MRI based radiomics: Brain tumors

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Conflicts of interest

Nothing to disclose

Objectives

- have basic knowledge of imaging biomarkers and radiomics
- know what the (potential) roles and challenges are of the use of imaging biomarkers and radiomics
- share some preliminary results of the use of radiomics in pediatric neuro-oncology

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Biomarkers

"… characteristics that are objectively measured as indicator of normal biological processes, pathological changes, or pharmaceutical responses to a therapeutic intervention."

- Prediction
- Detection
- Staging
- Grading
- Assessment of treatment response

Personalized medicine

ESR. White paper on imaging biomarkers. Insights Imaging (2010) 1:42–45

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Biomarkers

- biochemical or histological parameters (tissue samples)
- biochemical parameters or cells (blood, urine)
- anatomical, functional or molecular parameters (imaging)

Imaging biomarkers

- noninvasive
- spatial resolution
- temporal resolution

ESR. White paper on imaging biomarkers. Insights Imaging (2010) 1:42–45

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Imaging biomarkers

Anatomical imaging biomarkers
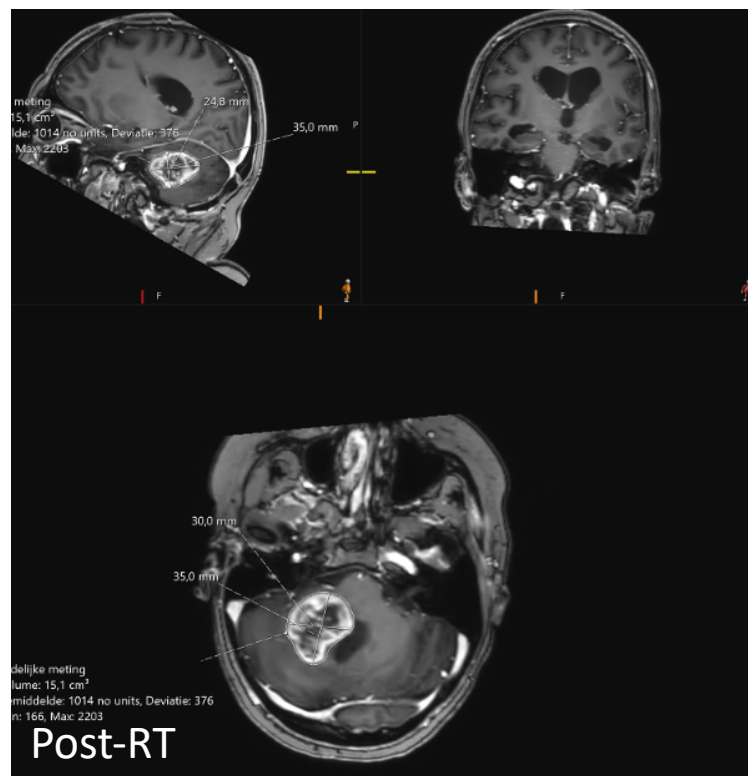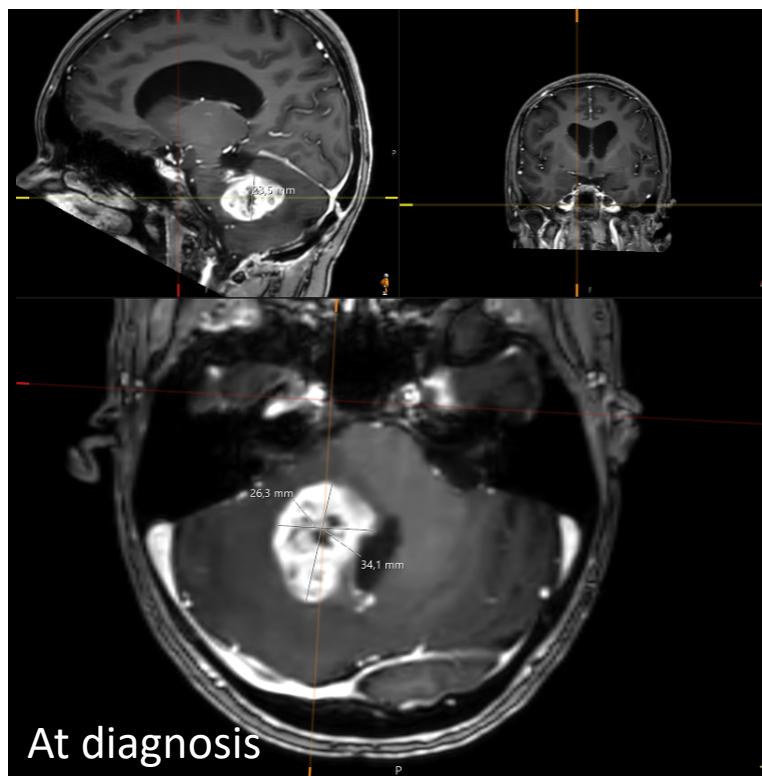- cross-sectional diameters (RECIST, RANO, RAPNO)
- tumor volume

