STRUCTURAL MRI CHANGE ASSOCIATED WITH REPETITIVE HYPOBARIC NON-HYPOXIC EXPOSURE

Stephen McGuire, MD, Paul Sherman, MD, and Peter Kochunov, PhD

U.S. Air Force School of Aerospace Medicine, OH; 59th Medical Wing, TX; University of Maryland, MD

INTRODUCTION

Neurologic decompression sickness affects pilots with variable central nervous system symptoms. Lesions are believed to be produced by gas bubble formation in the blood or tissues with occlusion of vasculature, although an inflammatory component may also be relevant. We performed high resolution magnetic resonance imaging (MRI) on 106 U-2 pilots (U2P) and 162 doctorate controls (DOC), previously reporting increased subcortical white matter hyperintensity (WMH) burden and decreased neurocognitive test performance associated with normoxic hypobaric exposure ($p<0.001$). We postulated that subcortical white matter injury associated with repeated exposure to hypobaric non-hypoxic environments will be associated with other permanent MRI change.

METHODS

Imaging was performed at the Research Imaging Institute, San Antonio using a Siemens 3T Trio scanner with 12-channel head coil and at the Wilford Hall Ambulatory Surgical Clinic, Lackland AFB using a Siemens 3T Verio scanner with 32-channel head coil. Cross-calibration of scanners was obtained by dual-imaging 46 subjects. Three-dimensional T2-weighted imaging data were acquired as previously reported. Diffusion tensor imaging data were collected using a single-shot echo-planar, single refocusing spin-echo, T2-weighted sequence as previously described and analyzed using the cerebral white matter tract atlas developed at John Hopkins University. The overall count and location of sub-cortical WMH were compared between U2P and DOC using the Wilcoxon test. Fractional anisotropy (FA) values were compared between the U2P and DOC using the t-test. The correlation of FA to WMH was performed with Spearson's rho coefficient. All analyses were 2-tailed and we considered $p<0.05$ as significant.

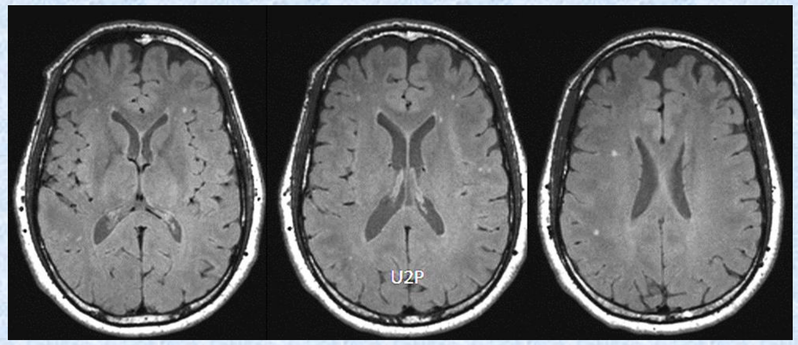
RESULTS

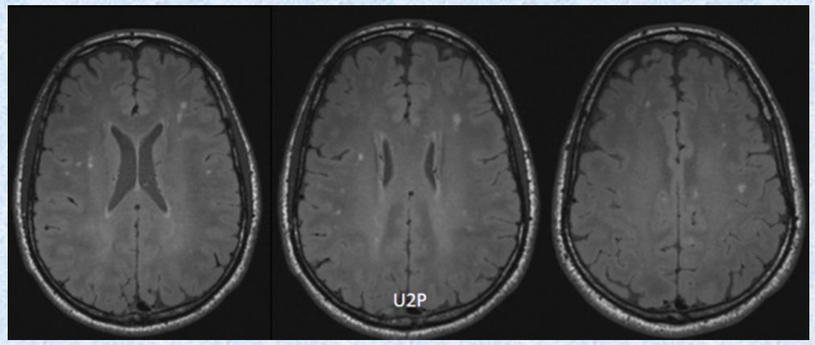
	Subject #	*Average FA*
DOC	***162***	***4965***
U2P	***103***	***4571***
sU2P	***103***	***4903***
sU2P (upper vol)	***79***	***4892***
sU2P (lower vol)	***24***	***4938***
sU2P (upper cnt)	***60***	***4906***
sU2P (lower cnt)	***43***	***4899***

	DOC (n=162)	*sU2P (n=106)*	*Mann-Whitney-Wilcoxon Significance (2-tailed)*
	mean±std dev	***mean±std dev***	***DOC:sU2P***
WMH volume (mL)	***0.035±0.058***	***0.143±0.256***	***p<0.0001***
WMH count	***2.8±3.1***	***7.5±14.2***	***p<0.0002***

	Average FA Significance (2-tailed)
DOC:sU2P	***p = 0.009***
DOC:U2P	***p < 0.000***
DOC:sU2P(up vol)	***p = 0.002***
DOC:sU2P(low vol)	***p = 0.532***
DOC:sU2P(up cnt)	***p = 0.020***
DOC:sU2P(low cnt)	***p = 0.049***
sU2P up:low vol	***p = 0.353***
sU2P up:low cnt	***p = 0.866***

The WMH burden is significantly increased in U2P compared to age- & education-controlled, health-matched controls. Average FA is significantly lower in U2P than controls. Furthermore, this significant difference is maintained when comparing those U2P with higher burden (above the median burden of DOC) to DOC but was no longer significant when comparing those U2P with lower WMH burden to DOC. Spearman rho correlation of average FA to WMH burden was not significant (WMH volume r=-0.0133/p=0.8943 and WMH count r=0.0021/p=0.9836.)





CONCLUSION

We previously reported significantly increased WMH burden in U2P and in altitude chamber technicians exposed repetitively to non-hypoxic hypobaric conditions. This study demonstrates the presence of a more diffuse injury with a decrease in axonal integrity that parallels but is not correlated with the WMH burden. This suggests any pathophysiological explanation must explain both the discrete and diffuse white matter changes detected on MRI.