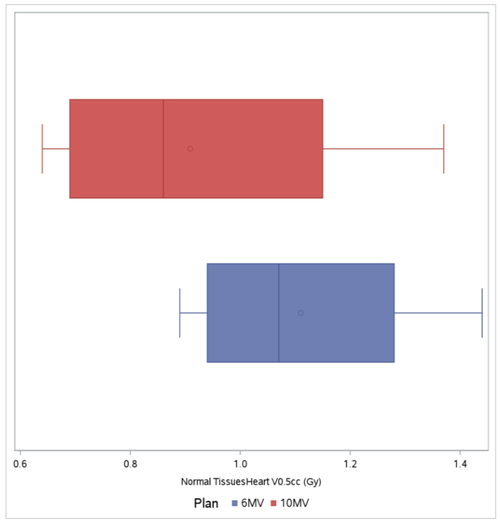

Fig 2. A boxplot representing the difference in the dose to 0.5cc of the heart for both 6MV and 10MV beam energies. The dose to the heart volume ranged from 0.64 to 1.44Gy.

Structure	Energy (MV)	Metric	Mean (Gy)	Standard Deviation (Gy)	Min (Gy)	Max (Gy)
Skin	6	Dmax	14.90	4.28	11.41	26.11
Skin	10	Dmax	13.11	4.63	9.14	25.26
Heart	6	V0.5cc	1.11	0.19	0.89	1.44
Heart	10	V0.5cc	0.91	0.26	0.64	1.37

Table 1. A dose statistics table representing the mean, minimum, maximum and standard deviation for both the Dmax of the skin and the dose received by 0.5cc of heart tissue with 6MV and 10MV energies.

Conclusion

The results of this study show that both 6MV and 10MV are both very effective energies to treat adrenal SBRT. Most of the data was found to have no significance. The sections that had a statistically significant difference were the Gradient Index, the maximum dose to skin and the dose delivered to a .5cc volume of the heart.

The 10MV energy beam had lower maximum dose to the skin which can be beneficial to the patient. It also showed a lower heart dose to a 0.5cc volume which is important in sparing the heart from pericarditis. Although all the doses received to both skin and heart were well within tolerance for both energies, the best practice is to always keep dose to the healthy normal tissue as low as reasonably achievable when treating with radiation.

The data collected on the gradient index can indicate which energy has better protection of surrounding healthy normal tissue by measuring dose fall-off. This study showed that 6MV had a slightly lower gradient index which is often preferable for a radiation treatment plan.

This study shows that while both 6MV and 10MV beam energies are both appropriate options for treating adrenal SBRTs, there are some benefits to using 10MV beams regarding skin and heart sparing, while 6MV beams provide better conformality. This study highlights the importance of energy selection to balance normal tissue sparing and target coverage.

Limitations

The most challenging aspect of this research study was the limited subject size. In the future, studies with larger subject size should be used to further investigate the most appropriate beam energy.

References

Haisraely O, Weiss I, Jaffe M, et al. Total dose, fraction dose and respiratory motion management impact adrenal SBRT outcome. *CLINICAL AND TRANSLATIONAL RADIATION ONCOLOGY*. 2024;47:100788. doi:10.1016/j.ctro.2024.100788

Mazonakis M, Kachris S, Damilakis J. VMAT for prostate cancer with 6-MV and 10-MV photons: Impact of beam energy on treatment plan quality and model-based secondary cancer risk estimates. *Molecular & Clinical Oncology*. 2021;14(5):N.PAG. Accessed January 13, 2025. https://research.ebsco.com/linkprocessor/plink?id=8e0d92e6-1505-309b-999c-4f659491aa46

Acknowledgements

Sarah Johnson, Research Project Advisor
GVSU Statistical Consulting Center
Dr. B. Sango Otieno, Associate Professor
Ben Miller, Graduate Student