Post-mortem neuroimaging in neurodegenerative diseases

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Learning objectives

- Post-mortem 7.0-Tesla MRI.
- Location and degree of cortical atrophy.
- Cerebral micro-bleeds.
- Cerebral micro-infarcts.
- Superficial siderosis
- Quantification of small cerebrovascular lesions.
- Degree of iron deposition.
- Selection histological samples.
- Alzheimer's disease.
- Cerebral amyloid angiopathy.
- Frontotemporal lobar degeneration.
- Amyotrophic lateral sclerosis.
- Lewy body disease.
- Progressive supranuclear palsy.
- Vascular dementia.

Methodology

- Previous obtained informed autopsy consent for diagnostic and scientific purposes.
- Brain tissue samples acquired from a neuro-bank and federated by an institutional review board.
- Formalin fixation of the brains for three weeks.
- Six coronal sections of a cerebral hemisphere and one or two sections of brainstem and cerebellum , submitted to a Spin Echo T2 and T2* 7.0-Tesla MRI, Bruker Biospec.
- Separate sections of a cerebral hemisphere and of brainstem and cerebellum are use for neuropathological – MRI comparison and validation
- Afterwards several small samples are taken for diagnostic histological and immunostained use.

7-tesla MRI methods

IRM 7T. Bruker Biospec

Cylindric Tube 72mm

Detectors inside the machine

1. Postmortem section in salt free water box placed inside the tube (positional sequence)

2. *Spin Echo T2 : section of interest*

RARE (**R**apid **A**cquisition with **R**efocused **E**choes)

TR/TE =2500/ 33ms
Acquisition time: 1,20min

3. T2* : Visualization of haematomas, micro- and mini-bleeds

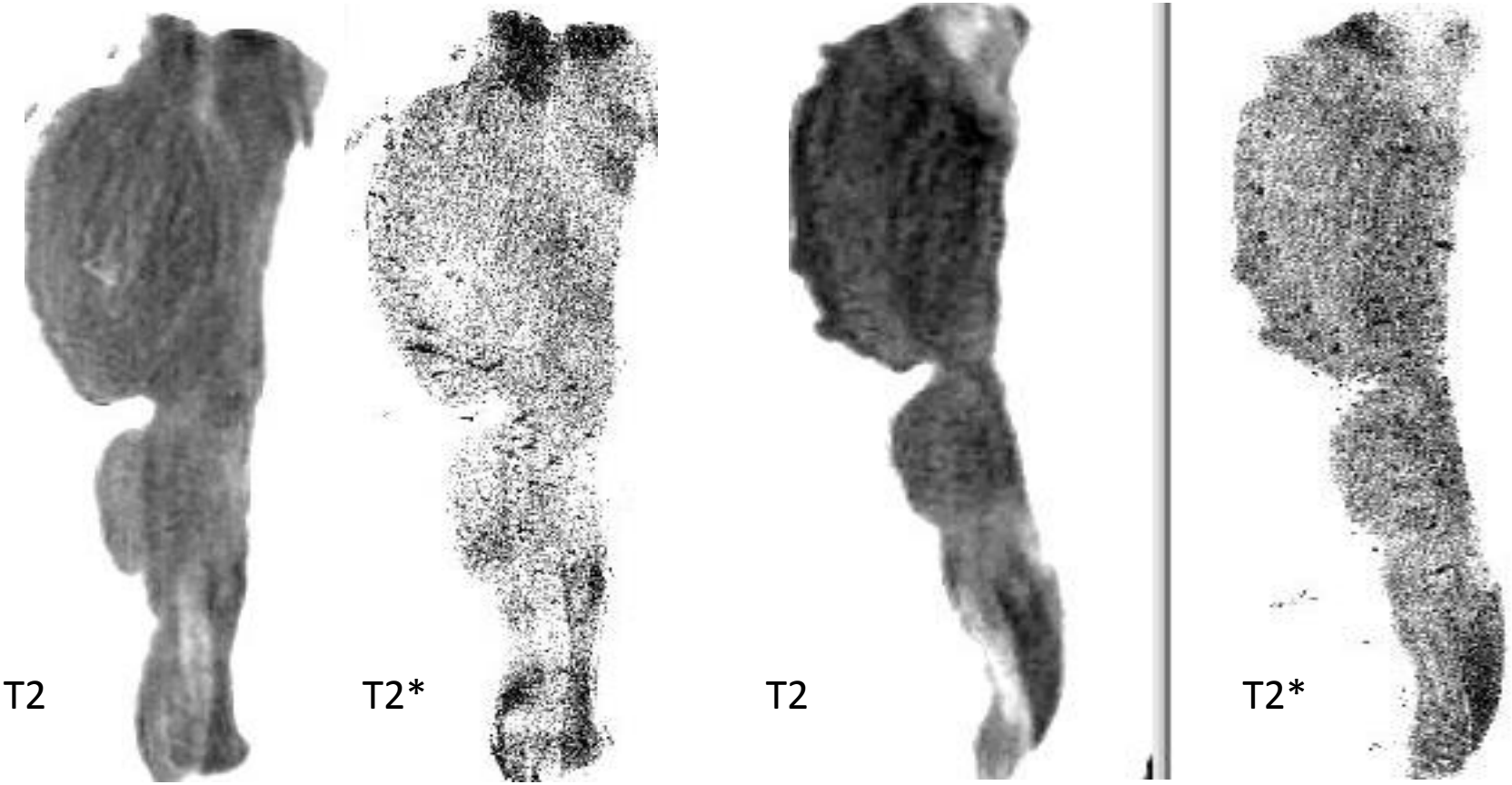
FLASH : Flip **A**ngle **S**naps**H**ot

Single slide of 0.20mm thickness
Spacial resolution of 200µm

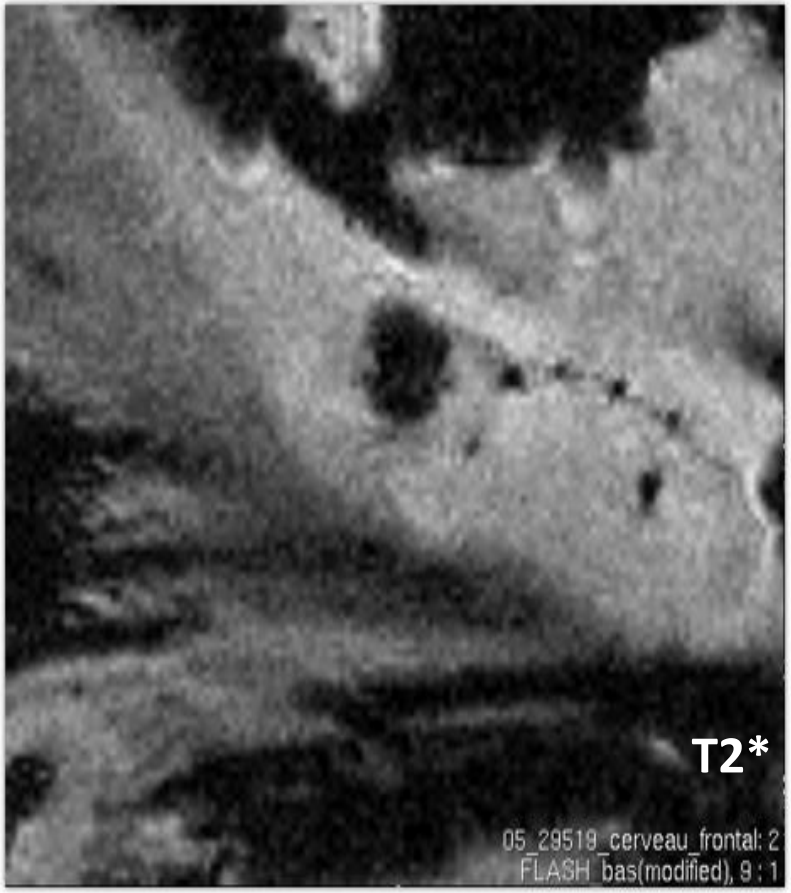
TR/TE = 60 / 22ms
Flip Angle = 30°
Acquisition time: 10min

