Prevalence of cerebrovascular reserve impairment in patients with severe intracranial stenosis

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Objectives

- Management of patients with SIAS remains controversial Chimowitz *NEJM 2013*

- Better characterization of the risk of hemodynamic stroke would be helpful Yakota *Stoke 1998*

- BOLD fMRI to hypercapnic challenge has been proposed to identify impaired cerebrovascular reserve (CVR BOLD fMRI) as a safe and feasible method Spano *Radiology 2013*

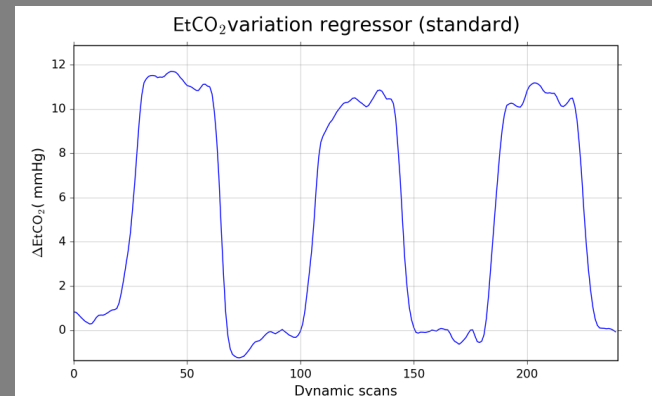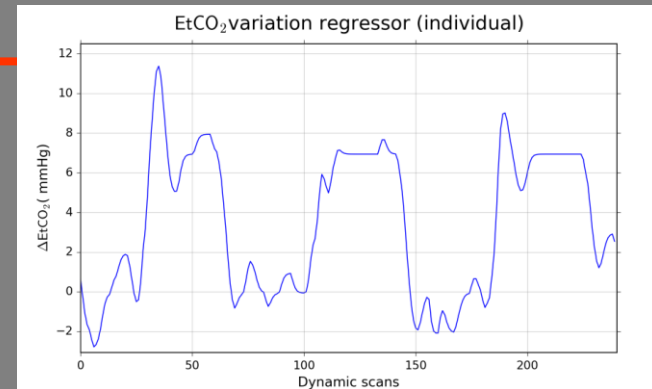- ➜ Prevalence of impaired CVR in patients with anterior SIAS
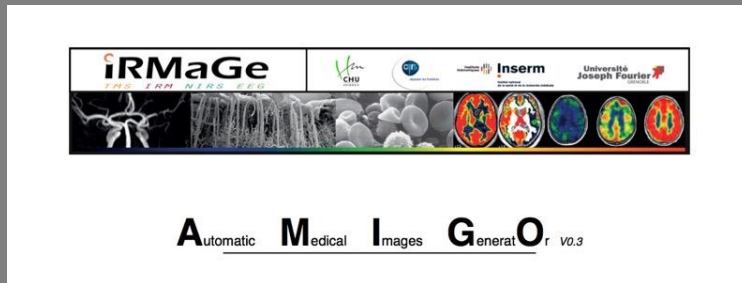

CBF

Materials and methods

- Between 2011 and 2016, 66 patients referred for stroke with SIAS were examined using CVR BOLD fMRI

- Data were compared to controls *Boudiaf J Neuroradiol 2015*

- MRI procedure (3T)
  - Anatomical volumes: 3DT1 FFE / 2D FLAIR / TOF MRA
  - Basal perfusion using DSC
  - BOLD fMRI: T2* GE SSH-EPI
  - Hypercapnic challenge (8%)
    - Block-design: [air (1') – hypercapnia (2') – air (1')] x 3
    - Total duration: 12 minutes

