

## Neuroimaging Markers of Cerebral small vessel disease : a Practical Guide

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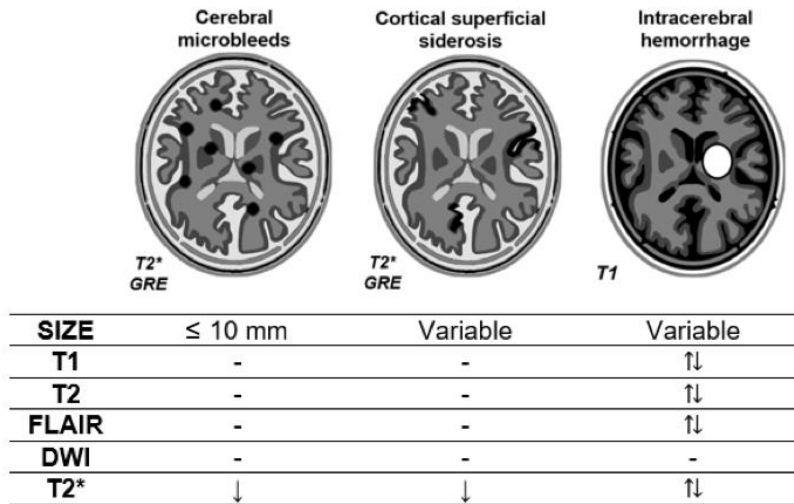
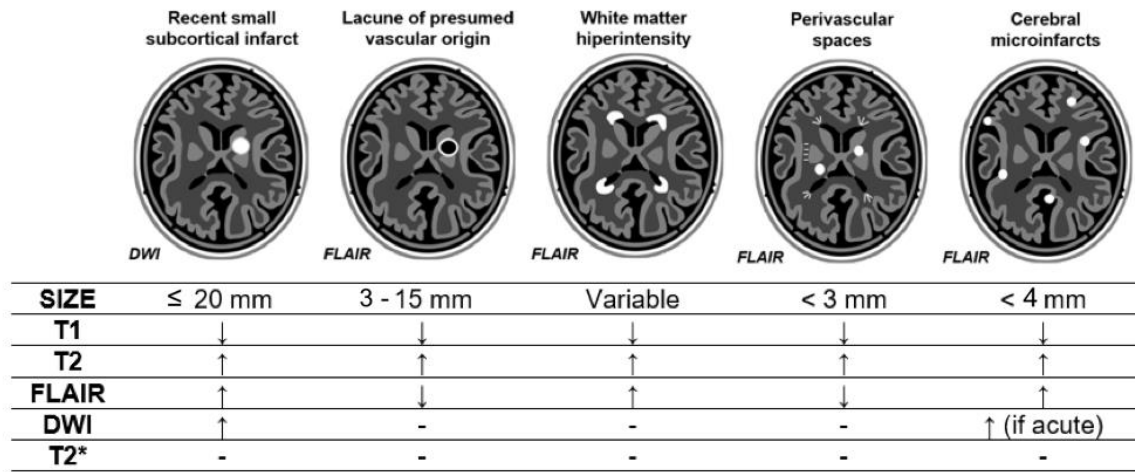
**Figure 1 – Comparison of MRI non-hemorrhagic and hemorrhagic CSVD markers**

<b>NON-HEMORRHAGIC MARKERS</b>				
	<b>Pathogenesis</b>	<b>CSVD Subtype</b>	<b>Risk Factors</b>	<b>Prognosis</b>
<b>RSSI</b>	Infarcts due to occlusion of small perforating arterioles	Arteriosclerosis: Deep brain locations  CAA: CSO and lobar regions	Hypertension Diabetes	Similar to lacunes and WMH
<b>LACUNE</b>	End-product of subcortical infarcts	Arteriosclerosis: Deep brain locations  CAA: CSO and lobar regions	Older age Hypertension Smoking	Lower scores on neuropsychological tests and higher risk of symptomatic strokes.
<b>WMH</b>	Chronically hypoperfused parenchyma	Arteriosclerosis: periganglionic pattern  CAA: multispot subcortical pattern	Older age Smoking Hypertension Female gender	Increased risk of stroke, dementia, worse cognitive function and death
<b>PVS</b>	Interstitial fluid-filled spaces surrounding blood vessels.	Arteriosclerosis: Predilection for the basal ganglia  CAA: predilection for CSO	Older age Hypertension	Not fully understood, but likely related of higher risk of cognitive decline over time
<b>Cortical CMI</b>	small cortical ischemic infarcts	CAA-related	Cardiac pathologies Atherosclerosis	Higher risk of cognitive decline
<b>HEMORRHAGIC MARKERS</b>				
	<b>Pathogenesis</b>	<b>Subtype</b>	<b>Risk factors</b>	<b>Prognosis</b>
<b>CMB</b>	Foci of hemosiderin-laden macrophages	Arteriosclerosis: Deep brain locations  CAA: Cortical locations	Hypertension	Higher risk of stroke and cardiovascular death.