Functional imaging biomarkers
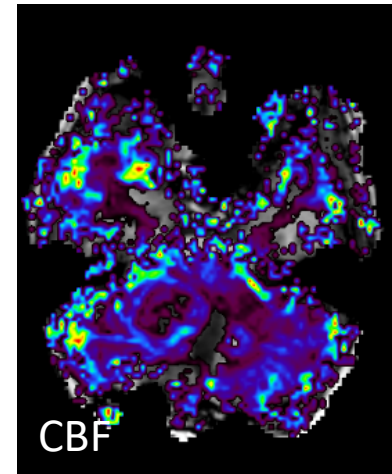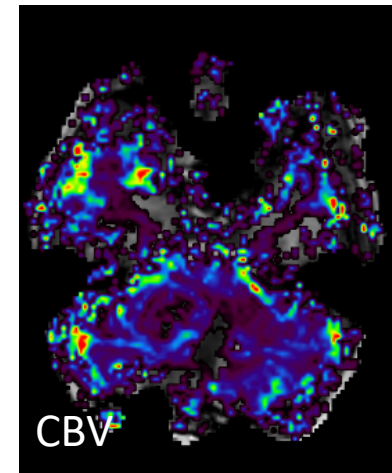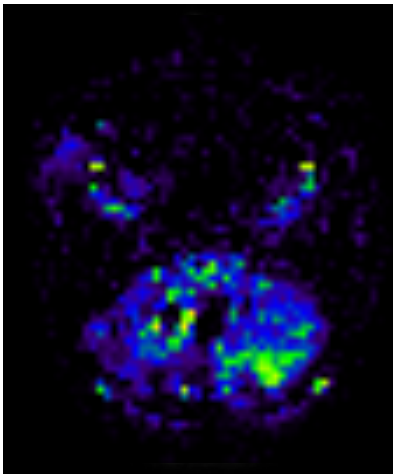- contrast-enhanced or perfusion CT/MRI
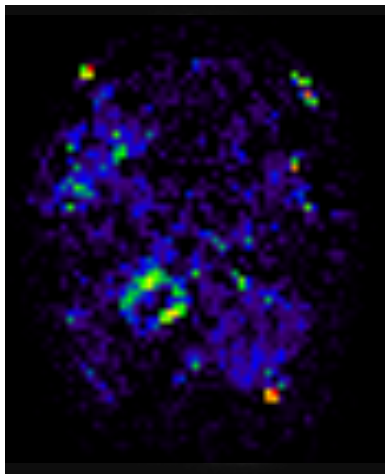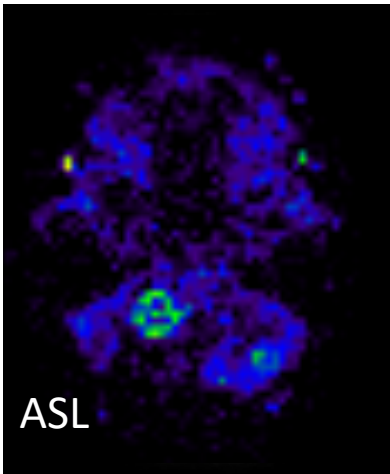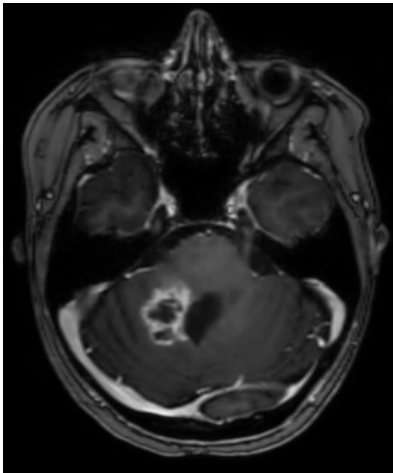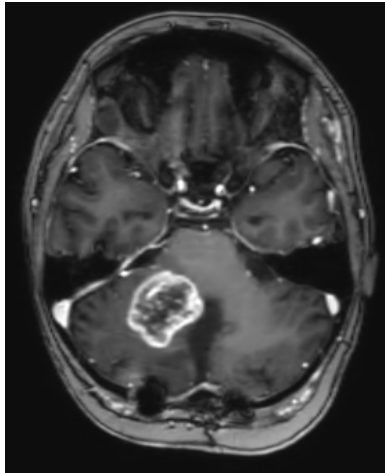- DWI, DTI
- MRS
- PET/CT, PET/MRI

