Title

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Data Article

ADC, D, f dataset calculated through the simplified IVIM model, with MGMT promoter methylation, age, and ECOG, in 38 patients with wildtype IDH glioblastoma

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ABSTRACT

Patients undergoing standard chemoradiation post-resection had MRIs at radiation planning and fractions 10 and 20 of chemoradiation. MRIs were 1.5T and 3D T2-FLAIR, pre- and post-contrast 3D T1-weighted (T1) and echo planar DWI with three b-values (0, 500, and 1000s/mm^2) were acquired. T2-FLAIR was coregistered to T1C images. Non-overlapping T1

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contrast-enhancing (T1C) and nonenhancing T2-FLAIR hyperintense regions were segmented, with necrotic/cystic regions, the surgical cavity, and large vessels excluded. The simplified IVIM model was used to calculate voxelwise diffusion coefficient (D) and perfusion fraction (f) maps; ADC was calculated using the natural logarithm of $b = 1000$ over $b = 0$ images. T1C and T2-FLAIR segmentations were brought into this space, and medians calculated. MGMT promoter methylation status ($MGMT_{PMS}$), age at diagnosis, and Eastern Cooperative Oncology Group (ECOG) performance status were extracted from electronic medical records. The data were presented, analyzed, and described in the article, "Intravoxel incoherent motion (IVIM) modeling of diffusion MRI during chemoradiation predicts therapeutic response in IDH wildtype Glioblastoma", published in Radiotherapy and Oncology [1].

Specifications Table

Subject	Radiology and Imaging
Specific subject area	Median nonoverlapping T1C and T2-FLAIR of ADC, D, and f values, and clinical variables, are provided from 38 patients with IDH wildtype glioblastoma.
Type of data	Table
How data were acquired	MRI data was acquired on a single 1.5T Philips Ingenia system (Philips Medical Systems, Best, The Netherlands) at the specified timepoints. Segmentation was performed semi-automatically using Amira 2019.2 (Thermo Fischer Scientific, Berlin, Germany). Parametric maps were calculated using an in-house code developed in MATLAB 2018 (MathWorks, Natick, MA, USA). Voxels with values of $f < 0\%$ or $f > 30\%$ were considered non-physiological and excluded.
Data format	Raw
Parameters for data collection	Data were acquired following written consent from all patients. All patients underwent gross or subtotal resection, or biopsy. Patients with histologically proven, IDH wildtype glioblastoma who were undergoing and completed a standard course of chemoradiation (60 Gy in 30 fractions over 6 weeks) were included.
Description of data collection	T2-FLAIR images were coregistered to T1C for segmentation. Non-overlapping enhancing T1C and nonenhancing T2-FLAIR hyperintense regions were segmented semi-automatically, with necrotic/cystic regions, the surgical cavity, and large vessels excluded. Parametric maps were calculated voxelwise, with ADC calculated using the natural logarithm of $b = 1000$ over $b = 0$ images, and using the simplified IVIM model for D and f. Age at diagnosis, ECOG performance status, extent of resection, IDH status and $MGMT_{PMS}$ were extracted from electronic medical records.
Data source location	Institution: University of Toronto City/Town/Region: Toronto, Ontario Country: Canada
Data accessibility	With the article Images are held at the institution. Requests for access can be submitted to the corresponding author at pejman.maralani@sunnybrook.ca, and approval granted following standard institutional policies (https://sunnybrook.ca/research/content/?page=sri-crs-reo-faq-contractsagreements). Briefly, this requires: 1. Projects to be approved by the local host institution REB; 2. A data/material transfer agreement be executed

(*continued on next page*)

Related research article	P. Jabehdar Maralani, S. Myrehaug, H. Mehrabian, A.K.M. Chan, M. Wintermark, C. Heyn, J. Conklin, B.M. Ellingson, S. Rahimi, A.Z. Lau, C-L. Tseng, H. Soliman, J. Detsky, S. Daghighi, J. Keith, D.G. Munoz, S. Das, E.G. Atenafu, N. Lipsman, J. Perry, G. Stanisz, A. Sahgal. Intravoxel incoherent motion (IVIM) modeling of diffusion MRI during chemoradiation predicts therapeutic response in IDH wildtype Glioblastoma. Radiother Oncol. https://doi.org/10.1016/j.radonc.2020.12.037

Value of the Data

- There is a paucity of literature in this topic, and even less publicly available datasets providing *D* and *f* data generated using the simplified IVIM model. These data will be helpful for future analyses.
- Research projects investigating the use of IVIM models and/or ADC that include publicly available data may benefit from this data.
- These data may be used, or reused, in research that involves IVIM parameters for comparative reasons, or to incorporate them as part of a larger dataset.

