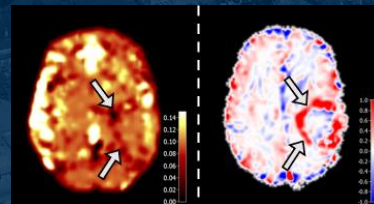


Comparing non-invasive blood-brain barrier mapping with dynamic susceptibility contrast MRI in patients with high-grade glioma and metastasis

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Philips Combined Neuroscience and Spine
User Meeting – Brain and Spinal Cord
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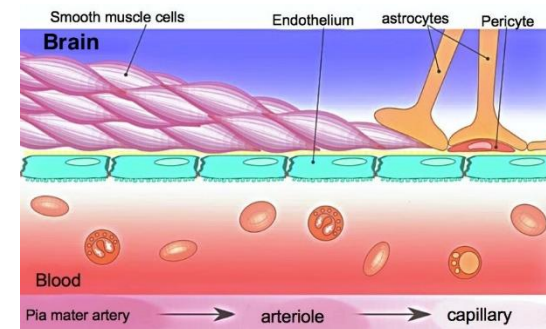
⁸ Leiden Institute of Brain and Cognition, Leiden University, Leiden, The Netherlands

⁹ Philips GmbH Market DACH, Hamburg, Germany

How can blood brain barrier (BBB) integrity be mapped?

Background

- BBB disruptions in high-grade Tumors¹⁻³
- Qualitative imaging used clinically
- K_2 quantitative based on DSC



1: Jain, Nature Rev Neurol., 2007

2: Heye, Neuroimage-Clin, 2014

3: Keil, Clin. Neurorad., 2021

Image: https://commons.wikimedia.org/wiki/File:Blood_vessels_brain_english.jpg#/media/File:Blood_vessels_brain_english.jpg

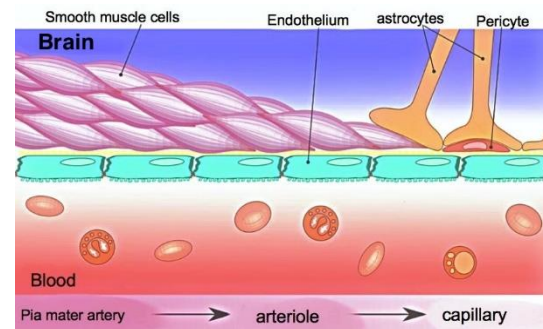
How can blood brain barrier (BBB) integrity be mapped?

Purpose

- Evaluate sensitivity of non-invasive water exchange time T_{ex} from multi-TE ASL¹

Hypothesis

- T_{ex} and K_2 correlate in regions with impaired BBB integrity
- T_{ex} may yield superior sensitivity



1: Mahroo, Front Neurosci., 2021

Image: https://commons.wikimedia.org/wiki/File:Blood_vessels_brain_english.jpg#/media/File:Blood_vessels_brain_english.jpg

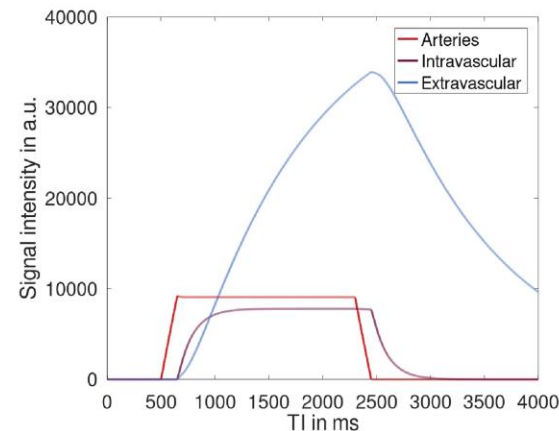
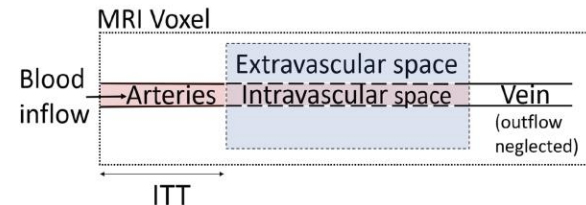
How does ASL map BBB non-invasively?

Method

- Multi TE Hadamard-encoded¹ ASL
- Two-compartment model $\rightarrow T_{ex}^{2,3}$

$$r_{blex}(t) = e^{-\frac{t}{T_{ex}}}$$

$\rightarrow$ Reduced T_{ex} in impaired BBB



How is K_2 calculated based on dynamic susceptibility contrast (DSC) MRI?

