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**Comprehensive dosimetric and clinical
evaluation of lexicographic optimization-based
planning for cervical cancer**

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Abstract

Aim

This study aims to fully investigate the capability of a not yet commercially available fully automated lexicographic optimization (LO) planning algorithm, called mCycle (Elekta AB, Stockholm, Sweden), to produce plans at least comparable to accepted clinical manual plans for a retrospectively selected cohort of cervical cancer patients.

Material and Methods

Twenty-four mono-institutional consecutive cervical cancer treatment volumetric-modulated arc therapy (VMAT) plans delivered between November 2019 and April 2022 with a prescription dose of 50 Gy in 25 fractions have been retrospectively selected. The mCycle planning system is now implemented in the Monaco TPS research version v5.59, in which the LO planning algorithm was combined with the a-priori multi-criterial optimization (MCO). The mCycle fluence map optimization is designed as a two-pass automated LO in which constraints and goals are progressively optimized by MCO in accordance with an a-priori assigned priority list, or so-called Wish-List (WL). Two versions of WL have been defined. The first one (WL1) aimed to reproduce manual plans, while the second one (WL2) to improve the organs-at-risk (OAR) sparing without affecting minimum target coverage and plan delivery accuracy. Robust WLs have been tuned using a subset of 4 randomly selected patients. The remaining selected treatment plans have been automatically re-planned by using the designed WLs. Manual plans (MP) and mCycle plans (mCP01 and mCP02) were compared in terms of dose distributions, complexity, delivery accuracy, and clinical acceptability. Furthermore, two senior radiation oncologists independently performed a blind clinical evaluation ranking the three competing plans. Finally, a global quality index has been defined to gather into a single score the plan quality evaluation.

Results

The two WLs have been defined by performing a tweaking on the same 4 randomized selected patients requesting 5 and 3 working days for the WL01 and the WL02, respectively. The re-planning took in both cases 3 working days. mCP01 best performed in terms of target coverage (PTV $V_{95\%}$ (%): MP 98.0 [95.6 – 99.3], mCP01 99.2 [89.7 – 99.9], mCP02 96.9

[89.4 – 99.5]). On the other hand, mCP02 results pointed out a large OAR sparing improvement, especially in the rectum parameters (e.g., Rectum D_{50%} (Gy): MP 41.7 [30.2 – 47.0], mCP01 40.3 [31.4 – 45.8], mCP02 32.6 [26.9 – 42.6]). An increase in plan complexity has been registered in mCPs without affecting plan delivery accuracy (Passing Ratio (3%/3mm): MP 97.0 [92.7 – 99.2], mCP01 97.2 [95.0 – 98.6], mCP02 96.7 [94.4 – 98.2]). In the blind comparisons, all automated plans were considered clinically acceptable, and mCPs were preferred over MP in 90% of cases. Globally, automated plans registered a plan quality score at least comparable to MP.

Conclusions

This first feasibility retrospective study demonstrated the novel mCycle auto-planning capability to generate high-quality VMAT cervical treatment plans according to the site-specific institutional protocol.