P041 / #865 Upright body positioning for fixed beam radiotherapy: patient perspectives [abstract only]

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The pretreatment screening period will be 1 week, and the safety evaluation period will be 90 days after BNCT. Since iBNCT is a first-in-human device, the acute safety evaluation period: 35 days after BNCT will be used for confirmation. The efficacy evaluation period was set at a maximum of 24 months after BNCT was performed. If the patient is found to be PD by RANO criteria, the safety or efficacy evaluation period will be terminated, and the patient will be moved to the follow-up period to continue survival observation only.

The plan is to enroll 12 to 18 patients through a 3-step dose escalation process to determine the recommended dose.

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P039 / #547
ADVANCED TREATMENT PLANNING TECHNIQUES TO IMPROVE IMPT PLAN ROBUSTNESS LEVEL FOR GYN CANCER PATIENTS

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Background: Cervical cancer radiotherapy planning has always been difficult because of uncertainty caused by bladder and rectum filling. To account for the inter- and intra-fractional variations, the PTV encompasses most of the pelvis and includes a large portion of the bladder and rectum, causing many normal tissue complications. This creates additional challenges for IMPT planning with the extra uncertainties such as range. Our goal is to explore planning parameters to create robust plans that allow us to treat patients with minimal margins while still accounting for various uncertainties.

Methods: Two patients who have been treated clinically with VMAT were selected for this retrospective study. All plans were done in RayStation v12A. Patient 1(Pt1) is nodal reoccurrence case, and patient 2(Pt2) is whole pelvis case. Two IMPT optimization strategies were evaluated for each patient: Strategy 1(S1): With 3mm setup uncertainty and 3.5% range uncertainty for robustness optimization and optimization to cover PTV (CTV + 5mm), Strategy 2 (S2): with 5mm setup uncertainty and 3.5% range uncertainty for robustness optimization and optimization only to CTV (ITV). Plan robustness level was evaluated against patient's pitch and roll uncertainties for both IMPT plans and compared to the robustness level of clinical VMAT plans.

Results: While maintaining similar coverage to CTV(ITV) (V4500cGy > = 100%), the difference in field width of plan optimized with S1 is bigger than the one optimized with S2 (0.48cm and 1.03cm for P1 and P2, respectively), even though S2 have higher setup uncertainty. For both patients, S2 plans showed better robustness level for CTV coverage with 3mm setup uncertainty used for evaluation, 96% and 94.6% S2 vs 86.3% and 87.6% for S1. Another setup error of concern is pitch and roll variation during daily patient setup. S2 cases show generally better robustness level against pitch and roll setup errors than S1, and S2 robustness level is comparable to clinical VMAT plans.

Conclusion: Our study has shown that planning with higher setup uncertainty using the CTV instead of PTV resulted in smaller treatment area while maintaining target coverage and resulted in better robustness. We plan on proceeding with all cervical cancer treatment planning with S2 technique.

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P040 / #609
ENCOURAGING EARLY OUTCOMES OF PEDIATRIC PATIENTS RECEIVING VERTEBRAL-BODY-SPARING PROTON CRANIOSPINAL IRRADIATION WITH PENCIL BEAM SCANNING

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Background and aims: For skeletally immature children, proton craniospinal irradiation (CSI) is currently delivered to the whole vertebral body to avoid potential spinal abnormalities. Vertebral-body-sparing (VBS) proton CSI is a novel technique that spares the anterior vertebral bodies from the target volume and alleviates spinal growth inhibition. We aim to investigate the early spinal growth outcomes and acute toxicities of children treated with VBS protoncraniospinal irradiation utilizing pencil beam scanning (PBS).

Methods: Seventy-one pediatric VBS proton CSI patients treated between January 2019 and December 2022 were retrospectively evaluated. Early axial growth outcomes of forty-one patients were evaluated by magnetic resonance imaging (MRI) scans using Cobb angle calculations and clinical symptoms. All acute toxicity outcomes were evaluated by medical chart review.

Results: Median patient age at treatment was 6 years (range 2–16y), and histologies include 60 medulloblastoma, 2 germ cell tumor, 1 ependymoma, 2 AT/RT, 2 embryonic tumor and remaining 4 constituted other diagnoses. At median follow up of 19 months (range 6-45 mo), the overall survival (OS) rate and progression-free survival (PFS) rate were 95.8% and 90.1%, respectively. Among forty-one patients with imaging data, median radiographic follow-up was 14 months (range 5-43 mo) after radiation therapy initiation. The maximum Cobb angel measured by 2 trained physicians with MRI was 8.9°. No patients were clinically diagnosed with scoliosis or had experienced chronic back pain. For acute toxicities, 40 (56.3%) patients had grade ≥3 hematological toxicities; 3 (4.2%) patients had grade ≥3 gastrointestinal toxicities and 7 (9.9%) patients had any-grade esophagitis during the treatment.

Conclusions: VBS proton CSI with pencil beam scanning may not increase spinal abnormalities in our study and allow for vertebral column growth for children. Patients exhibited great tolerance to the treatment for a reduction in the dose to organs at risk. Long-term growth outcomes and prospective clinical trials are needed in the future.