Method

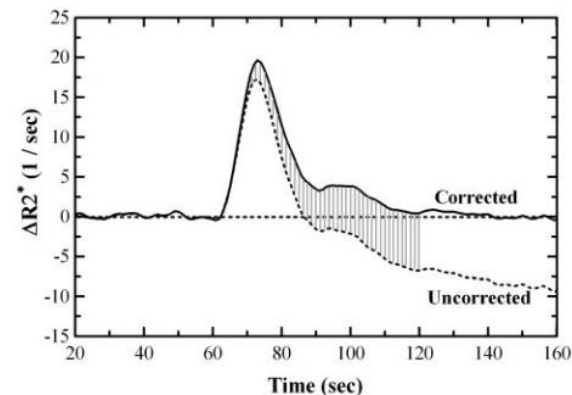
- Correct ΔR_2^* with reference (non-leaky tissue)¹

$$\Delta R_2^* = K_1 \overline{\Delta R_2^*(t)} - K_2 \int_0^t \overline{\Delta R_2^*(t')} dt'$$

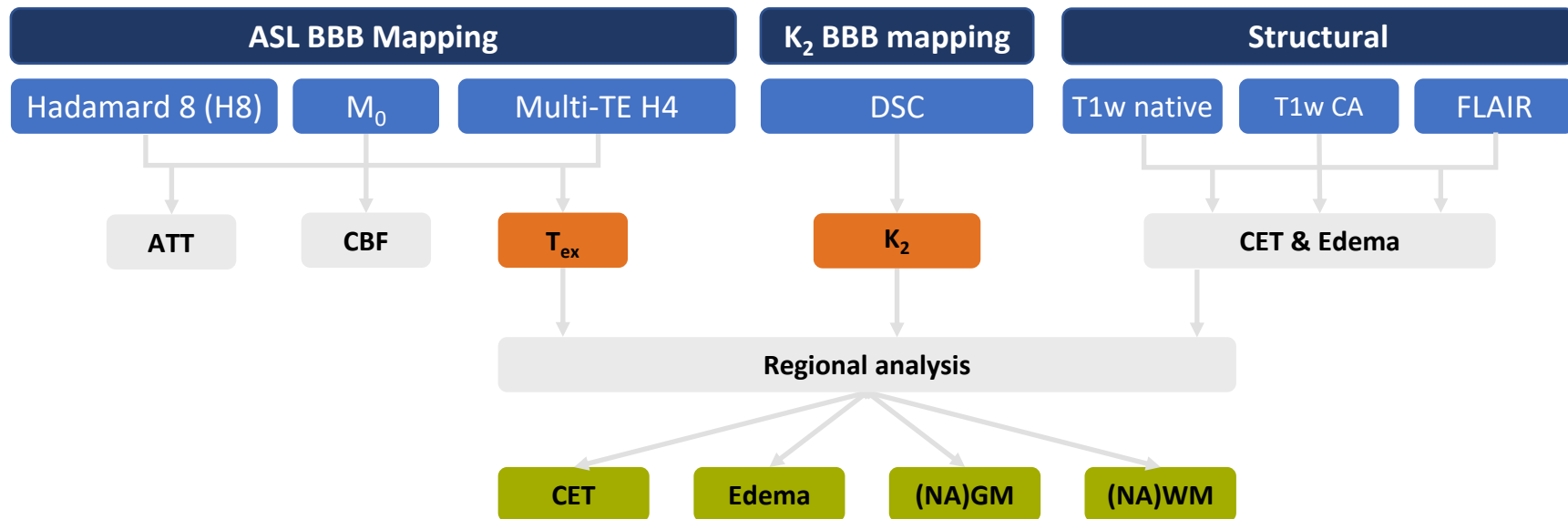
- $K_2 > 0 \rightarrow T_1$ shortening
- $K_2 < 0 \rightarrow T_2^*$ effects

→ Increased $|K_2|$ in leaky areas

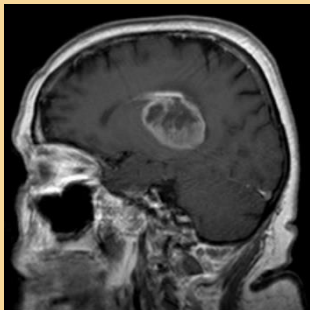
→ $T_{ex} \downarrow \triangleq |K_2| \uparrow$



