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Pipeline for Measuring Residual Tumour Volume in Patients with Glioblastoma Based on a Diffusion Tensor Tissue Signature

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INTRODUCTION

Glioblastoma (GBM) is the most common malignant primary brain tumour in adults. It has a poor prognosis despite surgery and chemoradiotherapy, with a median overall survival of 8 months in the latest CBTRUS report 2016-2020. [1] Among the major prognostic factors, extent of resection (EOR) is an important modifiable one. Gross total resection (GTR) is associated with longer overall survival and progression-free survival. The latest Response Assessment in Neuro-Oncology (RANO) categories found that post-operative residual tumour volume was negatively associated with patient outcomes and the prognostic value was independent from clinical and molecular markers. [2,3]

Therefore, our study aimed to set up a pipeline for measuring pre-operative and post-operative brain volumes and tumour volumes based on anatomical magnetic resonance imaging (MRI) brain and diffuse tensor imaging (DTI) images. This pipeline would allow subsequent analysis of the association between residual tumour volume and patient outcomes.

Pre-operative and post-operative MRI brain images, including T1 contrast and DTI, were obtained from patients recruited in the 'Predicting Sites of Tumour Progression in the Invasive Margin of Glioblastomas' (PRaM-GBM) trial. The diffusion tensor tissue signature involved the splitting of tensor information into isotropic diffusion (p) and anisotropic diffusion (q) components.

REFERENCES

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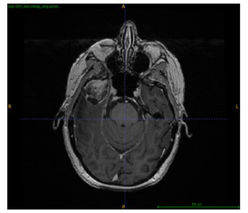
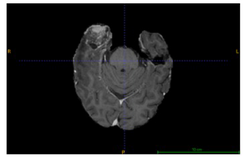
PIPELINE

Brain extraction → Co-registration → Manual segmentation → Calculation of volumes

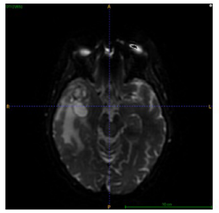
1. Automated brain extraction



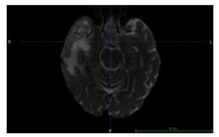
HD-BET [4]



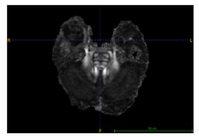
MRI T1 contrast



FSL [5]

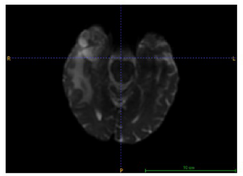


DTI

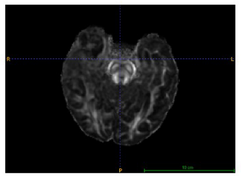


q-map

2. Co-registration of DTI to T1 contrast by FLIRT



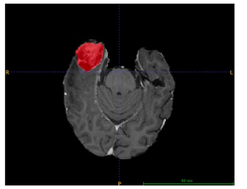
Co-registered DTI



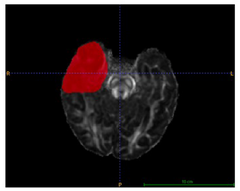
Co-registered q-map

PIPELINE (CON'T)

3. Manual segmentation on ITK-SNAP



Tumour mask on T1 contrast



q-mask (i.e. q abnormality) on DTI

4. Calculation of volumes

(1) Pre-operative brain volume, excluding CSF spaces and contrast-enhancing tumour

(2) Post-operative brain volume, excluding CSF spaces and contrast-enhancing tumour

(2) – (1) = **(5) Volume of resected non-enhancing tissue**

(3) Pre-operative T1 contrast-enhancing tumour volume → (3) + (5) = **(6) Overall resection volume**

(4) Pre-operative q-abnormality-defined tumour volume → (4) – (6) = **(7) Post-operative residual tumour volume defined by the q abnormality**