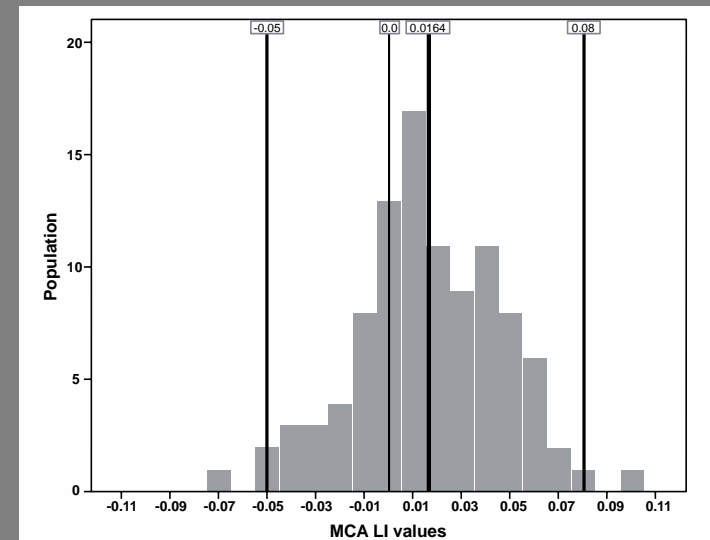| 1'	2'							
AIR	Hypercapnia	AIR	AIR	Hypercapnia	AIR	AIR	Hypercapnia	AIR
	BLOCK 1			BLOCK 2			BLOCK 3	
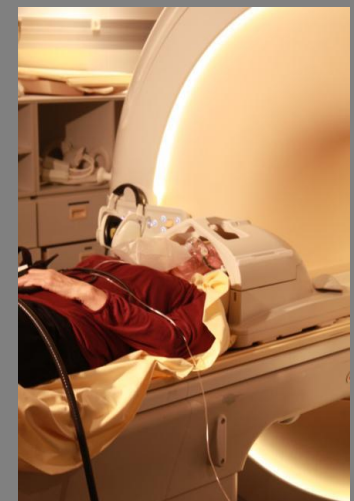
Data analyses

- MATLAB - SPM 12

- Coregistration – Realignment – Segmentation & MNI normalization – Spatial smoothing (6mm)

- GLM: $EtCO_2$ physiological regressor

- ROI analysis
  - Set of cannonical ROIs
  - GM/WM segmentation (smooth 6mm)
  - ➔ set of individual GM ROI

- $LI_{MCA} = (CVR_{left} - CVR_{right})/(CVR_{left} + CVR_{right})$

- Data compared to 100 volunteers' study *Boudiaf J Neuroradiol 2015*
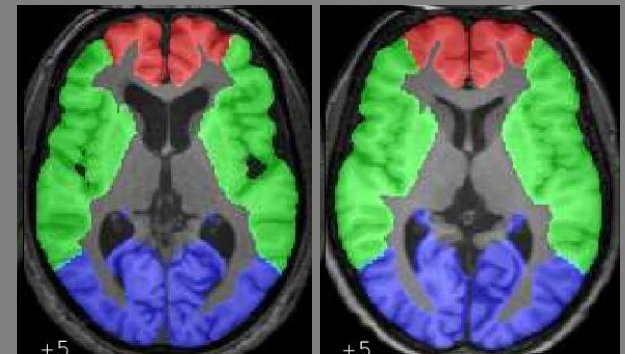
Results

- Among 66 patients referred for stroke with SIAS
  - ➔ 46 patients (14 females; 62.2±14.9 years)
    - Unilateral SIAS of internal carotid (n=25) (R/L=13/12)
    - Unilateral SIAS of middle cerebral artery (MCA) (n=21) (R/L=12/9)