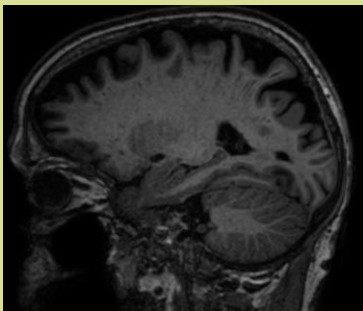
Imaging protocol includes conventional MRI and ASL-BBB mapping



Study population contains patients and age-matched HCs



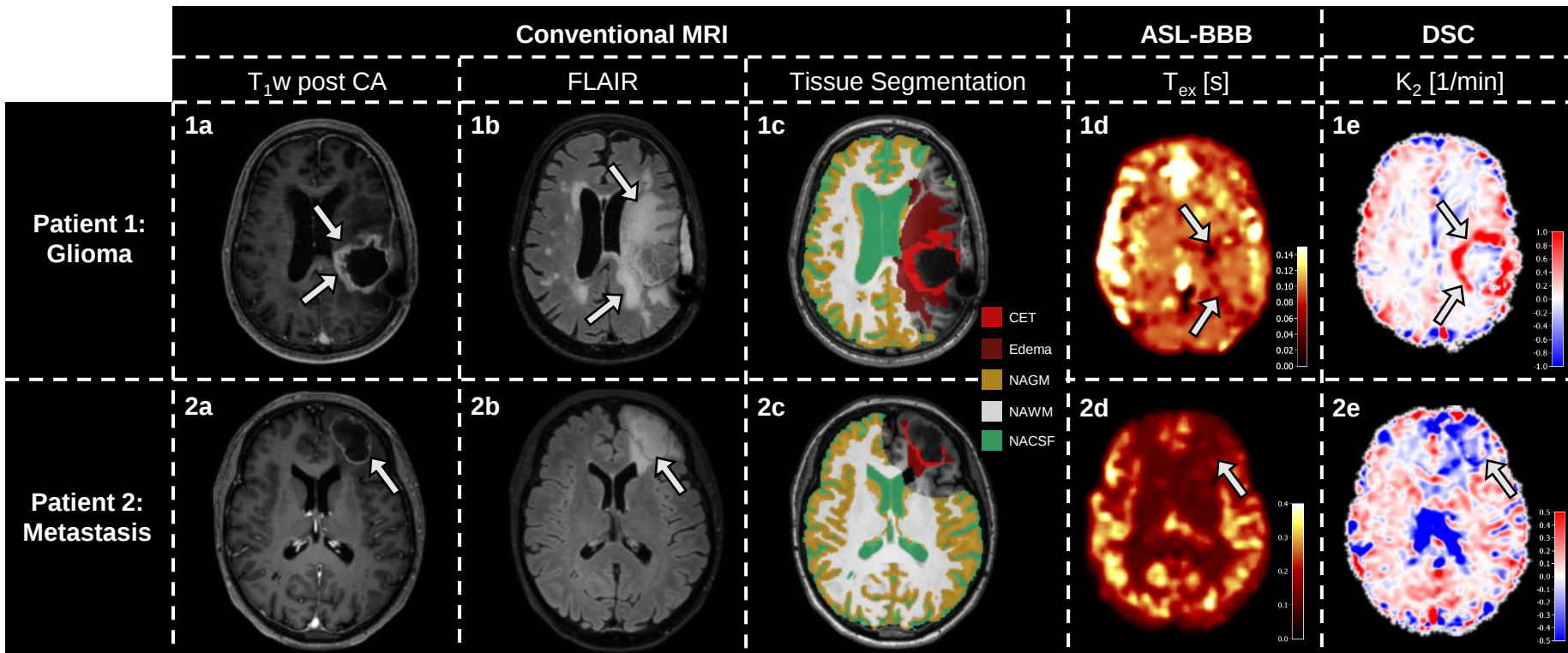
- 28 patients ($64.5 \pm 12.3y$)
- 12 female / 16 male
- High-grade (WHO 3&4) relapsed Glioma & Metastasis



