Purpose: Intensity modulated proton therapy (IMPT) allows for the delivery of ionizing radiation over a well-defined range with minimal exit dose compared to photons, and may further improve dose conformity compared to other proton modalities. IMPT is not available for brain cancer treatment in Canada. Instead, patients who would likely benefit from proton over photon therapy are evaluated on a case-by-case basis for referral to US facilities. Improved neurocognitive outcomes would certainly constitute a strong argument. As such, tools were developed to estimate the intelligence quotient (IQ) and the risk of hearing loss post radiotherapy and to compare outcomes of proton against photon in pediatric brain tumours on a case-by-case basis. Methods and Materials: Pediatric patients who had received radical photon intensity modulated radiation therapy (IMRT) were randomly selected from our retrospective database: 10 cases each of craniopharyngioma, ependymoma and medulloblastoma, and 20 cases of glioma. The existing planning CT and contoured structures were used to generate IMPT plans employing a robust optimization procedure. The RBE-corrected dose to brain structures and the cochleas were calculated for both IMPT and IMRT. A dose dependent IQ model was applied to estimate IQ, and a Markov chain Monte Carlo technique. Cumulative probability distributions (CDF) were calculated to perform a statistical interpretation and to compare proton versus photon outcomes. The reported incidence of hearing loss as a function of cochlear dose in the literature was used to estimate the probability of occurrence. Results: The average dose to the brain was less in all IMPT plans compared to IMRT: ranging from a 6.7% reduction (p = 0.003) in the case of medulloblastoma to 38% (p = 0.007) for craniopharyngioma. This dose reduction translated into a gain in IQ of 1.9 points on average for protons versus photons for the whole cohort at five years post-treatment (p = 0.011). In terms of specific diseases, the gains in IQ points were 0.8, 1.6, 2.3, and 2.7 for medulloblastoma, ependymoma, glioma and craniopharyngioma, respectively. When estimating the IQ using dose to the temporal lobes, these gains increased to 3.1 to 6.0 IQ points. Overall, the probability for IQ deficits ≥ 7.5 points was estimated to be 32% for IMPT compared to 48% for IMRT, an absolute reduction of 16% for the whole cohort (p = 0.014). Hearing loss probability was evaluated on a per-ear-basis and was found to be systematically less for proton versus photon: 2.9% versus 7.2% (p < 0.05). Conclusions: IQ predictions post IMPT and IMRT were found to be very similar, but a modest gain was systematically observed in proton for all patients. Given the uncertainties within the IQ model used and our reinterpretation, the predicted gains may be underestimated. Additional long-term clinical studies are needed to improve our understanding of radiation on the developing brain.

45 VOLUMETRIC MODULATED ARC THERAPY OF HIGH-GRADE GLIOMAS USING 18F-FDOPA POSITRON EMISSION TOMOGRAPHY FOR DOSE PAINTING

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Purpose: Patient outcomes with dose escalation for high-grade gliomas have been disappointing because of non-central relapses and radionecrosis. Dose-painting can maximize central disease control, while minimizing the risk of radionecrosis. This study aimed to determine whether dose painting with volumetric modulated arc therapy (VMAT) for high-grade gliomas using 3,4-dihydroxy-6-[18F]fluoro-L-phenylalanine (18F-FDOPA) positron emission tomography (PET) could achieve dose-escalated coverage of biological target volumes (BTVs) without increasing the dose to cranial organs at risk (OARs).

Methods and Materials: Computed tomography, magnetic resonance imaging (MRI) and 18F-FDOPA PET/CT images were obtained for post-operative radiation therapy planning of 10 patients with high-grade glioma. The gross tumour volume (GTV) was contoured by a radiation oncologist using gadolinium-enhanced T1 and T2 FLAIR MRI. The clinical target volume (CTV) was defined as a 2 cm expansion of the GTV and surgical cavity. The planning target volume (PTV) was defined as a 0.5 cm expansion of the CTV. Two VMAT plans (Eclipse version 11.01, Varian Medical Systems, Palo Alto, CA) were generated for each patient: a conventional VMAT plan without dose escalation with a prescribed dose of 60 Gy in 30 fractions in the PTV and a plan with dose escalation up to a maximum dose of 80 Gy. The BTVs were created by thresholding the 18F-FDOPA uptake on PET/CT using a linear quadratic model that assumed tracer uptake was linearly related to tumour cell density in each image voxel and rounded the number of surviving tumour cells in each voxel to be the same. The treatment planning OARs were: brainstem, optics (combined optic nerves and chiasm), anterior chambers, and retinas. Dose conformity was quantified using van’t Reit’s conformation number. Mean OAR and maximum doses were compared using two-sided paired t tests (α = 0.05).

Results: The mean volume of the PTV receiving 95% of the prescribed dose (V95%) was 99.1% with and 99.1% without dose-escalation (p = 0.6). The average PTV conformation number was high for plans with (0.92) and without (0.93) dose painting. The mean V95% was 98.7% for BTV65, 94.6% for BTV70 and 97.2% for BTV75. The patient-averaged mean doses were 64.3 Gy for BTV65, 68.5 Gy for BTV70, and 73.9 Gy for BTV75. The patient-averaged maximum doses to the brainstem (43.6 Gy versus 44.5; p = 0.9), optics (25.8 Gy versus 25.9 Gy; p = 0.8), anterior chambers (5.8 Gy versus 5.9 Gy; p = 0.2) and retinas (8.7 Gy versus 8.6 Gy; p = 0.9) did not differ significantly between the types of plans.

Conclusions: Using commercially available treatment planning software, dose painting for high-grade gliomas was planned with good BTV coverage and no significant change in the dose delivered to OARs.

46 FACTORS AFFECTING ACCESS TO RADIOTHERAPY FOLLOWING PROSTATECTOMY FOR PROSTATE CANCER PATIENTS IN ONTARIO IN A CONTEMPORARY COHORT

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Purpose: Evidence-based guidelines confirm a survival advantage of adjuvant radiotherapy (ART) for prostatectomy (RP) patients with high-risk pathologic features. Delayed referral for salvage radiotherapy is under evaluation as an alternative strategy, and current Ontario guidelines recommend radiation oncology (RO) referral of high-risk cases for discussion of options. We sought to evaluate factors associated with referral and use of ART after RP for patients with adverse pathology in a recently diagnosed cohort.

Methods and Materials: This retrospective study used electronic treatment records linked to Ontario’s population-based cancer registry and pathology records. Multivariable regression analysis was used to evaluate clinical and health systems factors associated with radiation oncology (RO) consultation and ART use within six months post-RP.

Results: From January to November 2012, 2663 prostate cancer patients (mean age 61.3, s.d. 6.6 years) received RP in Ontario. Following RP, 1130 (42.3%) had at least one high-risk pathologic feature as a guideline indication for referral: extracapsular extension (ECE, 33.2%), seminal vesicle invasion (SVI, 10.1%), or positive margins (20.4%). Of these, 466 (41.2%) were seen by RO within six months of RP, of which 52.6% received ART. Of the 885 patients with adverse pathologic risk factors who did not receive ART, 75.0% were never assessed by RO. Multivariate analysis confirmed that RO assessment within six months was more frequent amongst patients with adverse pathology, including