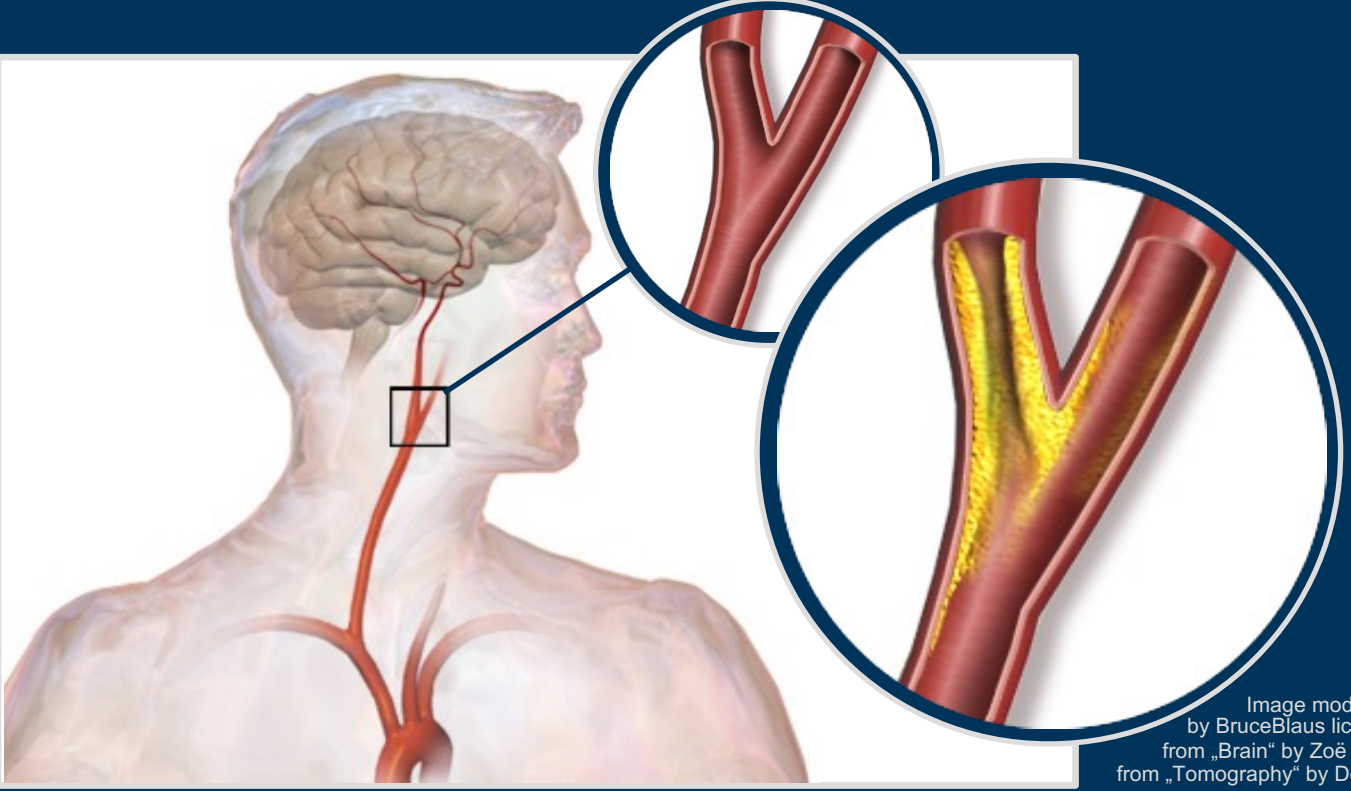


Background:

- Internal carotid artery stenosis (ICAS) accounts for 10-20% of strokes¹
- Significance of secondary collateral flow in chronic hypoperfusion as induced by ICAS is not understood
- Coefficient of variance (CoV) of a dynamic susceptibility contrast (DSC) time series as a proxy of pial collaterals²
- Investigation of high CoV voxels in ICAS and healthy controls (HC) and characterization of these voxels with respect to hemodynamic properties



Methods:



