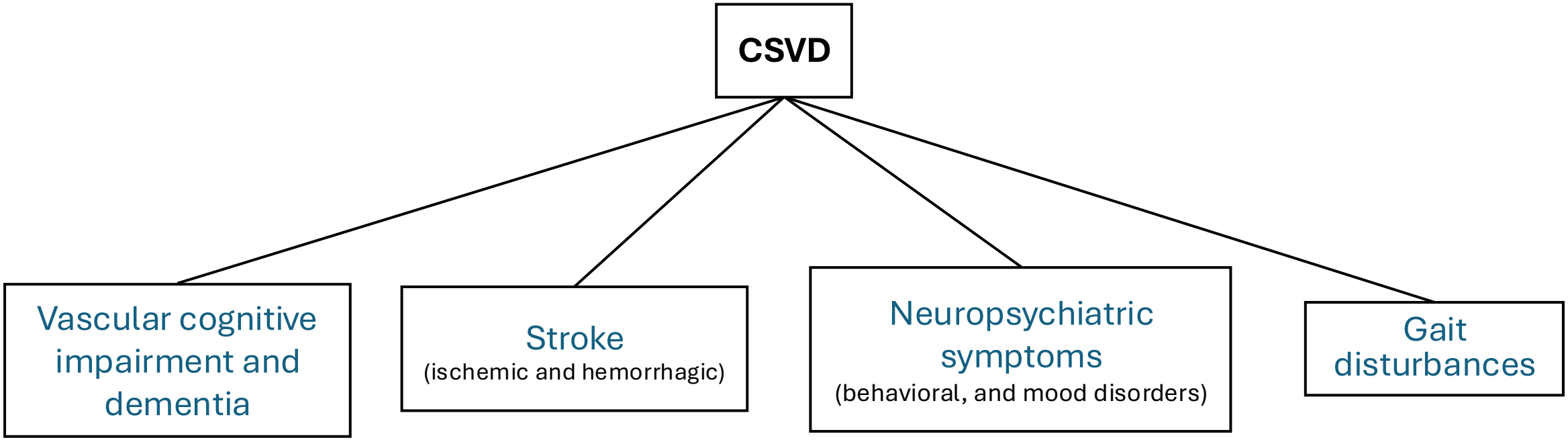
Using Ultra-High Field Quantitative MRI and Inflammatory Biomarkers to Improve the Characterization, Diagnosis, and Treatment of Cerebral Small Vessel Disease

Baudru J., Delvoye F., Dasnoy-Sumell G., Oury C., Ly J., Maquet P., Bastin C.

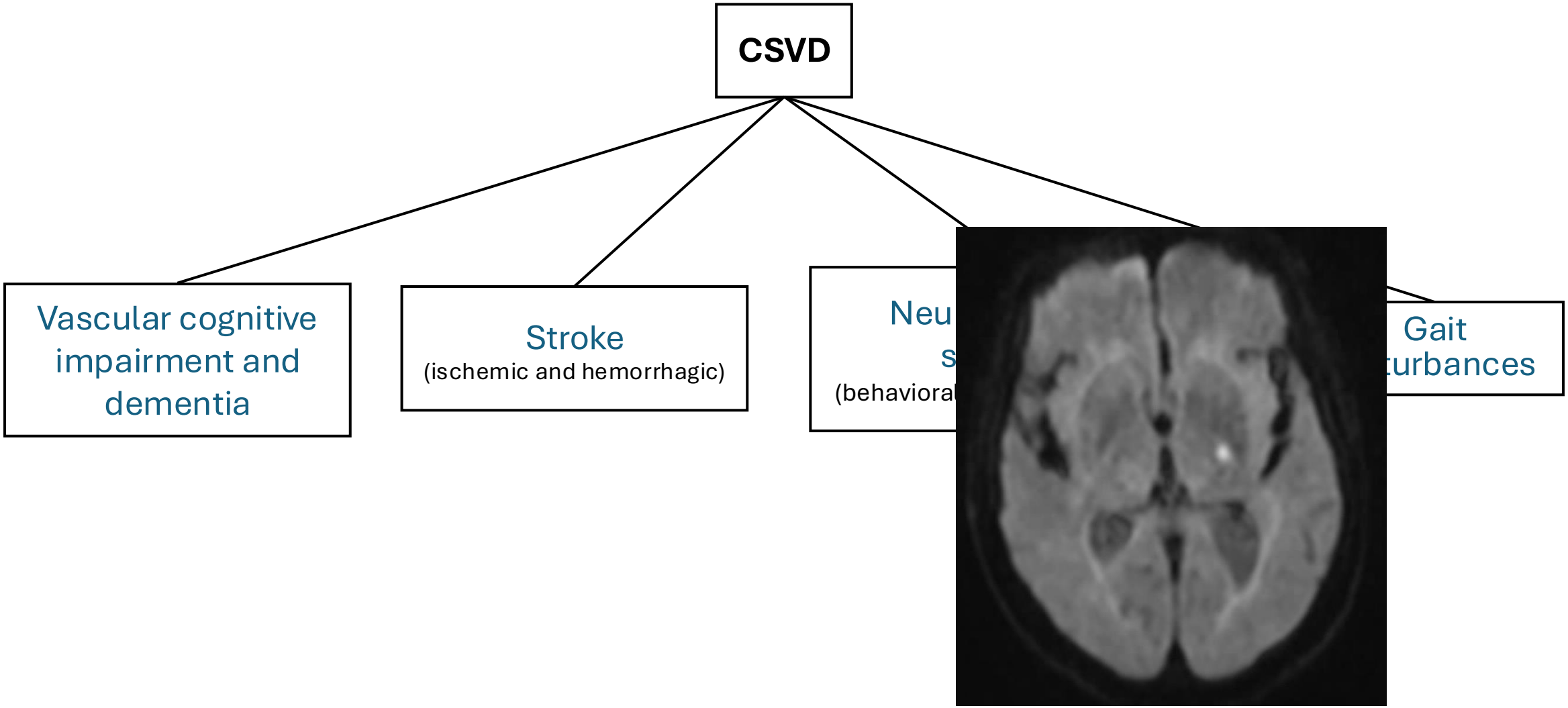
Introduction

Cerebral small vessel disease (CSVD) is a group of cerebrovascular pathologies affecting the brain's small caliber vessels

Introduction



Introduction

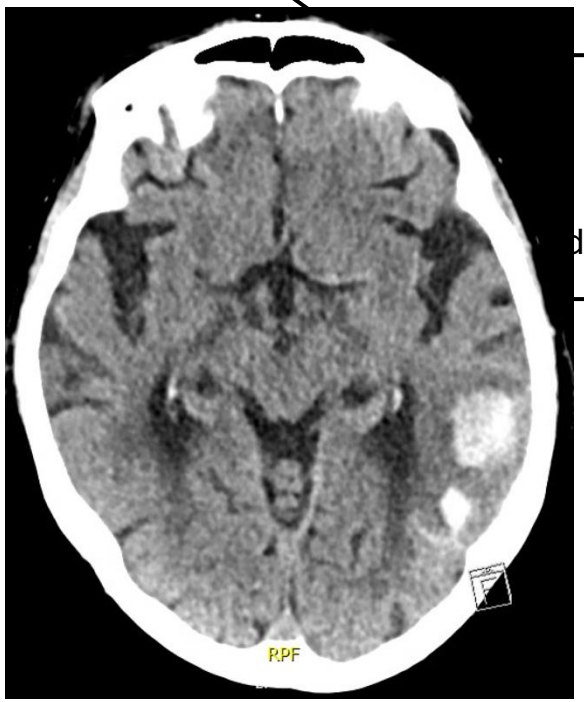


Introduction

CSVD

Vascular cognitive impairment and dementia

Stroke
(ischemic and hemorrhagic)



