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Original article

Assessing dosimetric performance of HyperArc for thyroid-associated ophthalmopathy radiotherapy

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A B S T R A C T

Objective: To assess the dosimetric performance of HyperArc in comparison with coplanar volumetric modulated arc therapy (c-VMAT) and non-coplanar VMAT (nc-VMAT) in the radiotherapy of thyroid-associated ophthalmopathy (TAO).

Methods: This retrospective study involved 10 patients with TAO who received radiotherapy at our center from December 2021 to December 2023. A single qualified physicist generated treatment plans using c-VMAT, nc-VMAT, and HyperArc techniques on the TrueBeam machine with the Eclipse treatment planning system. We compared the dosimetric parameters for target volumes and organs at risk (OARs) among these planning approaches. Monitor units (MUs) were also evaluated to assess beam efficiency and delivery effectiveness for each plan type.

Results: Compared to c-VMAT and nc-VMAT plans, HyperArc plans achieved the highest conformity index (CI), with increases of 3.35% ($t = 3.84$, $P = 0.004$) and 4.05% ($t = 5.01$, $P = 0.001$), respectively. They also achieved the lowest gradient index (GI), with decreases of 29.41% ($t = -10.41$, $P < 0.001$) and 25.11% ($t = -5.55$, $P < 0.001$), respectively, and the lowest $R_{50\%}$, with decreases of 31.69% ($t = -11.74$, $P < 0.001$) and 28.01% ($t = -5.50$, $P < 0.001$), respectively. In terms of the dosimetric parameters of OARs, HyperArc plans produced the best results among the three types of plans. Furthermore, HyperArc plans reduced MUs by 31.39% ($t = -8.59$, $P < 0.001$) and 20.60% ($t = -2.70$, $P = 0.024$) compared to c-VMAT and nc-VMAT plans, respectively.

Conclusions: This study compared c-VMAT, nc-VMAT, and HyperArc for the radiotherapy of TAO and demonstrated the superior dosimetric performance of HyperArc. HyperArc provided better dose conformity for targets, sharper dose falloff outside targets, more effective sparing of OARs, and more efficient utilization and delivery of rays.

1. Introduction

Orbital diseases present a serious threat to patients' visual function, appearance, and even their lives. The complex structure of orbital tissue, which is rich in nerves and blood vessels and closely connected to the visual organs, makes the treatment of orbital diseases more challenging and risky than treatments for other parts of the body. Achieving a radical cure or significant symptom improvement through surgery alone is often difficult. Radiotherapy is a crucial treatment method that can be used not only for orbital and intraocular tumors but also for inflammatory diseases. It can be administered alone or in combination with surgery or chemotherapy to eradicate or alleviate orbital and intraocular tumors and inflammatory conditions.

In a retrospective analysis involving 81 patients with 85 affected orbits of stage IE low-grade ocular adnexal lymphoma, Woolf et al.[1] found that radiotherapy provided excellent local control and was associated with acceptable levels of toxicity. In a clinical trial conducted by Mizoguchi et al.,[2] 21 patients with locally advanced primary epithelial carcinoma of the lacrimal gland were treated with carbon-ion radiotherapy. The study reported a three-year overall survival rate of 82.2% and a local control rate of 79.0%. Kim et al.[3] conducted a retrospective analysis of 23 patients treated with multisession Gamma Knife radiosurgery for benign tumors of the orbital apex, demonstrating that this approach is both effective and safe for managing these conditions. Boutroux et al.,[4] in a retrospective analysis of 82 orbital rhabdomyosarcoma patients treated with combination chemotherapy along with

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