Molecular imaging biomarkers
- target-specific imaging biomarkers

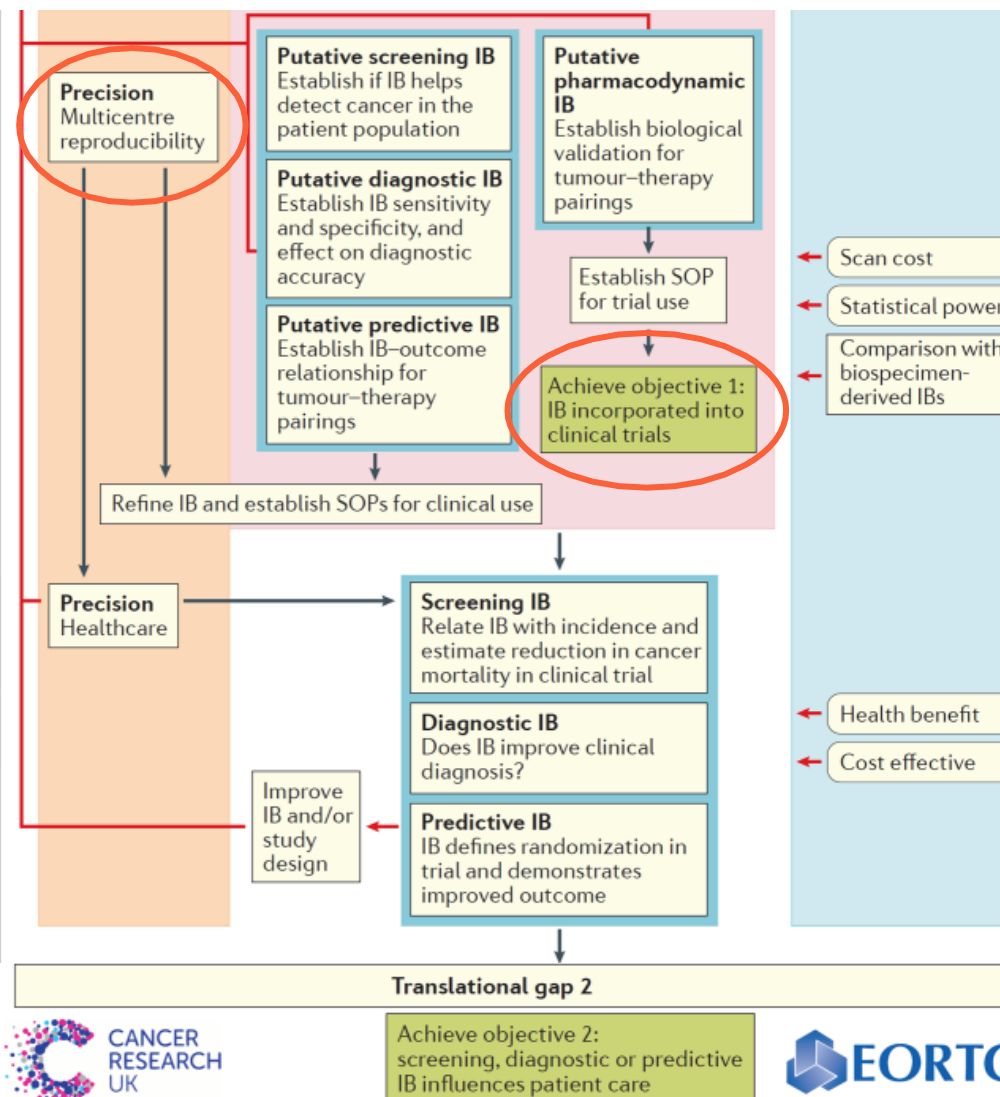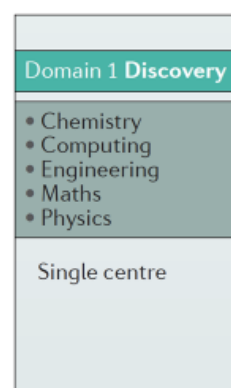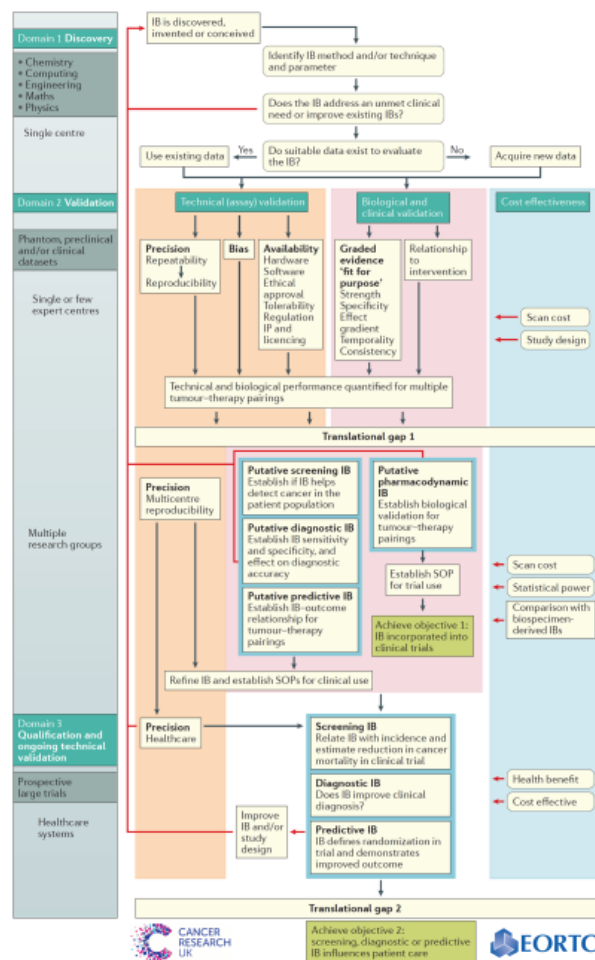*ESR. White paper on imaging biomarkers. Insights Imaging (2010) 1:42–45*

