Madisin DePas, BSRS, RT(R)(T)
Grand Valley State University
depasm@mail.gvsu.edu

Dosimetric Comparisons of 6MV, 6FFF, 10MV, and 10FFF on VMAT Planning in Patients with Endometrial Cancer

Introduction

Radiation therapy is a cornerstone in the treatment of endometrial cancer. Over the past decade, radiation techniques for gynecologic malignancies have evolved significantly—although, relative to other disease sites, the adoption of advanced technologies in pelvic malignancies has lagged. Historically, the 4-field box technique was the standard approach for treating female pelvic cancers. However, the transition to more sophisticated methods, such as volumetric modulated arc therapy (VMAT), has led to improved treatment outcomes and organ sparing.Despite these advancements, limited research has compared VMAT plans using different photon beam energies and delivery modes, specifically flattened versus flattening filter free (FFF) beams, in the context of endometrial tumors. This study was designed to evaluate the dosimetric effects of these beam variations to better understand their impact on treatment planning and delivery

Methods

Four treatment plans with different energies (6MV, 6FFF, 10MV, 10FFF) were created for each patient. Each plan consisted of 3 full arcs. The prescription utilized was 50Gy in 25 fractions.

Dose Parameters Evaluated

PTV:
- V100%≥95%
- Dmax ≤110%
- CI
- HI

OARs:
- Bladder
  - D35% ≤ 4500cGy
  - D0.03cc ≤ 6000cGy
- Small Bowel
  - D30% ≤ 4000cGy
  - D0.03cc ≤ 5500cGy
- Rectum
  - D60% ≤ 4500cGy
  - D0.03cc ≤ 6000cGy

Overall treatment plan:
- Total MU

This retrospective study included 25 patients who received external beam radiation therapy for endometrial cancer. Patient separation was a key factor in analyzing the results.

Results

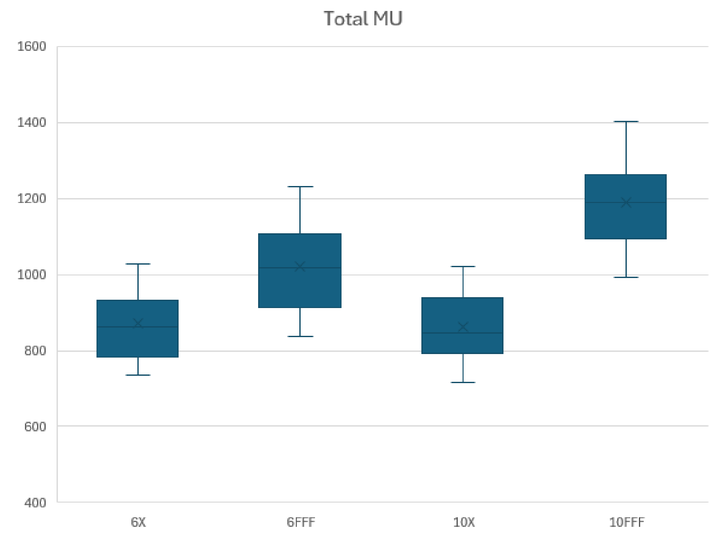

Fig. 1 Plot of the total number of MU for each beam energy, 6X, 6FFF, 10X, and 10FFF (n=25)

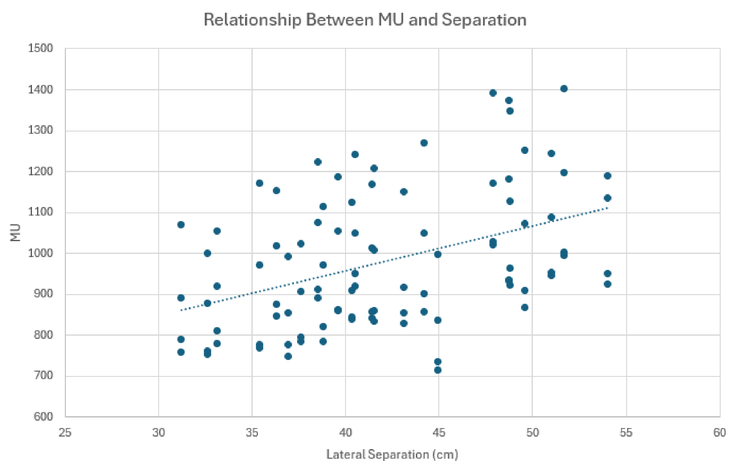

Fig 2. Distribution total MU as it relates to the patient's lateral separation.