- No adverse effect

- Physiological regressor 29/46

- Normal $|LI_{MCA}| < 0.08$

Boudiaf J Neuroradiol 2015
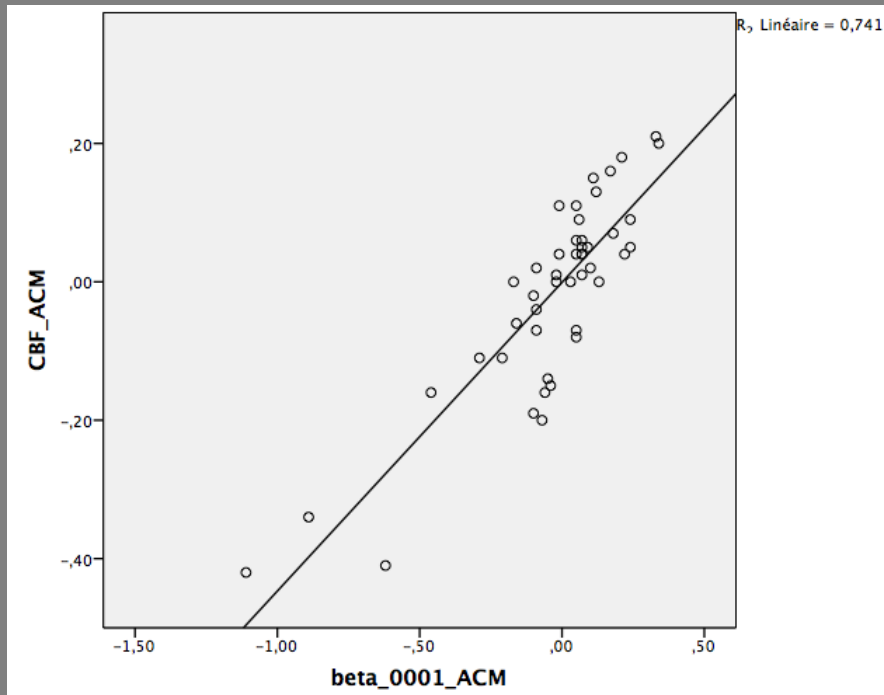
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Results

- Among patients with ICA stenosis
  - $|LI_{MCA}| = [0.01 - 1.11]$
  - **14 patients out of 25 had an abnormal $|LI_{MCA}| \geq 0.08$**

- Among patients with MCA stenosis
  - $|LI_{MCA}| = [0.01 - 0.29]$
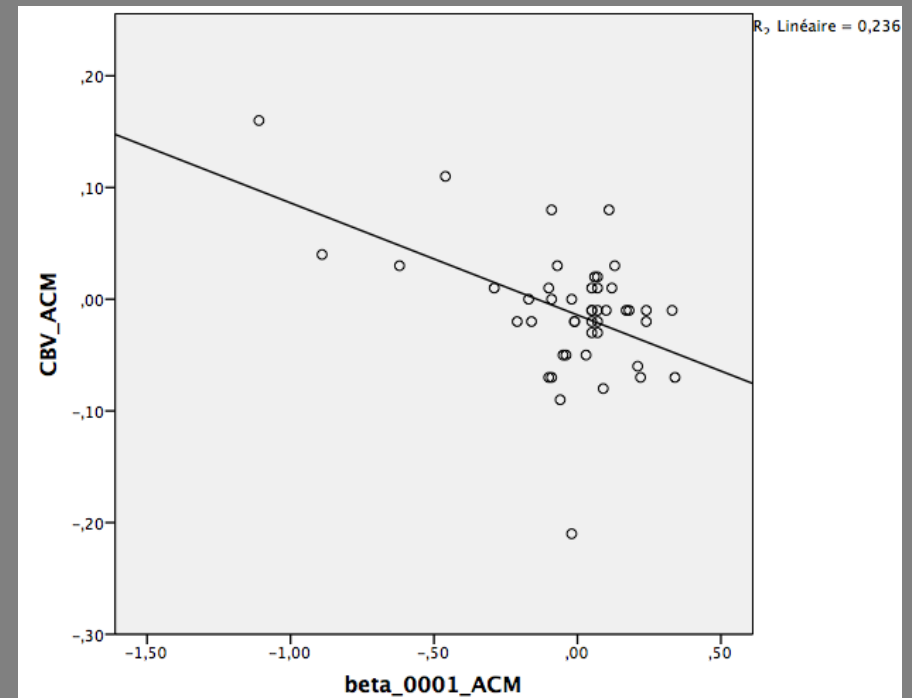 - **12 patients out of 21 had an abnormal $|LI_{MCA}| \geq 0.08$**

