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RECORDING HUMAN HEMODYNAMICS DURING PARABOLIC FLIGHTS USING PHOTOPLETHYSMOGRAPHY

ENREGISTREMENT D'HÉMODYNAMIQUE HUMAINE PENDANT DES VOLS PARABOLIQUES À L'AIDE DE LA PHOTOPLÉTHYSMOGRAPHIE

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Introduction: Parabolic flights currently present one of the few possibilities to simulate alternating gravity conditions, including zero-g, under laboratory-type conditions. The special parabolic trajectory allows for approximately 22 seconds of zero-g, preceded and followed by a hyper-G phase. Parabolic flights are therefore excellent for examining rapid hemodynamic changes in humans under alternating G accelerations. Earlier studies of our group proved photoplethysmography (PPG) to be suitable even with high-Gz accelerations found in the human centrifuge and high-performance aircraft. PPG provides valuable information on circulatory parameters that are otherwise hard to obtain under said conditions. This study aimed at continuously recording the pulse wave during parabolic flights and drawing conclusions about blood volume distribution and changes in cardiac contractility from the derived DC and AC components.

Methods: 26 subjects performed a parabola series with hyper-g and zero-g phases. Among other physiological data the photoplethysmogram was continuously monitored, i.e. all subjects wore a forehead-mounted reflectance pulse oximetry sensor which was connected to the multisensor data-recording and analyzing system called HealthLab. Filtered PPG was used to derive DC and AC components. All signals were subsequently evaluated using commercial biological data processing software.

Results: Compared to baseline values determined before each parabola the PPGDC components increased during hyper-g phases and decreased during zero-g phases reflecting blood volume shifts from head to toe and vice versa. This was accompanied by PPGAC component decrements during hyper-g phases and increases during zero-g phases arguing for an increase of contractility of the heart due to increased filling.

Conclusions: Our study proved PPG to be suitable for obtaining relevant information on cardiovascular regulation even under inflight conditions with alternating accelerations. The findings obtained are in accordance with earlier studies demonstrating a blood volume shift in the body during hyper-g and zero-g phases, respectively.