Implementation of rapid plan for stereotactic body radiation therapy lung treatment

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Résumé

Introduction: Stereotactic Body Radiation Therapy (SBRT) has become a standard approach for early-stage non-small cell lung cancer (NSCLC), allowing high-dose radiation delivery with sub-millimeter precision (Chang et al.,2009). Volumetric Modulated Arc Therapy (VMAT) is increasingly utilized due to its superior conformality (Yap et al.2014). Knowledge-Based Planning (KBP) tools like RapidPlan (Varian) enhance plan quality by using databases of optimized plans to predict achievable dose distributions and reduce inter-planner variability (Yang et al.2016; Niemierko et al.2014). This study evaluates VMAT-SBRT plans generated by RapidPlan versus manually optimized ones in terms of dosimetric quality (Yeo et al.2020).

Materials and Methods: 2 regimens were analyzed: 54 Gy in 3 fractions and 60 Gy in 5 fractions. Planning was performed in Eclipse17.10 using 6MV Flattening Filter Free (FFF) beams at 1400MU/min. Dose calculations were conducted using the Acuros algorithm (dose-to-water mode, 0.1mm grid). Plans were normalized such that 95% of the Planning Target Volume (PTV), received 100% of the dose and PTV=ITV (Internal Target Volume) +5mm.

For each regimen, 40 patients were included. The 1stcohort (n=20) was used for model training; the 2nd (n=20) for validation. RapidPlan-generated plans were compared to manually optimized reference plans using 4 metrics: Biologically Effective Dose to 98% of the PTV (BED-D98PTV), mean BED to ITV (BED-DmoyITV), Modified Gradient Index (MGI) and Modified Conformity Index (MCI) (UK SABR guidelines2019).

Results:

MGI: in 3fr group, the difference ranged from +1.60% to -16.55% favoring Rapidplan. For 5fr, in 15 out of 20 cases, RapidPlan cases showed a higher MGI than the non-rapid one, with differences reaching up to +15.28% (2.35 cc).

MCI: For 3fr, the differences are minimal, ranging from +0.96% to -3.34% in favor of Rapidplan. For 5fr, MCI values were equal or slightly better for rapid plans in 13 out of 20 cases.

BED D98 PTV: For 3fr, Rapidplan yielded slightly higher values in most cases, with differences ranging from +1.33% to -1.25%. For 5fr group, 9 out of 20 plans showed minor differences within ($\pm$2%).

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BED Dmoy ITV: For 3fr plan, results ranged from +11.16% to -6.74%, with no consistent trend. In the 5fr group, the results were most variable, Rapid was superior in 11 of 20 cases, with large improvements at 7.2cc: +27.48%. However, in 9 cases, manuel planning was better, especially at 27.2cc: -6.45%.

Conclusion: The comparative analysis of the 2 protocols shows that rapid offers better or equivalent performance that the manuel planning. MGI and MCI improvements with rapid suggest more efficient modulation and smoother delivery. BED D98 PTV is slightly higher in most rapid plans, supporting its robustness. However, BED Dmoy ITV shows greater variability, with no consistent advantage for either technique, underlining the importance of individualized plan assessment.

Références :

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Mots-Clés: SBRT, RapidPlan, KBP, VMAT, MCI, MGI, NSCLC