DOSIMETRIC COMPARISON OF PRIMO MONTE CARLO SIMULATION AND ECLIPSE TREATMENT PLANNING SYSTEM FOR GLIOBLASTOMA RADIOTHERAPY TREATMENT PLANNING

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ABSTRACT

Accurate radiotherapy planning is crucial to optimize the dose to the tumour while minimizing exposure to healthy organs. The Eclipse Treatment Planning System (TPS) with the Analytical Anisotropic Algorithm (AAA) is widely used clinically, yet it has limitations in heterogeneous regions and high-dose gradient areas. This study aims to compare the dose distribution calculated by Eclipse TPS (AAA) with Monte Carlo (MC) simulations using PRIMO software in glioblastoma patients treated with Intensity Modulated Radiation Therapy (IMRT). This study utilized DICOM data from four glioblastoma patients planned with Eclipse TPS using 6 MV photon beams. The process began with the modelling and validation of the Clinac CX LINAC in PRIMO against measured data, which was successfully achieved with a gamma passing rate of 98.9% using 2%/2 mm criteria. Due to the unavailability of the MLC80 type used in Eclipse TPS within PRIMO, the treatment plan parameters from Eclipse were manually re-entered with MLC120 substitution for the re-simulation. The evaluation was performed by analyzing the dose distribution, Dose Volume Histogram (DVH), Homogeneity Index (HI), and Conformity Index (CI). The results showed that the HI values obtained from PRIMO and Eclipse TPS were in relatively good agreement, whereas the CI values from PRIMO were lower than those from Eclipse TPS due to differences in dose calculation algorithms and the use of MLC120 as a substitute for MLC80. PRIMO simulations also revealed that several organs at risk, particularly the brainstem and optic nerves, received doses approaching or exceeding tolerance limits, thus providing additional information for treatment plan evaluation.

Keywords: Analytical Anisotropic Algorithm, glioblastoma, IMRT, Monte Carlo, PRIMO.

PERBANDINGAN DOSIMETRI ANTARA SIMULASI MONTE CARLO PRIMO DAN SISTEM PERENCANAAN TERAPI ECLIPSE PADA PERENCANAAN RADIOTERAPI GLIOBLASTOMA

ABSTRAK

Perencanaan radioterapi yang akurat sangat krusial untuk mengoptimalkan dosis pada tumor dan meminimalkan paparan pada organ sehat. Eclipse Treatment Planning System (TPS) dengan algoritma Analytical Anisotropic Algorithm (AAA) banyak digunakan secara klinis, namun memiliki keterbatasan pada area heterogen dan gradien dosis tinggi. Penelitian ini bertujuan untuk membandingkan distribusi dosis pada Eclipse TPS (AAA) dengan simulasi Monte Carlo (MC) menggunakan perangkat lunak PRIMO pada pasien glioblastoma yang menjalani radioterapi menggunakan teknik Intensity Modulated Radiation Therapy (IMRT). Penelitian ini menggunakan data DICOM dari empat pasien glioblastoma yang direncanakan dengan Eclipse TPS yang disinari dengan foton berenergi 6 MV. Proses dimulai dengan pemodelan dan validasi LINAC Clinac CX di PRIMO terhadap data pengukuran, yang berhasil dengan nilai gamma passing rate 98,9% dengan kriteria 2%/2 mm. Karena ketidaktersediaan jenis MLC80 yang digunakan di Eclipse TPS pada PRIMO, parameter rencana dari Eclipse diinput ulang secara manual dengan substitusi MLC120 untuk simulasi ulang. Evaluasi dilakukan dengan menganalisis distribusi dosis, Dose Volume Histogram (DVH), Homogeneity Index (HI), dan Conformity Index (CI). Hasil penelitian menunjukkan bahwa nilai HI yang diperoleh dari PRIMO dan Eclipse TPS memiliki kesesuaian yang relatif baik, sedangkan nilai CI pada PRIMO lebih rendah dibandingkan Eclipse TPS akibat perbedaan algoritma perhitungan dosis dan penggunaan MLC120 sebagai pengganti MLC80. Simulasi PRIMO juga menunjukkan beberapa organ berisiko, terutama batang otak dan saraf optik, menerima dosis yang mendekati atau melebihi batas toleransi sehingga memberikan informasi tambahan terhadap evaluasi rencana penyinaran.

Kata kunci: Analytical Anisotropic Algorithm, glioblastoma, IMRT, Monte Carlo, PRIMO.