field MR-Linac. In addition to 4D-MRI, the high-performance architecture facilitates clinical use of other advanced MRI techniques (e.g., MR fingerprinting). Future work will focus on developments to further speed up image reconstruction.

Abstract 61; Table 1 Cumulative total time-to-image [min'sec]

Base Resolution	256x256	192x192	160x160	144x144	128x128
Motion-Averaged	6'31	4'38	4'5	3'39	3'17
Mid-Position	8'55	6'4	5'12	4'35	4'9
Respiratory Phases	11'46	8'40	7'46	7'1	6'44

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Imaging-driven Biophysical Model for the Differentiation of Tumor Progression from Radiation Necrosis

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Purpose/Objective(s): This project validates the ability of a novel clinical imaging-driven biophysical model to predict the etiology of enhancing lesions following stereotactic radiosurgery (SRS) for brain metastasis (BM). These lesions present enormous clinical challenges as clinical symptoms and radiographic findings for radiation necrosis (RN) and tumor progression are often indistinguishable. We hypothesized that our model for differentiating RN from tumor progression could be validated in a large-scale retrospective cohort study.

Materials/Methods: A prospectively maintained database at our institution with 73 patients with 78 BM treated with SRS and histologically confirmed RN or tumor progression were retrospectively assessed using our biophysical model. Briefly, a reaction-diffusion logistic growth model mechanically coupled to the surrounding tissue was used to extract tumor cell proliferation rate and diffusion coefficients based on fitting areas of post-contrast *T1*-weighted MR enhancement observed during serial imaging time points. The model was then used to calculate mass effect due to the mechanical stress field incurred during lesion expansion. The Dice similarity coefficient was used to quantify the similarity of the model-estimated stress field with the edema front visualized in FLAIR imaging. These metrics for prediction of tumor progression versus RN were evaluated using a receiver operating characteristic curve and compared to standard radiographic morphometric analysis including the change in the longest dimension of the lesion, change in the volume of the lesion, and FLAIR/*T1* lesion quotient.

Results: Standard radiographic morphometric analysis of the serial post-contrast *T1*-weighted enhanced and FLAIR images reflected poor ability to differentiate between tumor progression and RN for the change in the longest dimension of the lesion (ROC AUC = 0.73, 95% CI: 0.61 − 0.85, p = 0.0009, 74% sensitivity and 63% specificity), change in lesion volume (ROC AUC 0.61, 95% CI: 0.47 − 0.75, p = 0.1262, 43% sensitivity and 64% specificity), and FLAIR/*T1* lesion quotient (ROC AUC = 0.55, 95% CI: 0.41 − 0.69, p = 0.4723, 77% sensitivity and 43% specificity). Conversely, parameters derived from our imaging-driven model were able to differentiate lesion etiology with excellent accuracy for tumor cell proliferation rate (ROC AUC = 0.86, 95% CI: 0.76 − 0.95, $p < 0.0001$, 74% sensitivity and 95% specificity) and Dice similarity coefficient associated with high model-estimated mechanical stresses (ROC AUC = 0.93, 95% CI: 0.86 − 0.99, $p < 0.0001$, 81% sensitivity and 95% specificity).

Conclusion: In patients with BM treated with SRS, our model demonstrated excellent accuracy for differentiating enhancing lesions and significantly outperforms standard radiographic assessment of image morphometric features.

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Acute Toxicity Patterns in Adaptive High Precision Radiotherapy for Head and Neck Cancer - a Randomised Controlled Trial

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Purpose/Objective(s): Adaptive Radiation therapy (ART) aims to take into account the changes in target volume and organs at risk during the course of fractionated radiation therapy & this has possible advantage in terms of improved local control, reduced toxicities and improved the QOL. This study aims to assess the clinical impact of ART in terms of toxicities in primary SCC of HNC undergoing radical/adjuvant concurrent chemo-radiotherapy treatment.

Materials/Methods: The study enrolled 100 patients of histopathologically proven primary head-and-neck cancer and were randomized into ART and non-ART arms. Target/OAR delineation was done after CT simulation following rigid immobilization. All patients were started treatment with VMAT & image guidance. After treatment start, the patients were re-simulated using CT imaging again at 3rd, 5th and 7th week. Predefined adaptive re-contouring workflow using deformable image registration was applied to generate adaptive plan. For patients in ART Arm, the new plan was executed for the remaining fractions. In Non ART Arm treatment was continued as per the original plan. All the patients were observed for total volume of Parotid glands at week 1, 3, 5 and 7. RTOG Criteria was used for documenting acute reactions in form of acute xerostomia, mucositis and dysphagia in both arms at week 3, 5 and 7. Median follow-up was 6mo.

Results: The percentage volume change in parotid glands was observed to be 6.25%, 16.37% and 28.39% in adaptive arm and 11.53%, 23.54% and 32.56% at 3, 5 and 7 weeks (P-value 0.009 and 0.0123rd and 5th wk respectively). On clinical examination Grade 2 Xerostomia at 3, 5 and 7 wk was seen in 10%, 36% and 70% patients in adaptive arm whereas in 16%, 46% and 88% in non-adaptive arm (P-value 0.006 at 7th wk). The significant difference in mucosal reactions between both arms was observed throughout the course of study in favour of adaptive arm. None of the patients in adaptive arm had Grade 3 mucosal reactions as compared to 26% in non adaptive arm. The difference in mucosal reaction was most significant at 7th week of treatment (p value 0.004). At week 3 and 5, patients having grade 2 or higher reactions were 14% and 46% in adaptive arm as compared to 26% and 70% in non-adaptive arm. (p values 0.029, 0.023). Dryness of mouth has a significant impact on swallowing. In our study we observed grade 2 or higher dysphagia to be 6%, 38% and 80% in adaptive arm whereas 2%, 48% and 84% in non-adaptive arm at 3, 5 and 7 weeks. Though absolute number of patients having adverse dysphagia reaction was lower in adaptive arm, this difference was not statistically significant (p value 0.15, 0.59, 0.09).

Conclusion: Volume changes in parotid glands and gross tumour is observed throughout the course of radiation treatment and ART can aid in better sparing of parotid glands with an advantage over non-ART in terms of reduced acute toxicity reactions. Present study is first RCT reported in literature where an attempt is made to correlate dosimetric and toxicity criteria.

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Effective Volume of Parotid Glands for Assessing Radiation Injury during Radiation Therapy for Head and Neck Cancer

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