1. Data Description

The dataset consists of **one** Excel file. The Excel file contains the raw data and includes:

- Patient ID
- When, relative to a standard 6 week/30 fraction chemoradiation regimen, MRIs were acquired (either radiation planning, fraction 10, or fraction 20)
- Values from T1C and T2-FLAIR for each map:
  - ADC, with units $x10^{-3}$ mm^2/s
  - *D*, with units $x10^{-3}$ mm^2/s
  - *f*, with percentage value shown
- ECOG, $MGMT_{PMS}$, extent of resection, age at diagnosis
- Progression-free survival (PFS), relative to the date baseline radiation MRI was acquired
- Overall survival (OS), relative to the date baseline radiation MRI was acquired

MRI acquisition parameters can be found in Table 1 of the related research article [1].

2. Experimental Design, Materials and Methods

2.1. Patient population

A total of 50 consecutive patients with a potential new high-grade glioma diagnosis on neuroimaging were considered for recruitment. All 50 cases underwent either surgical resection or biopsy. After pathologic examination, a total of 12 patients were excluded: four cases had a pathologic diagnosis of glioma WHO grade II or III; three withdrew; three discontinued chemoradiation; one patient was excluded as they progressed with treatment interruption; and one had an IDH mutation. This resulted in a total of 38 patients with a diagnosis of IDH wildtype glioblastoma included in the final cohort. Prognostic factors such as age at diagnosis, Eastern Cooperative Oncology Group (ECOG) performance status, extent of resection, IDH status and MGMT promoter methylation status were extracted from the electronic medical record.

Table 1
MRI acquisition parameters.

Sequence[a]	TR (ms)	TE (ms)	IR(ms)	Flip Angle (°)	Field of View (cm^2)	Slice thickness (mm)	Spacing between center of slices (mm)	In-plane resolution (mm^2)	Acquisition Matrix	Number of averages	Acquisition time (min)
Multi-slice DWI	6800	73.7	N/A	90	24 × 24	5	5	0.83 × 0.83	211 × 165	Variable[b]	~2
3D T2-FLAIR[c]	4800	291	1650	90	25 × 25	2	1	0.55 × 0.55	216 × 216	2	~5.2
3D T1[c,d]	6.2	2.3	N/A	24	24 × 24	2	1	0.5 × 0.5	240 × 240	2	~5.3

[a] All sequences had no gap between slices.
[b] b=500 and 1000 s/mm^2 were trace-weighted and performed in three orthogonal directions. 2 signal averages of 3 orthogonal directions (= 6 total scans) at b=500 and 3 signal averages of 3 orthogonal directions (= 9 total scans) at b=1000 were performed. No trace-weighting was performed at b=0 s/mm^2.
[c] There was overlap between neighboring slices for both 3D T2-FLAIR and 3D T1.
[d] Acquired before and after intravenous injection of 0.1 mmol/kg of Gadobutrol (Bayer, Mississauga, Canada) followed by a 20 mL saline flush.

2.2. MR imaging acquisition

All patients were scanned on a single 1.5T Philips Ingenia system (Philips Medical Systems, Best, The Netherlands). Acquisition parameters are further described in the Data Description and Table 1 of the related research article.

2.3. Image co-registration and segmentation

T2-FLAIR images were coregistered to T1 post-contrast (T1C) images using Elastix registration software [2]. Volumes of interest (VOIs) were then manually delineated, using assistance from the semiautomatic thresholding software Amira (version 2019.2, Thermo Fischer Scientific, Berlin, Germany). The VOIs consisted of the T1 enhancing regions and surrounding nonenhancing FLAIR hyperintense regions on the coregistered T1C and T2-FLAIR images, respectively. Areas of intrinsic T1 hyperintensity representing hemorrhagic material were not included in T1C contour delineations. This was achieved by slice-by-slice comparison with pre-contrast images during VOI contouring. The T1C regions were subtracted from the FLAIR hyperintense regions to ensure no overlap of VOIs occurred. Necrotic or cystic regions, the surgical cavity and large vessels were excluded from all VOIs, which were reviewed by a senior neuroradiologist. VOIs were then coregistered to DWI images corresponding to $b = 0$ and re-sampled with the resolution of the DWI sequence using affine registration using Elastix registration software (Table 1).