26 patients out of 46 (57%)
had impaired CVR

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Results

Correlation CVR – CBF
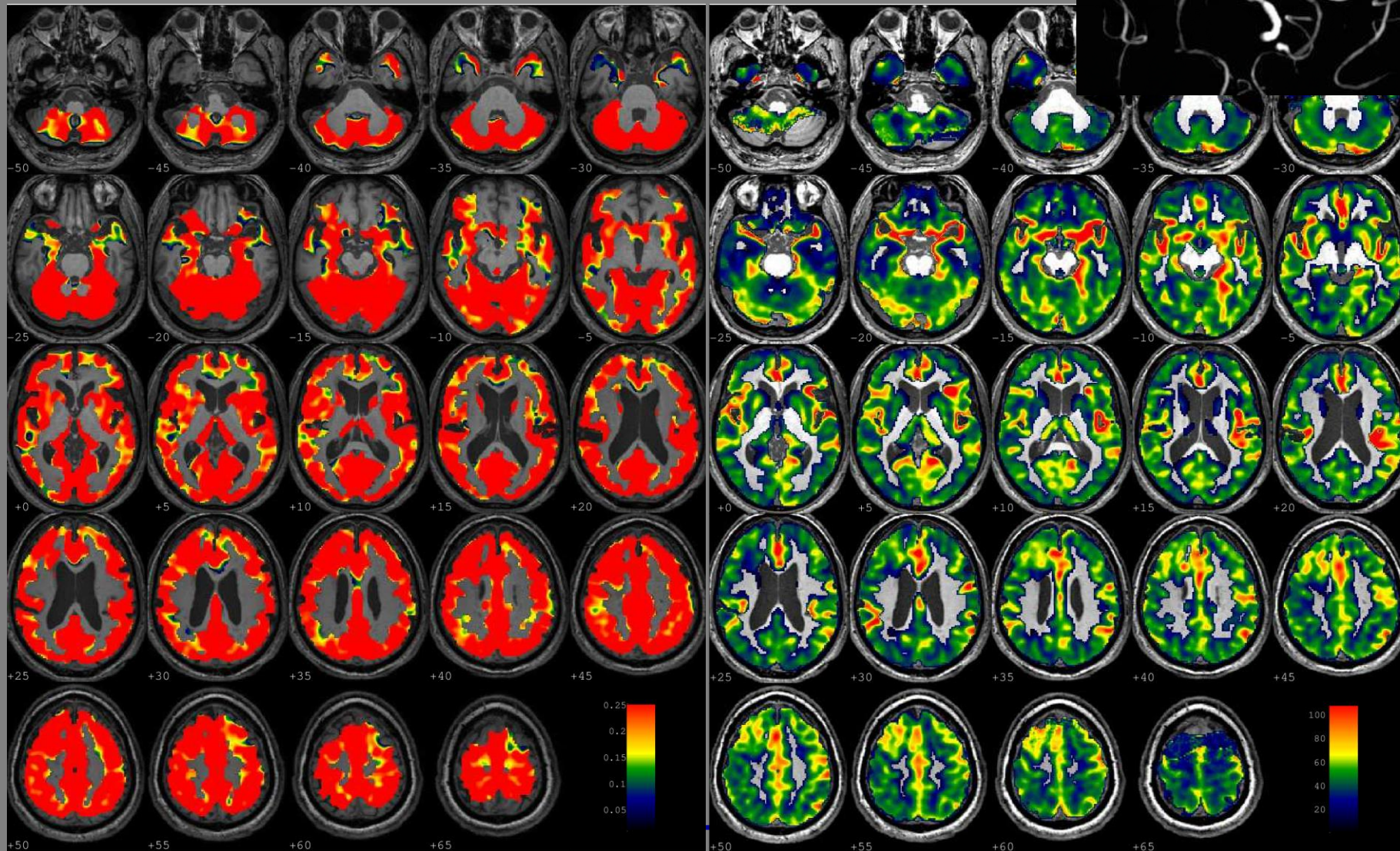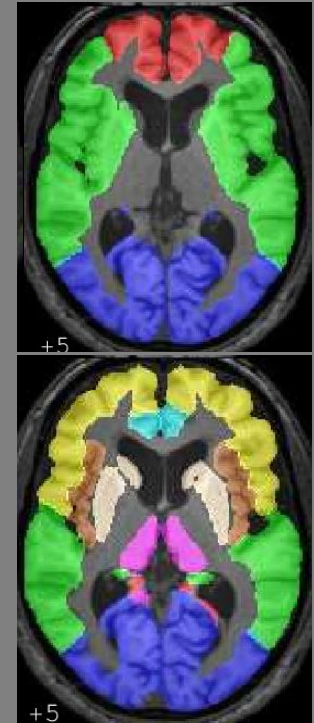R=0.86 (p<.001)

