

Structural brain changes in Haemodialysis patients compared to Healthy Controls assessed using MRI

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Introduction

Ischaemic end-organ damage during haemodialysis (HD) is a significant problem and leads to functional/structural deterioration in the long term. We compared the structural morphology of the brain in a prevalent haemodialysis group compared to age-matched healthy controls using magnetic resonance imaging (MRI).

Methods

Structural 1mm isotropic T1-weighted magnetization-prepared rapid gradient echo (MPRAGE) MR images were acquired on a 3T Phillips Ingenia scanner in prevalent HD patients (n = 10) and age-matched healthy volunteers (HVs) (n = 10). HD patients were scanned 1 hour prior to their scheduled dialysis session. All participants completed the Montreal cognitive assessment (MOCA) and trail making tests (TMT) A & B on the day of their MRI scan. Voxel-based morphometry analysis was performed using Statistical Parametric Mapping software (SPM12). Images were registered to the Montreal Neurological Institute (MNI) template and segmented into grey matter volume (GMV), white matter volume (WMV) and cerebrospinal fluid (CSF). A general linear model of HD patients and HVs, adjusted for total intracranial volume (TIV) and age, was interrogated to assess differences between the groups using a voxel-wise two-sample t-test at a false discovery rate (FDR) of $p < 0.05$.

Results

Median age of the HD group (HDs) was 59 (18) yrs vs 60 (17) yrs in the HVs ($p=0.727$). In the HD group, dialysis vintage was 18.5 months (IQR 52) and 3 participants had diabetes. The HD group took longer to complete TMT B compared to HVs [74 (44) s vs 51 (35) s; $p=0.07$], but there were no differences in MOCA scores [27 (1) vs 29 (2), $p=0.15$] or TMT A [30 (15) s vs 20 (13) s; $p=0.134$].

The WMV/TIV ratio was 0.349 (0.05) in the HDs, significantly lower than the value of 0.365 (0.02) in HVs ($p=0.021$). GMV/TIV was also lower in the HDs [(HDs 0.380 (0.07) vs HVs 0.421 (0.02), $p=0.013$], whilst the CSF/TIV ratio was higher [(HDs 0.286 (0.1) vs HVs 0.216 (0.05), $p=0.006$]. When GMV/TIV was plot as a function of age, a similar gradient was found for the HDs and HVs (Figure 1a). In contrast, WMV/TIV versus age had a significantly greater decline in the HDs compared to HVs (Figure 1b).

Voxel-wise analysis showed that this lower WMV was widespread in the HDs with the greatest reduction in WMV in right cerebral white matter, right inferior temporal gyrus and left supramarginal gyrus. In contrast, the only area of significant GMV difference between groups was that of reduced GMV in the right middle frontal gyrus of the HDs. There were no brain regions that showed higher WMV or GMV in HDs compared with HVs.

Conclusion:

There are significant alternations in the structural brain morphology in HD patients, with predominant loss in WMV when compared to HVs. The greater decline of WMV/TIV in the HD group compared to HVs

supports an accelerated ageing phenomenon in HD patients. We are currently combining these morphological findings with diffusion tensor imaging to assess the effect on white matter tracts.