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Simulation-based study to understand how brain tumour growth affects MRI appearance

Submission date
03/02/2026

Recruitment status
No longer recruiting

Registration date
06/02/2026

Overall study status
Completed

Last Edited
05/02/2026

Condition category
Cancer

[_] Prospectively registered
[_] Protocol
[_] Statistical analysis plan
[_] Results
[_] Individual participant data
[X] Record updated in last year

Plain English summary of protocol

Background and study aims
Gliomas are a common type of brain tumour that can behave very differently depending on their grade. Some grow slowly, while others grow quickly and are more aggressive. Magnetic resonance imaging (MRI) is widely used to examine these tumours, but MRI images do not always clearly show how aggressive a tumour is. This study aims to use computer-based simulations to better understand how different patterns of tumour growth may lead to different MRI appearances. The goal is to improve the interpretation of MRI scans in a non-invasive way.

Who can participate?
No new participants will be recruited for this study. The research uses previously collected, fully anonymised MRI scans from adult patients who were diagnosed with glioma as part of routine clinical care.

What does the study involve?
The study involves analysing existing MRI scans using a computer model that simulates how brain tumours grow and spread. The model generates synthetic MRI images based on different tumour growth patterns. These simulated images are then examined to understand how features such as tumour shape, boundaries, and surrounding swelling may differ between lower-grade and higher-grade gliomas. No additional tests, scans, or treatments are performed on patients.

What are the possible benefits and risks of participating?
There are no direct benefits or risks to individuals whose data are included, as no new procedures or contact with patients are involved. All MRI data are fully anonymised. The study may benefit future patients by helping doctors better understand MRI features of brain tumours and support non-invasive assessment in clinical practice.

Where is the study run from?
The Second Affiliated Hospital of Xuzhou Medical University (China)

When is the study starting and how long is it expected to run for?
The study uses retrospective MRI data collected before treatment. The analysis phase began in 2023 and was completed in 2024.

Who is funding the study?
The study is supported by research funding from the Xuzhou Science and Technology Bureau, the Jiangsu Provincial Health Commission, and Xuzhou Medical University–affiliated research programs (China)

Who is the main contact?
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Contact information

Type(s)
Principal investigator, Scientific, Public

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Study information

Scientific Title
Simulation-based modelling of tumor growth dynamics and MRI manifestations in low- versus high-grade gliomas

Acronym
SIM-Glioma-MRI

Study objectives
Primary objective:
To evaluate whether a biophysical, simulation-based tumor growth model can reproduce and quantitatively distinguish magnetic resonance imaging (MRI) phenotypes associated with low-grade and high-grade gliomas using retrospective, fully de-identified imaging data.

Secondary objectives:
1. To characterize the relationship between tumor growth kinetics (proliferation, diffusion, necrosis, and edema) and corresponding MRI features.
2. To derive interpretable imaging biomarkers that reflect underlying tumor biology and may support non-invasive glioma characterization.

Rationale:
Conventional MRI provides indirect and sometimes ambiguous information about glioma biology. Simulation-based modeling offers a complementary, mechanistic approach to link tumor growth dynamics with MRI appearance. This study was undertaken to improve the biological interpretability of MRI findings and to support standardized, non-invasive assessment of glioma grade in an observational research context.

Ethics approval required
Ethics approval required

Ethics approval(s)
approved 04/03/2024, Biomedical Research Ethics Committee of Xuzhou Mining Group General Hospital (The Second Affiliated Hospital of Xuzhou Medical University) (Science and Education Department, Xuzhou, -, China; +86 (0)516 85326137; zhaofangchao@suda.edu.cn), ref: 2024 030402

Primary study design
Observational

Secondary study design
Simulation-based observational study using retrospective, de-identified MRI exemplars

Study type(s)

Health condition(s) or problem(s) studied
Glioma (low-grade and high-grade brain tumors)

Interventions
This is an observational, simulation-based study using retrospective, fully de-identified magnetic resonance imaging (MRI) data. Pre-treatment MRI sequences (T1-weighted, post-contrast T1-weighted, T2-weighted, and FLAIR) from patients with histologically confirmed glioma are used as exemplar inputs to calibrate and qualitatively validate a biophysical tumor growth model.

The model simulates tumor proliferation, diffusion, necrosis, and edema, and is coupled with a forward MRI synthesis framework to generate synthetic MRI images. Quantitative imaging features, including enhancement fraction, tumor margin sharpness, edema-to-core volume ratio, and growth-related metrics, are derived from the simulated data and compared across low-grade and high-grade glioma parameter regimes.

No interventions are performed, no randomisation or allocation occurs, and no prospective participant recruitment is undertaken. All analyses are conducted on retrospective, anonymised data in accordance with institutional ethics approval.

Intervention Type
Not Specified

Primary outcome(s)
1. MRI-based differentiation of low-grade versus high-grade glioma growth phenotypes measured using simulation-derived enhancement fraction, tumor margin edge width, and edema-to-core volume ratio on synthetic MRI at a single retrospective analysis

Key secondary outcome(s))
1. Tumor growth velocity measured using the Fisher–KPP front-speed proxy derived from simulation parameters at a single retrospective analysis

2. Tumor margin sharpness measured using edge width between 90% and 10% tumor cell-density isocontours on simulation-generated MRI at a single retrospective analysis

3. Peritumoral edema burden measured using edema-to-core volume ratio derived from simulated FLAIR MRI at a single retrospective analysis

4. Sensitivity of MRI phenotypes to tumor growth parameters measured using one-factor-at-a-time variation of proliferation, diffusion, hypoxia threshold, and necrosis accrual at a single retrospective analysis

Completion date
31/05/2025

Eligibility

Key inclusion criteria
1. Patients with histologically confirmed glioma
2. Availability of pre-treatment MRI (T1, post-contrast T1, T2, FLAIR)
3. MRI acquired prior to any surgical, radiotherapy, or systemic treatment
4. Fully de-identified imaging data available for retrospective analysis

Healthy volunteers allowed
No

Age group
Mixed

Lower age limit
18 years

Upper age limit
120 years

Sex
All

Total final enrolment
10

Key exclusion criteria

1. Prior surgical resection, radiotherapy, or chemotherapy before MRI
2. Incomplete or poor-quality MRI data
3. Imaging data containing identifiable patient information

Date of first enrolment
01/04/2024

Date of final enrolment
31/03/2025

Locations

Countries of recruitment
China

Sponsor information

Organisation
Second Affiliated Hospital of Xuzhou Medical College

ROR
https://ror.org/04yrcjm56

Funder(s)

Funder type

Funder Name
Xuzhou Municipal Science and Technology Bureau

Alternative Name(s)
Xuzhou City Science and Technology Bureau, Science and Technology Bureau of Xuzhou, , Xuzhou Science and Technology Bureau

Funding Body Type
Government organisation

Funding Body Subtype
Local government

Location
China

Funder Name
Jiangsu Commission of Health

Alternative Name(s)
Jiangsu Provincial Health Commission, Jiangsu Health Department, Health Commission of Jiangsu Province,

Funding Body Type
Government organisation

Funding Body Subtype
Local government

Location
China

Funder Name
Xuzhou Medical University Affiliated Hospital

Results and Publications

Individual participant data (IPD) sharing plan

IPD sharing plan summary
Not expected to be made available