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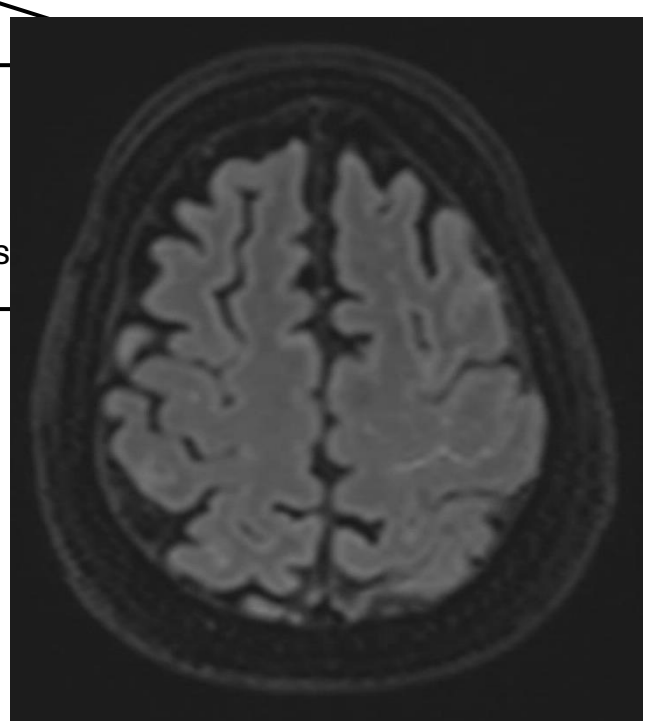

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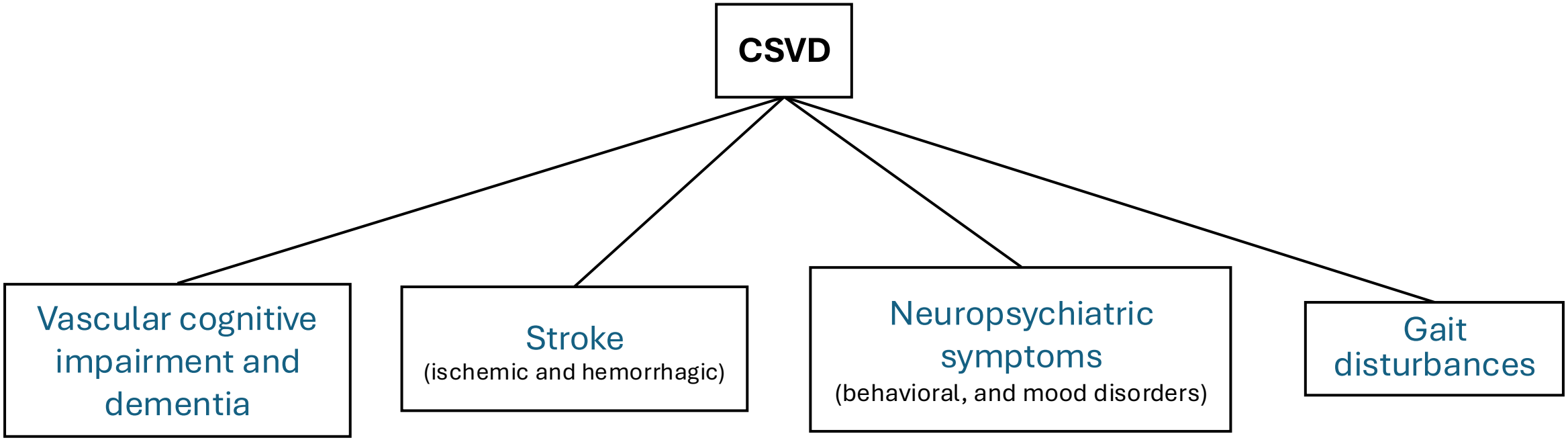


Covert CSVD

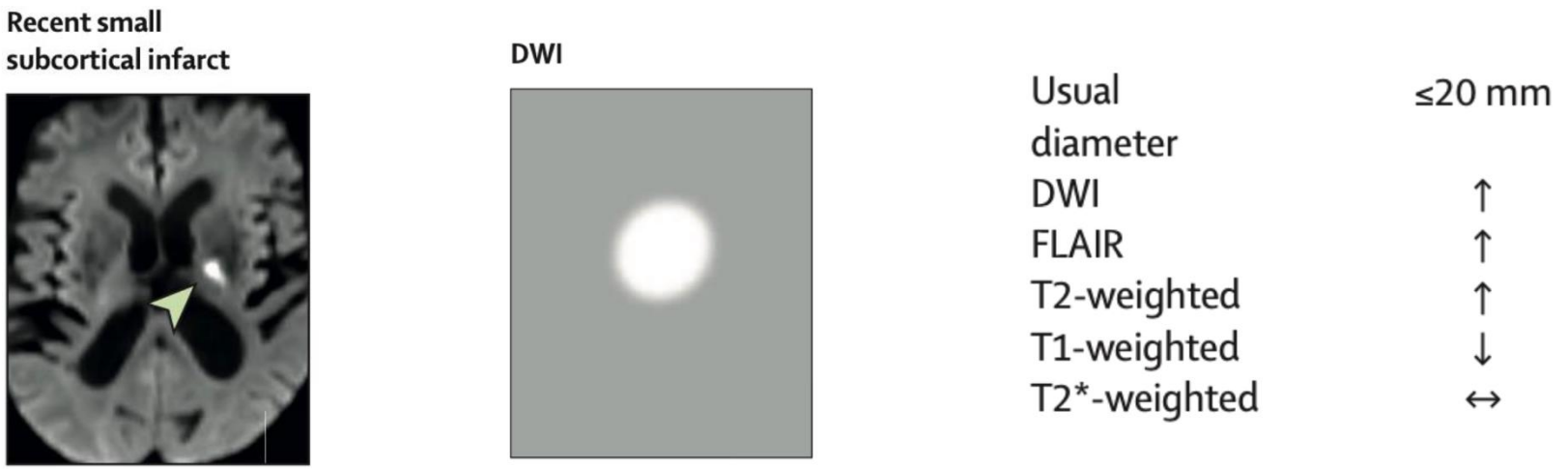
Introduction

CSVD features on neuroimaging :

Introduction

CSVD features on neuroimaging :

- Recent Small subcortical infarcts



Duering, Marco et al. "Neuroimaging standards for research into small vessel disease-advances since 2013." *The Lancet. Neurology* vol. 22,7 (2023): 602-618.