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High Grade Glioma

At diagnosis

Post-RT

After 3 months
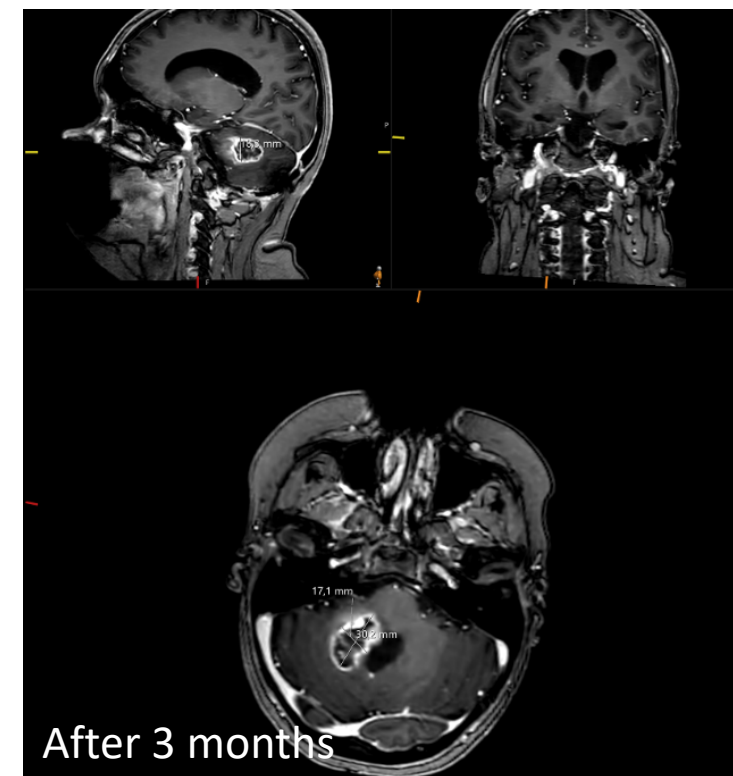
(Pseudo)progression?

Ce T1

ASL

CBV

CBF
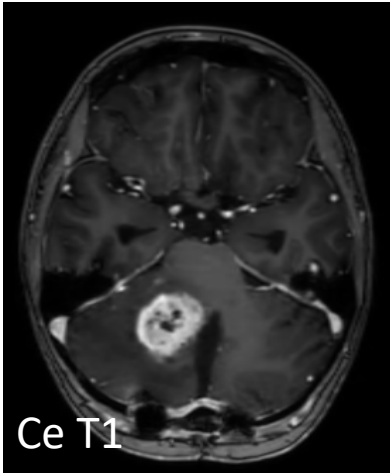
Imaging biomarker roadmap for cancer studies

Radiomics

"... a field of medical study that aims to extract a large number of quantitative features from medical images using data characterization algorithms."

- improved decision support
- potential to uncover disease characteristics not identified by human vision alone

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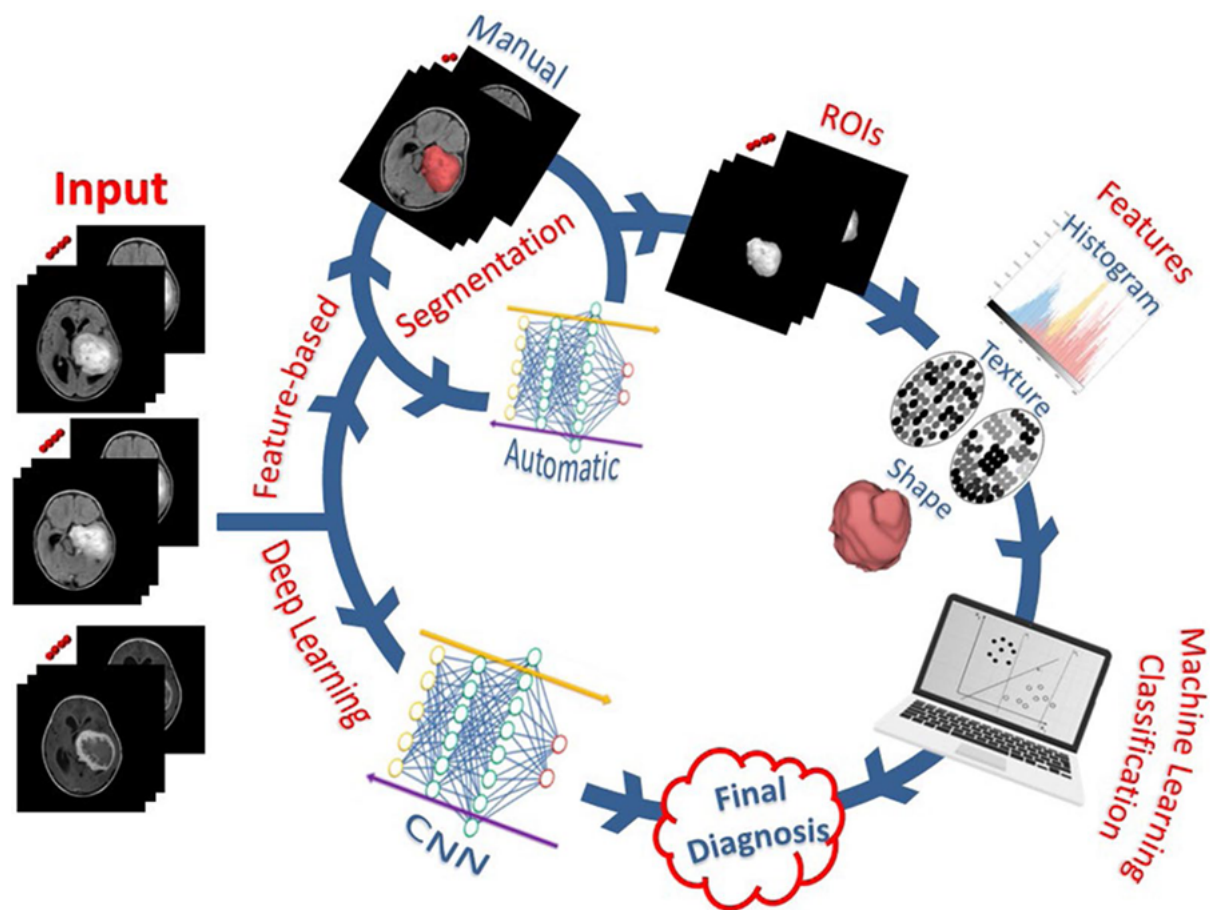*https://radiopaedia.org/articles/radiomics?msclkid=b6a99300d06711eca39bdd784b1a7f4f*

Radiomics

"… aims to extract quantitative, and ideally reproducible, information from diagnostic images, including complex patterns that are difficult to recognize or quantify by the human eye."

