or in the peritumoural oedema. FSL and MRTrix software were used for tracking, in each patient, CST (hand, foot and lips component), AF and OR using the same regions of interest. Qualitative evaluation of the agreement between the two methods was performed by two experienced observers in consensus. RESULTS: The tracts identified: Were comparable for: CST-foot in 8(5) out of 11(8) cases in groupA (B); CST-hand in 6 out of 8 cases in groupB; Had less false positives in MRTrix for: CST-hand in 7 out of 11 cases in groupA; CST-lips in 5(6) out of 8(8) cases in groupA (B); AF in 4(8) out of 7(9) cases in groupA (B); Were more accurate in FSL for: OR in 6(6) out of 6(7) cases in groupA (B). CONCLUSIONS: The accuracy of the tracts is comparable for most fascicle identification, with the exception of MRTrix presenting less false positives for AF in groupB, CST-hand in groupA and CST-lips in groupsA and B; and FSL identifying more accurately the OR in both groups.

RAMAN SPECTROSCOPY: A NOVEL TOOL FOR INTRAOPERATIVE GUIDANCE IN SURGICAL NEURO-ONCOLOGY

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INTRODUCTION: Raman spectroscopy offers an optical label-free and non destructive real-time solution for tissue identification and surgical guidance during Neurosurgery for brain tumours. We evaluate a novel fibre optic point-measurement system during its first use during surgery in a consecutive series of 30 patients with a range of brain tumors. **METHODS:** Raman spectroscopy was deployed using a surgical protocol in this single centre study of 30 consecutive craniotomies for tumor. Analysis of tissue was done in-vivo during surgery at the brain surface, on route to the tumor and in superficial and deep tumor zones. Sampling was also performed along the resection margin and all spectra were compared to matched core biopsy samples verified by routine histopathology. Ex-vivo tissue analysis was also performed at different time points to look at change in tissue signal characteristics over time. **RESULTS:** Over 3,000 Raman spectra from the brain were recorded. Multivariate analysis using PCA/LDA was performed. Most easily identified tumors include meningiomas and metastases. Low grade and high grade gliomas were also identified with high accuracy. **CONCLUSIONS:** Raman spectroscopy represents a new modality for in-vivo tissue characterisation with high accuracy. It has the ability to rapidly recognise healthy brain tissue and tumour tissue and could be a valuable tool aiding complete resection of low grade lesions in eloquent brain regions. Current challenges to more widespread adoption include the modifications necessary for it to work in the OR and patient-patient and machine-machine variability.

EVALUATION OF RESPONSE TO STEREOTACTIC RADIOSURGERY IN BRAIN METASTASES USING MULTI PARAMETRIC

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Purpose Conventional MRI methods are insufficient to accurately differentiate between local tumour recurrence and radiation-induced necrosis. Advanced MRI techniques such as perfusion imaging, diffusion imaging and spectroscopy have individually been shown to aid the assessment of response following SRS treatment of brain metastases [1–3]. However, the potential added-value of a multi-parametric approach using a combination of these techniques has not been investigated. Materials and Methods A retrospective analysis was performed on 10 multi-parametric MRI examinations following SRS for metastatic brain lesions in a cohort of 7 patients with varying primary malignant diseases (melanoma, n=3; breast, n=3; small cell lung, n=1). Multi-parametric MRI examination consisted of dynamic susceptibility contrast (DSC) perfusion imaging, diffusion weighted imaging (DWI) and both single- and multi-voxel MR spectroscopy (MRS) (TE = 30 ms). Relative cerebral blood volume (rCBV) and apparent diffusion coefficient (ADC) maps were calculated from DSC and DWI data respectively using Siemens Syngo software and an rCBV ratio (lesion: contralateral) calculated. Analysis of MRS was performed using TARQUIN [4]. Correlations between rCBV ratio, ADC and Cho:Cr were investigated. Predictions of response based on each parameter were tested using radiological and clinical follow up. Results Cho:Cr demonstrates a strong positive correlation with rCBV ratio ($r = 0.89$, $p < 0.01$). This is in agreement with previous work in pre-treatment metastases [5]. No significant correlations were observed between ADC and rCBV or Cho:Cr. Applying a reported threshold for rCBV ratio of 2.1 [1], patients were divided into two groups showing suspected tumour recurrence (n=4) and suspected radiation necrosis (n=3). Conclusion Preliminary results suggest that a combination of high rCBV, low ADC and high Cho:Cr can clearly identify local tumour recurrence and that multi-parametric MRI may show improved accuracy compared with any of the techniques in isolation.