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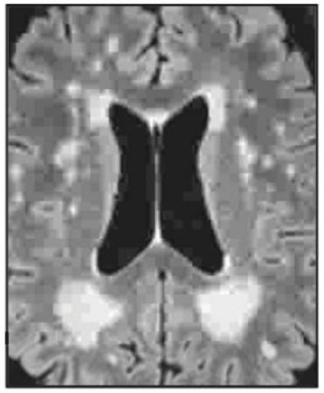
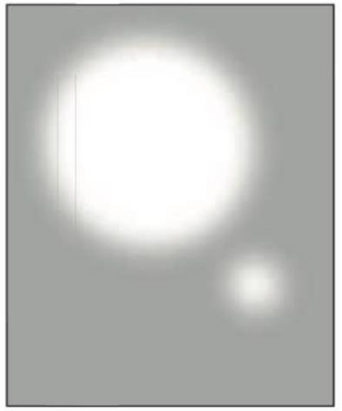
CSVD features on neuroimaging :

- Recent Small subcortical infarcts
- White matter hyperintensities of presumed vascular origin

White matter hyperintensity



FLAIR



Usual diameter	Variable
DWI	↔
FLAIR	↑
T2-weighted	↑
T1-weighted	↔ (↓)
T2*-weighted	↑

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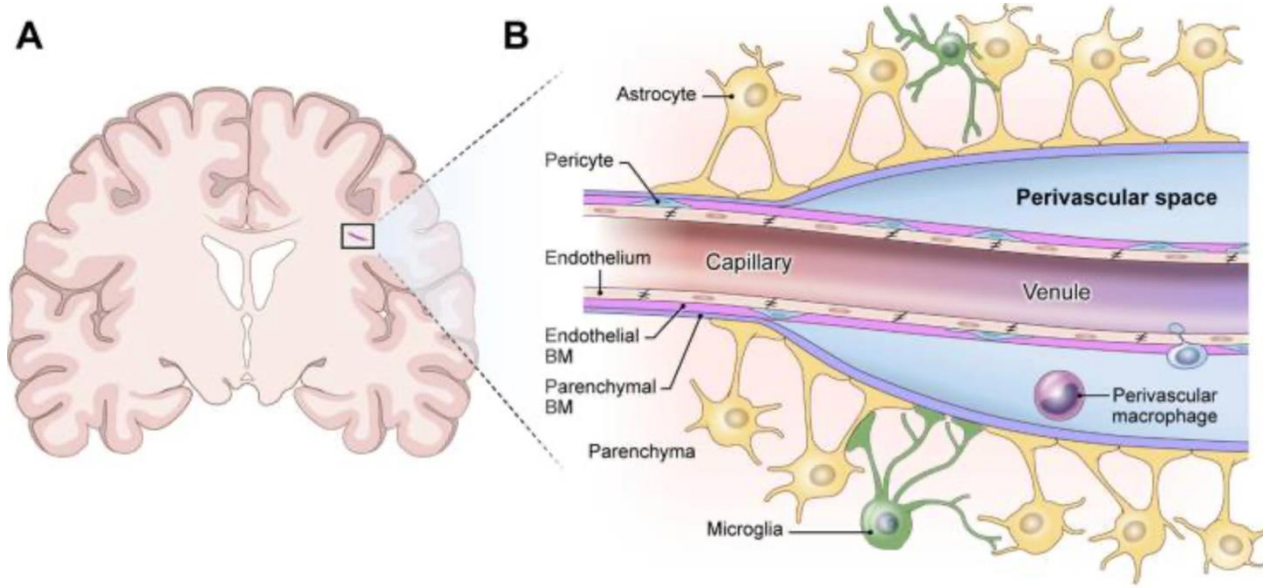

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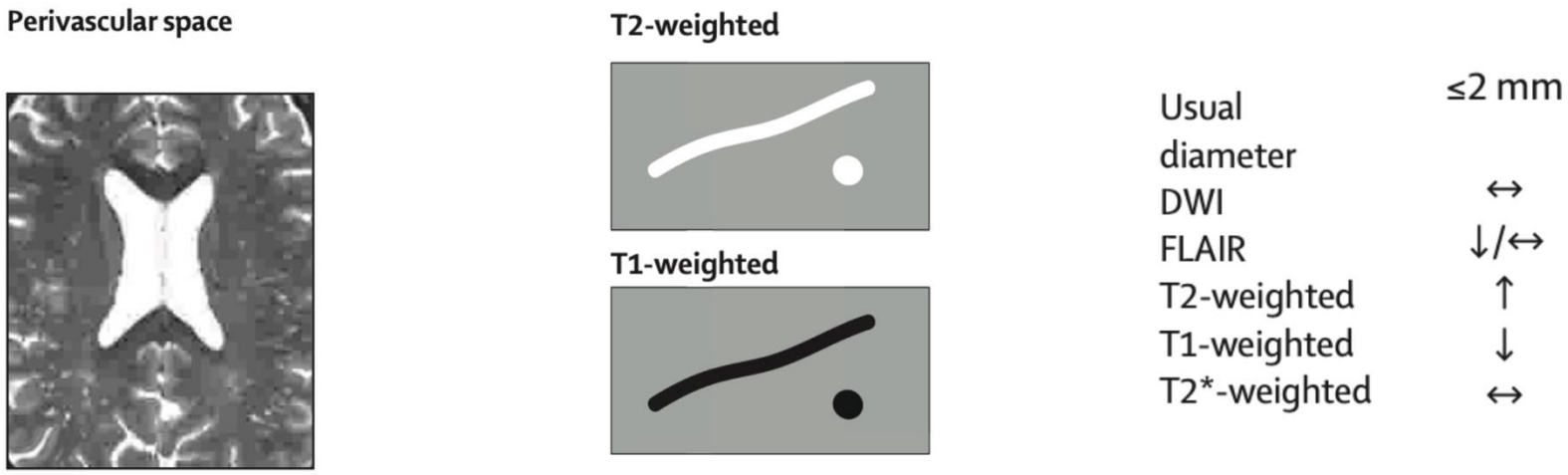

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CSVD features on neuroimaging :

- Recent Small subcortical infarcts
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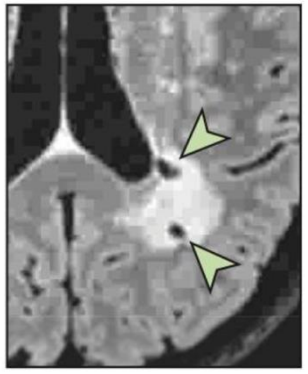
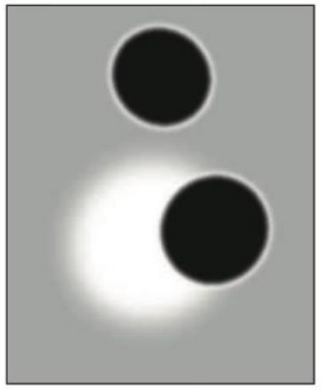
- Enlarged perivascular spaces
- Lacunes of presumed vascular origin

Lacune



FLAIR



Usual diameter	3–15 mm
DWI	↔ (↓)
FLAIR	↓
T2-weighted	↑
T1-weighted	↓
T2*-weighted	↔

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CSVD features on neuroimaging :

- Recent Small subcortical infarcts
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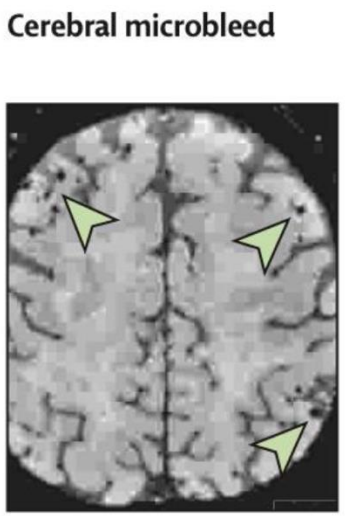
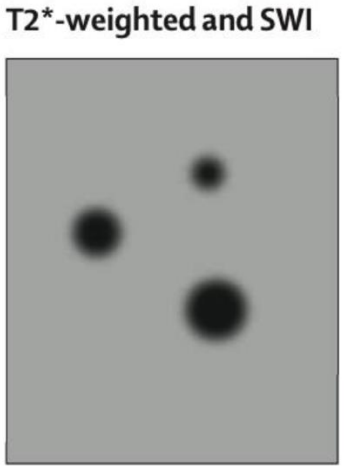
- Lacunes of presumed vascular origin
- Cerebral microbleeds