- capture tissue and lesion properties/features at diagnosis and their changes over time during treatment or surveillance
- radiomic data are mineable, to discover previously unknown markers and patterns of disease evolution, progression, and treatment response
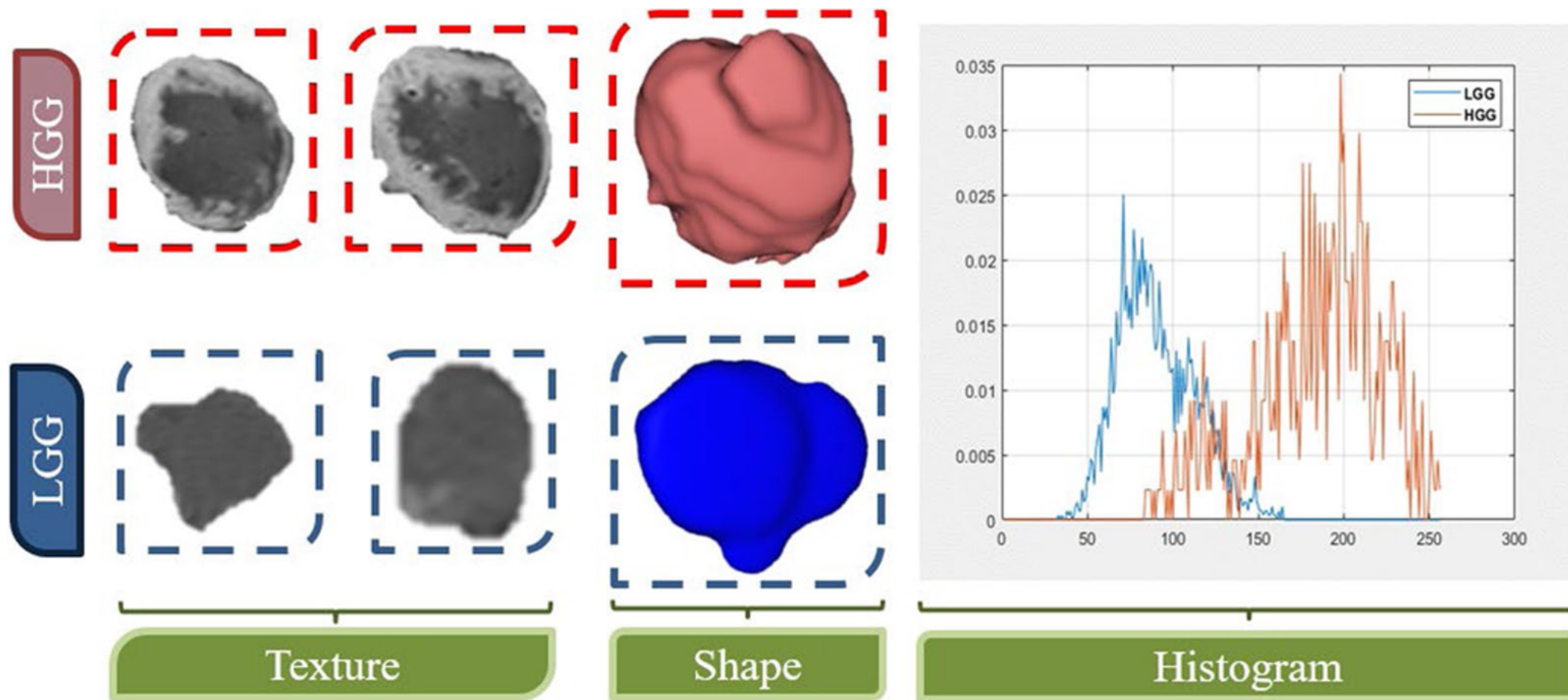
Mayerhoefer ME, et al. J Nucl Med 2020; 61:488–495

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Radiomic features

- shape
- surface
- texture
- density/intensity
- heterogeneity
- vascularity
- location
- relation with surrounding tissues
- ...

Wagner MW et al. Methods (2021) 188:37-43

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Radiomics

Abdel Razek AAK, et al. Insights Imaging (2021) 12:152

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Radiomics

Abdel Razek AAK, et al. Insights Imaging (2021) 12:152

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Radiomics

Radiomics combined with genetics and proteomic features
➤ Radiogenomics

Wagner MW et al. Methods (2021) 188:37-43

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Radiomics

- Molecular testing
  - high cost
  - general inaccessibility worldwide
  - restricted sample size

- Imaging
  - more readily accessible
  - less expensive
  - entire tumor volume
  - alternative non-invasive technique to identify tumor subtypes, guide appropriate therapy, identify patients needing additional genomic profiling, …

Radiomics in pediatric oncology

FULL PAPER

Differentiation of paediatric posterior fossa tumours by the multiregional and multiparametric MRI radiomics approach: a study on the selection of optimal multiple sequences and multiregions

[1]JIE DONG, [1]SUXIAO LI, [1]LEI LI, [2,3]SHENGXIANG LIANG, [1]BIN ZHANG, [4]YUN MENG, [1]XIAOFANG ZHANG, [4]YONG ZHANG and [1]SHUJUN ZHAO

Dong J, et al. BJR 2021;95:...