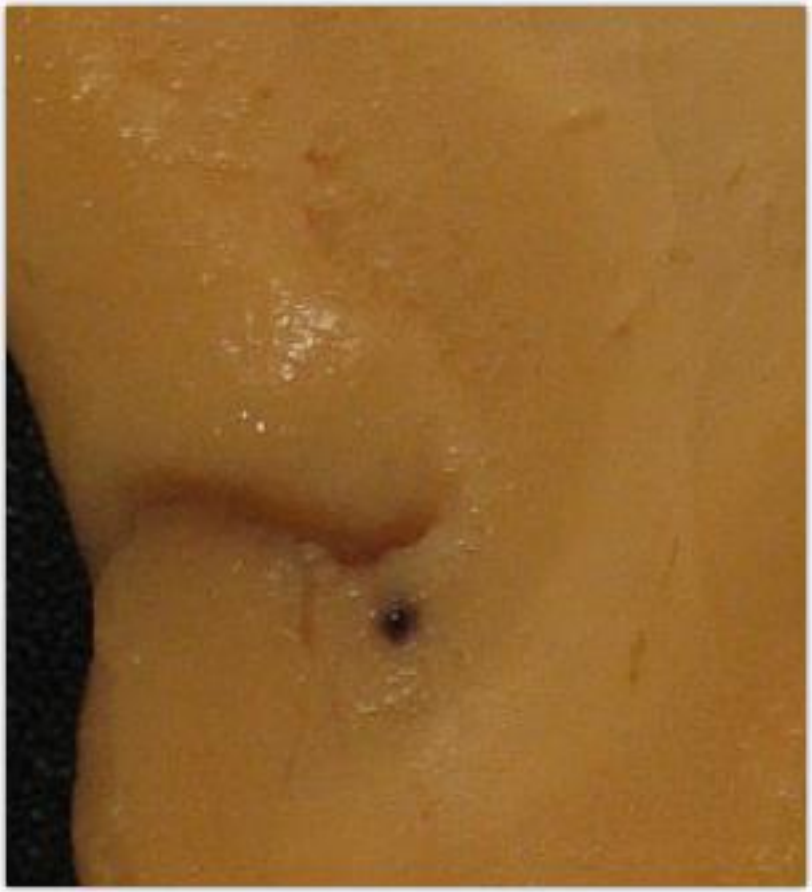
MRI sections of brainstem comparing the atrophy in progressive supranuclear palsy to control

- Control Brain
- PSP Brain

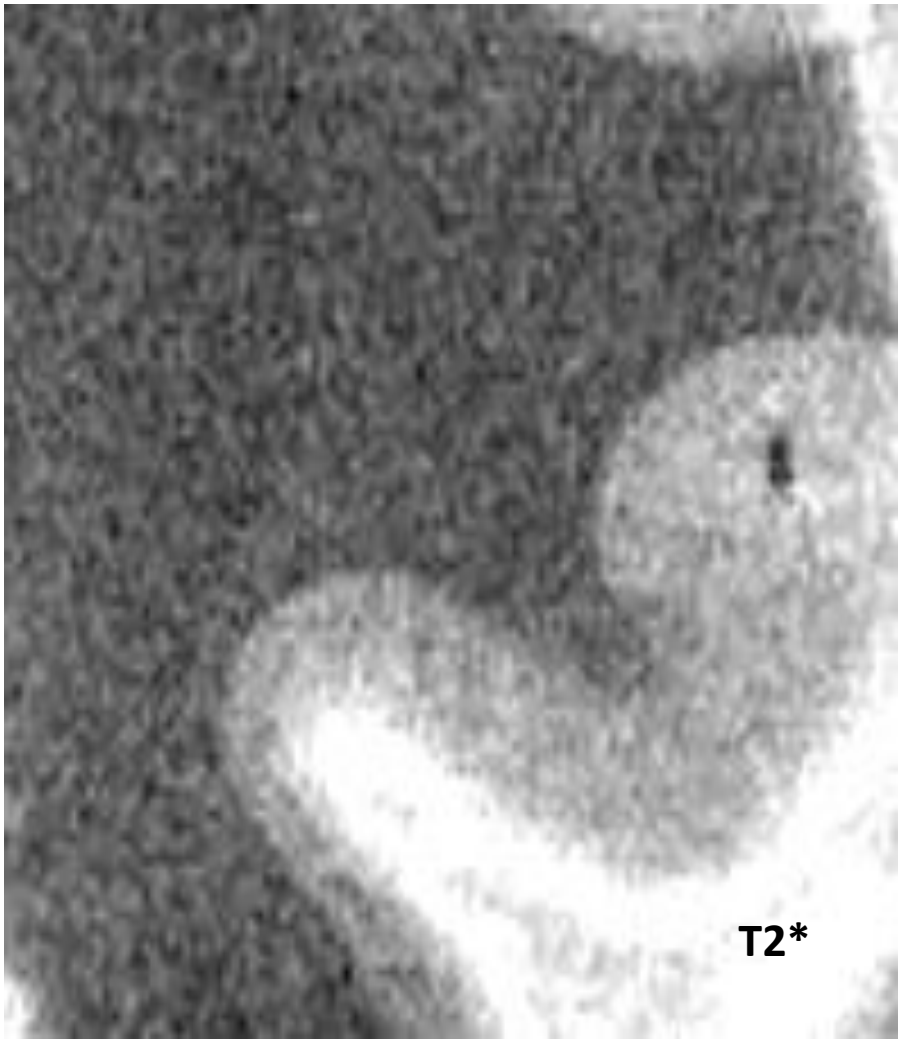


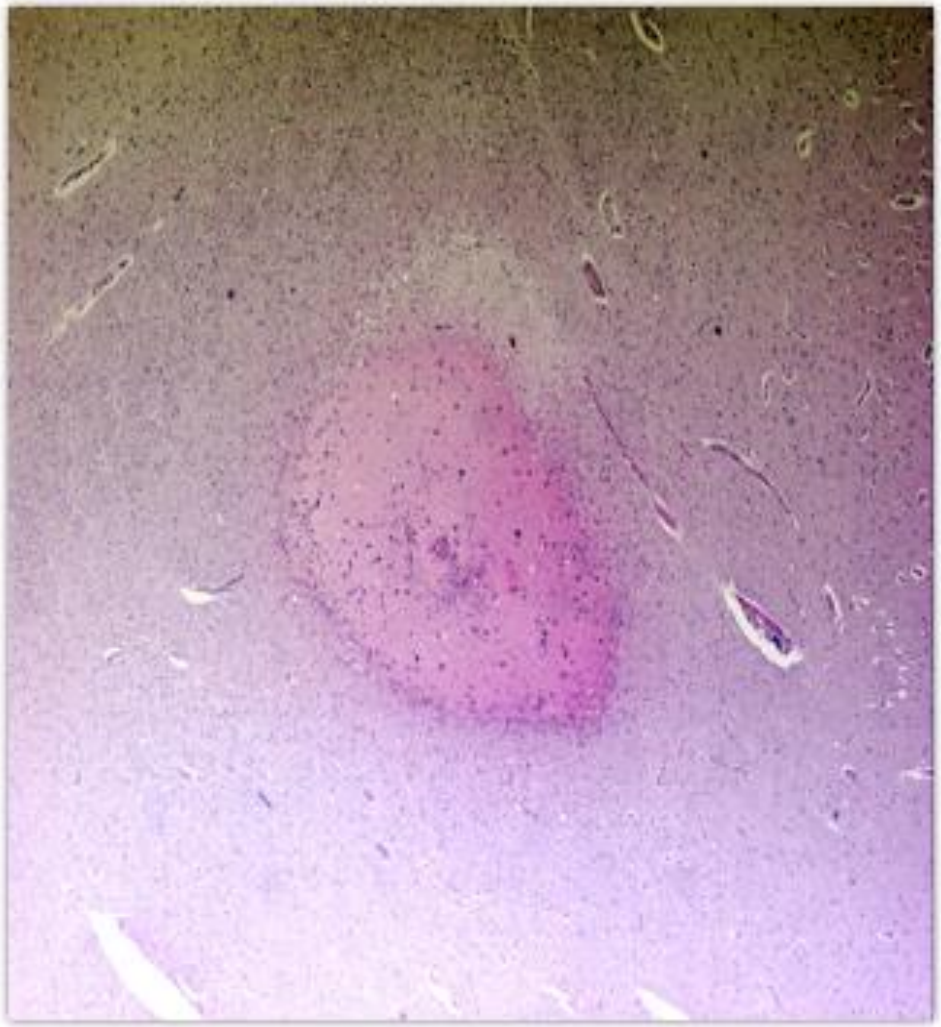
Micro-Bleed on 7.0 Tesla MRI and on the corresponding brain section