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P041 / #865
UPRIGHT BODY POSITIONING FOR FIXED BEAM RADIOTHERAPY: PATIENT PERSPECTIVES

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Background: Interest is growing in combining fixed particle beamlines with rotating, upright patient positioners. Relative to gantries, such systems can reduce room costs/footprints. Positioning and immobilisation have been identified as important contributors to overall patient comfort during radiotherapy. Yet thus far little data has been published regarding patient perspectives on upright body positioning.

Methods: After Ethics Committee approval, in-person workshops were conducted with volunteers who had completed photon-EBRT for primary cancers of the breast (n = 10), prostate (n = 11) or head and neck (H&N, n = 11). Participants trialled a demonstration version of the Eve upright patient positioning system (Leo Cancer Care). Discussions were transcribed, and questionnaires were used to assess patient views on comfort associated with upright/supine body positioning. A separate online patient survey was disseminated with a video explaining the concept of upright radiotherapy. 73 individuals responded, having received radiotherapy for any indication.

Results: Patients start their radiotherapy having already experienced diverse care-pathways (surgery, chemotherapy, brachytherapy…), with/without co-morbidities (limited mobility, blood pressure issues, obesity…). Consequently, patient views on radiotherapy body-positioning are diverse and multifaceted (please see Table 1/Figure 1). Lying down for treatment was difficult for a subset of participants. Figure 1 shows some individual views, as captured by a live-drawing artist. Upright positioning was often associated with increased social connection with radiation therapists and ease of ingress/egress (Table 1). 100% of the H&N cohort reported difficulties in swallowing while lying down and 91% thought that it would have been easier to swallow upright. In the online survey (n = 73), when asked "what is your reaction to the possibility of upright radiotherapy, compared to conventional, lying down treatments?", 41% of respondents answered "Excited, upright treatments sound like they'd be more comfortable"; 41% answered "I'm not sure; I'd need to try the chair" and 18% answered "No thanks, I'd prefer to lie down". In-person and online, many patients emphasised that clinical treatment quality, rather than body-positioning/comfort, was their primary concern.

Conclusions: This study collected perspectives on upright radiotherapy comfort from 105 volunteers who had completed conventional radiotherapy. Consistently across four different cohorts, < 20% of participants indicated an overall preference for lying down, over upright positioning.

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P042 / #904

CHIMERIC IMMUNOMAGNETIC NANOIMAGING OF PANCREATIC AND GLIOBLASTOMA CANCER STEM CELLS FOR MULTI-IONIC ABLATION

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Background: Even after margin-negative resection, pancreatic cancer (PDAC) and glioblastoma (GBM) undergo inelcutable recurrence and terminal progression due to exceptionally agressive cancer stem cells (CSCs). Super paramagnetic iron oxide nanoparticles (SPIONs) engineered to target CSC biomarkers enable clinical detection under MRI. By these means, multi-ionic ablation of minimized target volumes can achieve clonogenic extinction of PDAC-/GBM-CSCs without jeopardizing critical organs-at-risk (OARs).

Methods: SPIONs are synthesized via standard methods including co-precipitation and magnetotactic bacteria derivation enabling modular SPION geometries, then undergo surface coating for bio-optimization. SPION surface conjugation of PDAC-/GBM-CSC homing moieties using dimethyl aminopropyl carbodiimide and hydroxysuccinimide chemistry generates chimeric immunomagnetic nanosensors (CINs). Post-conjugation validation is via HPLC and NMR spectroscopy. Organoid models assay candiate SPION geometry/conjugate species combinations. Multi-ionic Monte Carlo modeling derived from SHArc and IMPACT is applied to CIN/organoid imaging and patient hypoxia imaging to simulate CSC-subregion LET painting.

Results: We demonstrate that application of cysteine-containing zwitterionic coating prevents biomolecular corona formation, the principal obstacle to generic nanoparticle (NP) throughput. AC133, AC141, CD44/CD44v6, SOX2, OCT4, CD109, etc., are shown to be effective NP-homing targets for PDAC-/GBM-CSCs. Aptamers improve upon mAbs due to sensitivity to splicing isoforms and greater CIN surface moiety-saturation ensuring specific, geometrically accurate T2 contrast signal above detection threshold with sub-millimeter spatial precision under 3T MRI. Modeled multi-ionic LET painting including helium, oxygen, and neon ions potentiates at-will dose/LET escalation to CIN-delineated organoid micro-targets and ^{18}F-FMISO-defined hypoxic subregions with steep gradients de-escalating parenchymal tumor irradiation and sparing OARs.

Conclusions: High LET irradiation is the only modality known to sterilize PDAC-/GBM-CSCs and reverse epithelial-mesenchymal-transition. However, no means of imaging CSCs for focal heavy particle target acquisition exists. Moreover, dose/LET thresholds for PDAC-/GBM-CSC eradication are suggested by CIRT data to be considerably higher than presently prescribed and untenably destructive to adjacent tissue. Consequently, the need to balance tumor coverage with OAR constraints in the absence of CSC delineation ensures insufficient clinical dose/LET delivery to CSCs. CIN-based target acquisition solves this problem, enabling safe delivery of CSC-extirpating ion combinations. This novel strategy holds promise to extinguish recurrence and improve survival in PDAC, GBM, and other seemingly intractable malignancies.

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