Head Down Tilt Bed Rest and Arterial Stiffness – Results from a Multi-Method Approach

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Background. Recent vascular biomarker studies indicate that long term space flight and head down tilt bed rest (HDTBR) might lead to premature vascular ageing. However, vascular ageing is a broad term and many different vascular biomarkers are currently used. Therefore, attention must be paid to the specific type of biomarker and its recording site within the arterial tree. We aimed to cover the entire arterial system from the aortic valve to the periphery by using a multi-method approach. Based on previous findings from space and space analog studies, we hypothesized that strict HDTBR would promote vascular stiffening and that daily artificial gravity training would counteract the response.

Methods. We studied 24 healthy participants (8 women, 24 - 55 years, BMI = 24.3 ± 2.1 kg/m^2) before and at the end of 60 days HDTBR. 16 subjects were assigned to daily artificial gravity. We applied echocardiography to measure stroke volume and isovolumetric contraction time (ICT), calculated arterial compliance (stroke volume/pulse pressure), and assessed distensibility and area of the ascending aorta by MRI. Furthermore, we measured brachial-femoral pulse wave velocity and pulse wave arrival times (PAT) in four different vascular beds by using blood pressure cuffs and photoplethysmography. PAT got corrected for ICT (cPAT).

Results. Over all subjects, PAT to the brachial and femoral artery was increased at the end of HDTBR (+9 ms, $p = 0.002$ and +8ms, $p = 0.022$). After correcting PAT for ICT, which increased by 8 ms ($p = 0.036$), cPAT and all other vascular biomarkers remained unchanged. Stroke volume decreased by 14 ml ($p = 0.001$). Heart rate (+7 bpm, $p = 0.002$) and diastolic blood pressure (+8 mmHg, $p < 0.001$) increased whereas systolic blood pressure remained unchanged ($p = 0.652$). Aortic area tended to increase ($p = 0.05$). None of the parameters were affected by artificial gravity training.

Conclusion. 60 days of HDTBR, while producing cardiovascular deconditioning and cephalad fluid shifts akin to weightlessness, did not worsen vascular stiffness. We also conclude that only ICT corrected PAT values should be used as vascular biomarkers. If artificial gravity is going to be used in future bed rest studies, its duration or intensity should be increased in order to gain a beneficial effect.