IRON MAPPING

Iron is the most abundant trace element in the human brain and it is essential to biochemical processes as oxygen transportation, myelin production, and neurotransmitter synthesis. However, it can become toxic when available in excessive amounts. Abnormal high iron concentrations have been linked to neurodegenerative and inflammatory processes occurring in prevalent neurological disorders such as Alzheimer's disease, Parkinson's disease and multiple sclerosis. A prerequisite for investigating the role of iron in the etiology and disease progression is the precise assessment of its concentration.

TECHNIQUES FOR IRON MAPPING

Several techniques have been proposed for the assessment of iron concentration in the brain including R2 and R2* Relaxometry (R2*=1/T2*), phase imaging, **quantitative susceptibility mapping (/pages/research/quantitative-susceptibility-mapping.php)**(QSM), and direct saturation imaging (DSI).

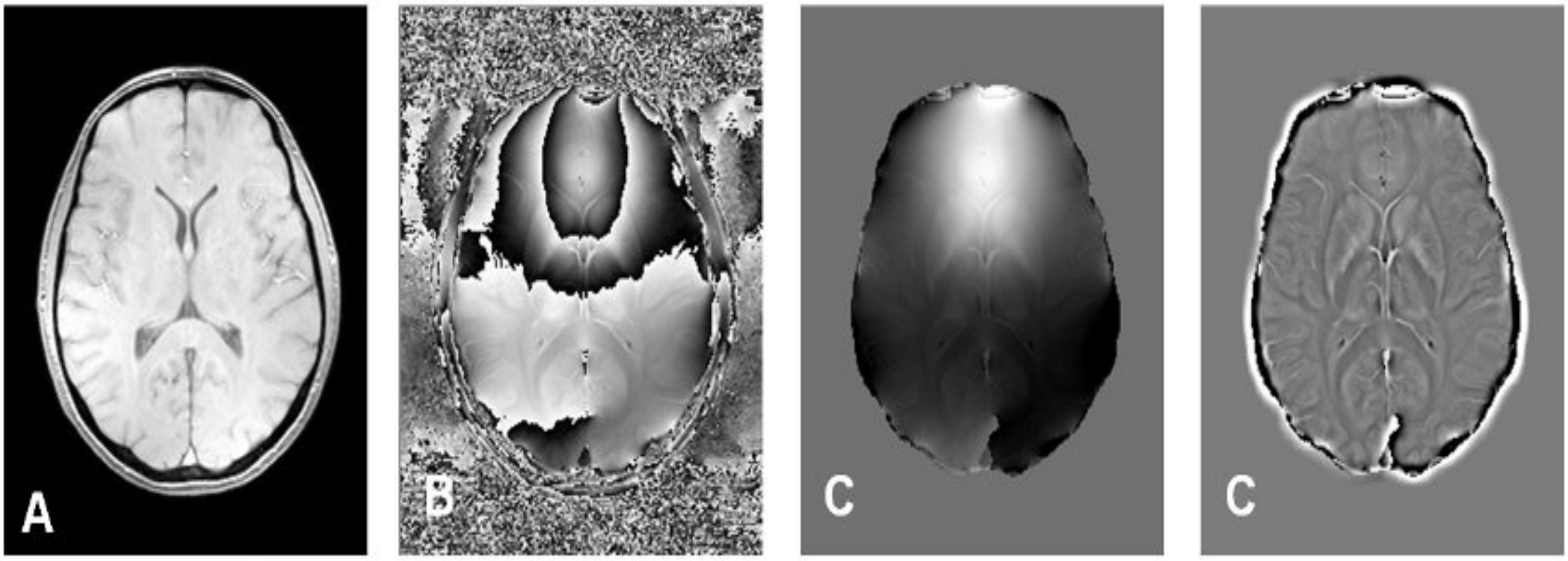

Figure: Paramagnetic iron is not only changing relaxation times of tissue (A), but also the phase of a gradient echo (B). To obtain maps representing susceptibility induced field shifts, typical 2-pi periodic phase wraps have to be unwrapped (C) and filtered (D)

VALIDATION OF IRON MAPPING METHODS

MRI is the only available technique which can assess indirect effects of iron in-vivo and therefore enables longitudinal investigations in the human brain. Because it was unclear so far which MR technique provides valid and sensitive measures for iron, **postmortem studies (/pages/research/postmortem-mri.php)**of the human brain were performed for a chemical validation. Iron concentrations were determined in a variety of anatomical brain regions using various MRI techniques and, additionally, using inductively coupled plasma mass spectroscopy.