- 17 age-matched HC ($61.0 \pm 14.9y$)
- 13 female / 4 male

$$T_{\text{ex}} \downarrow \triangleq |K_2| \uparrow$$

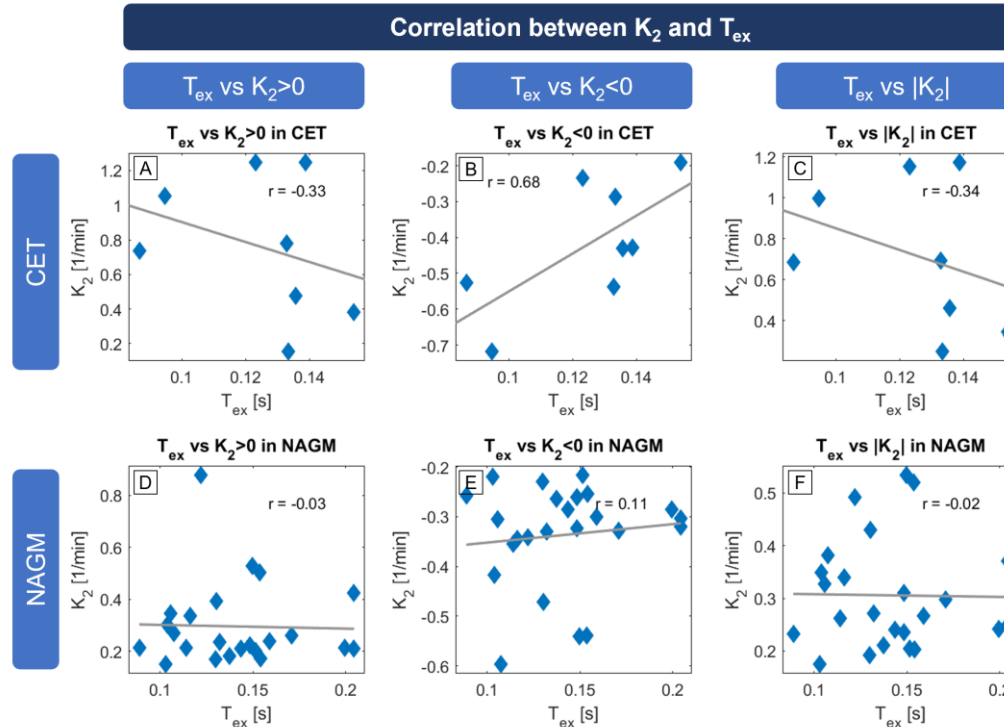
Exemplary data of glioma and metastasis patients



→ Visible concordance of T_{ex} & K₂ maps

$$T_{ex} \downarrow \triangleq |K_2| \uparrow$$

Do K_2 and T_{ex} correlate?

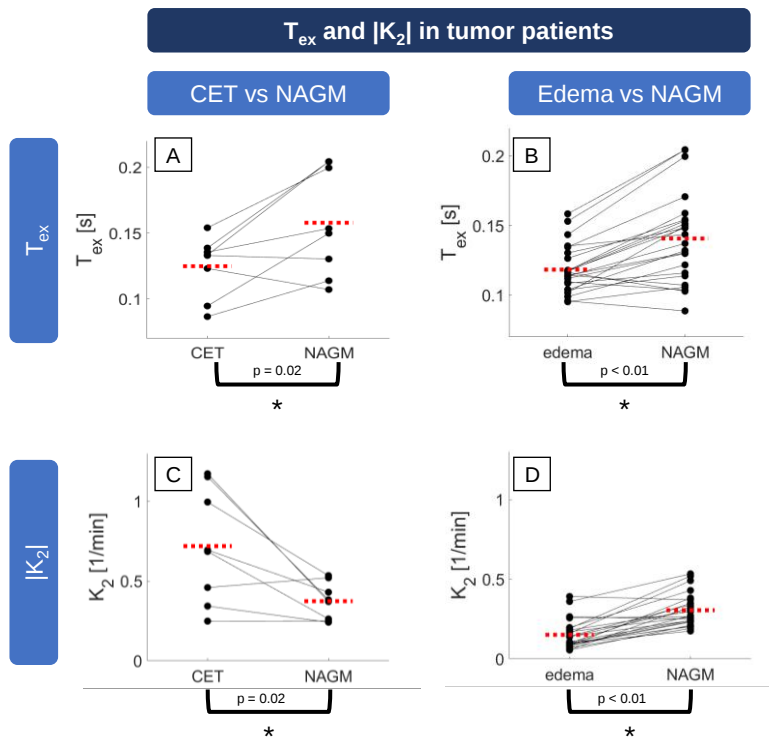


→ **Correlation** in Contrast Enhancing Tissue (CET)

