

Ultrashort Echo Time Magnetic Resonance Imaging Of Myelin And Iron In Parkinson’s Disease (PD)

Jiang Du

Department of Radiology, University of California, San Diego

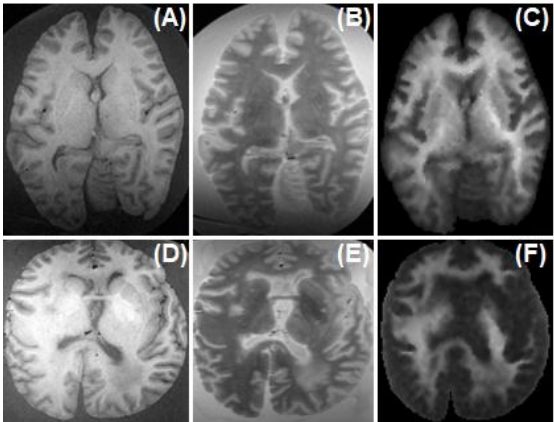
Background

PD is a neurodegenerative disease with ~30% of new patients having mild cognitive impairment (MCI). This can increase to 75% after 10 years, with a high risk of dementia. Clinical symptoms are related to disruptions in information flow through frontal-subcortical networks that mediate motor, spatial, visual, and affective functions. The anatomic substrate of these brain networks is myelinated axons that connect cell groups across cortical and subcortical regions ¹. Myelin damage disrupts axonal transport, integrity, and structural plasticity, deranging motor and non-motor functions. Clinical MRI techniques provide indirect imaging of myelin. Iron accumulation also plays a key role in the pathogenesis of PD by triggering oxidative stress and mitochondrial dysfunction, leading to the death of dopaminergic neurons ². Clinical MRI cannot accurately assess myelin and iron.

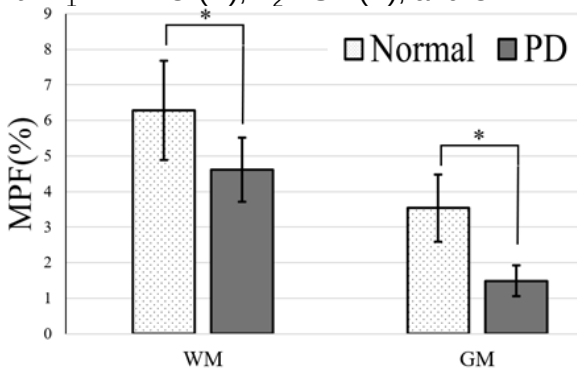
Methods

Ultrashort-echo time (UTE) MRI with echo times (TEs) ~100 times shorter than those used in clinical MRI enables direct detection of signals from myelin and iron overload. We present a short TR adiabatic inversion recovery UTE (STAIR-UTE) technique for myelin mapping and a UTE quantitative susceptibility mapping (UTE-QSM) technique for iron mapping ³. Cadaveric human brain specimens from PD donors were scanned with STAIR-UTE and UTE-QSM techniques. Clinical MRI and UTE-MPF maps of a normal brain and a PD brain are shown in the figure. The mean MPF values for PD brains (n=3) are significantly lower than control brains in both NAWM and NAGM. Preliminary results show significant myelin loss and iron overload in PD brains.

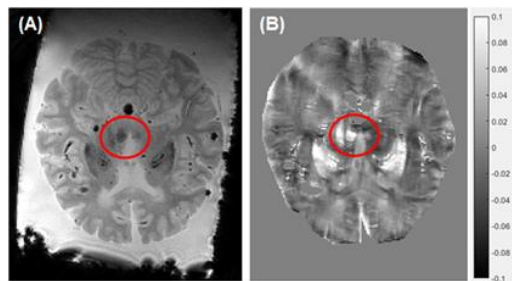
Results



Representative images of a normal brain with T₁-BRAVO (A), T₂-FSE (B), and UTE- MPF (C), age-matched PD brain with T₁-BRAVO (D), T₂-FSE (E), and UTE-MPF (F).



PD brains (n=3) show significantly lower MPF for WM (4.62±0.90% vs. 6.28±1.40%) and GM (1.49±0.43% vs. 3.53±0.94%) than age-matched normal brains (n=5) (G).



UTE (A) and UTE-QSM (B) of a PD brain (78y) highlight iron deposition in the substantia nigra and globus pallidus (red circle).

Conclusion

Preliminary results show significant myelin loss and iron overload in PD brains. The mean MPF values for PD brains are significantly lower than those of control brains in NAWM and NAGM. Iron accumulation in the substantia nigra and globus pallidus is obvious in UTE-QSM.

References

1. Dean DC, et al., *PlosOne* 2016
2. Bae YJ, et al., *Radiology* 2021
3. Ma Y, et al., *Appl Phys Rev* 2022