Usual diameter	≤10 mm
DWI	↔
FLAIR	↔
T2-weighted	↔
T1-weighted	↔
T2*-weighted	↓↓

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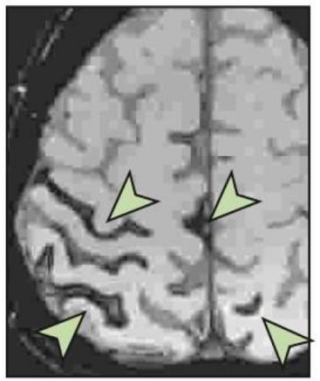
- Cerebral microbleeds
- Cortical superficial siderosis

Cortical superficial siderosis



T2*-weighted and SWI

	Variable
Usual diameter	
DWI	↔
FLAIR	↔
T2-weighted	↔
T1-weighted	↔
T2*-weighted	↓↓

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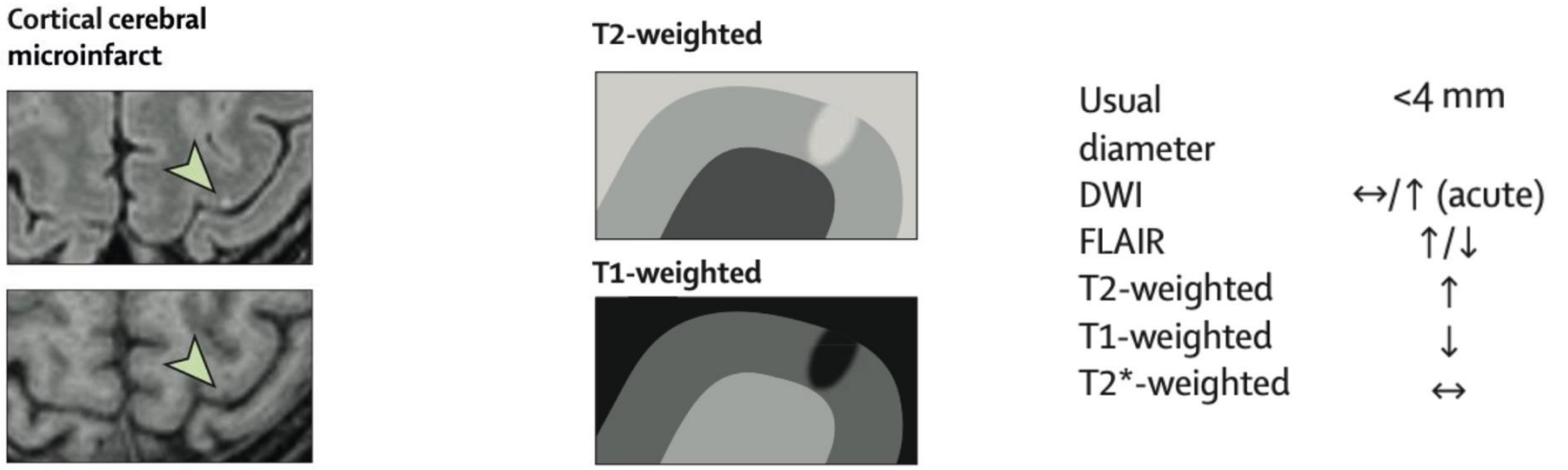
- Cerebral microbleeds
- Cortical superficial siderosis
- Cortical cerebral microinfarcts



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Introduction

Etiologies :

- Arteriolosclerosis
- Sporadic cerebral amyloid angiopathy
- Monogenic CSVD
- Infectious and inflammatory diseases
- Postradiation vasculopathy
- …

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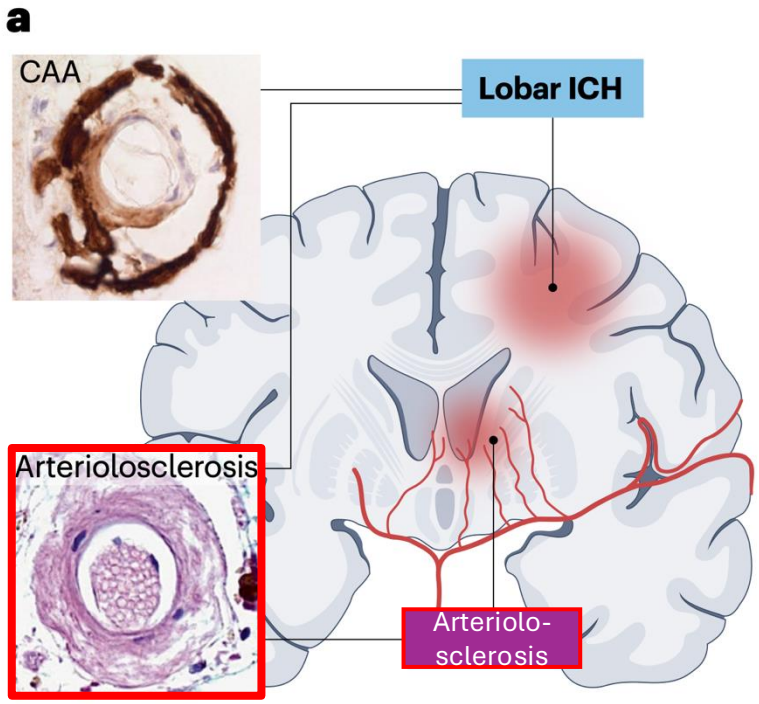
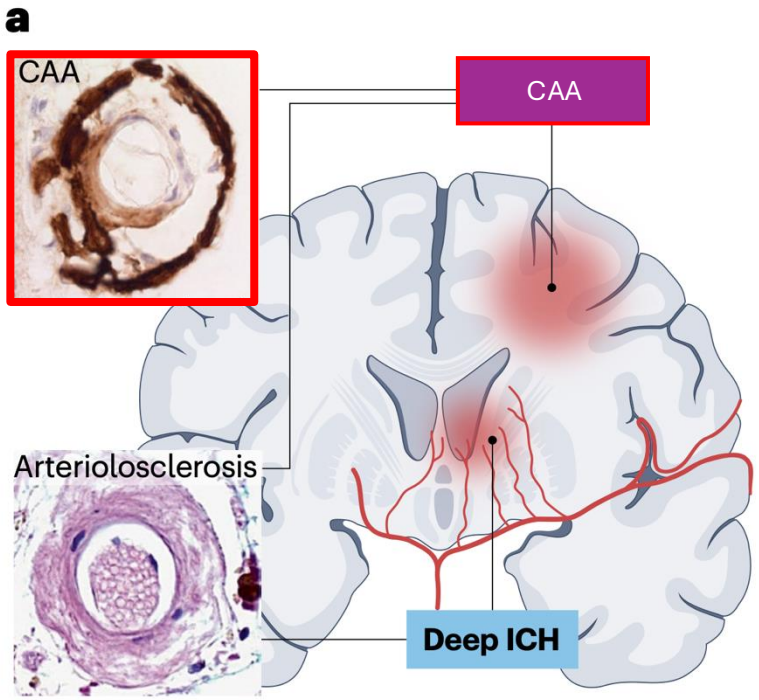


