treatment-related progression also known as pseudoprogression(PsP). Usually, PSP resolves or stabilizes without further treatment, whereas a true progression (TP) requires more aggressive management. Identifying PSP from TP will affect the patient's treatment plan. Conventional magnetic resonance imaging (MRI) reading techniques cannot distinguish these entities. This study investigated the feasibility of using deep learning to distinguish PsP from TP. METHOD: We included GBM patients who met our inclusion criteria. We evaluated all cases to see if they had a new enhancing lesion within the original radiation field or an increase in the size of an existing lesion. The challenging MRIs were collected. Clinical notes regarding tumor and recurrence location, clinical history, and medication were collected. We labeled the ones who stayed stable or improved in the imaging and clinical situation as PSP and those with further imaging and clinical deterioration as TP. We coregistered Contrast-enhanced-T1 MRIs with T2-weighted images for each patient. We performed five-fold cross-validation to generalize the performance. We trained A 3-D Densenet121 model to establish the prediction. We selected the best models with the highest accuracy. RESULT: After reviewing 1000 patients, we included 124 patients whose imaging showed suspicious progression and their medicational histories were completely retrievable; 63 PsP, and 61 TP. We developed a deep learning model based on the whole dataset. The 5-fold cross-validation revealed that the mean area under the curve (AUC) was 0.81. CONCLUSION: We report the development of a deep learning model that diagnoses PsP from TP in patients who received temozolomide. Further refinement and external validation are required prior to widespread adoption in clinical practice.

NEIM-03

A MULTICENTER PHASE 3 TRIAL IN PROGRESS: DIAGNOSTIC PERFORMANCE OF ^{18}F-FLUCICLOVINE PET FOR THE DETECTION OF RECURRENT BRAIN METASTASES AFTER RADIATION THERAPY (REVELATE)

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INTRODUCTION: Following treatment of brain metastases, which can affect up to 40% of patients with cancer, patients will typically be closely monitored with serial brain magnetic resonance imaging (MRI) owing to the high likelihood of recurrence. The recommended follow-up modalities (CE-T1-weighted and FLAIR/T2-weighted MRI) have poor specificity, meaning that differentiation of true disease from treatment-related changes such as radiation necrosis can be difficult. Recent pilot studies have reported amino acid PET radiopharmaceutical, ^{18}F-fluciclovine, to be potentially useful in discriminating tumor recurrence from treatment-related changes. This may potentially aid physicians in making confident diagnoses and inform subsequent treatment plans. METHODS: REVELATE (NCT04410133) will evaluate the diagnostic performance of ^{18}F-fluciclovine PET (read with conventional MRI for anatomical reference) for the detection of recurrent brain metastases in patients for whom MRI is equivocal. This multicenter, phase 3, prospective, open-label trial aims to enroll approximately 150 subjects from across 19 US sites with solid tumor brain metastases who have undergone radiation therapy, if they have a lesion considered equivocal on MRI that requires further confirmatory diagnostic procedures (either biopsy/neurosurgical intervention or clinical follow-up). Patients will undergo ^{18}F-fluciclovine PET <42 days after the equivocal MRI and 1–21 days pre-biopsy/neurosurgical intervention. Clinical follow-up will occur for 6m post-^{18}F-fluciclovine PET. Secondary objectives include evaluation of subject- and lesion-level ^{18}F-fluciclovine negative and positive percent agreement (equivalent to specificity and sensitivity, respectively) for recurrent brain metastases, inter-reader and intra-reader agreement, and safety evaluations. Enrolment began in October 2020 and the trial is active but not recruiting at the time of submission.

NEIM-04

LEVERAGING NOVEL NEUROIMAGING TECHNIQUES TO LINK BRAIN METASTASES AND LOCAL GENE EXPRESSION.