MUTATIONAL LANDSCAPE OF PRIMARY AND RECURRENT GLIOBLASTOMA REVEALS POTENTIALLY ACTIONABLE SNVS INCLUDING WNT PATHWAY VARIATION

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We used Next-Generation sequencing (NGS) panels to examine somatic variation in a cohort of 41 patients, 8 of which had matched primary biopsies and recurrent biopsies from subsequent tumour resection. 38/41 (92%) of the initial tumours harbour at least one variation in a gene which interacts with the RTK/Ras/PI(3)K pathway. 6/41 (15%) of initial tumours have an SNV in the IDH pathway. 27/41 (66%) of the initial biopsy samples have at least one SNV in the Wnt signalling pathway. 29/41 (71%) of initial tumours have at least one SNV in the p53 DNA damage repair pathway, and 12/41 (29%) have an SNV in the Rb cell-cycle regulation pathway. 3/41 (7%) of initial tumours have an SNV in the Nodal TGF- β signalling pathway for chromatin remodelling and pattern development, and 3/41 (7%) samples have a G-protein gene variation. Of the recurrent tissue samples, 6/8 (75%) have at least one somatic gene variation in the RTK/Ras/PI(3)K pathway, and 2/8 (25%) samples have an SNV in the IDH pathway. 3/8 (37.5%) have an SNV in the WNT signalling pathway, 4/8 (50%) have an SNV in the P53 pathway and no variation was identified in the Rb pathway. In 1/8 (12.5%) recurrent samples had an SNV in the Nodal TGF- β signalling pathway was identified, and 2/8 (25%) have a G-protein gene variation. Of the initial biopsy samples, 19/41 (46%) harboured at least one potentially actionable SNV. Of the recurrent tissue samples, 4/11 (36%) had at least one actionable SNV. Of the matched recurrent tumours, 6/8 (75%) contain SNVs that were present in the second tumour, as well as variation lost and gained. In 2/8 (25%) recurrent tumours, variation does not appear to correlate with the initial tumour. In conclusion, mutational analysis of primary and recurrent glioblastoma reveals potentially actionable SNVs including WNT pathway variation.

QUANTIFICATION OF TUMOUR MICROSTRUCTURE IN LOW AND HIGH-GRADE BRAIN TUMOURS USING VERDICT MRI: AN INITIAL FEASIBILITY STUDY

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INTRODUCTION: VERDICT (Vascular, Extracellular, and Restricted Diffusion for Cytometry in Tumours) MRI is a diffusion imaging technique which gives information about tumour microstructure beyond ADC measures and structural imaging. VERDICT uses a three-compartment mathematical model to estimate tissue parameters such as cell density, radius and vascular perfusion, and can differentiate malignant prostate cancer from benign pathology. We report the first application of VERDICT to human brain tumours, where we characterise a mix of low and high-grade gliomas. **METHODS:** 9 untreated patients with brain tumours (3 glioblastoma, 1 metastatic carcinoma, 3 astrocytoma, 2 oligodendroglioma) were scanned at 3T (Achieva, Philips). Multi b-value (9 shells from $b = 80\text{--}3000\text{ s/mm}^2$) diffusion MRI was conducted in combination with a 15-direction DTI scan. Acquisition time was 12 minutes. A three-compartment mathematical model was applied consisting of a 'Sphere' to represent restricted diffusion in cells, a 'Ball' to represent isotropic diffusion and a 'Stick' to represent vascular diffusion. VERDICT parameter maps were generated based on these compartments. **RESULTS:** ADC was highest in GBMs, whilst astrocytoma and oligodendroglioma had comparable mean ADC and metastatic carcinoma demonstrated the lowest ADC. VERDICT parameter maps in GBMs showed a rim of increased cellular density parameter compared to the centre, consistent with a necrotic core and showed areas of increased signal in the peri-tumour zone suggestive of increased cellular density. Astrocytoma VERDICT parameter maps also showed areas of increased signal within the tumour, suggesting that VERDICT may be more sensitive to tumour microstructure compared to conventional imaging. **CONCLUSION:** VERDICT is feasible in human gliomas and potentially provides information on internal tumour microstructure. We are currently working on further validation with detailed histological analysis and optimisation of scan times to develop a clinically viable sequence that could potentially have important implications for pre-surgical planning and assessment of therapeutic response.

A GBM INVASIVE REGION EXPRESSION PROFILE IDENTIFIED THROUGH A MULTI-REGION SAMPLING APPROACH

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INTRODUCTION: Maximal surgical resection for the malignant brain tumour Glioblastoma (GBM) inevitably leaves residual disease that