Arteriolosclerosis

Deep perforating arteries are mainly affected

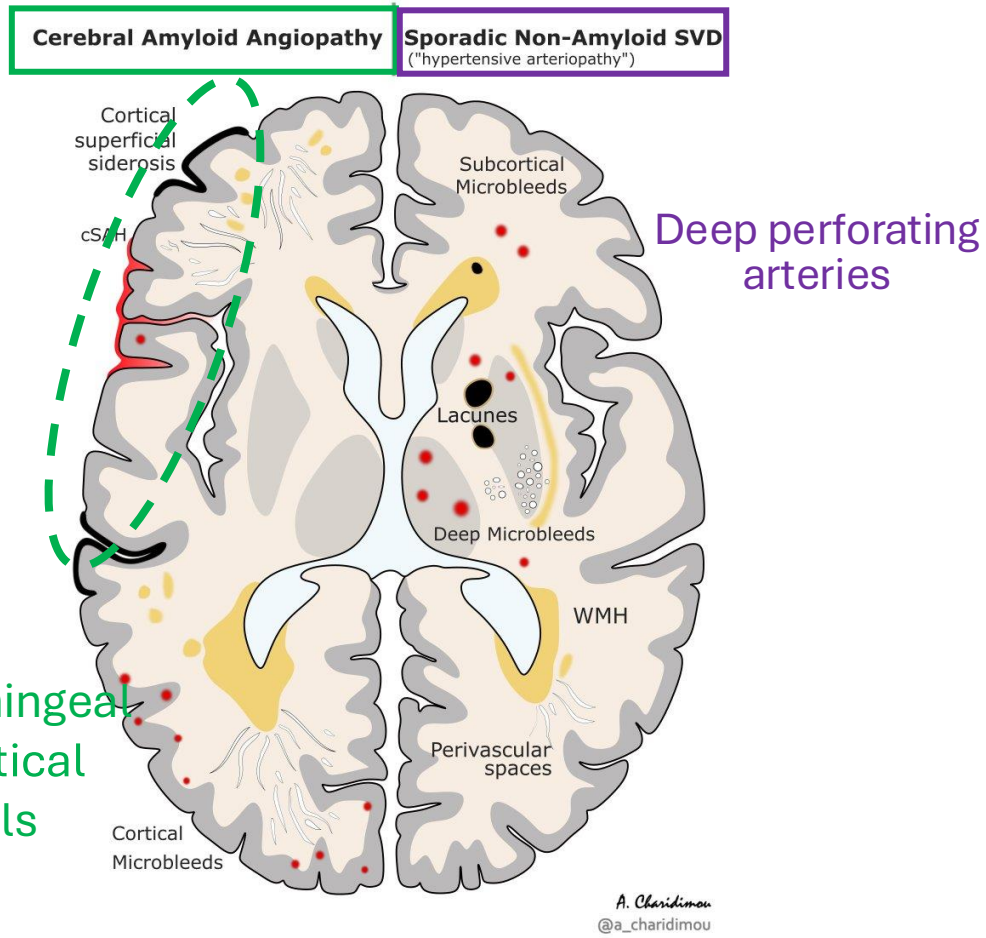


CAA

Leptomeningeal and cortical vessels are primarily affected

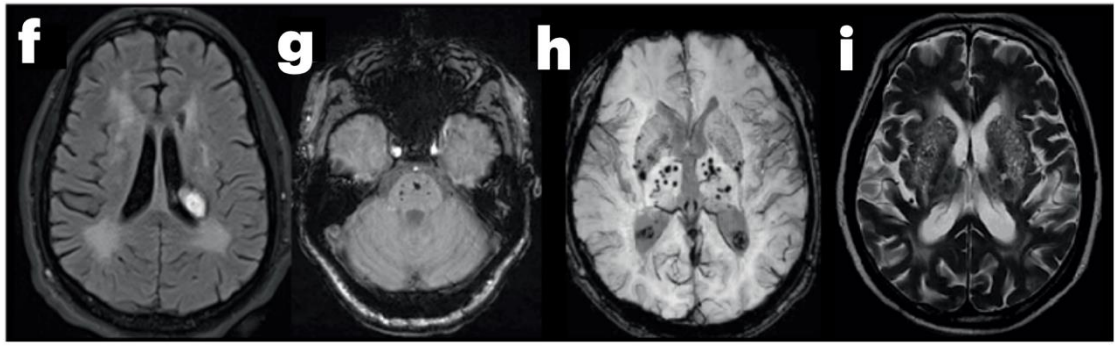
Introduction

- **Arteriolosclerosis versus cerebral amyloid angiopathy**

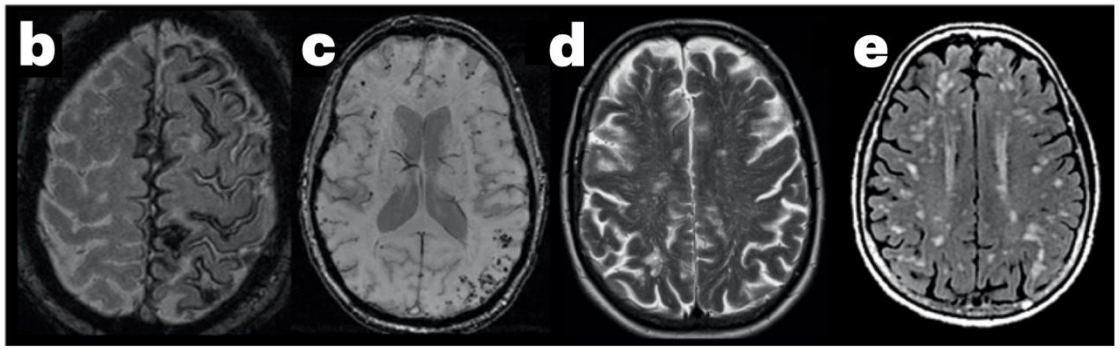


Deep perforating arteries