Correlation CVR – CBV
R=-0.49 (p<.001)

M 65yo, Right MCA *aitm280313*

BOLD CVR: IL = -0.01

DSC CBF: IL = 0.04

Laterality Index from BOLD functional MRI study of the cerebral vasoreactivity to hypercapnia
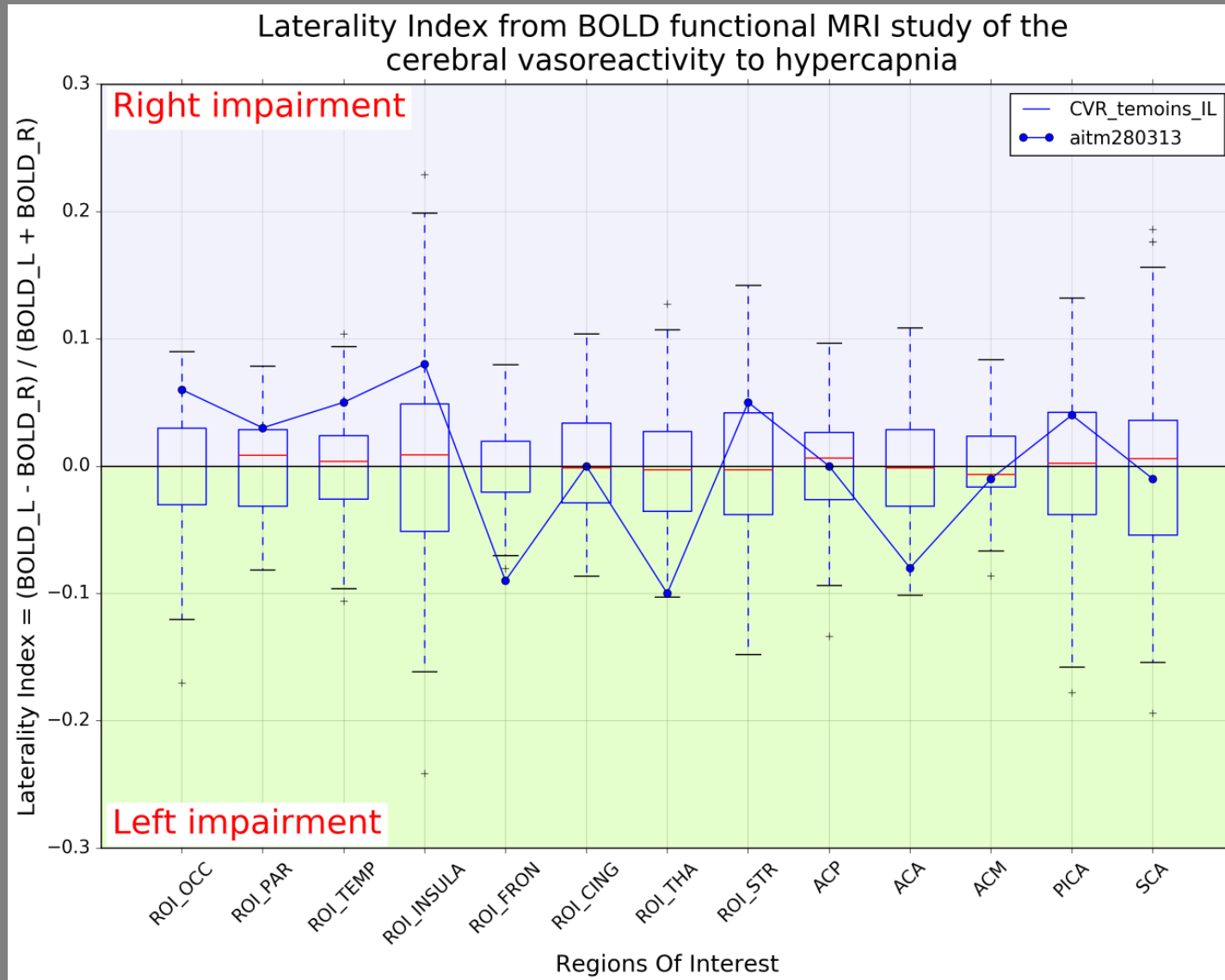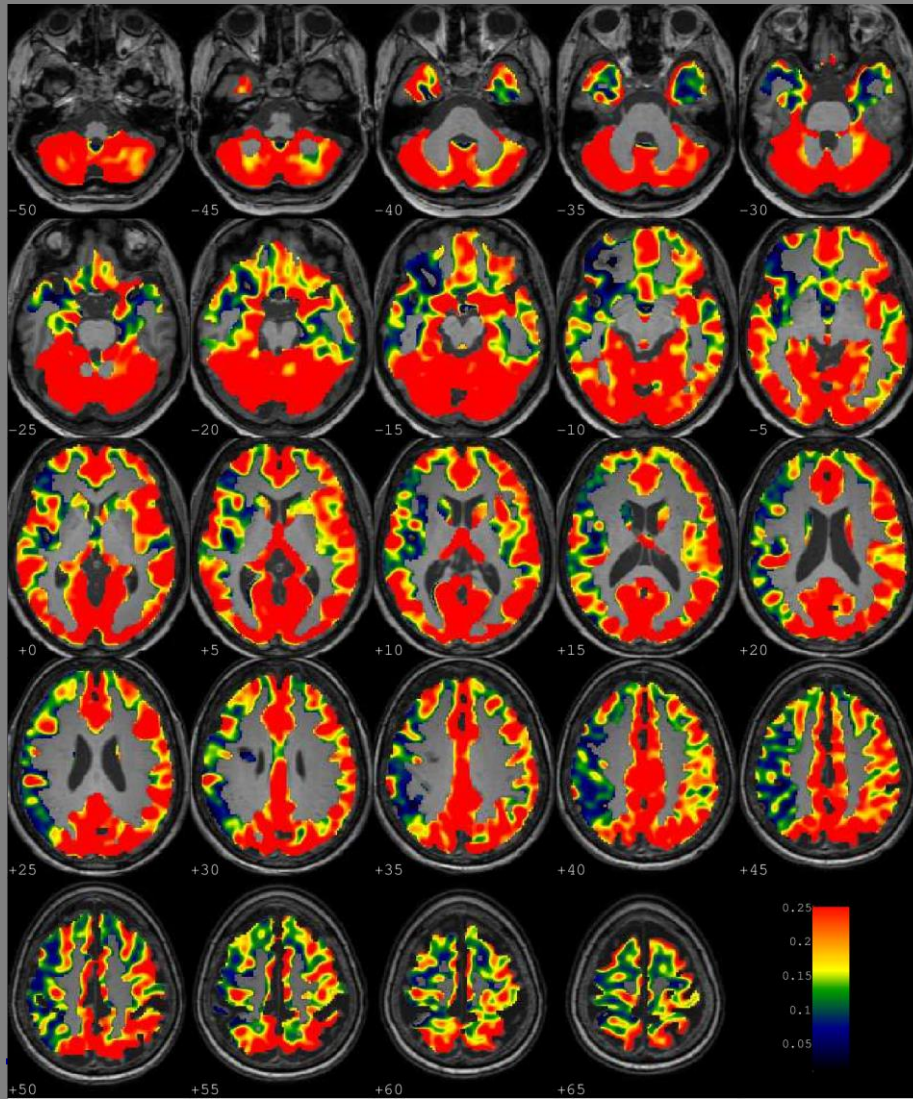
W 37yo, Right MCA *rufs110216*