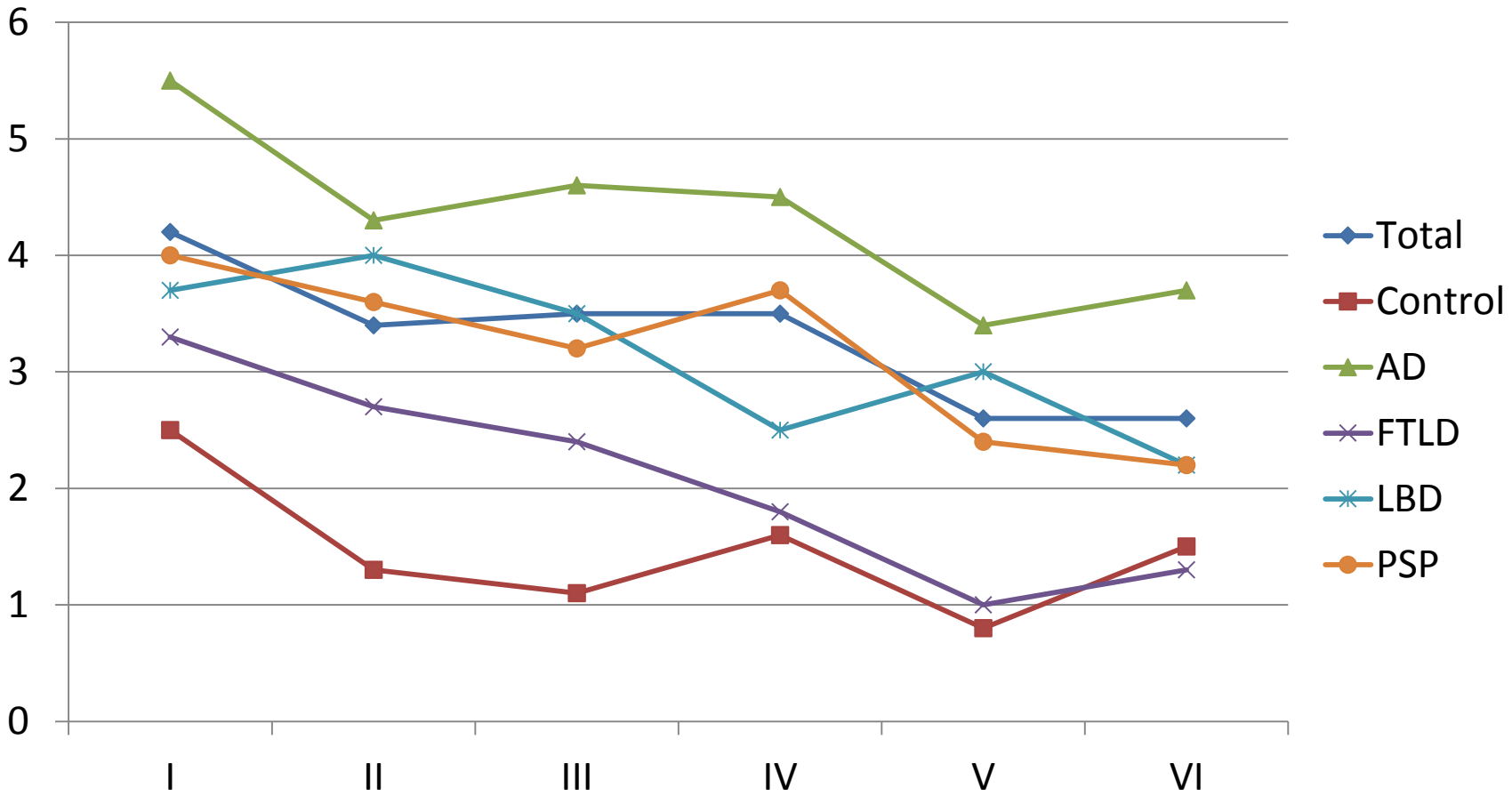


Cortical mini-bleed not visible on naked-eye examination but detected on T2* MRI

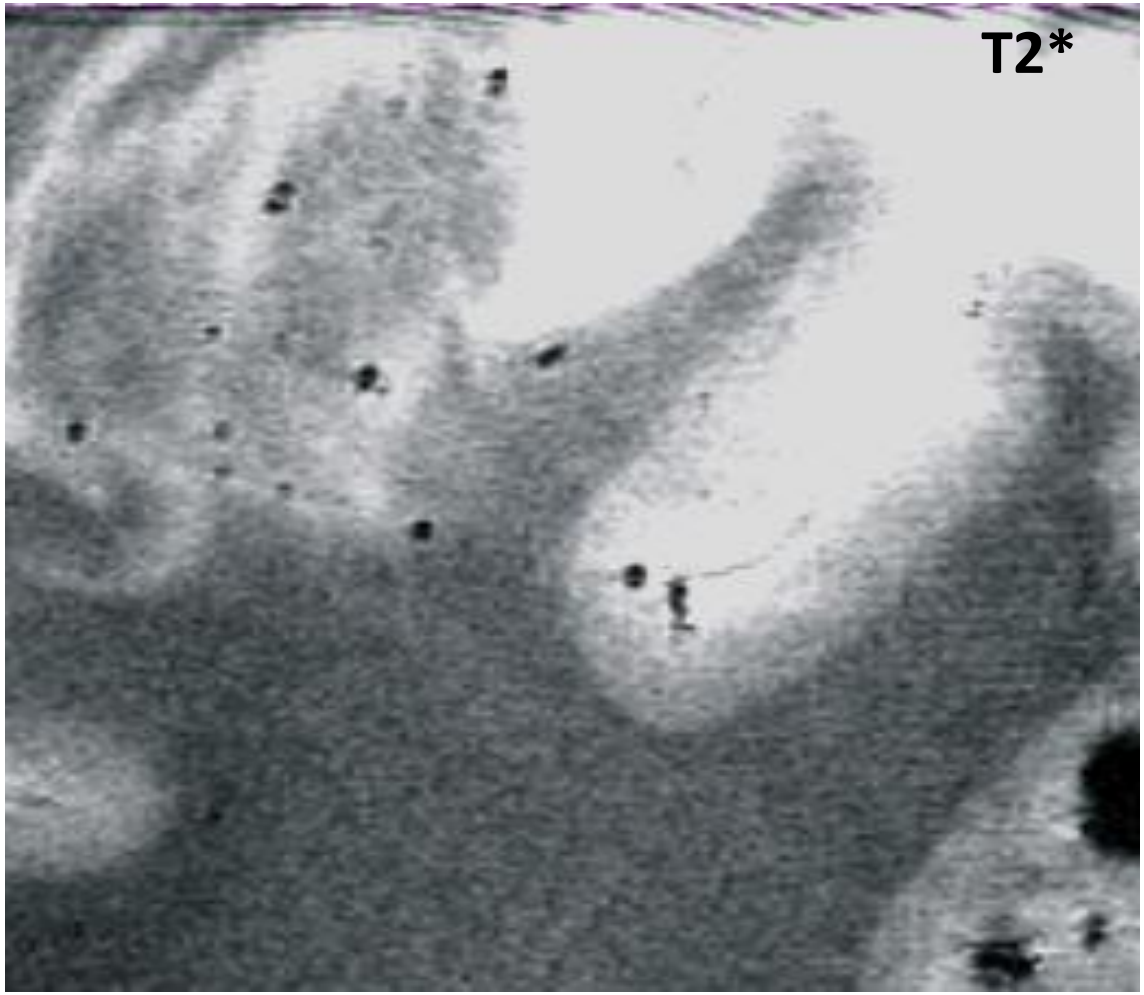




Micro-bleed distribution on MRI coronal sections showing the frontal predominance in all neurodegenerative diseases and the controls

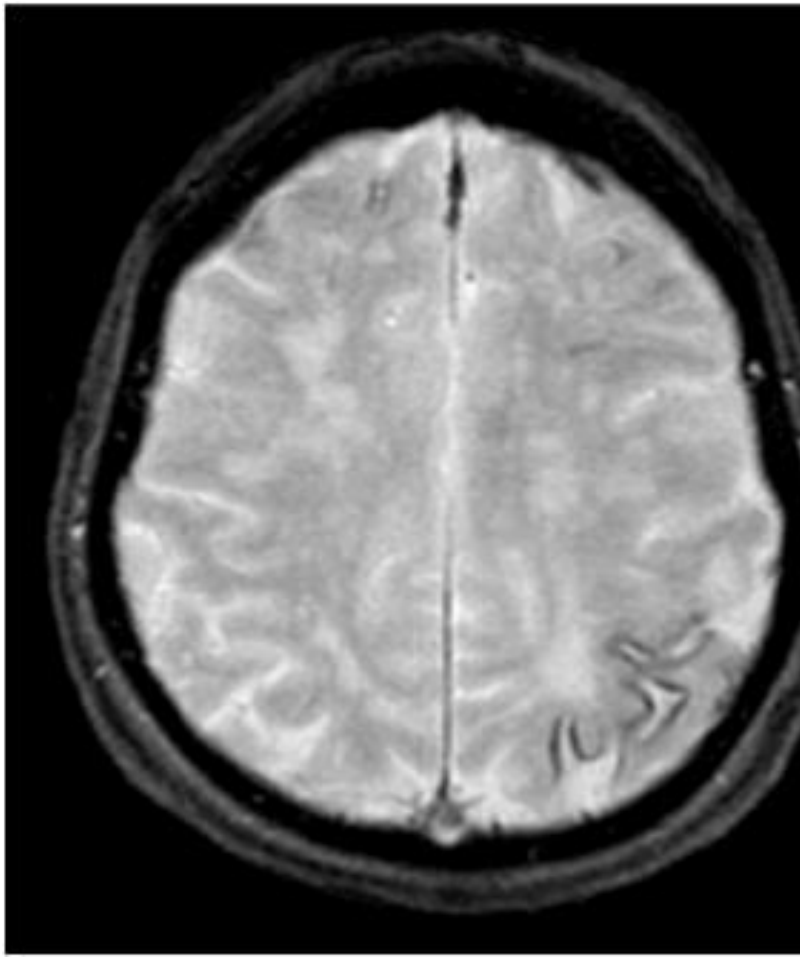


Frontal cortical micro-bleeds in frontotemporal lobar degeneration on 7.0-T T2* MRI

