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Evaluation of an Artificial Intelligence-Based Industrial Solution for Automated Prostate Planning

Youssef Khatib[1], Blandine Romain-Vilboux[2], Madalina Costea[3], Baris Ungun[4], Rémi Vauclin[4], Nikos Paragios[5], Vincent Plagnol[1]

[1]Radiation Oncology, Centre Catalan d'Oncologie, Perpignan, France. [2]Functional, Therapanacea, Paris, France.Clinical [3]Affairs, Therapanacea, Paris, France. [4]Physics, Therapanacea, Paris, France. [5]CEO, Therapanacea, Paris,France

Purpose/Objective:

Manual planning in radiotherapy involves the careful and deliberate selection of treatment parameters by skilled practitioners. New technologies offer attractive solutions for time-savings and standardization. This study evaluates an AI-driven automated planning solution for prostate cancer treatment, emphasizing its effectiveness, accuracy, and potential for clinical integration.

Material/Methods:

An automated treatment planning solution using a planning CT with structure contours, linac specifications, and prescribed dose as inputs has been developed by TheraPanacea. Key steps include dose prediction via a deep learning model and VMAT plan optimization to replicate the predicted dose. Clinical evaluation was conducted on 20 prostate cases with a prescription dose of 60 Gy in 20 fractions. Automated plans (AP) and manual plans (MP) were compared in terms of quantitative and qualitative evaluation, plan deliverability and plan complexity. Quantitative evaluation was based on achievement of dosimetric constraints, and the qualitative evaluation was done by a medical physicist, followed by physician approval, as per routine clinical practice. Plan deliverability was assessed by local gamma index measurements with 3%/3mm > 95% as criteria for acceptability. Finally, the plan complexity was assessed by calculating the monitor unit (MU) numbers and modulation complexity score (MSC).

Results:

The dosimetric analysis showed comparable PTV coverage between MP and AP, with AP achieving lower overdose values on the PTV with D2% below 105% of the prescribed dose, and an absolute difference compared to MP of 2Gy on average (Figure 1). AP demonstrated superior sparing of the rectum at low and moderate dose levels, while results in the high-dose region were similar for both plans (Figure 2). For the bladder and femoral heads, the results were comparable between MP and AP. In terms of qualitative evaluation, all AP plans were clinically acceptable by a medical physicist and a physician. Regarding plan deliverability, all plans met the quality assurance criterion of gamma index (local, 3%/3mm ≥ 95%), with AP achieving 99% to 100% and surpassing MP results. At the same time, MUs of AP were inferior to that of MP and MCS for AP was higher than for MP, indicating that automated plans were less complex, consequently easier to be delivered and likely to have better quality assurance outcomes.

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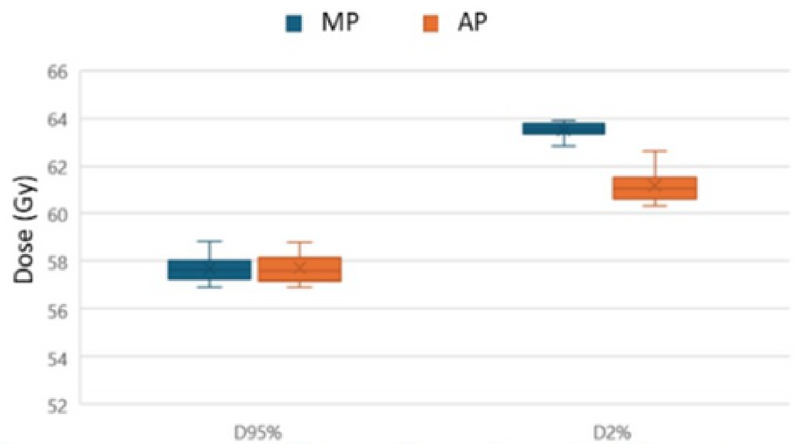

Figure 1. Comparison of MP and AP results for PTV dosimetric criteria

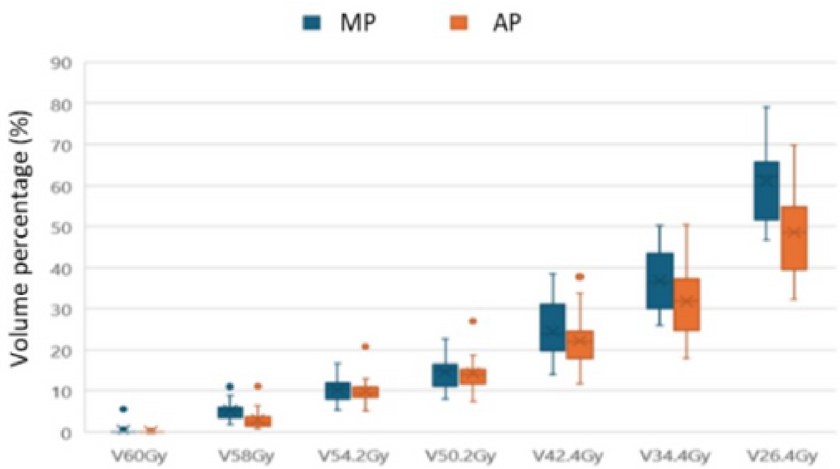

Figure 2. Comparison of MP and AP results for rectum dosimetric criteria

Conclusion:

The automated planning solution for prostate treatments has been accepted for clinical use for prostate treatments due to effective target coverage, improved organ-at-risk protection and better plan deliverability results compared to manual plans.

Keywords: autoplanning, deep learning, prostate cancer