Leptomeningeal and cortical vessels



Neuroimaging markers of arteriolosclerosis

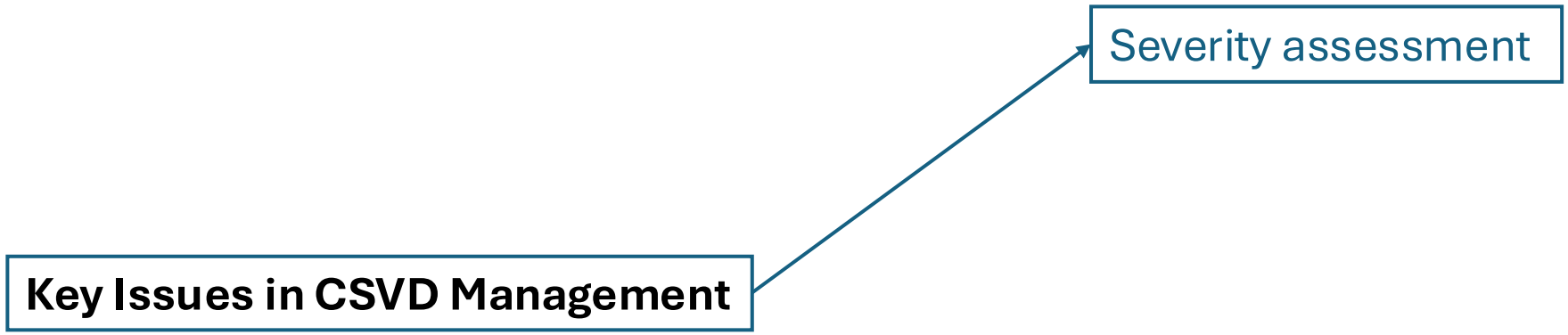


Neuroimaging markers of CAA

Introduction

Key Issues in CSVD Management

Introduction



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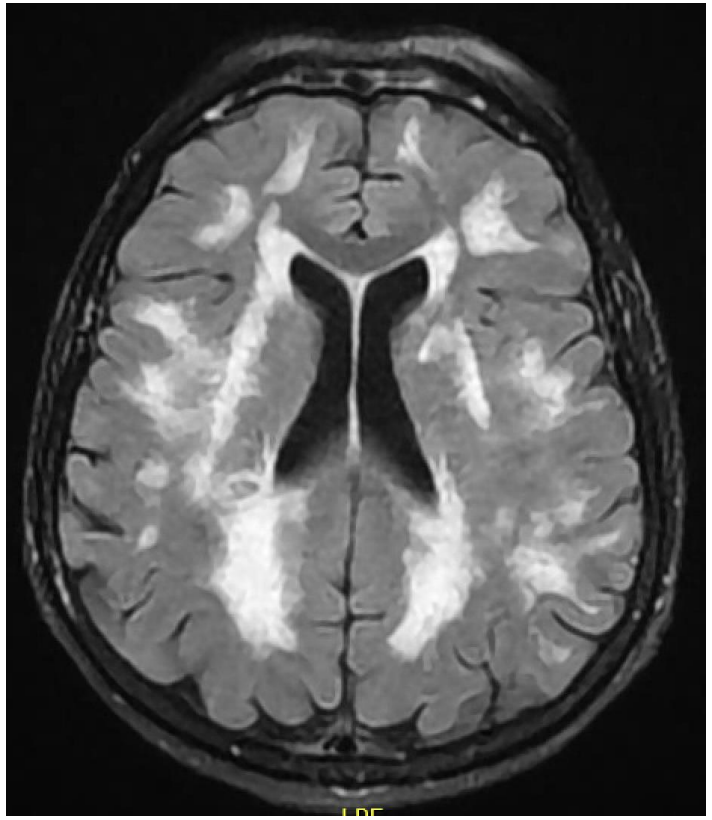
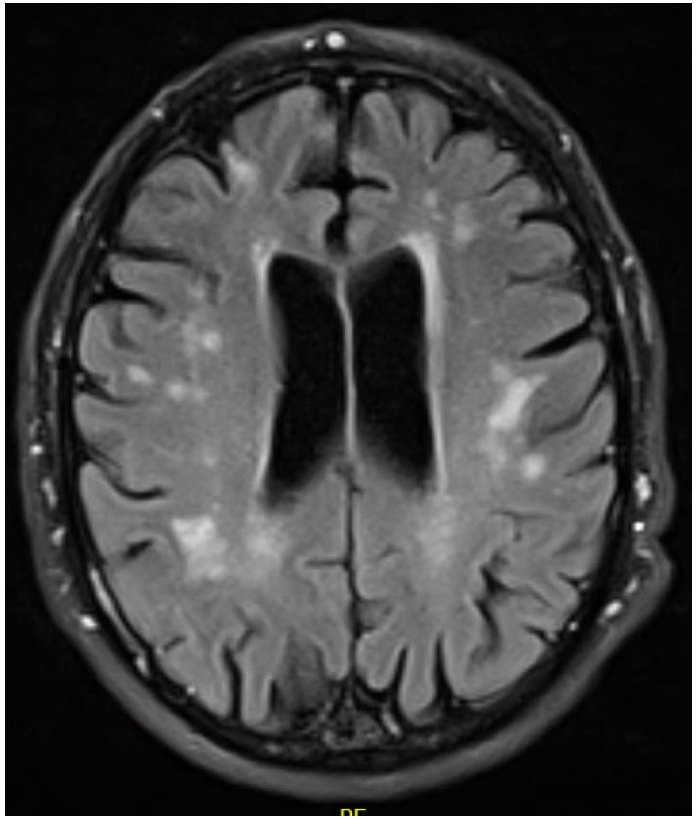
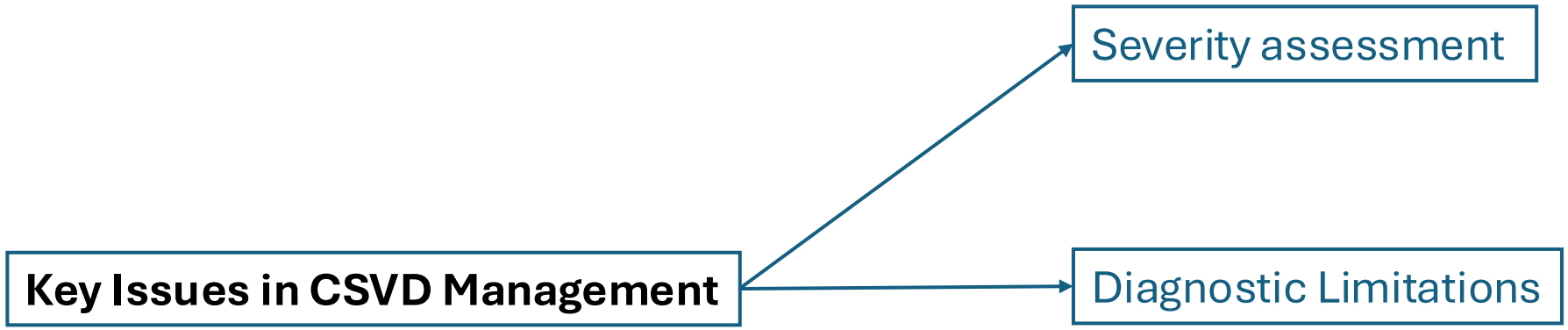