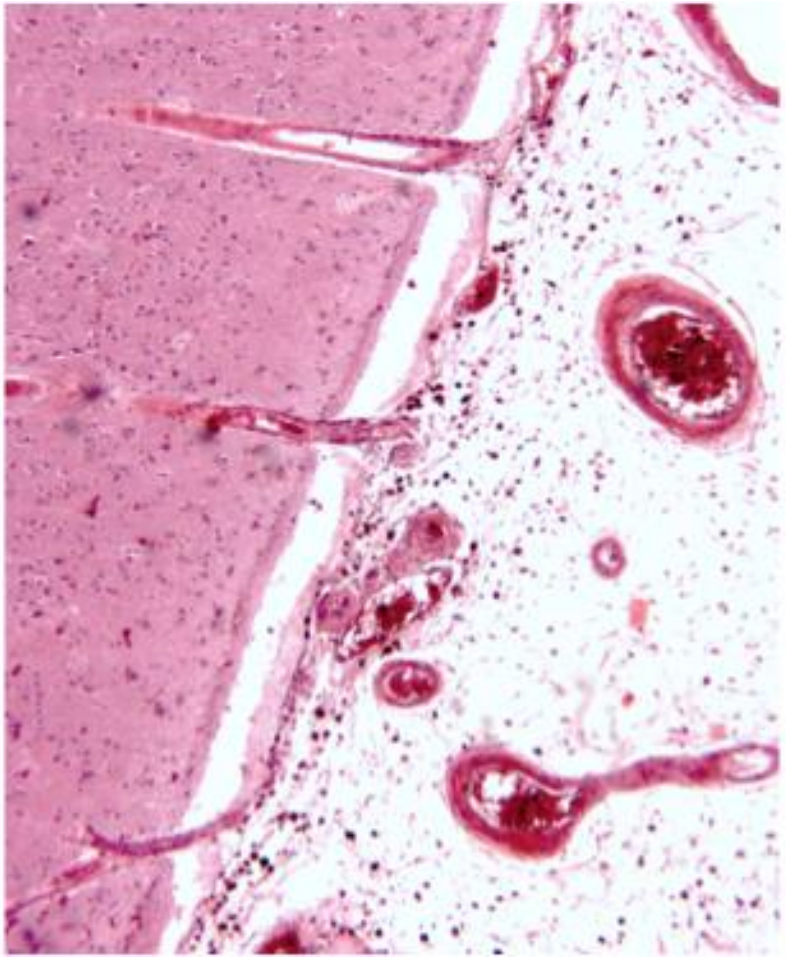


Superficial Siderosis

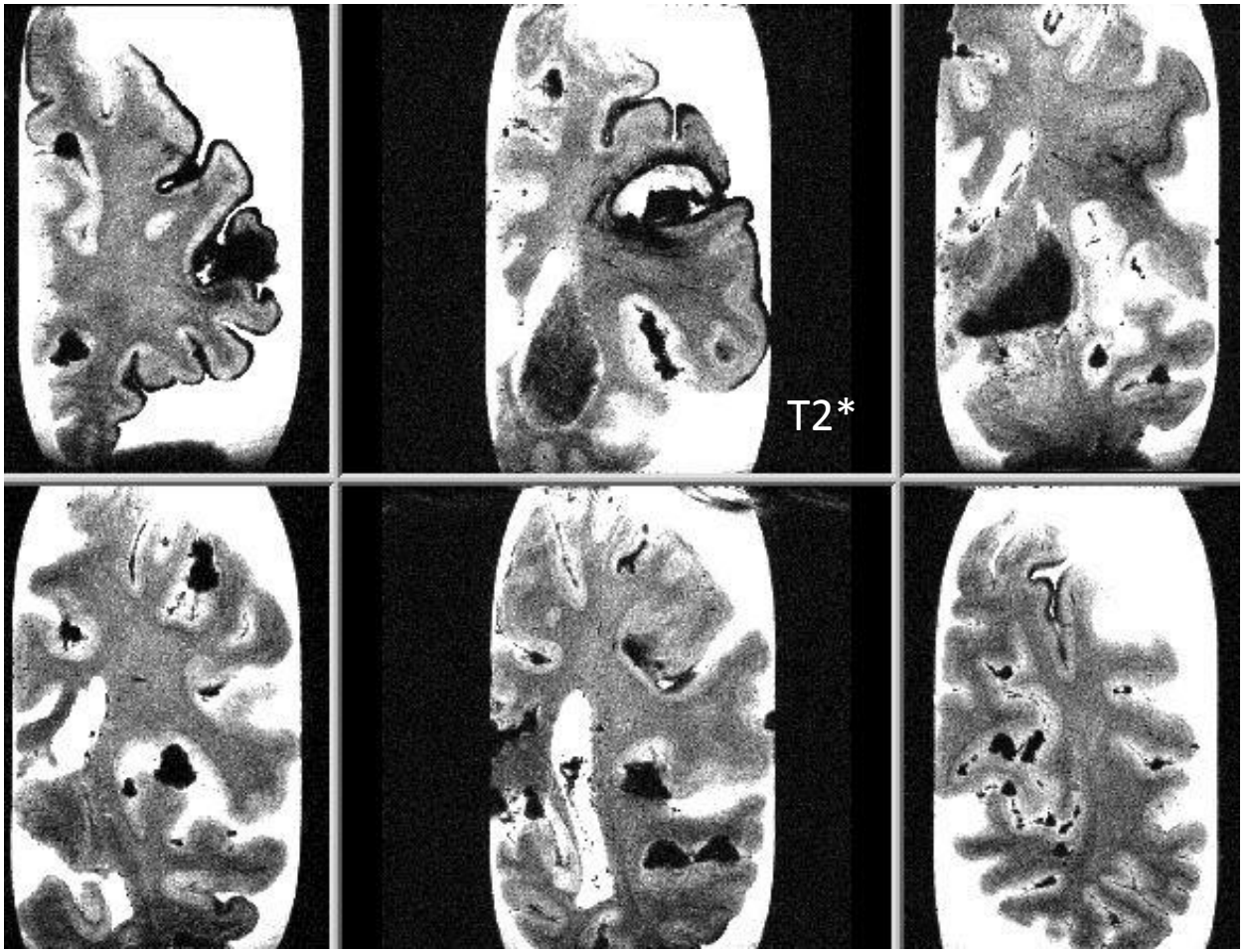
Superficial siderosis is observed on T2*-weighted MRI as a typical signal hypo-intensity outlining the brain surface.



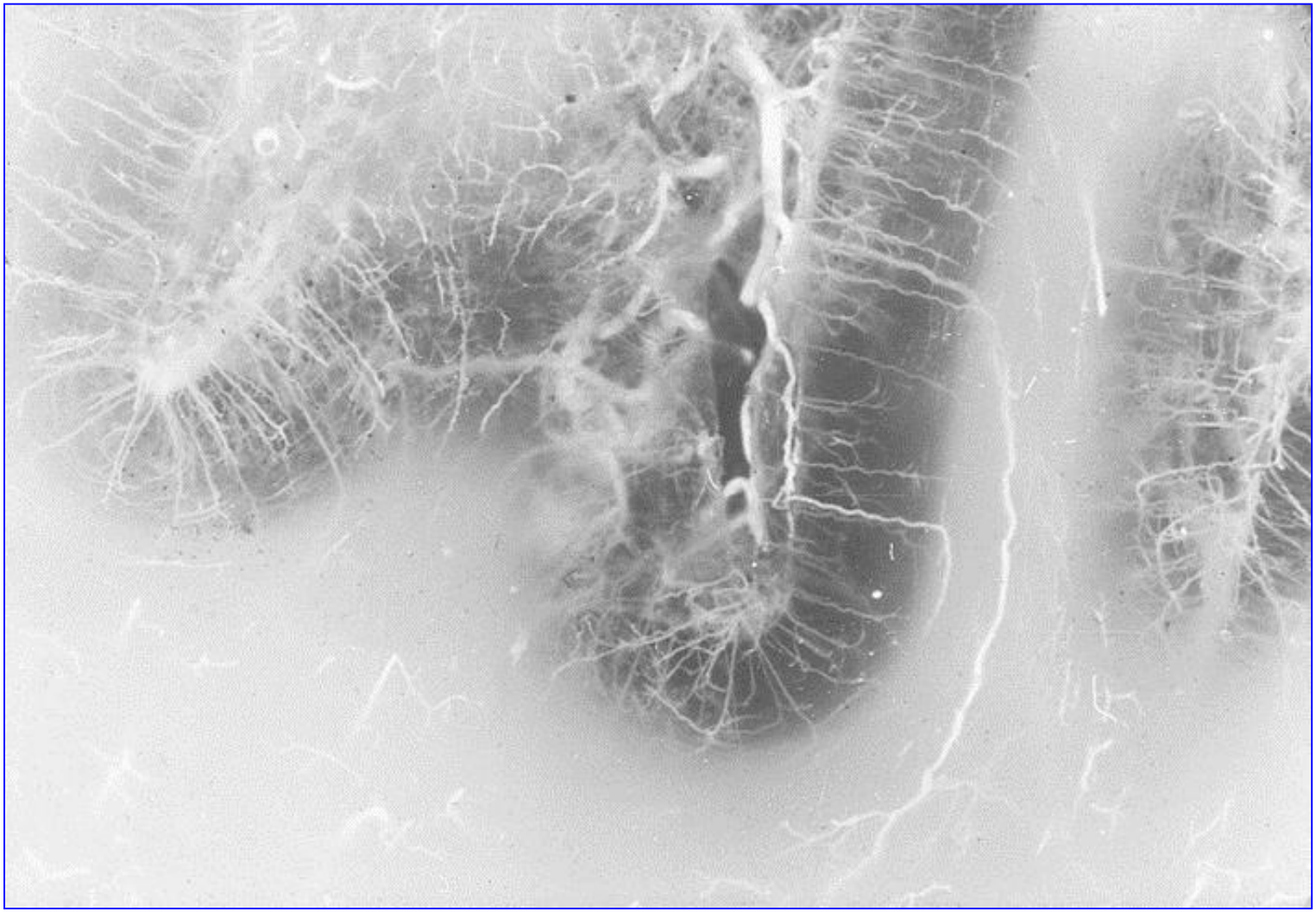
Superficial siderosis is considered as the result of chronic focal subpial hemorrhage



Superficial siderosis associated to a lobar frontal haematoma and to an occipital cortical infarct of a 68-year man with VaD due to CAA

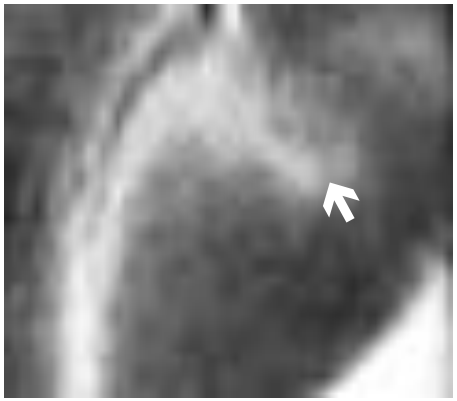


Cortical arterial angioarchitecture with several cortical branches of different lenght