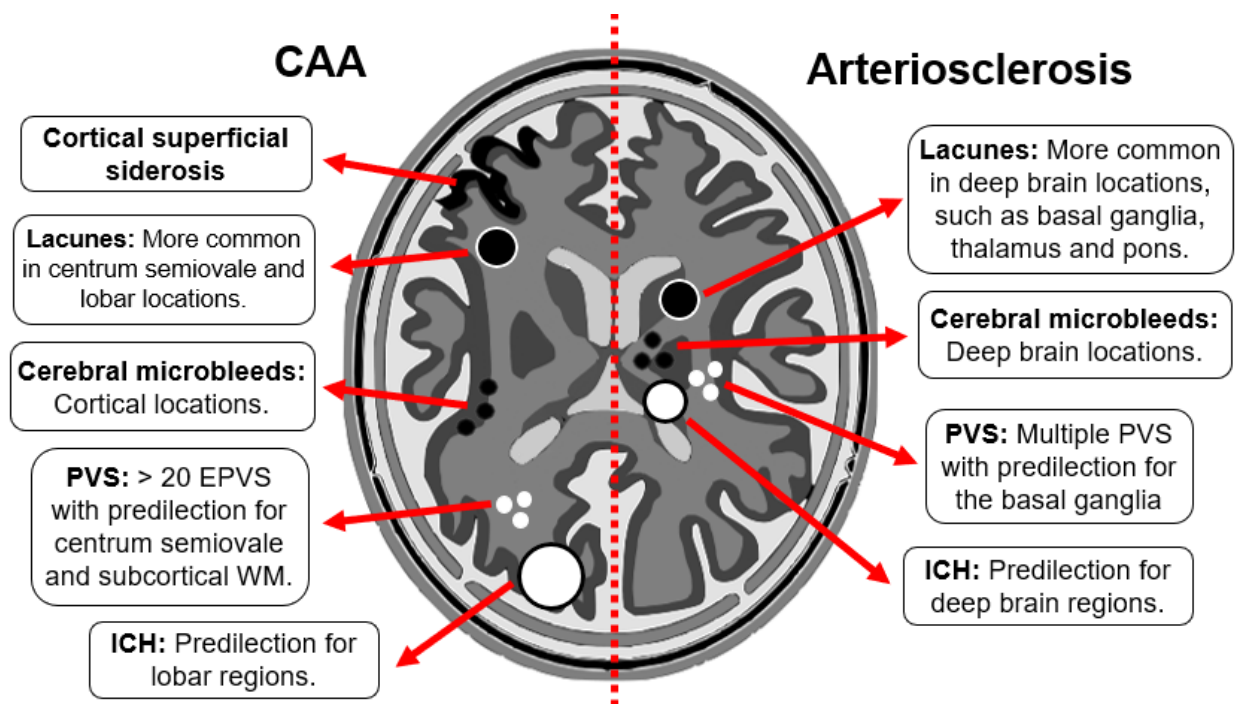
<b>CSS</b>	Chronic blood products underlying pia mater.	CAA-related	Unknown	Increased risk of first-ever or recurrent lobar ICH. Associated with cognitive decline.
<b>ICH</b>	Rupture and bleeding of arterioles into parenchyma.	Arteriosclerosis: Deep brain locations  CAA: Lobar regions	Older age Hypertension	Higher risk of developing dementia and recurrent ICH

MRI: Magnetic resonance imaging; RSSI: Recent small subcortical infarct; WMH: White matter hyperintensity; PVS: Perivascular space; CMI: Cerebral microinfarct; CMB: Cerebral microbleed; CSS: Cortical superficial siderosis; ICH: Intracerebral hemorrhage; CAA: Cerebral amyloid angiopathy; CSO: Centrum semiovale.

**Figure 2 – Imaging characterization of CSVD markers**



**Figure 3 – Different neuroimaging patterns in CAA and arteriosclerosis-related CSVD.**



**Table 1 – Summarized Boston Criteria 2.0 for the *in vivo* non-invasive diagnosis of CAA.**

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**PROBABLE CAA (Patient > 50 years old)**

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**Presentation with spontaneous ICH, transient focal neurological episodes or cognitive impairment/dementia.**

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**MRI criteria:**

- At least two: strictly lobar hemorrhagic lesions on T2\*-weighted MRI in any combination (ICH, cerebral microbleeds, convexity subarachnoid hemorrhage or cSS).

*Or*

- One lobar hemorrhagic lesion plus one white matter feature (PVS > 20 in the centrum semiovale in one hemisphere or > 10 WMH subcortical dots bilaterally) in the absence of:

- > Any deep hemorrhagic lesions on T2\*-weighted MRI;
- > Other cause of hemorrhagic lesions.

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**POSSIBLE CAA (Patient > 50 years old)**

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**Presentation with spontaneous ICH, transient focal neurological episodes or cognitive impairment/dementia.**

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**MRI criteria:**

One strictly lobar hemorrhagic lesion on T2\*-weighted MRI, which may include ICH, cerebral microbleeds, convexity subarachnoid hemorrhage or cSS.

*Or*

One white matter feature (PVS > 20 in the centrum semiovale in one hemisphere or > 10 WMH subcortical dots bilaterally) in the absence of:

- > Any deep hemorrhagic lesions on T2\*-weighted MRI;
- > Other cause of hemorrhagic lesions.

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CAA; Cerebral amyloid angiopathy; ICH: Intracerebral hemorrhage; MRI: Magnetic resonance imaging; cSS: Cortical superficial siderosis; PVS: Perivascular space; WMH: White matter hyperintensity.

**Table 2** – Simplified Edinburgh Criteria for the *in vivo* non-invasive diagnosis of CAA-related ICH.

<b>HIGH PROBABILITY CAA</b>
<b>Lobar ICH showing:</b> - Subarachnoid hemorrhage on CT; - Finger-like projections from the ICH on CT.
<b>INTERMEDIATE PROBABILITY CAA</b>
Lobar ICH showing subarachnoid hemorrhage on CT in isolation
<b>LOW PROBABILITY CAA</b>
Lobar ICH showing no subarachnoid hemorrhage.

CAA: Cerebral amyloid angiopathy; ICH: Intracerebral hemorrhage.