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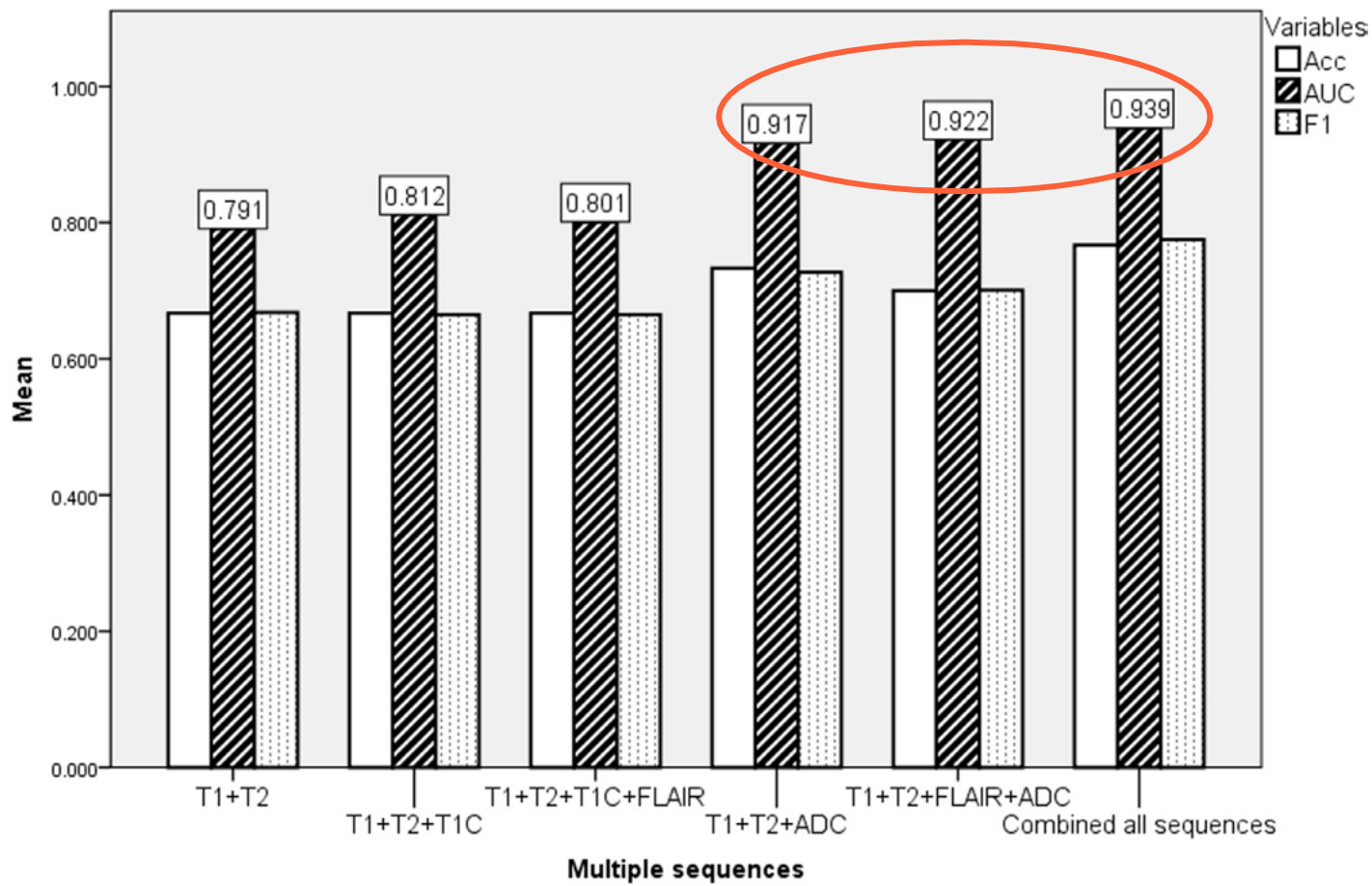*Dong J, et al. BJR 2021;95:…*