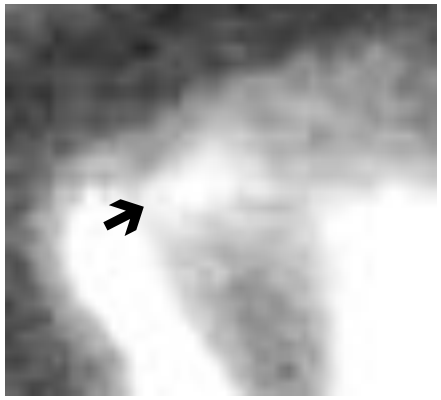


Types of cortical micro-infarcts on 7.0-t MRI

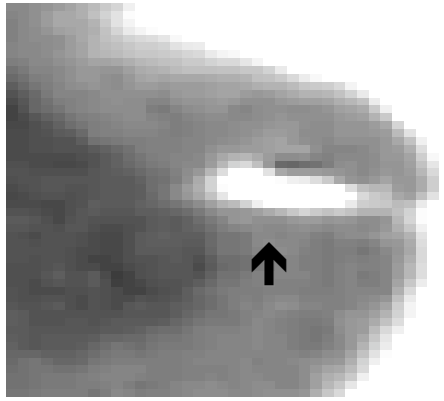
Type I



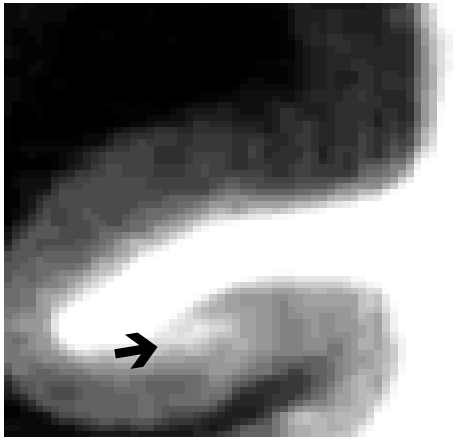
Type IIA



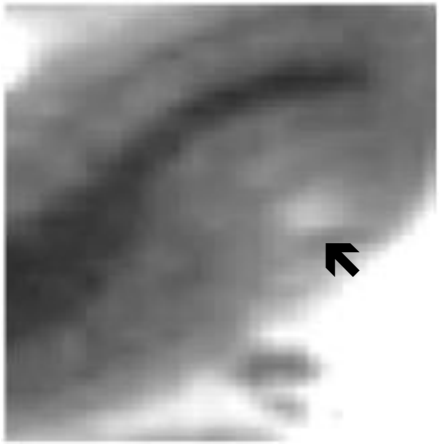
Type IIB



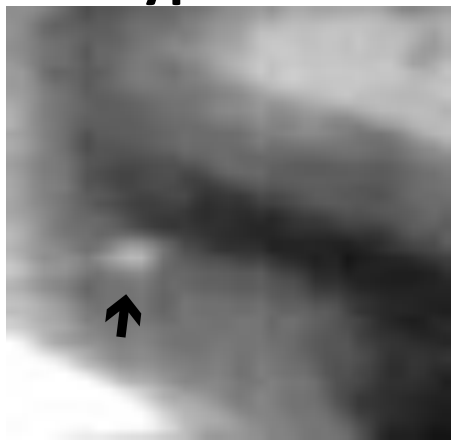
Type IIIA



