profiles (G-RAFFE familiarization run, gradual onset run (GOR) (0.1 G_z/s), rapid onset run (ROR) (6 G_z/s and +5, +7 and +9 G_z loads for 15 s) and an exhausting simulated aerial combat maneuver (ESACM) (150 s)) at the human-use centrifuge in Koenigsbrueck using both AGS. During all runs, G_z and physiological parameters (ECG, heart rate, pulse wave, etc.) were recorded. Subjective data characterizing key elements of G protection were collected during the ROR rest periods (2 min) and after the ESACM. **RESULTS:** The relaxed G_z-level tolerance (GOR) was nearly the same in both suits. In the ROR, all participants immediately fulfilled the requirements with the new suit, showing lower mean heart rates during the G-RAFFE runs. In the ESACM, the performance was nearly identical in both suits, whereas the load to the cardiovascular system in pilots and novices was significantly smaller with G-RAFFE. In the ROR, but also in the ESACM, the subjectively experienced G protection, safety and physical condition after the run were rated significantly better and the feeling of exhaustion after the run and the effort necessary to fulfill the mission were felt to be lower with G-RAFFE. There were also fewer cases of arm and foot pain with G-RAFFE in use. **CONCLUSIONS:** As in the 2013 study, also the new data suggest that the G-RAFFE performance was better or at least as good as the performance accomplished with AEA. Exclusive of integrated PBG and even though the familiarization period was pretty short (about 2–4 minutes) and the G-RAFFE suit could not be personally fitted, the subjective rating of the most important items was better and the cardiovascular load to the participants was smaller.

Learning Objectives

1. The participant will be able to understand the consequences of +Gz-acceleration.
2. The audience will learn about the objective and subjective evaluation of anti-G suits.

[23] ACCELERATION ATELECTASIS AFTER HIGH G FLIGHT BREATHING 60% OXYGEN AND INFLUENCE OF CABIN ALTITUDE

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(Original Research)

INTRODUCTION: Acceleration atelectasis has long been recognized as a potential hazard in fighter aircraft. Symptoms suggestive of atelectasis have recently been reported in aviators using modern pilot flight equipment and oxygen/anti-G systems. A flight trial was conducted to assess whether a breathing gas mix containing at least 40% nitrogen was sufficient to prevent atelectasis in aviators using contemporary flight equipment, and whether cabin altitude influenced atelectasis formation. **METHOD:** Pilots (n=14, male) conducted flights on 2 separate days in a jet trainer aircraft (Royal Air Force Hawk T Mk 1). Flights were conducted at HIGH (18,000ft-20,000ft) and LOW (6,000-8,000ft) cabin pressure altitude, and each flight included 16 manoeuvres at +5Gz sustained for 15 seconds. Participants wore standard flight equipment and breathed 60% oxygen throughout the flight. A safety pilot occupied the other seat. Forced Inspiratory Vital Capacity (FIVC) by spirometry, basal lung volume and FIVC by electrical impedance tomography (EIT), and peripheral oxygen saturation during transition from hyperoxia to hypoxia (pulmonary shunt fraction), were measured in the cockpit immediately before (PRE) and after (POST) flight. Data were analysed using repeated measures ANOVA. **RESULTS:** FIVC was significantly lower POST flight after HIGH (-0.24L) and LOW (-0.38L) sorties but recovered to PRE flight values by the fourth repeat (FIVC4). EIT-derived measures of FIVC decreased after HIGH (-3.3%) and LOW (-4.4%) sorties but did not recover to baseline by FIVC4. FIVC reductions were attributable to decreased inspiratory capacity. SpO_2 was lower POST flight than PRE flight in HIGH and LOW sorties. **DISCUSSION:** Breathing a maximum 60% oxygen during flight results in 3.8-4.9% reduction in lung volume (inspiratory capacity), associated with a slight decrease in blood oxygenation and an estimated pulmonary shunt of up to 5.7%. EIT measures of basal lung volume suggest mild persisting airway closure despite repeated FIVC manoeuvres. There was no meaningful influence of cabin altitude.

Learning Objectives

1. The audience will learn about the effect of acceleration atelectasis on lung function in pilots using typical flight gear after high G flying.
2. The audience will learn the effect of ambient pressure on the development of acceleration atelectasis.

[24] VISUAL SYMPTOMS AND G-LOC DURING CENTRIFUGE-SIMULATED SUBORBITAL SPACEFLIGHT

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(Original Research)

INTRODUCTION: Commercial suborbital spaceflight presents new challenges with acceleration in both the +Gz and +Gx axes simultaneously that varies with the specific flight profile and seating orientation. As part of a wider study into the physiological effects of centrifuge-simulated suborbital spaceflight, visual and cognitive effects of acceleration were assessed. **METHODS:** 24 participants (age range: 32-80 years) undertook launch and re-entry profiles on a long-arm human centrifuge. One profile represented a vertically launched rocket with a seatback angle of 70° from vertical ('head level' peak +Gz 2.7, peak +Gx 4.2). Two profiles represented an air-launched spaceplane, with a common seated launch phase (seatback angle 20°, peak +Gz 3.7, peak +Gx 3.6) and re-entry in either a reclined (seatback angle 70°, peak +Gz 1.2, peak +Gx 5.9) or upright seated position (seatback angle 20°, peak +Gz 4.0, peak +Gx 4.5). Profiles were performed twice; in normoxia and mild hypoxia (15% O_2, 8,000 ft cabin pressure altitude equivalent). Participants were asked to remain relaxed in the absence of visual symptoms, and to perform muscle tensing if greyout developed. **RESULTS:** 90% of participants reported visual symptoms at least once. The majority noted greyout during spaceplane launch (mean G at onset when breathing air: +3.3 Gz, +2.5 Gx; with mild hypoxia: +3.4 Gz, +2.5 Gx) and likewise during seated re-entry (breathing air: +3.4 Gz, +4.0 Gx; mild hypoxia: +3.8 Gz, +4.3 Gx), but none when supine. One participant noted visual changes during the vertical launch profile. More than a quarter of participants experienced complete visual loss (blackout) and a small number noted pre-syncopal symptoms. One episode of G-induced loss of consciousness (G-LOC) occurred during seated spaceplane re-entry in a participant aged 80 years. **DISCUSSION:** Centrifuge-simulated suborbital spaceplane profiles are associated with visual symptoms in a large proportion of individuals and can cause G-LOC. Visual changes appeared to occur at lower levels of +Gz than expected, suggesting a possible reduction in relaxed +Gz tolerance with concurrent +Gx. The microgravity phase during actual suborbital flights may further decrease +Gz tolerance, and further research is required to investigate these effects and the potential role of pre-flight physiological training/exposure.

Learning Objectives

1. The participant will be able to understand the head-level effects of various sub-orbital spaceflight acceleration profiles, including visual symptoms and loss of consciousness.
2. The participant will be able to understand the potential implications of mixed +Gz and +Gx acceleration and identify where further research is required regarding possible mitigations.