3° Πανελλήνιο Συνέδριο
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Investigation of the dosimetric characteristics of X-ray beams in the range of 2.5 to 6 MV for intracranial Stereotactic Radiotherapy and Radiosurgery applications

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ΣΧΟΛΗ ΕΠΙΣΤΗΜΩΝ ΥΓΕΙΑΣ
- ΤΜΗΜΑ ΙΑΤΡΙΚΗΣ, ΛΑΡΙΣΑ

Οργάνωση

ΕΦΙΕ
Ένωση Φυσικών Ιατρικής Ελλάδος

ΕΛΛΗΝΙΚΟ ΚΟΛΛΕΓΙΟ ΑΚΤΙΝΟΛΟΓΙΑΣ

Introduction

In linac-based Stereotactic Radiosurgery (SRS), standard 6 MV FFF X-rays are typically employed for the treatment of intracranial lesions.

Lower beam energy

↓

Reduced penetration of secondary e-

↓

Reduced penumbra width

→

This work investigates the advantages and drawbacks of using intermediate X-ray beam energies from both physics and plan quality perspectives.

↓

The aim is to provide a comprehensive overview of the outcomes associated with the use of intermediate energies in linac-based SRS, while also establishing a foundation for further research in this field.

Materials & Methods

Varian TrueBeam Linac head Model based on "FakeBeam" – FFF Mode

↓ PRIMO Monte Carlo code

Generated Phase Space Files for beam qualities:

2.5MV 4MV 6MV

PRIMO Monte Carlo code →

Phantom Study

- ❑ $(16cm)^3$ water tank
- ❑ 1×1 to 10×10 cm^2 square fields
- ❑ Scoring:
  - ❑ Depth of dose maximum
  - ❑ Penumbra Width
  - ❑ FWHM and inflection points

Patient Study

- ❑ Real patient geometry – CT images and RT structures
- ❑ Spherical 1 cm and 2 cm diameter targets
- ❑ Non-clinical (box fields) and clinical SRS - VMAT plans
- ❑ Evaluation and comparison
  - ❑ Gradient Index
  - ❑ Dose-Volume metrics
  - ❑ Max skin dose

➢ Equal target coverage

Results

Phantom Study

- **Penumbra** was narrower at lower energies across all depths (Fig. 1)
- **FWHM** did not differ significantly with beam energy (Fig. 2)

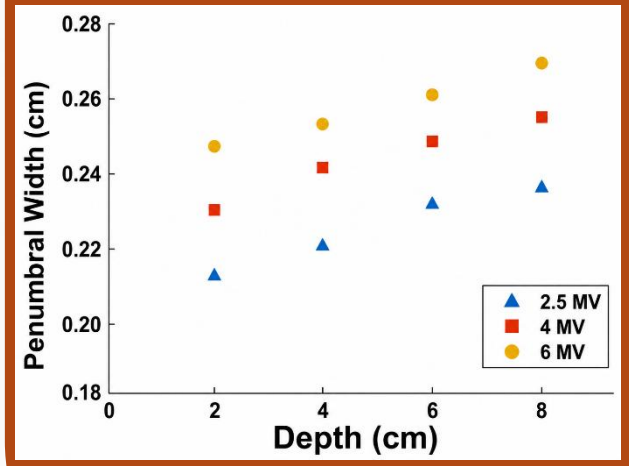


Figure 1: Variation of penumbra width with beam quality at different depths for a 1 ×1 cm^2 field.

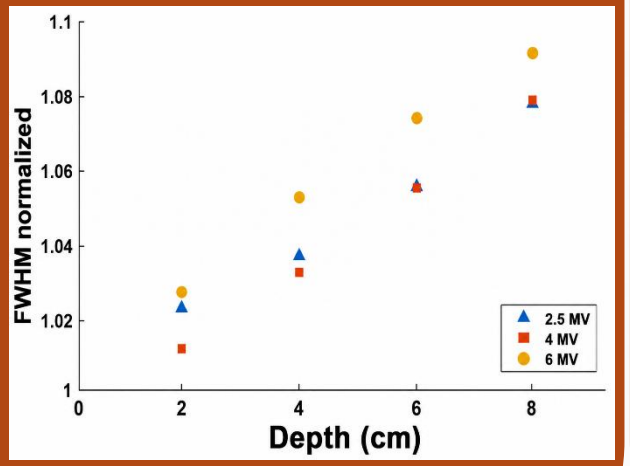


Figure 2: Variation of FWHM (normalized to the nominal field width) with beam quality at different depths for a 1 ×1 cm^2 field.

Patient Study

- **Gradient Index** decreases with decreasing beam energy. This effect is more prominent in smaller tumors (Fig. 3)
- **OAR sparing** improves with decreasing beam energy (Fig. 4)
- **Max skin dose** increases by approximately 10% (2.5MV vs 6MV), although limited in absolute dose terms (+0.23Gy in VMAT plan)

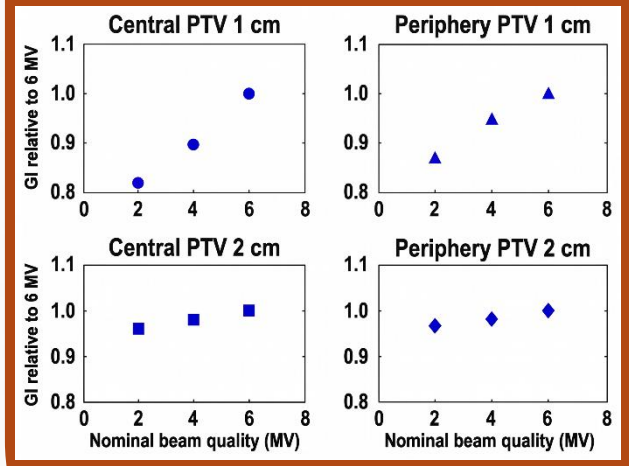


Figure 3: Gradient Index variation with beam quality for all tumors.

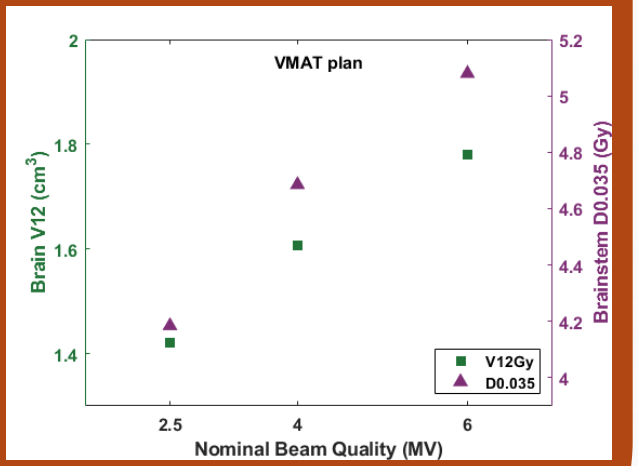


Figure 4: Brain V12 and brainstem D0.035 as a function of beam quality for the VMAT plan of the 1 cm central tumor.

Conclusion

Lower energy X-ray beams

- ❑ Reduced penumbra width
- ❑ Improved dose gradient
  - ➢ Greater effect on smaller lesions
- ❑ Improved OAR sparing

- ❑ Increased skin dose

↓

Net increase may still be clinically acceptable

Further studies are needed to characterize the benefits and pitfalls of adopting X-rays of intermediate energy in clinical practice

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