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Metastases are the most prevalent adult brain tumour, most commonly arising from lung, breast, or melanoma primaries. Studies have suggested that different primary tumor types may have predilection for seeding to specific brain regions. One hypothesis is that the interaction of the genomic environment within specific brain region(s) and seeding tumor cells is ideal for supporting this process. The recent availability of neuroimaging based transcriptomic atlases make it feasible to test this hypothesis. In this proof-of-concept study, we leverage the Allen atlas to evaluate whether variance in location among different tumour subtypes can be explained by normative gene expression. Manual segmentation was done on contrast-enhanced T1-weighted MRIs in 31 patients with brain metastases and known primary tumour [breast (n=7), lung (n=14), genitourinary (n=5) and melanoma (n=5)]. Segmented lesions were transformed to template brain space. First, odds-ratio maps were created for each primary tumour subtype. These maps delineate brain regions that were preferentially engaged by each subtype. Consistent with prior literature, odds-ratio maps demonstrated a preference for metastases to seed to different brain regions according to primary tumour subtype, e.g. lung - cerebellum, melanoma - frontal and temporal lobes. Next, mapping our lesions on the Allen atlas of normative gene expression, we identified significant ($p<0.01$) differences in the local expression of certain genes– such as LEPROT and ITPKA – related to the spatial pattern of breast, lung, genitourinary, and melanoma. This novel approach integrates imaging and transcriptomic techniques that could be used towards an improved understanding of neuro-oncologic processes. Crucially, this approach would allow investigators to leverage conventional anatomical images – acquired as part of a patient's normal clinical course and in the absence of tissue samples – to better understand cancer mechanics. This has potential ramifications for therapeutic decision-making. Large-scale prospective studies are underway.

NEIM-05

FEASIBILITY OF NAVIGATED TRANSCRANIAL MAGNETIC STIMULATION (NTMS) BASED DIFFUSION TENSOR IMAGING (DTI) TRACTOGRAPHY OF MOTOR PATHWAYS IN PATIENTS UNDERGOING STEREOTACTIC RADIOSURGERY: A CROSS-SECTIONAL DOSIMETRIC AND PATIENT OUTCOMES ANALYSIS

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BACKGROUND: No current dose limitations exist for the motor tracts during stereotactic radiosurgery (SRS) planning due to challenges in localizing this region of interest by conventional imaging. Navigated Transcranial Magnetic Stimulation (nTMS) is a non-invasive tool that utilizes electromyographic signal combined with magnetic resonance diffusion tensor imaging (DTI) to functionally map cortical motor tracts. Although nTMS is utilized for functional mapping prior to brain tumor resection, it has not been implemented in SRS planning. OBJECTIVES: To determine the feasibility of performing nTMS-based DTI in patients treated with SRS and examine the relationship between dose to functionally-defined motor tracts and patient outcomes measured by objective hand function testing and patient reported outcomes (PROs). METHODS: 16 patients treated with SRS to a brain metastasis located near anatomically-defined motor tracts were enrolled on an IRB-approved clinical trial. At median follow-up of 5.4m after SRS, patients underwent nTMS testing, brain MRI with DTI, functional outcomes testing (Pinch Dynamometer,9-Hole Peg Test), and quality-of-life (QOL) PROs (EQ-5D-5L, MDASI-BT). nTMS-seeded DTI tractography was generated (Brainlab iPlan) and imported into GammaPlan for dosimetric evaluation. RESULTS: Tractography reconstitution was attempted for 8/16 patients and successful in 7/8 (87.5%). One patient who had prior resection of a lesion in the right pre-central gyrus failed to map in the right cortex and was unable to complete functional testing for the affected extremity. Median D_{max} to the treated motor tracts was 4.6Gy [0.5-13.4Gy]. Median D_{mean} was 0.9Gy [0-1.2Gy]. Increased D_{max} correlated with deficits in lateral pinch strength (R^2=0.76) and 9-Hole Peg testing time (R^2=0.61). Increased D_{mean} correlated with increased MDASI-BT interference scores (R^2=0.93) and EQ5D5L score (R^2=0.94) indicating worsened QOL. CONCLUSIONS: nTMS testing was feasible and dose to nTMS-defined motor tracts correlated with subjective and objective patient outcomes. Future steps will include characterization of motor tract dose tolerance for SRS.

NEIM-06

COMBINING CLINICAL VARIABLES AND RADIOMIC FEATURES TO HELP DISTINGUISH RADIATION NECROSIS FROM TUMOR IN PATIENTS WITH MELANOMA BRAIN METASTASES TREATED WITH RADIOSURGERY

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BACKGROUND: Following Gamma Knife SRS (GK-SRS), the conventional imaging characteristics of radiation necrosis (RN) mimic those of tumor progression, introducing considerable uncertainty in diagnosis. Previous studies have identified clinical variables associated with RN; however, diag-