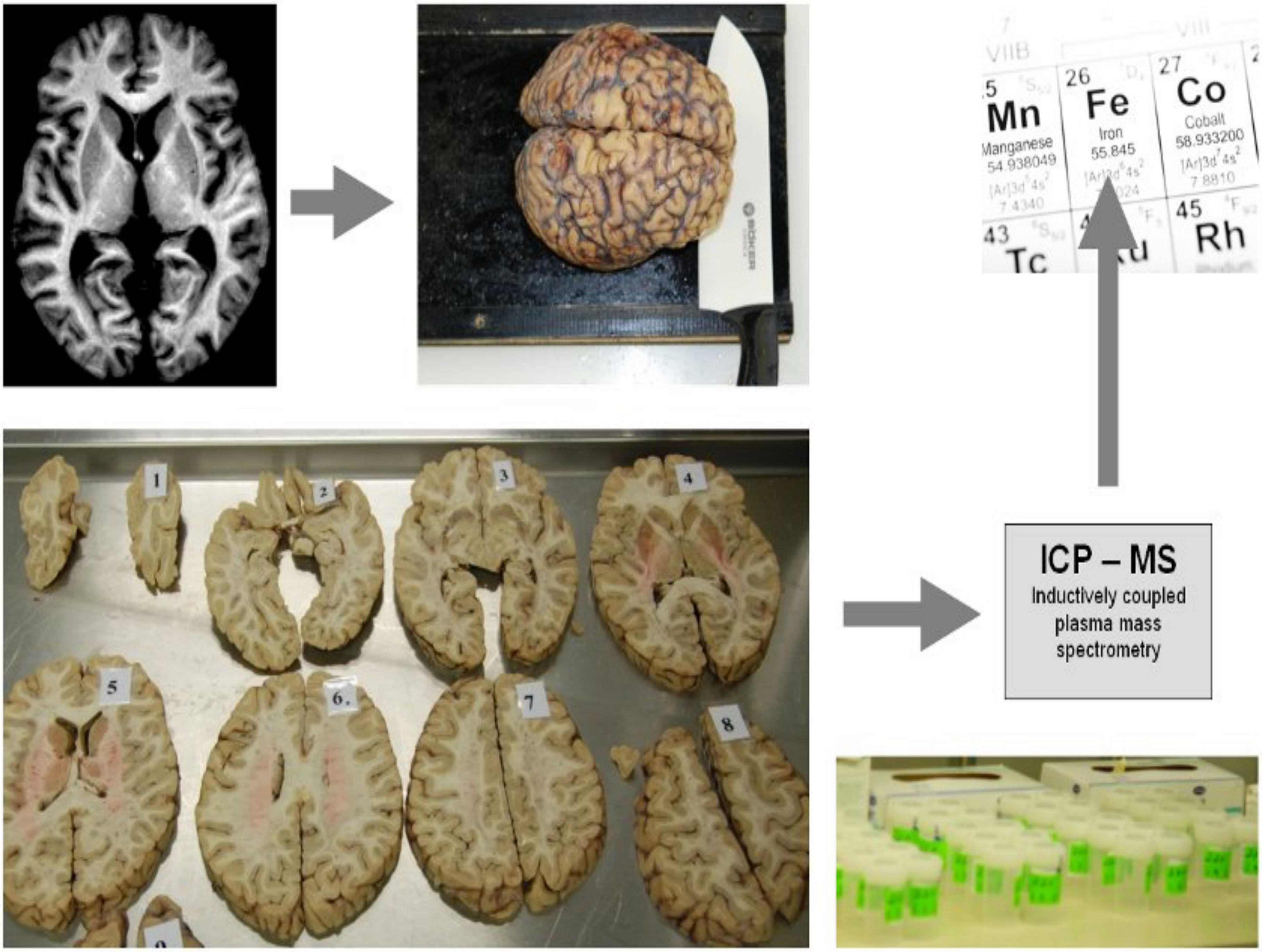

Figure: Postmortem studies including in situ MRI directly after death and chemical analysis of regional brain iron concentrations enable a direct validation. In our work, the formalin-fixed brains were cut into 10mm-thick brain slices and tissue specimens were subsequently referred to an inductively coupled plasma mass spectrometer.

CLINICAL APPLICATIONS OF IRON MAPPING - IN-VIVO

Based on these measurements a model of the biophysical mechanisms underlying MRI contrast generation in the human brain was developed and subsequently applied in clinical studies. The results showed that iron levels are elevated in the basal ganglia of multiple sclerosis (MS) patients. In patients suffering from amyotrophic lateral sclerosis (ALS) white matter changes in the corticospinal tract were paralleled by increased focal iron deposition. Current work focuses on MS, ALS, Parkinson´s disease, Alzheimer´s disease as well as the cause of iron accumulation in the process of normal aging.

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