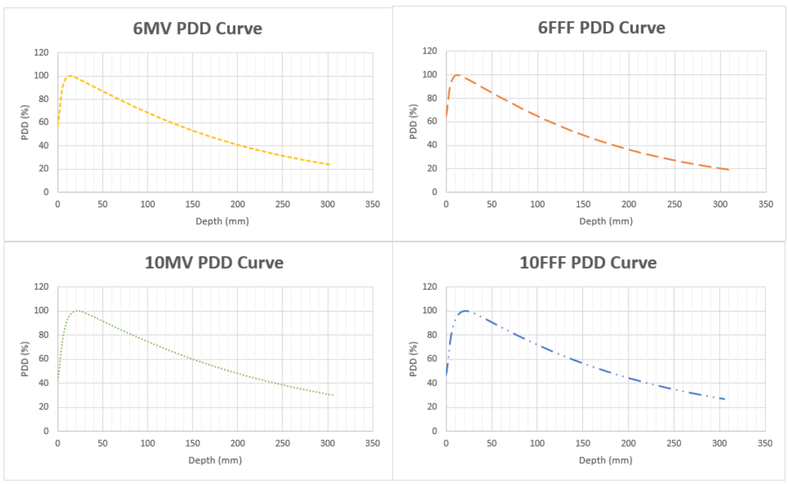

Fig 3. Depth dose curves for photon percentages depth doses (PDDs). PDDs for a 15x15cm field at 100cm Source-to-surface distance (SSD) for a 6MV, 6FFF, 10MV, and 10FFF photon beam.

Conclusion

This study aimed to evaluate dosimetric consistency and efficiency among different beam types in pelvic radiation therapy. The results showed minimal variation in target coverage and organ-at-risk point doses, with the most significant difference being the higher number of MU required for FFF beams. This increase was correlated with greater patient separation, suggesting that anatomical factors influence beam efficiency. Although dosimetric outcomes were comparable, the higher MU requirements may impact treatment delivery time and clinical workflow. Overall, 10X beams appeared to produce more favorable plans. Further research is warranted to explore these findings and their clinical implications more thoroughly.

Limitations

One of the primary challenges encountered in this study was identifying a beam arrangement that consistently worked well across all patient cases. Standardizing the optimization process limited the ability to make individualized adjustments for each plan, which may have impacted dosimetric outcomes. Additionally, variation in the superior extent of the planning target volumes (PTVs)—with some extending higher into the abdomen—likely influenced bowel dose and the number of monitor units (MU) required to achieve adequate coverage.

References

Petrović, Borislava, Olivera Ivanov, Milana Marjanović, Jelena Ličina, Ivan Gencel, and Nemanja Golubovac. "The Transition from Conformal to Advanced Radiotherapy Techniques in the Treatment Planning of Gynecological Cancer Patients." *Vojnosanitetski Pregled: Military Medical & Pharmaceutical Journal of Serbia 79, no. 10* (October 1, 2022): 951–57.

Kumar L, Kishore V, Bhushan M, Yadav G, Dewan A, Kumar P, Kumar G, Chowdhary R.Impact of Flattening Filter Free Photon Beam on Rapidarc Radiotherapy for Gynaecological Malignancies: A Comparative Study.Iran J Med Phys 2021; 18: 23-29.10.22038/ijmp.2020.43068.1650.

Acknowledgements

Mubin Shaikh, PhD DABR, Research Project Advisor
Jinxian Dai, DABR, Medical Physicist
GVSU Statistical Consulting Center
Dr. B. Sango Otieno, Associate Professor