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Topic (read-only)

Physics: Dose prediction/calculation, optimisation and applications for photon and electron planning

Keywords (read-only)

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Abstract title (read-only)

Automated VMAT Planning for Oropharynx Head and Neck Radiotherapy

Authors and affiliations (required)

Frederic Gassa (Presenting) frederic.gassa@lyon.unicancer.fr

Medical Physics department, Centre Leon Berard, Lyon, France

Anais Chardon anais.chardon@lyon.unicancer.fr

Radiation Oncology department, Centre Leon Berard, Lyon, France

Gorkem Gungor gorkem.gungor@acibadem.com
Radiation Oncology department, Acibadem MAA University School of Medicine, Istanbul, Turkey

Ana-Maria Gardareanu oprea.nicoleta93@yahoo.com
Radiation Oncology department, Coltea Clinical Hospital, Bucharest, Romania

Madalina-Liana Costea m.costea@therapanacea.com
Clinical Affairs, TheraPanacea, Paris, France

Baris Ungun b.ungun@therapanacea.eu
Physics, TheraPanacea, Paris, France

Remi Vauclin r.vauclin@therapanacea.com
Physics, TheraPanacea, Paris, France

Elie Mengin e.mengin@therapanacea.com
Physics, TheraPanacea, Paris, France

Nikos Paragios n.paragios@therapanacea.com
CEO, TheraPanacea, Paris, France

Marie-Claude Biston marieclaude.biston@lyon.unicancer.fr
Medical Physics department, Centre Leon Berard, Lyon, France

Purpose/Objective (read-only)

Automation in radiotherapy treatment planning is a rapidly evolving field aiming at increasing planning efficiency, improving plan quality, and reducing inter-observer variability. Promising results have been reported using a two-step auto-planning (AP) workflow combining knowledge-based dose prediction and dose mimicking [1,2]. The purpose of this study was to develop and evaluate two end-to-end automated VMAT planning methodologies for head and neck (HN) radiotherapy in oropharyngeal cancer patients.

Material/Methods (read-only)

Two AP methodologies were implemented. For the first method (AP-Method1), a machine learning-based dose prediction model was trained using datasets from two large European centers. For the second method (AP-Method2), a dose prediction was generated using a published analytical formula [3]. Aside from the dose prediction approach, both methods used an identical dose mimicking component.

External validation was performed on 8 patients from one center. For each case, two automated VMAT treatment plans were generated for a VersaHD linac to deliver 70Gy to the high-risk and 54.25Gy to the low-risk target in 35 fractions. The RTplan output was imported into Monaco TPS for final dose calculation. The resulting doses were qualitatively and quantitatively compared against corresponding manually generated clinical plans following guideline-based evaluation criteria [4]. Two medical physicists and two radiation oncologists reviewed the automated plans, adjusted the plan normalization if necessary, and assessed clinical acceptability. They also indicated preference between the two automated solutions. All plans underwent patient-specific QA measurements to verify deliverability.

The average total generation time per automated plan was approximately 10 minutes. Both AP methods produced clinically comparable or superior results relative to manual plans, showing improved PTV coverage and enhanced parotid sparing (Table1). After minor normalization adjustments (mean 2%, range 1.4–2.6%), all automated plans were deemed clinically acceptable. The overall clinical acceptability rate was 81.3% for AP-Method1 and 93.8% for AP-Method2. Two experts also reviewed the manual clinical plans, and interestingly their average clinical acceptability rate was only 50%, highlighting considerable inter-observer variability in plan evaluation. Plan preference between the two automated methods was evenly split (50%vs50%), with full expert agreement in 3 of 8 cases (Table2). Patient-specific QA results demonstrated excellent deliverability for all automated plans.

Structure	DVH metric	Manual Plans	AP-Method 1	AP-Method 2
PTV_HighDose	D95>66.5 Gy	67.56 ± 0.53	67.97 ± 0.33	67.99 ± 0.34
PTV_HighDose	D5<75 Gy	71.97 ± 0.52	71.42 ± 0.19	71.29 ± 0.14
PTV_LowDose	D95>51.53 Gy	53.05 ± 0.54	52.89 ± 0.52	52.86 ± 0.38
Brainstem	Dmax<54 Gy	23.37 ± 4.28	24.42 ± 7.67	31.84 ± 4.19
Spinalcord	Dmax<45 Gy	34.84 ± 3.71	32.79 ± 2.36	32.85 ± 2.25
Mandible	D2<70 Gy	66.58 ± 2.23	65.95 ± 2.16	66.22 ± 1.88
Parotid_Left	Dmean<26 Gy	28.33 ± 6.84	25.75 ± 7.83	28.08 ± 10.39
Parotid_Right	Dmean<26 Gy	28.34 ± 5.78	24.49 ± 6.03	24.35 ± 1.77
PCM	Dmean<45 Gy	58.31 ± 9.02	57.77 ± 10.91	55.82 ± 9.57
SubmandibularGland_L	Dmean<35 Gy	55.77 ± 12.84	56.15 ± 9.95	53.44 ± 12.92
SubmandibularGland_R	Dmean<35 Gy	64.28 ± 5.74	62.07 ± 5.92	60.94 ± 7.52
Larynx	Dmean<35 Gy	47.78 ± 10.27	42.76 ± 12.25	44.78 ± 10.82
OpticNerve_L	Dmax<54 Gy	4.64 ± 2.69	3.61 ± 1.35	3.35 ± 1.1
OpticNerve_R	Dmax<54 Gy	5.6 ± 3.72	3.61 ± 1.3	3.24 ± 0.93

Table 1. Quantitative evaluation of manual and automated plan solutions

	Expert category	AP-Method 1	AP-Method 2
Evaluation 1	Medical physicist + Radiation Oncologist	5	3
Evaluation 2	Medical physicist	5	3
Evaluation 3	Radiation Oncologist	2	6

Table 2. Plan Preference among experts' evaluations

Conclusion (read-only)

Both automated VMAT planning methodologies successfully generated high-quality, clinically acceptable plans with minimal human intervention. These findings demonstrate the feasibility

References (read-only)

[1] M. Hussein *et al.*, “Automation in IMRT planning – recent innovations,” *Br. J. Radiol.*, vol. 91, p. 20180270, 2018.

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Conflict of Interest Disclosure (read-only)

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