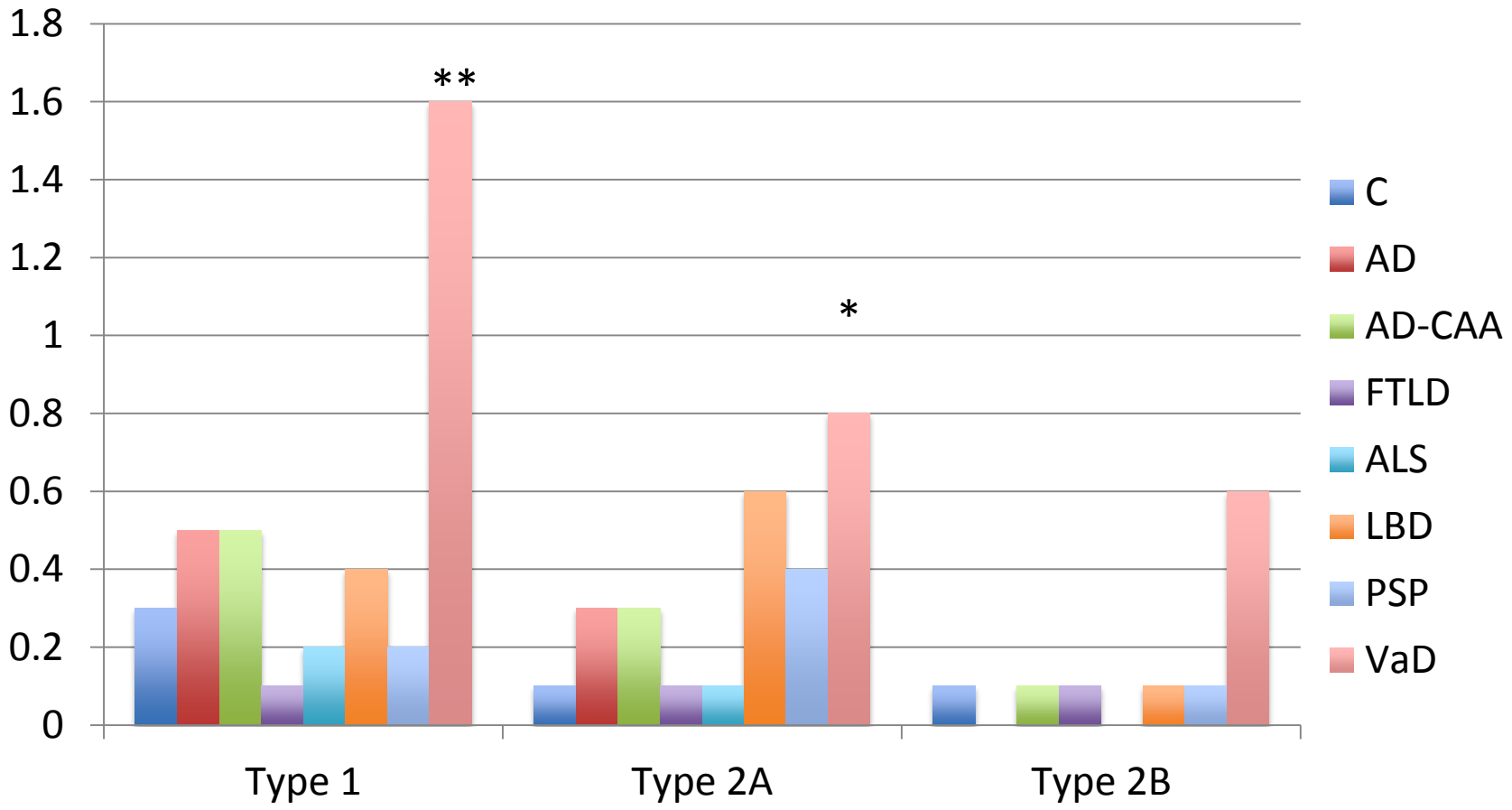
Type IIIB



Type IIIC



Comparison of the subtypes of cortical micro-infarcts on MRI



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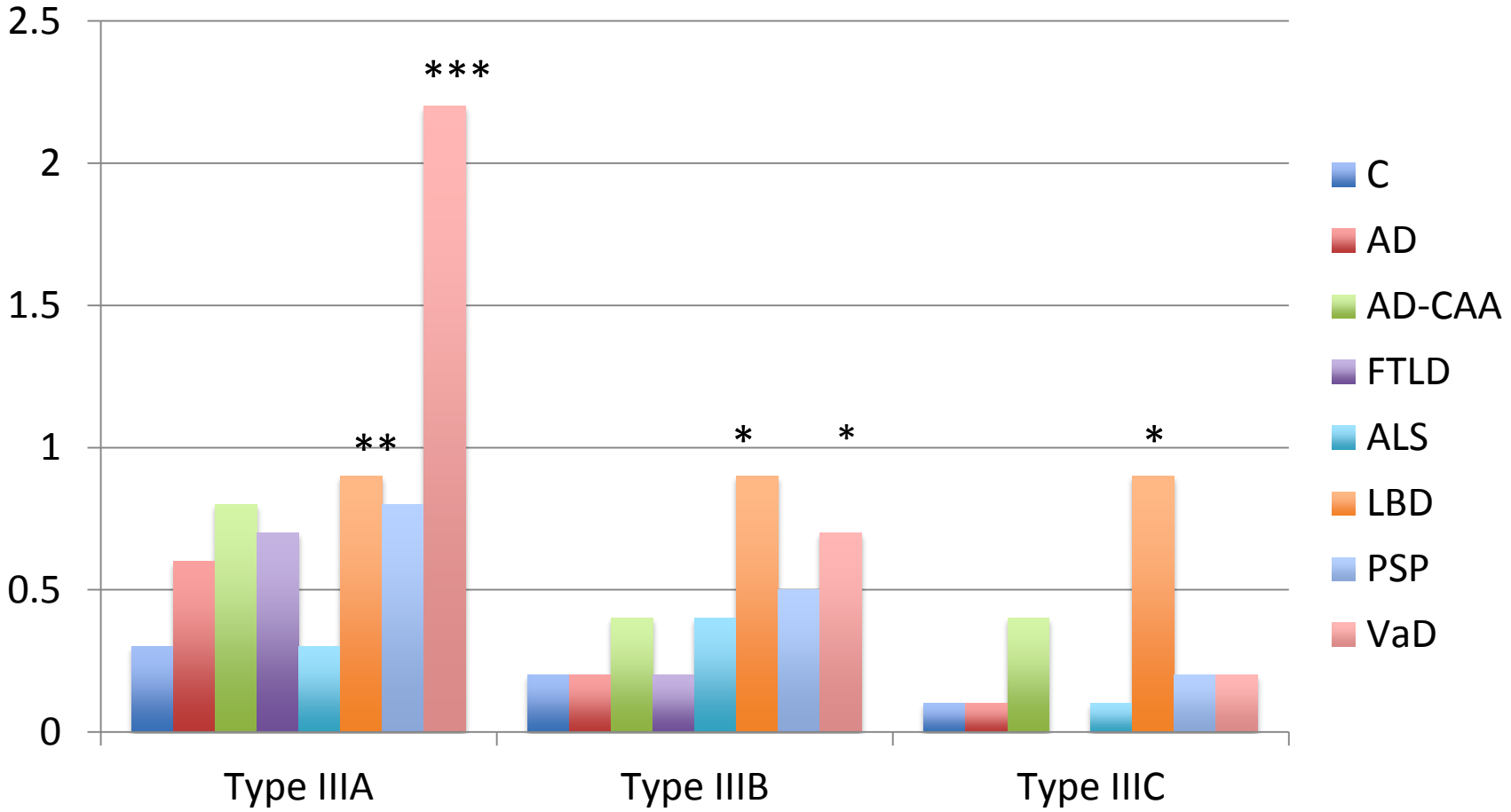
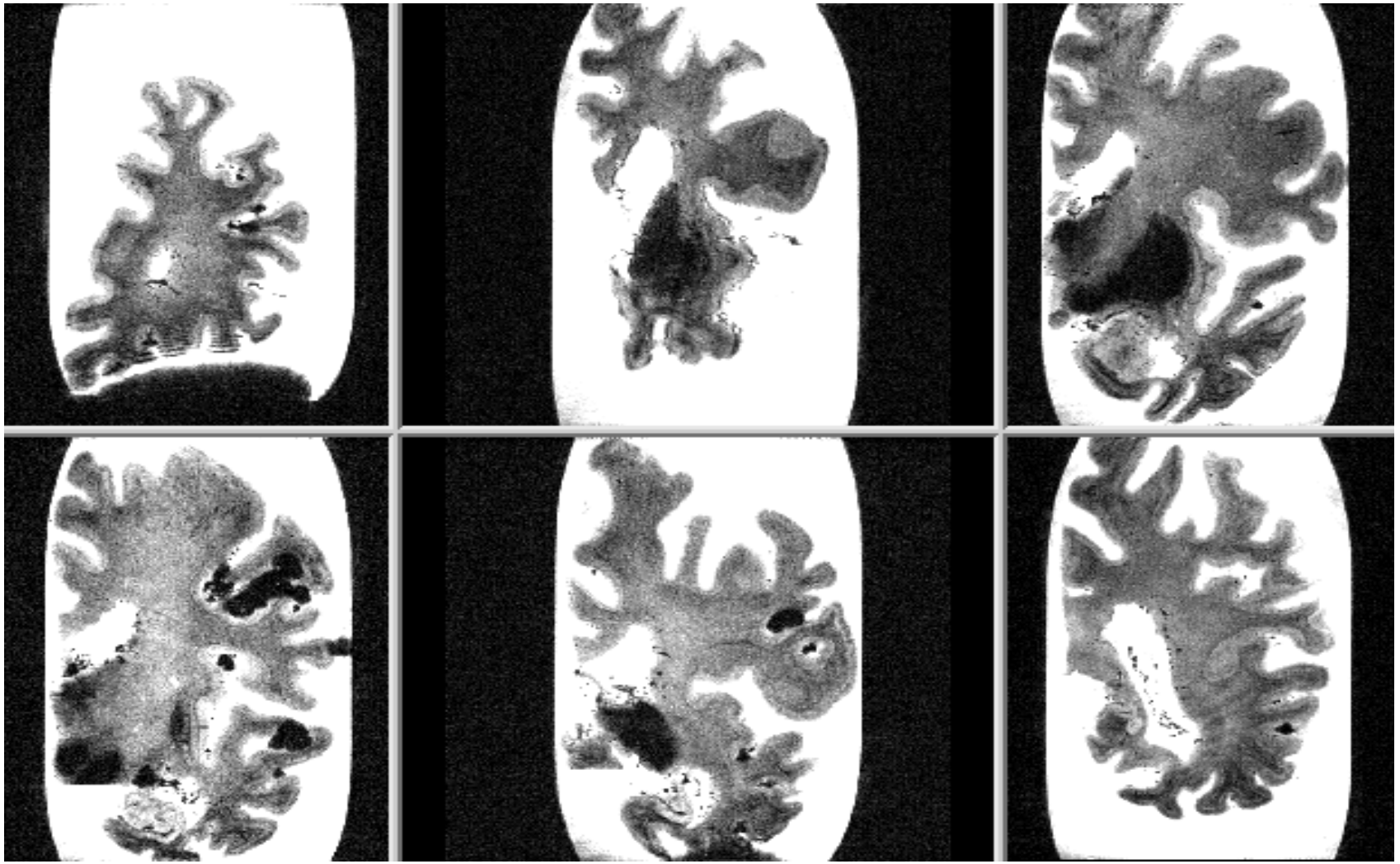
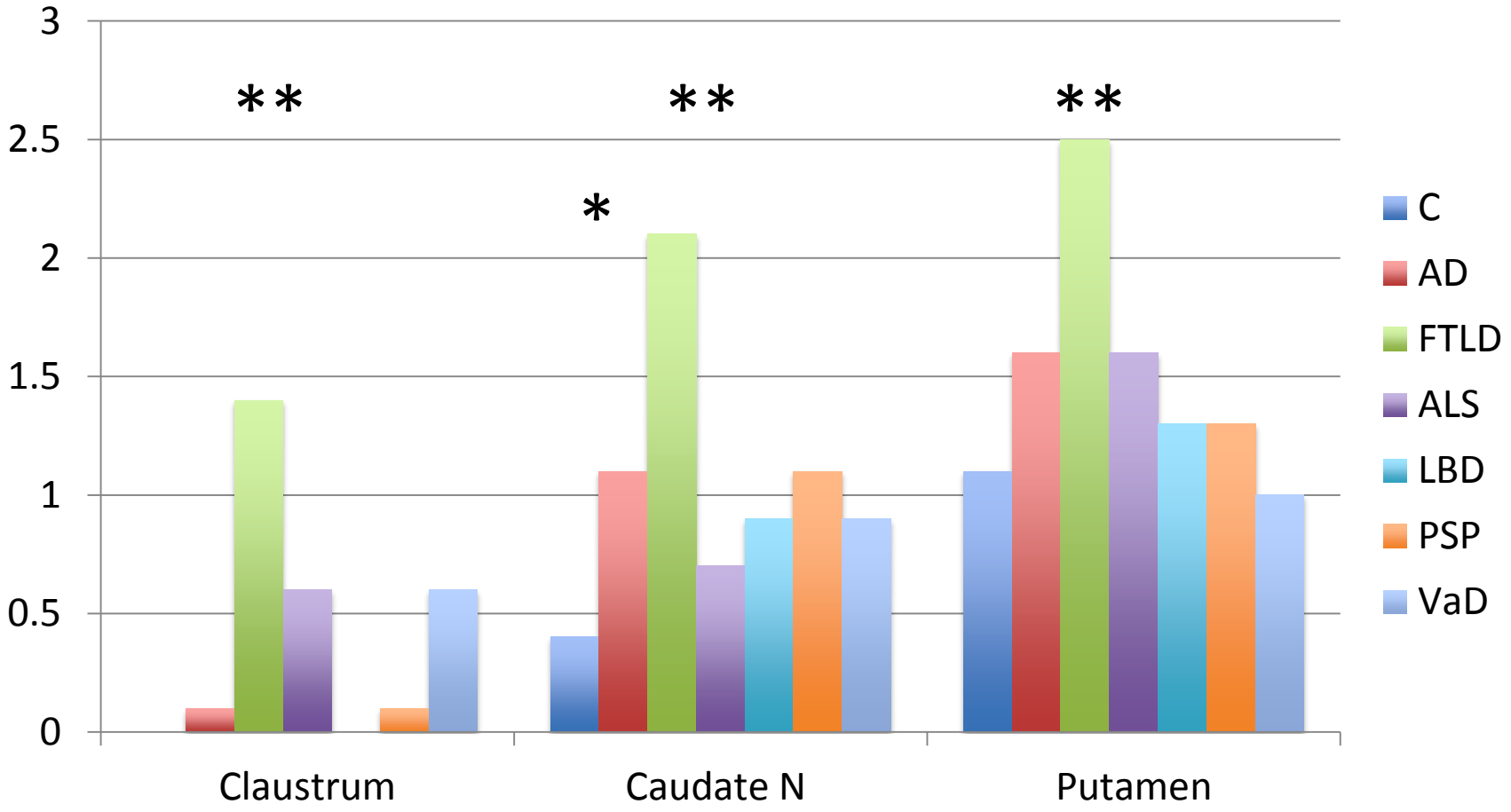