2.4. MRI quantification

A previously validated simplified IVIM model [3,4] was used to calculate the diffusion coefficient (D) and perfusion fraction (f) maps.

The technique assumes the DWI signal loss due to blood flow in the microvasculature has negligible contribution to DWI images acquired at high b-values. By taking the natural logarithm of the ratio of high b-value DWI data over $b = 0$ image we have:

$$\ln\left(\frac{S(\mathrm{b})}{S(0)}\right) = -\mathrm{b}D + \ln(1-f)$$

which provides a linear relationship with respect to b and its intercept, allowing the calculation of f. As in prior studies [3,5], voxels with values of f smaller than zero or greater than 30% were considered non-physiological and excluded.

ADC also calculated by calculating the slope of the natural logarithm of the $b = 1000$ over $b = 0$ images.

Ethics Statement

This work was approved by institutional Research Ethics Board approved, with written informed consent was obtained from all patients.

CRediT Author Statement

Pejman Jabehdar Maralani: Conceptualization, Methodology, Supervision, Data Curation, Writing – Original Draft, Writing - Review and Editing, Visualization, Resources; **Sten Myrehaug:** Conceptualization, Data Curation, Writing – Original Draft, Writing - Review and Editing; **Hatef Mehrabian:** Conceptualization, Investigation, Software, Validation, Data Curation, Writing

– Original Draft; **Aimee KM Chan:** Investigation; Data Curation, Writing – Original Draft, Writing – Review and Editing, Project administration; **Max Wintermark:** Conceptualization, Writing – Review and Editing; **Chris Heyn:** Conceptualization, Resources, Writing – Review and Editing; **John Conklin:** Conceptualization, Resources, Writing – Review and Editing; **Benjamin M. Ellingson:** Conceptualization, Writing – Review and Editing; **Saba Rahimi:** Software, Investigation, Writing – Review and Editing; **Angus Z Lau:** Methodology, Validation, Writing – Review and Editing; **Chia-Lin Tseng:** Investigation, Writing – Review & Editing; **Hany Soliman:** Investigation, Writing – Review & Editing; **Jay Detsky:** Investigation, Writing – Review & Editing; **Shadi Daghighi:** Investigation, Writing – Review & Editing; **Julia Keith:** Investigation, Writing – Review & Editing; **David G. Munoz:** Investigation, Writing – Review & Editing; **Sunit Das:** Investigation, Writing – Review & Editing; **Eshetu G. Atenafu:** Methodology; Formal Analysis, Writing – Original Draft, Writing – Review and Editing; **Nir Lipsman:** Investigation, Writing – Review & Editing; **James Perry:** Investigation, Writing – Review & Editing; **Greg Stanisz:** Investigation, Writing – Review & Editing; **Arjun Sahgal:** Conceptualization, Resources, Visualization, Supervision.

Declaration of Competing Interest

Arjun Sahgal:
Advisor/consultant: AbbVie, Merck, Roche, Varian, Elekta, BrainLAB, VieCure
Board Member: International Stereotactic Radiosurgery Society
Co-Chair: AO Spine Knowledge Forum Tumor
Past educational seminars: Elekta AB, Accuray Inc., Varian, BrainLAB, Medtronic Kyphon
Research support: Elekta AB
Travel support: Elekta, Varian, BrainLAB
Consortia: Elekta MR Linac Research Consortium, Elekta Spine, Oligometastases and Linac Based SRS Consortia.

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Chia-Lin Tseng:
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Past educational seminars: AbbVie, Congress of Neurological Surgeons, American Association of Neurological Surgeons, Society for NeuroOncology
Research supports: Alkerme, Medicenna
Travel support: Subcortical Surgery Group, Congress of Neurological Surgeons, American Association of Neurological Surgeons, Society for NeuroOncology, Integra

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