3T MRI
Philips Ingenia

29 ICAS



70.1 ± 4.8 y



- No stroke or severe head trauma
- Asymptomatic and Unilateral
- NASCET > 70%

30 HC



70.3 ± 4.9 y



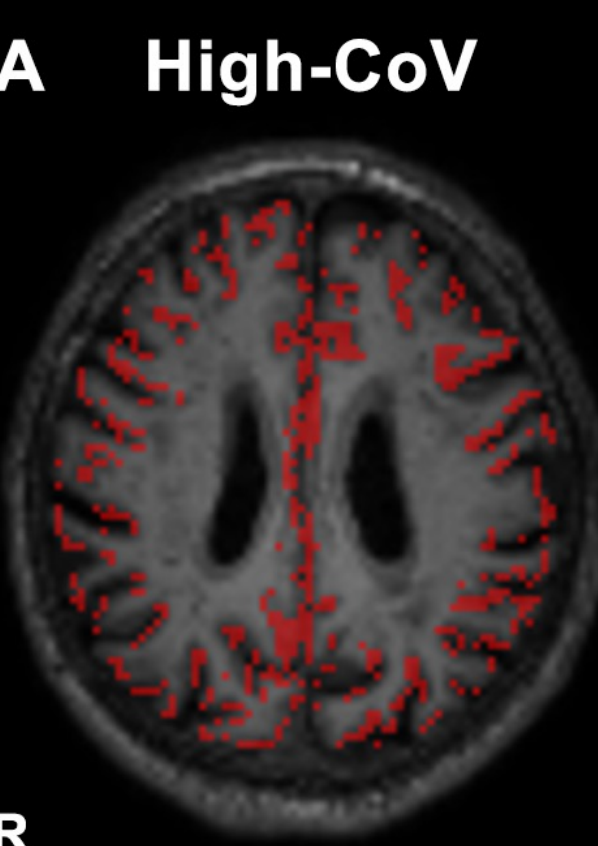
- No stroke or injuries

Structural		Perfusion		T ₂ & T ₂ [*] Relaxation	
MP-RAGE		pCASL	DSC	T ₂ GraSE	T ₂ [*] GRE
1x1x1 mm ³ , TE=4 ms, TR=9 ms, TI=1000 ms, α=8°, 5:59 min		Segmented 3D GraSE, 2.7x2.8x6 mm ³ , TE=7.4 ms, TR=4403 ms, 16 slices, D=1800 ms, PLD=2000 ms, 3 dynamics, PDW, 5:43 min	GE-EPI, 2x2x3.5 mm ³ , TE=30 ms, TR=1.5 s, α=60°, 80 dyn, 2:01 min, 15 ml Gd-DOTA bolus-injection, 4 ml/s	2D GraSE, 2x2x3 mm ³ , 30 slices, 8 echoes, TE=ΔTE=16 ms, TR=8596 ms, 2:23 min	2x2x3 mm ³ , 30 slices, 12 echoes, TE=ΔTE=5 ms, TR=1950 ms, α=30°, 6:08 min
WM	GM	CBF	CoV	T ₂	T ₂ [*]
mq-BOLD $rOEF \propto \frac{R_2'}{rCBV}$				$R_2' = \frac{1}{T_2} - \frac{1}{T_2^*}$	

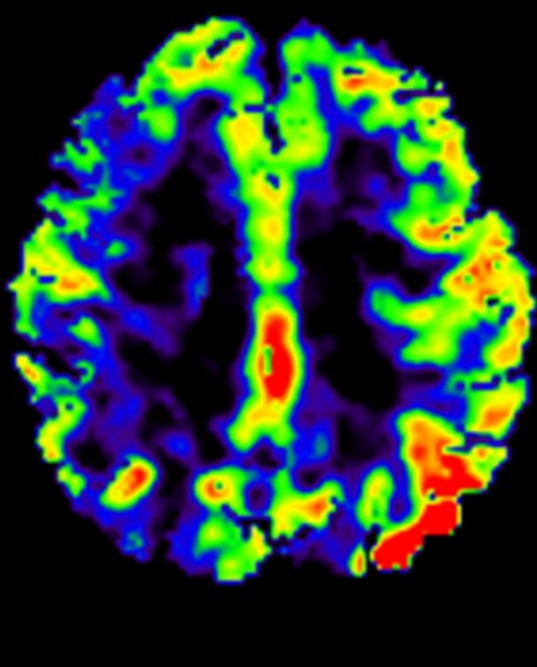
Results:

A

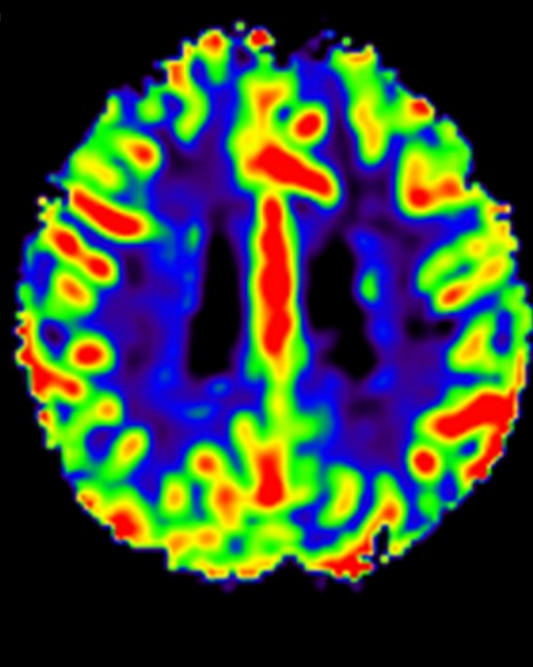
High-CoV



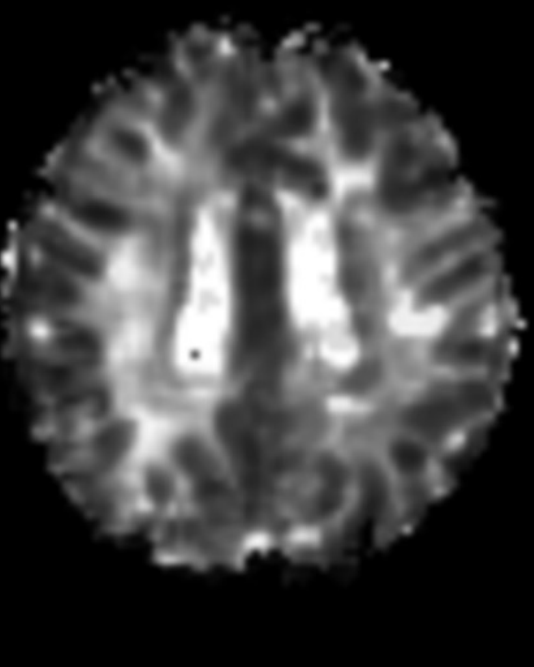
CBF



rCBV



rOEF



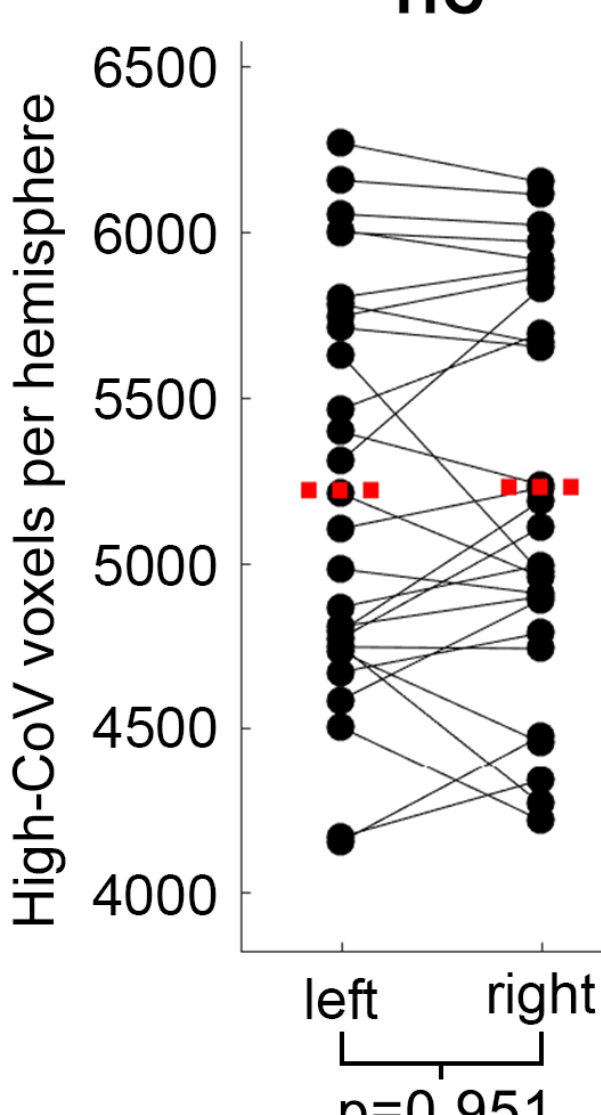
R

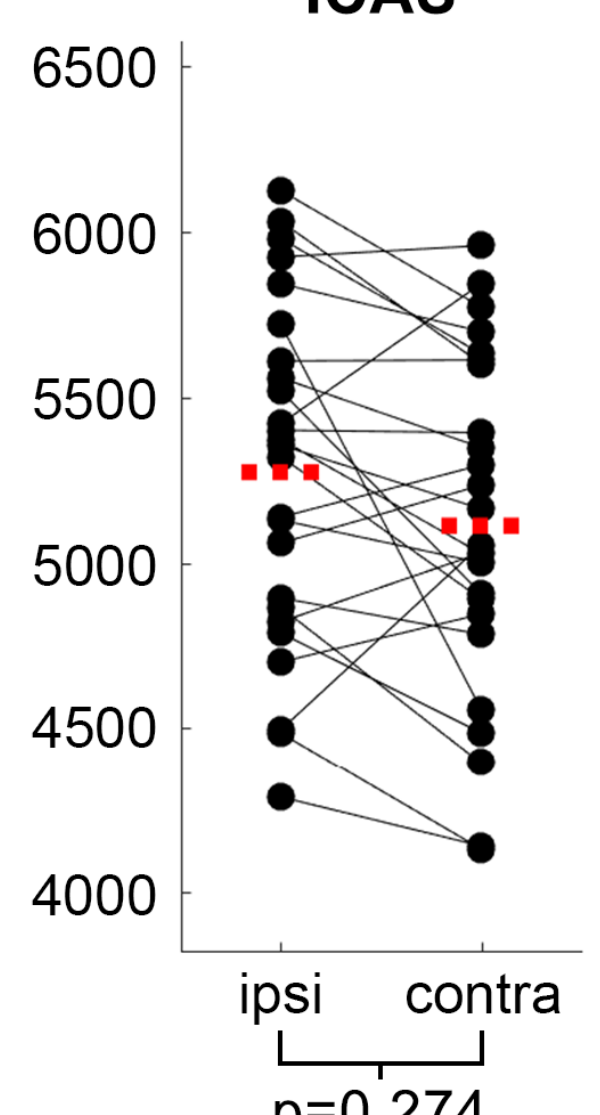
Exemplary data of an ICAS patient.

- High CoV voxels were symmetrically distributed over hemispheres in both, the ICAS and HC groups, indicating no collateral recruitment. (Fig. B)
- Within the high CoV mask, CBF and rCBV were significantly elevated by approximately 20% compared to grey matter in ICAS and HC. (Fig. C-D)
- In contrast, rOEF was 20% lower in high CoV compared to grey matter in both groups. (Fig. E)
- The hemodynamics within high CoV voxels imply a high density of arteriols in high CoV voxels.³