→ No correlation in Normal-Appearing Grey Matter (NAGM)

$$T_{ex} \downarrow \triangleq |K_2| \uparrow$$

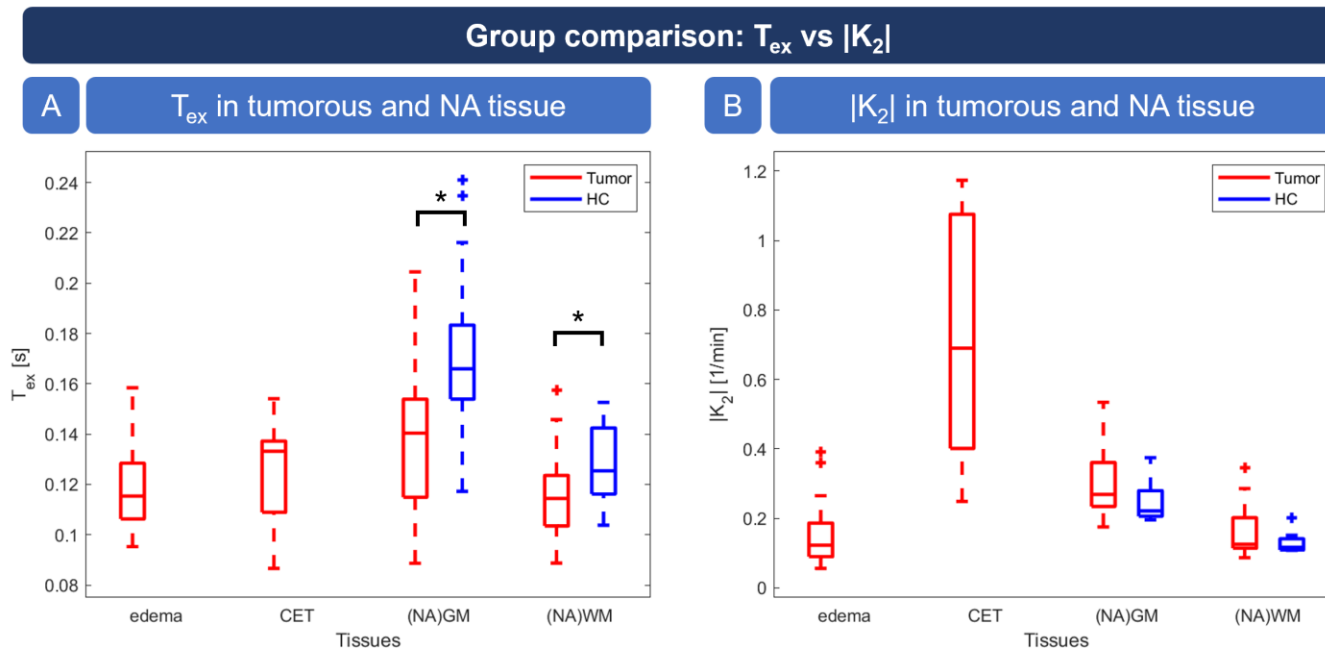
How do T_{ex} and K_2 compare in CET?



→ **CET:** Reduced T_{ex} agrees with increased $|K_2|$

→ **Edema:** Reduced T_{ex} vs reduced $|K_2|$

Does BBB leakage differ between patients and HCs?



→ Patients' T_{ex} reduced in Normal-Appearing (NA) tissue; no effects for $|K_2|$

$$T_{ex} \downarrow \triangleq |K_2| \uparrow$$

Is the T_{ex} a reliable proxy for BBB impairments?

Discussion

In CET correlation between T_{ex} and K_2

Decreased T_{ex} in CET agrees with increased $|K_2|$ and literature¹⁻⁴

Reduced T_{ex} in edema $\leftrightarrow$ high sensitivity to impaired BBB⁵

Reduced T_{ex} in NAWM & NAGM $\rightarrow$ subtle impairments?

Summary

ASL-based T_{ex} mapping sensitive for BBB impairments

T_{ex} may have superior sensitivity compared to K_2

Promising for detecting more subtle impairments (e.g., Alzheimer, small vessel disease)^{6,7}

1: Heye, Neuroimage-clinical, 2014
5: Solar, Front Cell Neurosci 2022

2: Keyl, Clinical neurorad., 2021
6: Starr, Psychiatry Res., 2009

3: Kluge, MRI, 2016
4: Bonekamp, JMRI, 2015
7: Thrippleton, Alzheimers Dement., 2019

Digital Poster Session: Neuro-Oncology: Assessment of
Metastases, Lymphoma
Date & Time: Wed, 2.30-3.30 pm
Abstract #: 3834

Thank you for your attention!

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