White matter differences in divers versus other off-shore workers: a diffusion tensor imaging study

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Introduction

The long-term health effects of diving have been studied in a number of groups including both normal diving populations (1) and those following diving accidents (2). Wilmshurst (3) speculated, "Diving itself may cause brain damage, but we need more evidence". The likely pathogenesis of brain damage is generation of gas microemboli during decompression, with a number of studies reporting an increase in white matter hyperintensities (WMH) in divers compared to controls (1,4). The Examination of the Long Term Impact on Health (ELTHI) study has shown that professional divers report more subjective memory impairment than other off-shore workers (5) This has been conformed on neuropsychological testing. We sought to demonstrate the structural basis of memory impairment in forgetful divers, compared with non-forgetful divers and other off-shore workers, in an MRI study of a subgroup of the ELTHI study. Using Diffusion Tensor Imaging (6), this study investigates the hypothesis that there are white matter differences in divers, compared with other off-shore workers.

Methods

291 male subjects underwent brain MRI, including T2W, FLAIR and 3D T1W sequences. The results reported here are of a subgroup of 10 divers, mean age 46 years (SD=6.8) and 10 age matched off-shore workers, mean age 46 years (SD=6.7), who underwent additional diffusion tensor imaging. Imaging was performed using a 1.5T scanner (NVi, General Electric Medical Systems, Milwaukee, WI). A single shot, diffusion weighed, spin echo EPI sequence was used. The diffusion scheme was as follows; one image without diffusion gradients (b=0 s/mm^2) followed by 25 images with different diffusion encoding gradients isotropicaly distributed in space (b=1000 s/mm^2). Nineteen axial slices were acquired with a matrix size of 160x128, slice thickness 5mm and FOV 320mm. TE was 108ms. Spin echo weighted images were realigned using SPM2. Fractional anisotropy (FA) maps were calculated for each subject. High-resolution T1 weighted images were also obtained using an SPGR sequence: FOV, 24cm; 20/6, (TR/TE); flip angle, 35^o; slices, 124; slice thickness, 1.6mm; matrix, 256x192; and in-plane resolution, 1 x 1 mm. The mapping between the anatomical and diffusion data was found by maximisation of mutual information of the two volumes. Firstly the mean of all 26 diffusion images for each subject was co-registered to the SPGR volume, and the warping parameters applied to the FA map. Next mapping to the MNI standard was performed, based on the normalisation of the SPGR volume to the T1 template., The warping parameters were then applied to the co-registered FA map. Regionally specific differences in FA between groups were assessed with a two-sample t-test, using SPM2. The resulting t-statistics were thresholded at p=0.01 (uncorrected).

Results

Significant reductions in FA were found in divers compared with control subjects, bilaterally in the posterior limb of the internal capsule, in the pre-central gyrus of the right frontal lobe, and the left precuneus (Table 1).

Table 1. Talairach co-ordinates of significant reduction in fractional anisotropy in divers compared to controls

X	Y	Z	Region
50	8	12	R pre-central gyrus
-32	-72	40	L precuneus
30	-17	17	R posterior limb of the internal capsule
-26	-24	18	L posterior limb of the internal capsule

Discussion

We have shown that significant local differences in FA are present when comparing divers with non-diving controls. There are too few subjects in this DTI pilot study to assess differences between forgetful and non-forgetful divers. An analysis of WMH, in the larger study of 291 ELTHI subjects, has shown an excess of frontal WMH in divers (7). The FA differences presented here suggest these lesions may be associated with disruption of white matter tracts. A larger DTI study is required to explore FA correlates of neuropsychological abnormalities in forgetful divers.

References

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