Patiente de 64 ans
MOCA 26/30

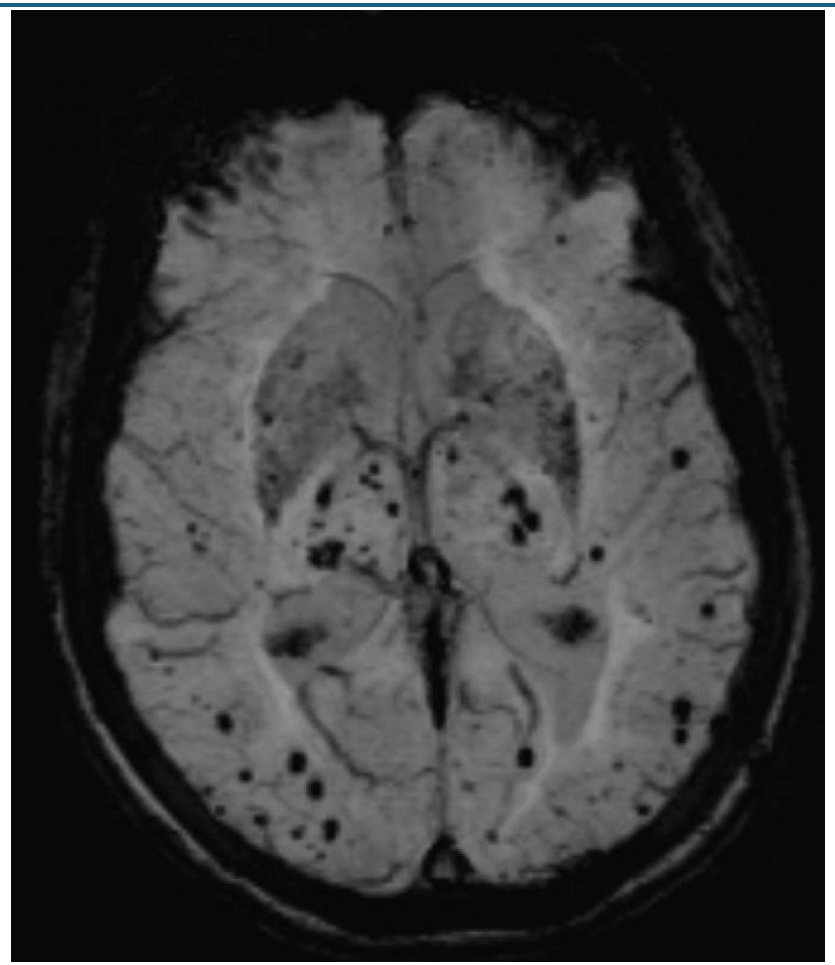


Patient de 75 ans
MOCA 19/30

Introduction

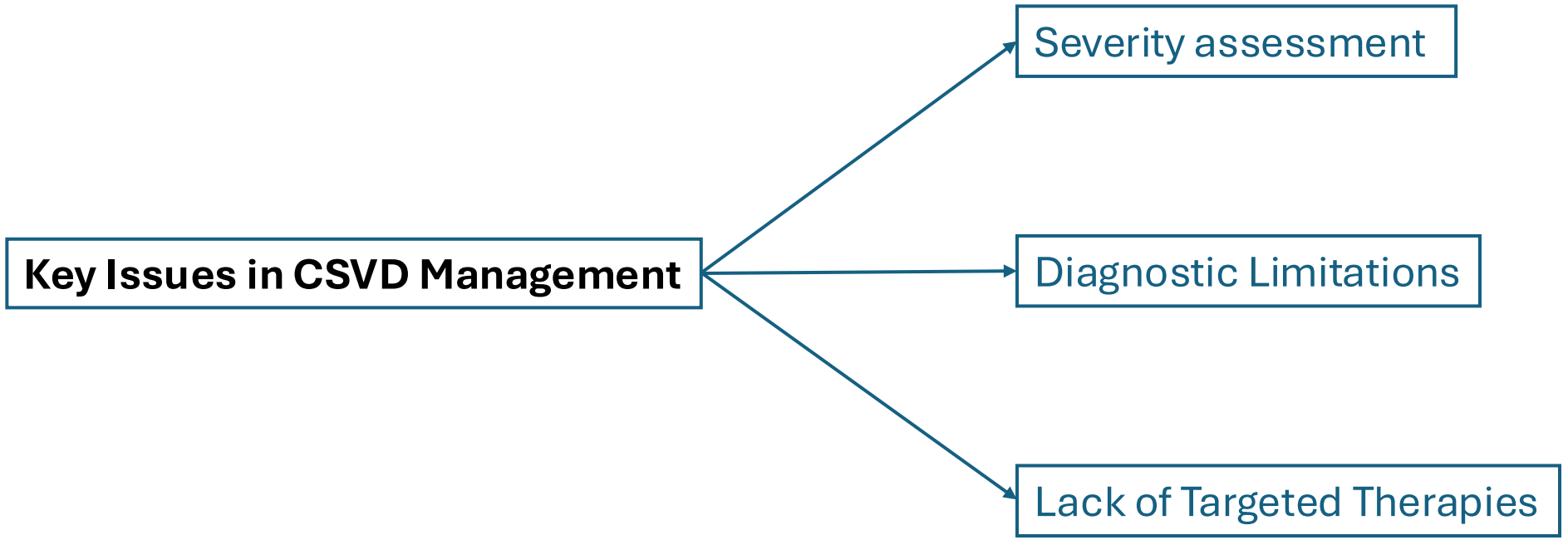


Introduction



Artériolosclérose VS CAA ?

Introduction



Materials and methods

Cohort :

- Adult patients whose routine MRI shows signs of CSVD.
- A sample of healthy controls (HCs) : 33% HC to 66% patients.

100 participants

Materials and methods

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First step : Medical consultation

- Medical history
- Clinical and cognitive assessment.

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- Adult patients whose routine MRI shows signs of CSVD.
- A sample of healthy controls (HCs) : 33% HC to 66% patients.

100 participants

First step : Medical consultation

- Medical history
- Clinical and cognitive assessment.

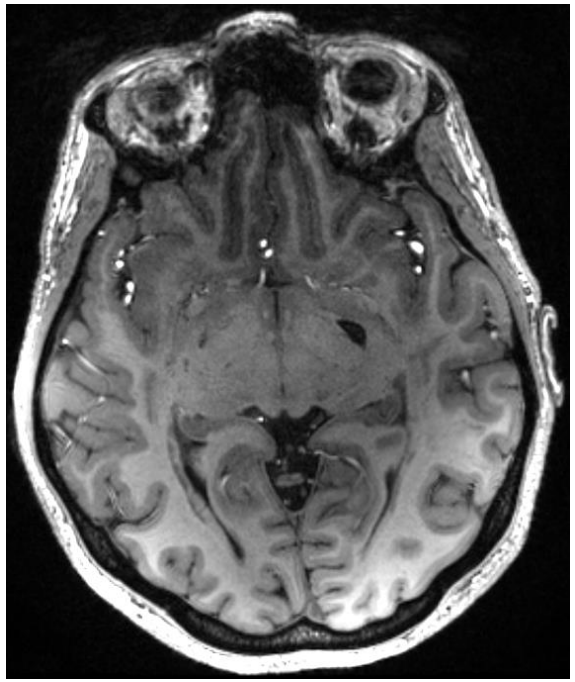
Second step : Scanning day (Cyclotron Research Centre in Liège)

- 7T Tesla MRI
- Blood sample

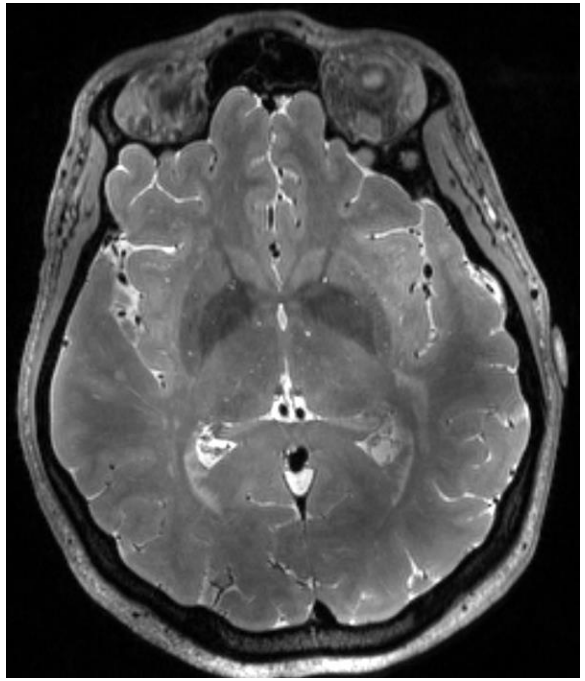
Materials and methods

7T Tesla MRI protocol :

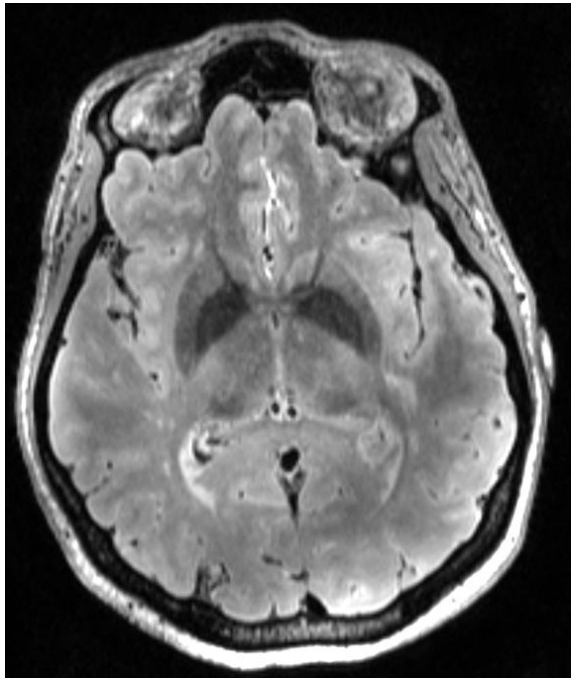
- Identification of CSVD lesions : T1w, T2w, FLAIR and TOF
- Microstructural information : Multiparameter mapping protocol and NODDI



