Identification of mineral deposits in the brain in radiological images: A systematic review

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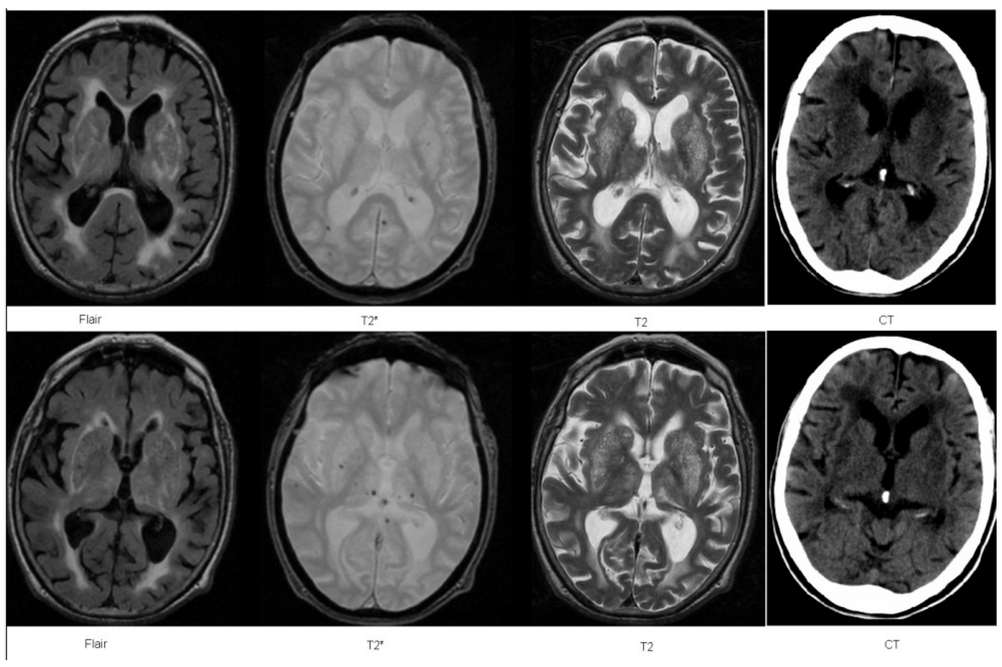
Background and Purpose:

- Brain iron deposits in old age, mainly in the basal ganglia, are associated with both normal-range intelligence and cognitive ageing [1]
- Other minerals appear commonly associated with hemosiderin depositions with little, similar or no effect in some types of radiological images, leading to contradictions in their identification.
- We studied how accumulations of iron, calcium, cupper, aluminum, zinc and manganese, in their different stages, appear in different types of radiological images and their association with lifelong health conditions and common pathologies found in older individuals.

Methods:

We did a systematic review of the literature using OvidSP in Medline, PubMed and Web_of_Science up to July 2010 searching for studies that included the identification of different types of minerals in radiological images.
We also selected 15 stroke patients that had CT and different modalities of MR images at the onset and follow up, and 17 that had, in addition, susceptibility weighted images (SWI).
On the sample, we identified and compared the areas where minerals were accumulated and graded the SWI according to the Modified Scale of Hypointensity in the putamen and globus pallidus wave score [2] based on the conclusions obtained from the systematic review.

Results:



The literature review confirmed that iron and calcium appear hyperintense on CT scans and hypointense on T2*W MR, however calcium affects T1signal while iron doesn't. This was the case across a variety of pathologies including Parkinson's, Alzheimer's, cerebral amyloid angiopathy, microbleeds, stroke, multiple sclerosis, meningiomas, calcifications, Fahr's disease and systemic sclerosis. It was found that iron and calcium tended to be deposited in the basal ganglia.
Copper appears hypointense on CT scans as well as T2 and T2*W MR scans, and thus is distinguishable from iron and calcium.
In the figure above, from a stroke patient, microbleeds (iron) are observed in the basal ganglia and thalamus and calcification in the choroid plexus.

Several studies associated the pathological mineral deposits in the brain with cognitive decline and ageing. Some had histological confirmation (highlighted)

Brewer, Res Toxicol 2010 (Review)	Copper, toxic iron (hemosiderin)	Ageing, Alzheimer's, neurodegenerative diseases, cognition, artherosclerosis, diabetes
Sparks, J Nutrition, Health and Aging	Copper	Alzheimer's disease
Religa, Neurology 2006	Zinc	Alzheimer's disease
Squitti, Neurology 2002	Copper	Alzheimer's disease
Arnal, Brain Research 2010	Copper (in plasma)	Alzheimer's, Parkinson's, vascular dementia
González, Eur J Clinical Investigation 1999	Zinc, copper	Alzheimer's disease
Moir, Eur J Clinical Investigation 1999	Zinc, copper	Alzheimer's disease
Ripa, M Med 1994	Zinc	Artherosclerosis
Boll, Neurochem Res 2008	High free copper in CSF	Parkinson's disease
Blanco, J Neurol Neurosurg Psych 1999	Calcium	Systemic sclerosis, ageing
Thant, J Royal Soc Med 2002	Calcium	Parkinson's disease
Brass, Topics Mag Res Imag 2006	Iron	Ageing, multiple sclerosis
McNeill, Neurology 2008	Iron	Neurodegeneration
Schenck, NMR Biomed 2004	Iron	Alzheimer's, Parkinson's diseases
Stem, Neurology 1989	Iron	Parkinson's disease
O'Brien, Neurology 1990	Iron	Parkinson's disease
Schrag, Acta Neuropathologica 2010	Iron	Cerebral amyloid angiopathy, dementia
Pfefferbaum, Neurobiol Aging 2010	Iron	Ageing
Wallis, J Mag Res Imag 2008	Iron	Parkinson's disease

Conclusions:

- This study confirmed our previous hypotheses to identify, in structural brain MR images, mineral depositions
- It will allow us to segment mineral deposits more accurately in the images of the participants of The Disconnected Mind Study and research how they affect cognition

References:

[1.] Penke L., et al. Neurobiology of Aging 2010; Jun.7

[2.] Harder SL, et al. Am J of Neuroradiol. 2008 Jan; 29:176-83

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