Dong J, et al. BJR 2021;95:…
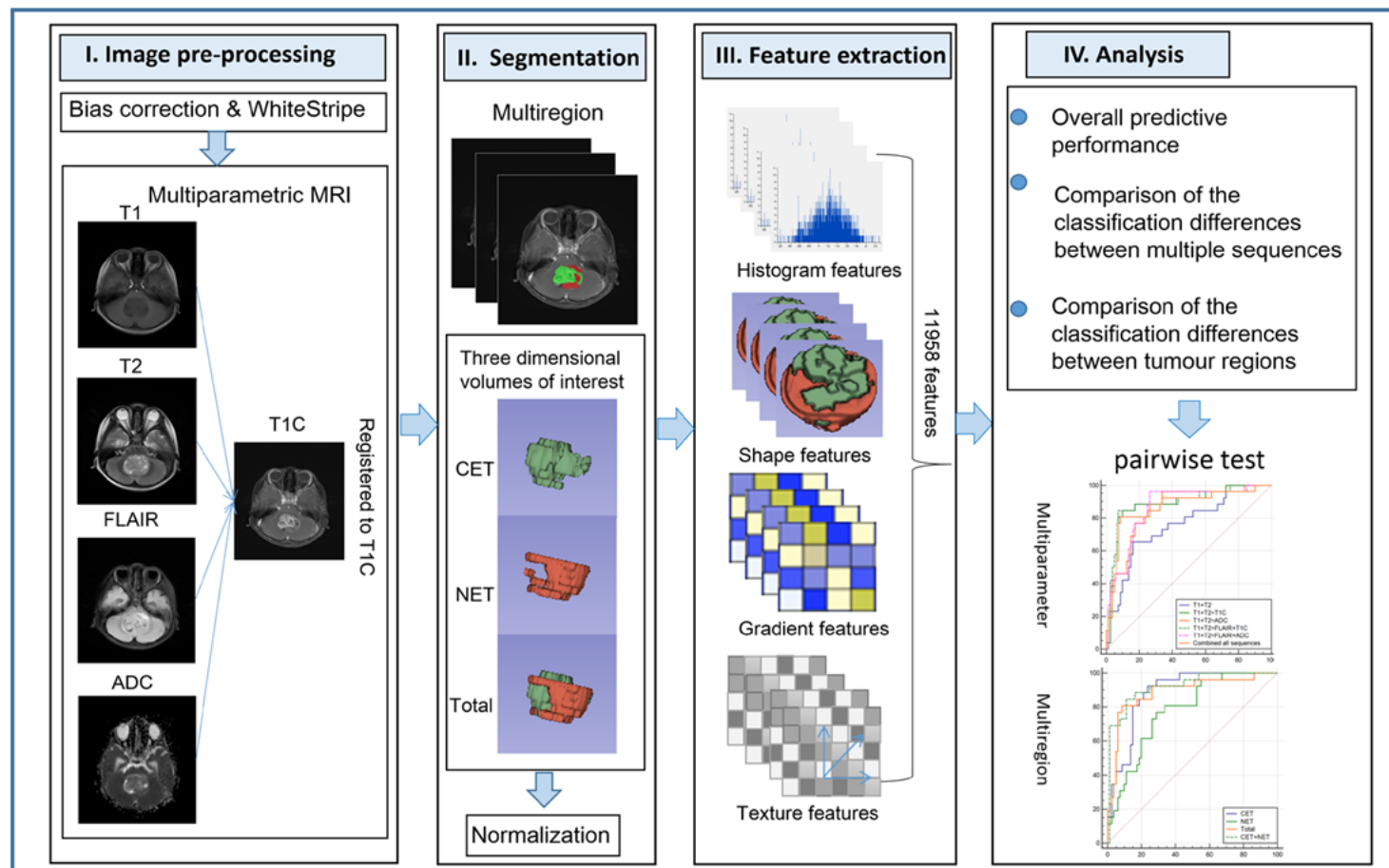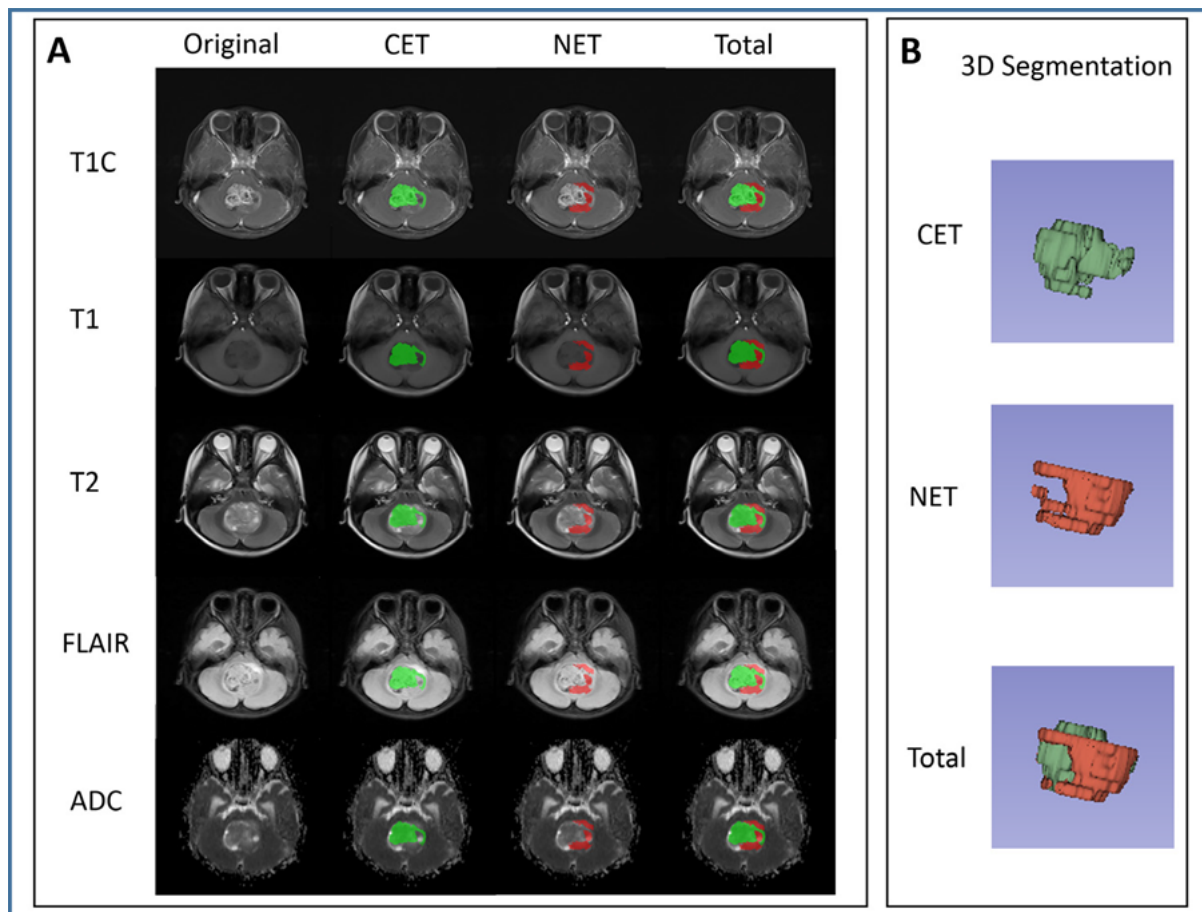
Objective: To evaluate the diagnostic performance of a radiomics model based on multiregional and multiparametric MRI to classify paediatric posterior fossa tumours (PPFTs), explore the contribution of different MR sequences and tumour subregions in tumour classification, and examine whether contrast-enhanced T_1 weighted (T1C) images have irreplaceable added value.