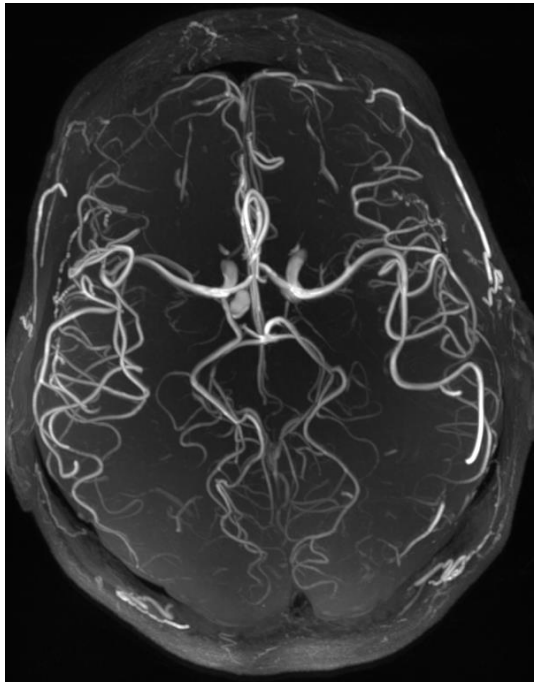
T1w



T2w



FLAIR



TOF

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7T Tesla MRI protocol :

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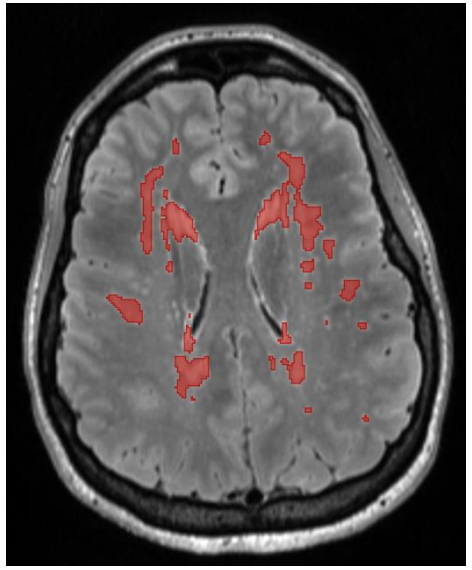
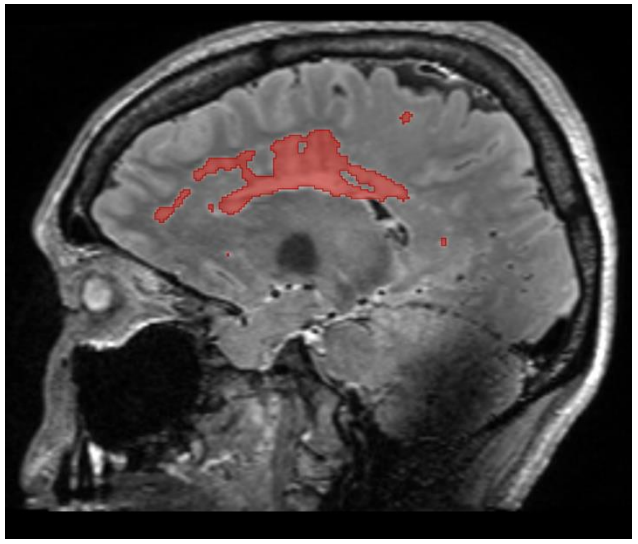
Data processing :

- Parenchymal lesions of CSVD will be separated from NABT using an automatic segmentation process





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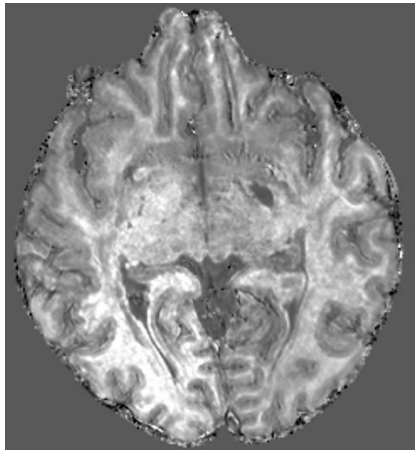
- Quantitative values will be extracted from each tissue type.



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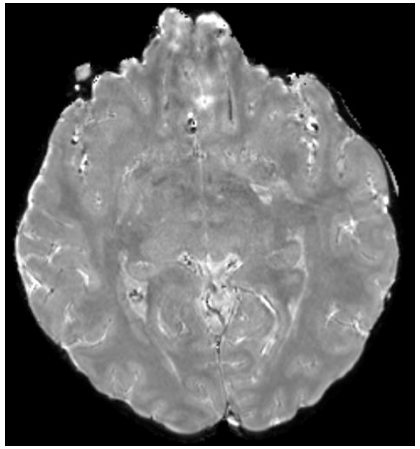
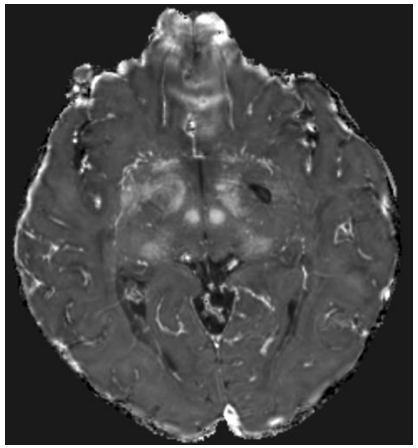
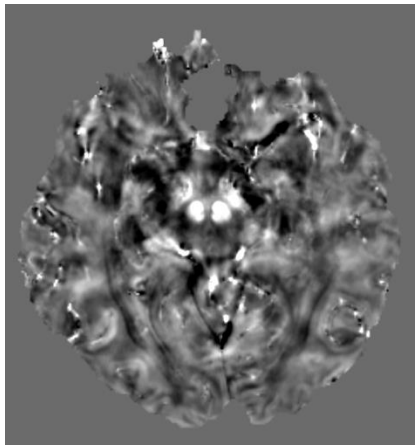


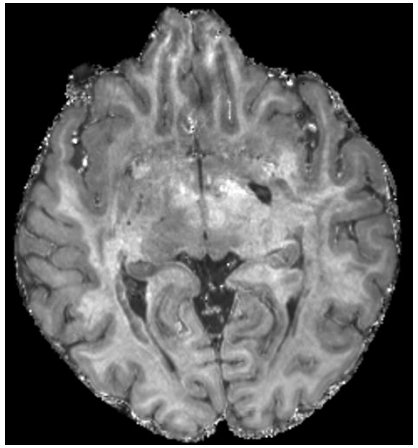
PD



R2s



QSM



R1

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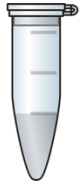

Inflammation biomarkers : GFAP, galectin-3, UCH-L1, S100B, S100A8/A9, CXCL4-PF4, serpin E1, MMP-2, D-dimers, H3cit (NUQ), IL-6, hs-CRP, MPO and NE.

Objectives

This study aims to use **ultra-high field (7 Tesla) quantitative MRI (qMRI)** to measure microstructural abnormalities within CSVD macroscopic lesions and in normal-appearing brain tissue (NABT).

The characterization of these CSVD microstructural alterations will be associated with the measurement of **inflammation markers in the blood.**

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The characterization of these CSVD microstructural alterations will be associated with the measurement of **inflammation markers in the blood.**

We hope to identify potential **new biomarkers** that could improve :

- CSVD severity assessment
- Etiological diagnosis
- Potentially identifying new targets for future treatment.

FREEDOM TO RESEARCH

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