B

High-CoV voxels per hemisphere





left right

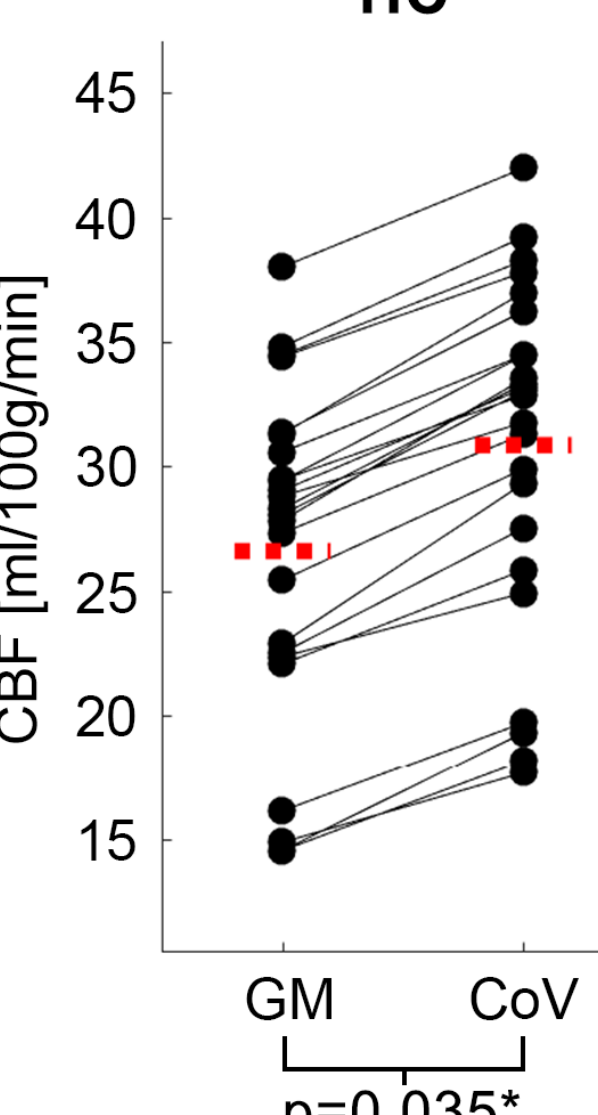
ipsi contra

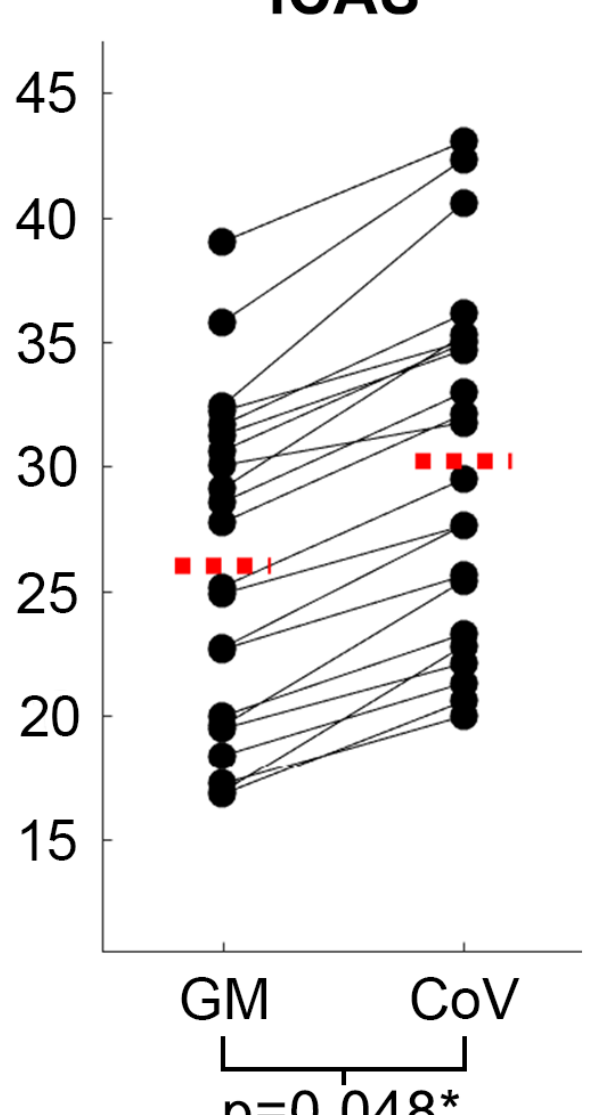
p=0.951

p=0.274

C

CBF





GM CoV

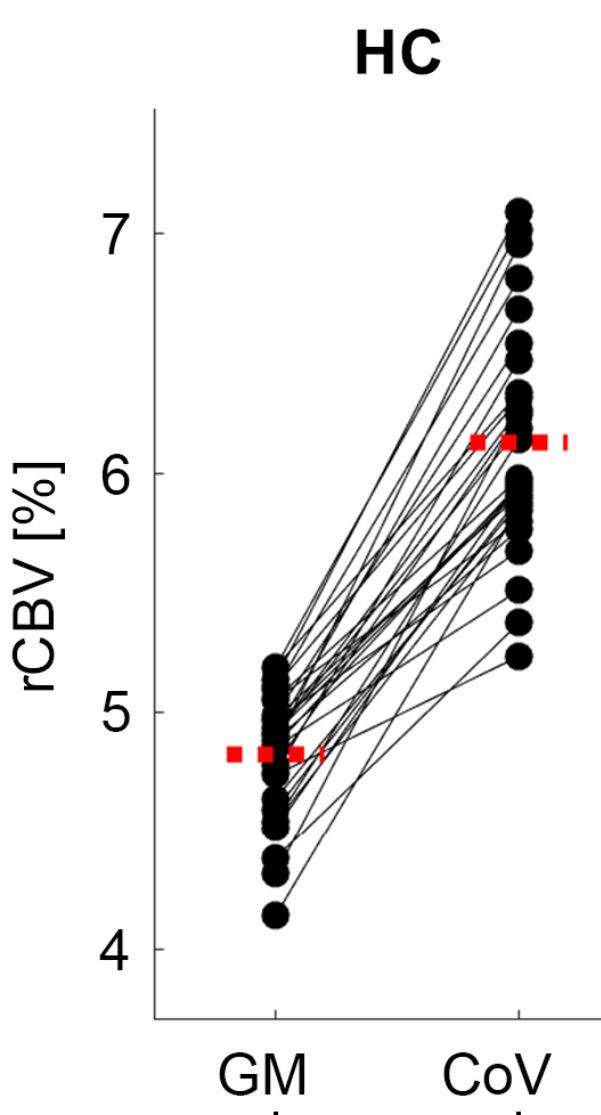
GM CoV

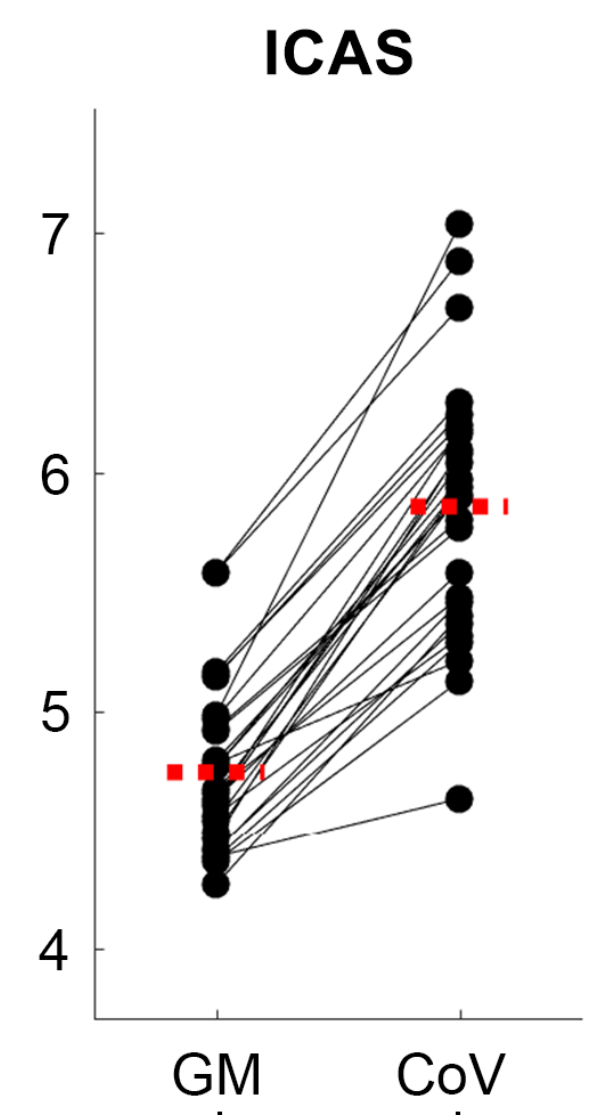
p=0.035*

p=0.048*

D

rCBV





GM CoV

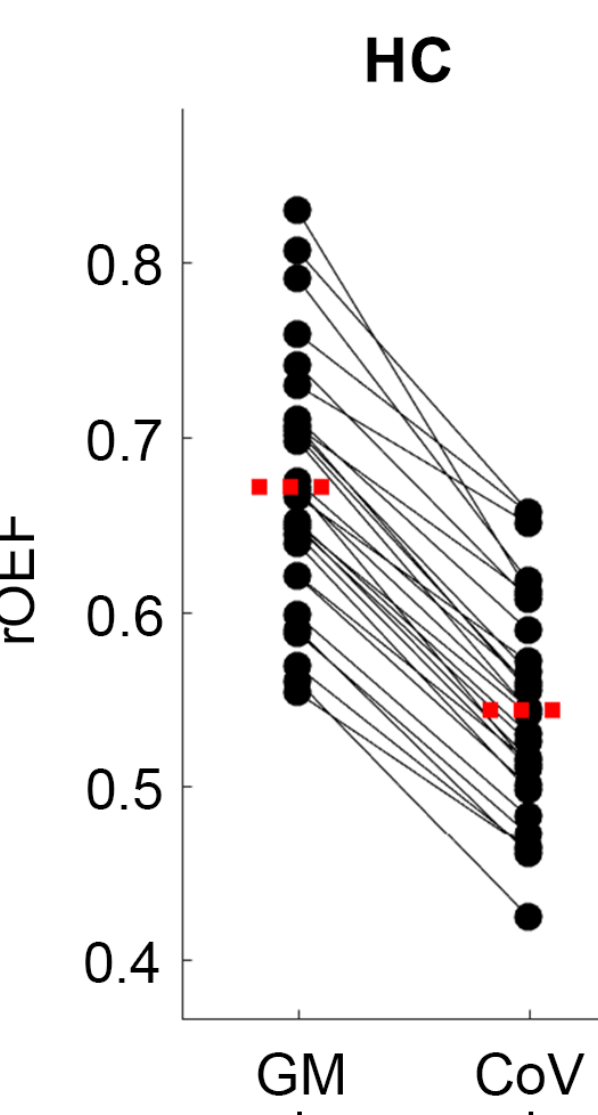
GM CoV

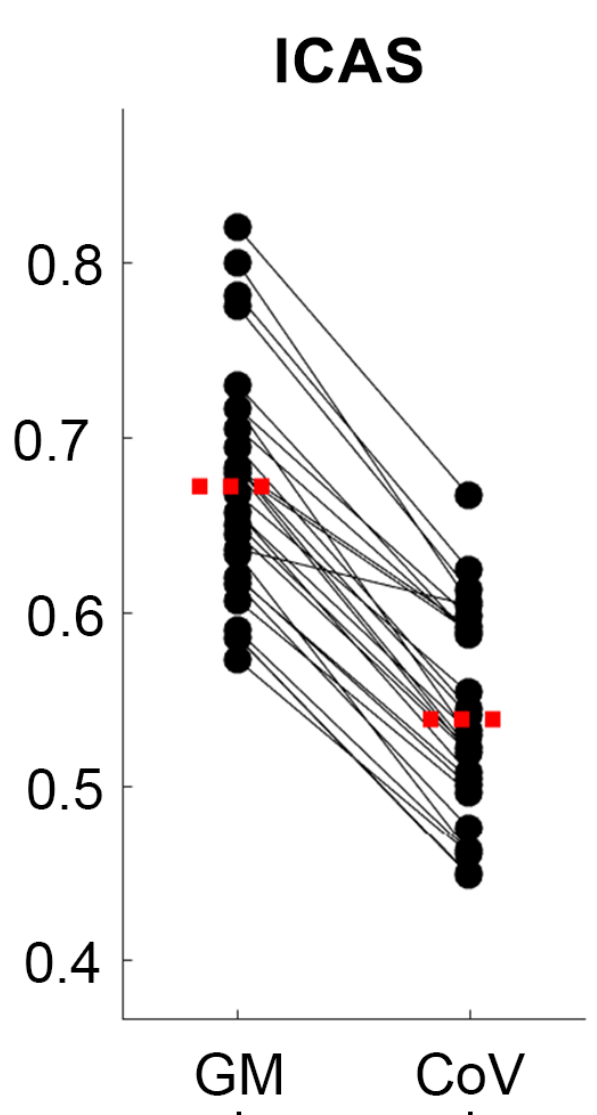
p<0.001*

p<0.001*

E

rOEF





GM CoV

GM CoV

p<0.001*

p<0.001*

Group-level comparison of the number of high-CoV voxels per hemisphere between HCs and ICAS patients (B) and hemodynamic characterization of CBF, relative CBV and relative OEF in whole brain grey matter (GM) vs. high-CoV voxels (C-E).

Discussion:

- Pial collateral recruitment is considered to be a sign of severely deteriorated hemodynamics and insufficiency of oxygen supply^{4,5}
- In our group of asymptomatic patients, hemodynamic impairment might still be compensated possibly also by primary collateral pathways via the Circle of Willis⁶

Conclusions:

- Absence of secondary collateral flow in our group of asymptomatic patients
- High potential to detect future pial collateral flow

References:

- Petty et al., *Stroke*, 1999
- Seiler et al., *JCBFM*, 2020
- Brozici et al., *Stroke*, 2003
- Sebök et al., *JCBFM*, 2021
- Kunieda et al., *InternMed*, 2017
- Schmitzer et al., *JMRI*, 2021

Acknowledgements:

German Research Foundation
German Academic Exchange
Leonhard-Lorenz Stiftung

Contact information:

Lena Schmitzer
Technical University of Munich (TUM)
Diagnostic and Interventional Neuroradiology
l.schmitzer@tum.de
 @NMRMgroup