Methods: This retrospective study of 136 PPFTs extracted 11,958 multiregional (enhanced, non-enhanced, and total tumour) features from multiparametric MRI (T_1- and T_2 weighted, T1C, fluid-attenuated inversion recovery, and diffusion-weighted images). These features were subjected to fast correlation-based feature selection and classified by a support vector machine based on different tasks. Diagnostic performances of multiregional and multiparametric MRI features, different sequences, and different tumoral regions were evaluated using multi-class and one-*vs*-rest strategies.

Results: The established model achieved an overall area under the curve (AUC) of 0.977 in the validation cohort. The performance of PPFTs significantly improved after replacing T1C with apparent diffusion coefficient maps added into the plain scan sequences (AUC from 0.812 to 0.917). When oedema features were added to contrast-enhancing tumour volume, the performance did not significantly improve.

Conclusion: The radiomics model built by multiregional and multiparametric MRI features allows for the excellent distinction of different PPFTs and provides valuable references for the rational adoption of MR sequences.

Advances in knowledge: This study emphasized that T1C has limited added value in predicting PPFTs and should be cautiously adopted. Selecting optimal MR sequences may help guide clinicians to better allocate acquisition sequences and reduce medical costs.

Dong J, et al. BJR 2021;95:...

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Dong J, et al. BJR 2021;95:…

Radiomics in pediatric oncology

ORIGINAL RESEARCH · PEDIATRIC IMAGING

MRI Radiogenomics of Pediatric Medulloblastoma:
A Multicenter Study

Michael Zhang, MD • Samuel W. Wong, MS • Jason N. Wright, MD • Matthias W. Wagner, MD •
Sebastian Toescu, MBChB • Michelle Han, MD • Lydia T. Tam, BS • Quan Zhou, PhD • Saman S. Ahmadian, MD •
Katie Shpanskaya, MD • Seth Lummus, DO • Hollie Lai, MD • Azam Eghbal, MD • Alireza Radmanesh, MD •
Jordan Nemelka • Stephen Harward II, MD, PhD • Michael Malinzak, MD, PhD • Suzanne Laughlin, MD •
Sébastien Perreault, MD • Kristina R. M. Braun, MD • Robert M. Lober, MD, PhD • Yoon Jae Cho, MD •
Birgit Ertl-Wagner, MD, PhD • Chang Y. Ho, MD • Kshitij Mankad, FRCR • Hannes Vogel, MD •
Samuel H. Cheshier, MD, PhD • Thomas S. Jacques, FRCPath, PhD • Kristian Aquilina, MD • Paul G. Fisher, MD •
Michael Taylor, MD • Tina Poussaint, MD • Nicholas A. Vitanza, MD • Gerald A. Grant, MD • Stefan Pfister, MD •
Eric Thompson, MD • Alok Jaju, MD • Vijay Ramaswamy, MD, PhD • Kristen W. Yeom, MD

ORIGINAL RESEARCH
PEDIATRICS

Radiomics Can Distinguish Pediatric Supratentorial Embryonal Tumors, High-Grade Gliomas, and Ependymomas

M. Zhang, L. Tam, J. Wright, M. Mohammadzadeh, M. Han, E. Chen, M. Wagner, J. Nemalka, H. Lai, A. Eghbal, C.Y. Ho, R.M. Lober, S.H. Cheshier, N.A. Vitanza, G.A. Grant, L.M Prolo, K.W. Yeom, and A. Jaju

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Challenges

- Standardization
  - acquisition parameters, field strength, ...
  - post-processing methods

- Validation (in large datasets)
  - repeatability
  - reproducibility

- Implementation in clinical practice
  - integrated into radiologist's workflow
  - semi-/fully-automatic segmentation
  - ...

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Thank you for your attention

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