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Contralateral Control Rate With Unilateral Proton Beam Radiotherapy for Oropharyngeal SCC: A Multi-Institutional Prospective Study From the Proton Collaborative Group

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Purpose: To evaluate the feasibility of proton therapy of ocular melanomas using a non-dedicated treatment planning system (TPS) and proton pencil beam scanning gantry beam line.

Methods: The commercial Eclipse TPS was used to generate robust multifield optimized (rMFO) intensity-modulated proton plan for representative ocular tumor patients. Doses were compared among the initial plan and 40 additional scenarios of combined setup errors and range uncertainties. An in-house fast Monte Carlo dose calculation platform was used to assess the dosimetric impact of 3 tantalum fiducial markers for imaging-guidance treatment.

Results: Retina, optic nerve, cornea, lens, lacrimal gland, conjunctiva, sino-nasal mucosa and GTV were contoured on the treatment planning CT. 3-dimentional rMFO planning accounting for 2mm setup uncertainty and 3.5% range uncertainty was performed, utilizing 3 fields at different optimal gantry angles. All plans achieved satisfactory target coverage (TC), with at least 95% of CTV receiving full prescription of 50 Gy RBE in 5 fractions while achieving clinical dose limits of all organ at risks. The average target coverage remained D95=97.7% over 40 scenarios. Monte Carlo dose calculation revealed up to an 11% local dose shadow within target and D95 decreased by 3.2% if tantalum marker is in the beam path.

Conclusion: Non-dedicated TPS and gantry beam line can be used to effectively treat ocular tumors. This procedure is feasible with relatively low doses to anterior structures and achieves acceptable plan robustness. Fiducial markers could cause dose shadows and theoretically compromise local tumor control. Optimized beam angle and fiducial positioning should be considered.

PTCNA-0036

Contralateral Control Rate with Unilateral Proton Beam Radiotherapy for Oropharyngeal SCC: a multi-institutional prospective study from the Proton Collaborative Group

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Introduction: Select patients with oropharyngeal SCC are candidates for unilateral radiation therapy. We sought to investigate if ipsilateral targeting leads to increased contralateral recurrences.

Methods: We queried the PCG database for patients treated with unilateral proton RT for head and neck SCC from 2015 – 2020 at 12 institutions. DICOMs were evaluated to ensure dose delivered matched a unilateral proton treatment plan. Demographic, clinical and pathological, toxicity and dosimetry information were compiled.

Results: We found 43 cases treated with unilateral proton RT. 94% (n=16) of recurrent cases received prior radiation. Oropharyngeal sites included tonsillar fossa (n=32), and base of tongue (n=11). 70% (n=30) of patients underwent concurrent chemotherapy - typically weekly cisplatin. The median dose and BED delivered was 69.96 CGE and 84.00 Gy respectively. Eight (18.6%) patients experienced at least one grade $\geq$3 toxicity. With a mean follow-up of 10.6 months (range 0 - 48) the local control rate at 1 year was 90.7%. All locoregional recurrences occurred within the ipsilateral neck; there were no contralateral failures. Distant metastasis developed in 4.6% of cases. For five cases (n=5), additional dosimetric analyses were performed for centralized review and revealed that ipsilateral level 2 doses were similar, whereas contralateral level 2 doses were higher with photons, mean: 15.4 Gy vs 0.36 CGE, D5%: 24.5 vs 4.62.

Conclusions: Unilateral Proton Beam RT for oropharynx cancer has similar disease control to photon therapy. The dosimetric advantage of proton beam therapy did not result in excess contralateral failures when compared to historical unilateral photon beam radiotherapy series.

Multi-disciplinary: Carbon and Neutron

PTCNA-0092

Development of Intensity Modulated Neutron Therapy (IMNT) at the University of Washington (UW)

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Purpose: High linear energy transfer (LET) neutrons have been used to treat over 3,300 patients at the UW because of their ability to overcome multiple mechanisms of resistance to low LET radiations. Technical and clinical challenges of implementing IMNT are presented along with an analysis of the potential therapeutic benefits.

Methods: A commercial treatment planning system (TPS) has been modified to incorporate neutron scattering kernels and accommodate the unique characteristics of the Clinical Neutron Therapy System (CNTS). A Monte Carlo model of the CNTS has been developed to independently confirm TPS doses. A portal imaging system based on ^{11}C positron emission tomography has also been developed.

Results: Comparisons of measurements, TPS and Monte Carlo doses are in excellent agreement (3%/3mm g analysis) for a wide range of field sizes, both open and wedged. An analysis IMNT plans for seven head and neck patients shows an average 56% decrease in organ at risk dose compared to 3D conformal neutron therapy (3DCNT). The maximum dose decreased by 20% and 21% for the spinal cord and temporal lobe, respectively. The mean larynx D50% decreased by 80%. The overall number of monitor units for wedged and IMNT treatments is similar.

Conclusions: With IMNT, comparative planning studies demonstrate significant reductions in OAR dose are possible with similar target coverage. Clinical trials to compare 3DCNT to IMNT are in development. Such trials will inform ongoing work to evaluate the use of other types of high LET radiations for patient care, including carbon ions.

PTCNA-0093

Comparison of Micronuclei Formation by High LET Fast Neutrons and Low LET X-rays

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Purpose: DNA fragmentation leads to micronuclei (MN) and release of self-DNA triggering the cGAS-STING pathway. Compared to low-LET radiation, we hypothesize that high-LET radiations 1) increase the number of MN per unit dose, and 2) rupture more frequently. Impact on MN for cells exposed to a DNA damage repair inhibitor (DDRi) were also assessed.

Methods: MN formation and rupture assessed in vitro using MCC-13 cells after 8 Gy of x-rays and 3 Gy of fast neutrons. Cells irradiated then fixed after first mitosis. Immunofluorescence markers were used for evaluation of DNA, MN rupture and plasma membrane integrity. Confocal microscopy imaging with automated image analysis provided: MN per cell, proportion of