BOLD CVR: IL = 0.24   DSC CBF: IL = 0.09

W 37yo, Right MCA *rufs110216*

Laterality Index from BOLD functional MRI study of the cerebral vasoreactivity to hypercapnia

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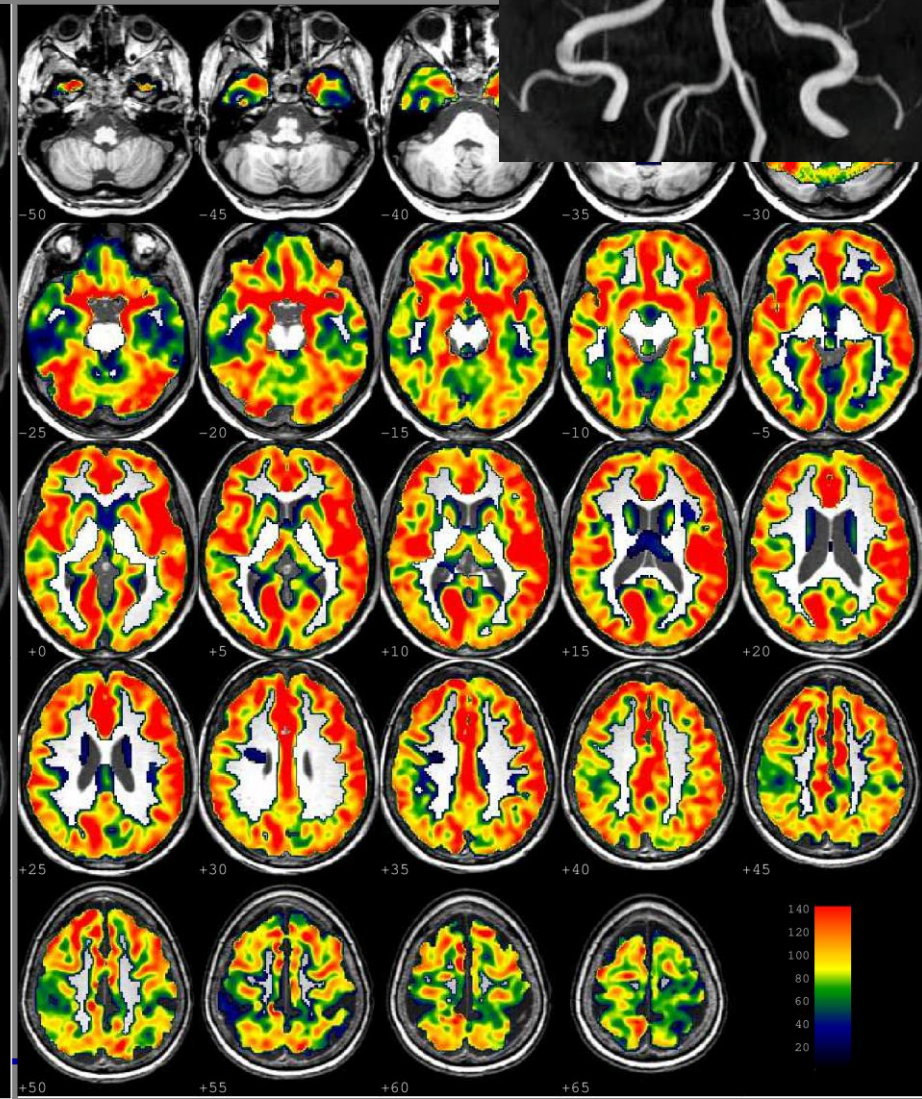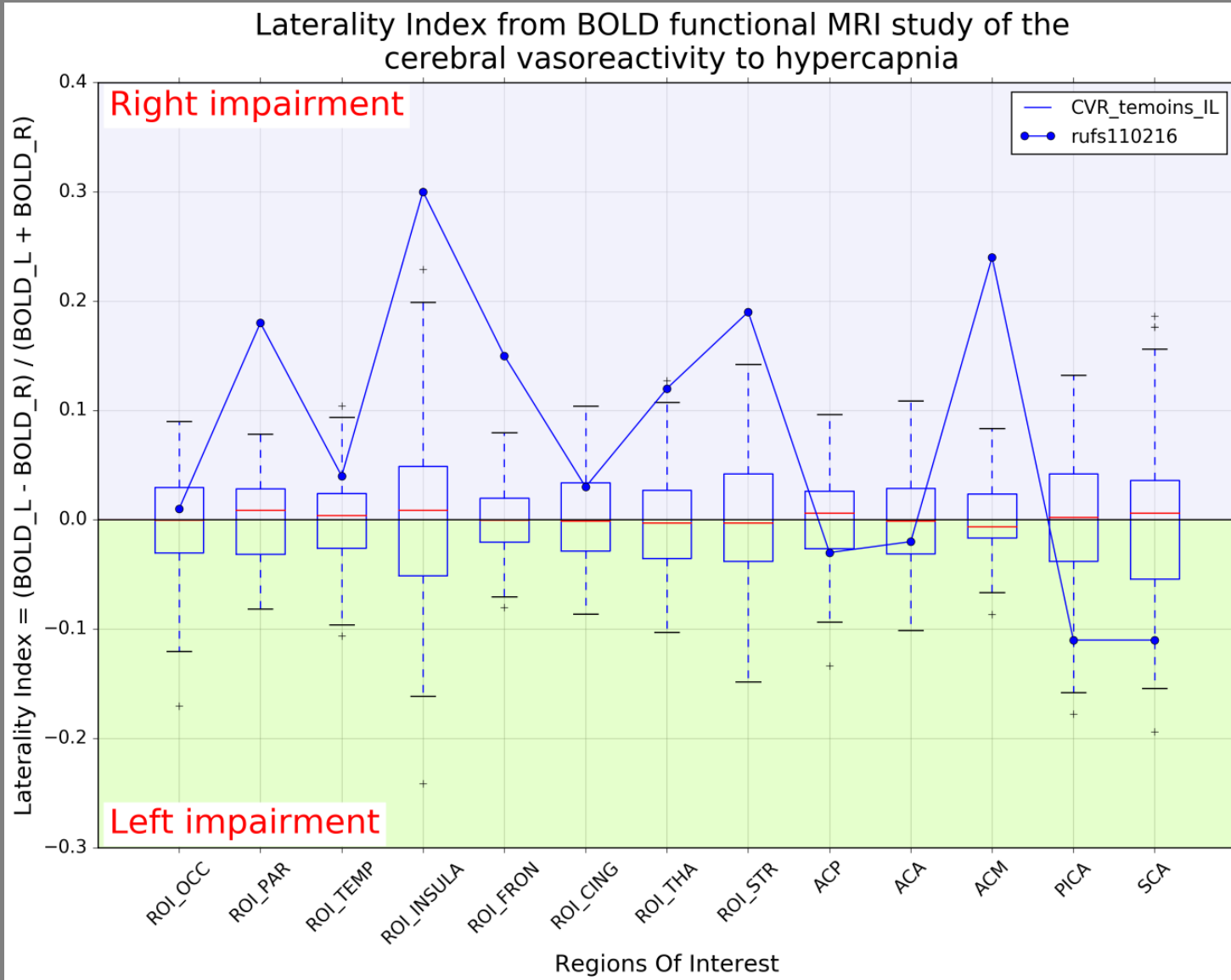
Conclusion

- In our series, CVR impairment occurs in 57% of patients referred for stroke with anterior SIAS

- Downstream SIAS, impaired CVR
  - Negative correlation with CBV
    - Basal vasodilation (autoregulation)
  - Positive correlation with CBF
    - Insufficient vasodilation (chronic low grade ischemia)
  - In line with Bouvier *et al.* Hum Brain Mapp 2015 (12 cases)

- Therapeutic strategy should take into account CVR information in order to better identify patients at risk of hemodynamic stroke

- ➔ New SAMMPRIS study ?

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Thank you for your attention

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Perspectives

- For better quantification, individual physiological regressor ought to be implemented...

and better recorded..