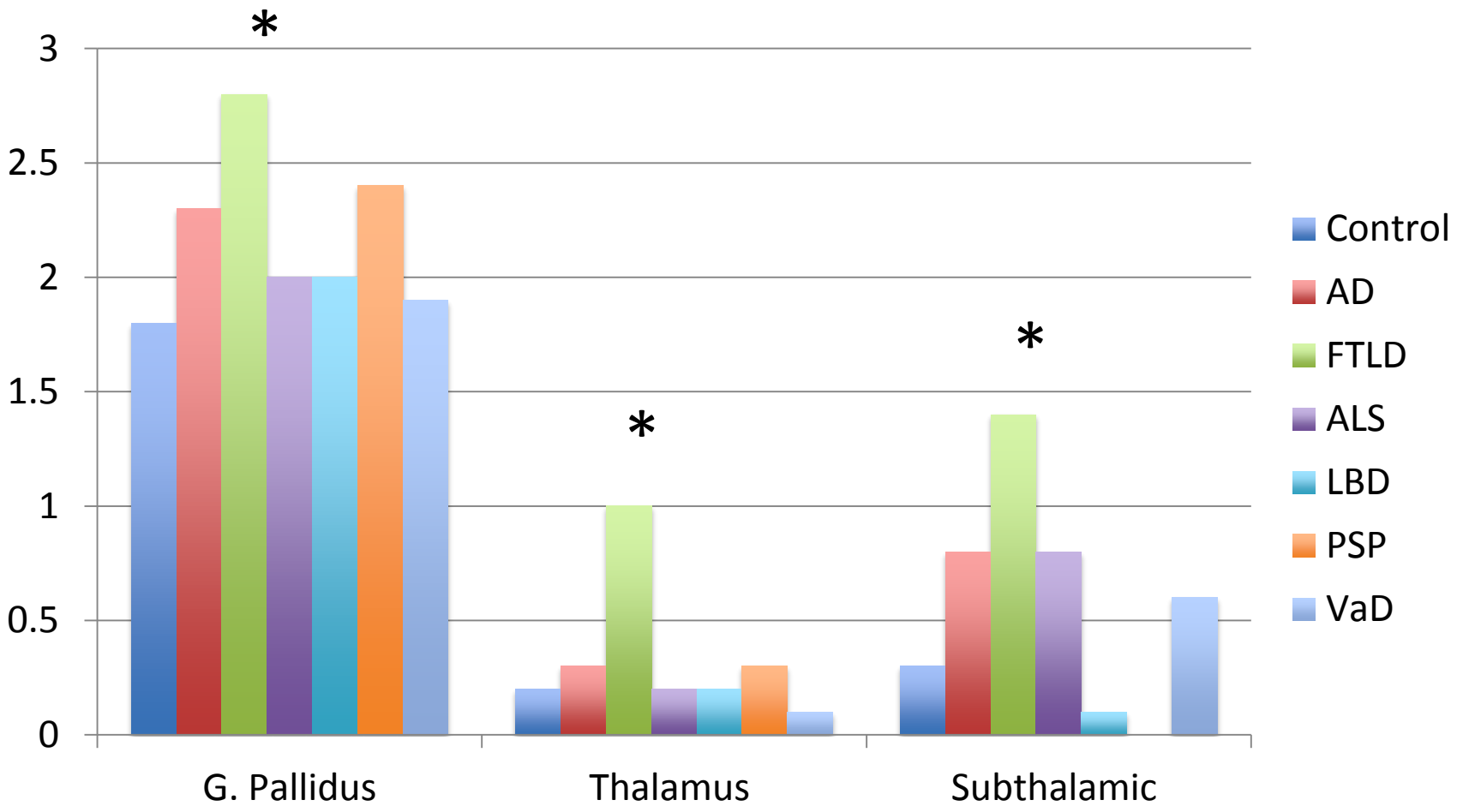
Increased iron accumulation in striatum, thalamus, lateral geniculate body and upper-brainstem nuclei on T2* MRI sections in frontotemporal lobar degeneration-TDP type



Comparison of average iron ranking scores in the neostriatum between control and disease groups



Comparison of iron ranking scores in deep gray nuclei between control and disease groups



Key Messages

- 7.0-tesla MRI is an additional tool in the examination of post-mortem brains with neurodegenerative and cerebrovascular diseases.
- It allows to determine the degree of cerebral atrophy.
- It evaluates the degree and distribution of small cerebrovascular lesions.
- It determines the underlying cause of superficial siderosis.
- The degree of iron deposition in the different deep nuclei can be evaluated.

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