Comparison of G-protective properties afforded by the Libelle® suit with those afforded by the Anti-G ensemble 39.

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It has been suggested that the G-protection afforded by a recently developed hydrostatic anti-G suit (Libelle®, Autoflug Libelle, Rellingen, Germany) is far superior to that by any of the conventional pneumatic anti-G systems. However, no data has been published to support this notion.

Accordingly, the present study was undertaken to compare the G-protection afforded by the Libelle (L) suit with that of the anti-G system used in the 9 G aircraft JAS 39 Gripen (Anti-G ensemble 39; AGE-39, Swedish Defence Material Administration, Stockholm, Sweden) comprising an extended coverage pneumatic anti-G suit and an assisted pressure-breathing system (5).

METHODS

Three pilots participated. The experiments were conducted in the centrifuge (ASEA, Sweden) at Karolinska Institutet. G-intensity tolerance was examined in a conventional manner employing Rapid Onset Rate (ROR) profiles of 15 sec duration (G-onset rate: 5 G/sec). Prior to the experiments relaxed G-intensity tolerance was established whilst the subject was not wearing any anti-G garments. Thereafter, each subject was investigated in three experimental conditions using: (i) The AGE-39 in combination with maximal L1 anti-G straining maneuvers (AGSM) throughout each high-G exposure (Full Maneuver; FM). (ii) The AGE-39 in combination with L1-AGSM during the initial 4-5 sec of each 15 sec G-profile (Reduced Maneuver; RM). (iii) The L-suit in combination with varying straining maneuvers. The instructions regarding straining were given by representatives from Autoflug Libelle and varied between subjects and between G-exposures from ”perform full L1 AGSM throughout the high-G exposure” to ”tense your leg muscles and speak to the experimenter during the G-exposure”.

RESULTS AND DISCUSSION

G-intensity tolerance was 6.3 G (=mean; range 6.0 G - 7.0 G) in the L-condition and 9.0 G in all subjects in the FM and RM conditions. Relaxed G-intensity tolerance without any anti-G garment was 4.0 G (3.5 – 4.5 G).

That the AGE-39 provides adequate G protection at forces up to or even exceeding +9 Gz confirms previous studies (1, 4, 5), and is in agreement with several studies on various other G-protective systems comprising an extended coverage single-pressure pneumatic anti-G suit in combination with assisted pressure breathing (for reviews see 2, 3).

That L-suit in combination with muscle straining does not provide sufficient G-protection for a 9 G aircraft is in line with several unsuccessful attempts in the past to design hydrostatic anti-G suits with high-G protective properties (for ref. see 6). The early attempts, dating back to the forties, to design hydrostatic anti-G suits were based on the then prevailing notion, that the key to improve G-tolerance was to maintain an

adequate venous return to the heart by preventing G-induced pooling of blood in the veins of the lower body. However, we now know that the tolerance to sustained high +Gz forces is mainly determined by arterial pressure homeostasis (for reviews see: 2, 6). Thus, to maintain blood flow in the head of a seated pilot exposed to +9 Gz, his arterial pressure at heart level must be increased by 130-180 mmHg. Typically, hydrostatic anti-G suits increase arterial pressure by 20-25 mmHg corresponding to an improvement in G-tolerance of about 1 G (6). In the present study the improvement in G-tolerance provided by the combination of L-suit and muscular straining ranged from 1.5 to 3.0 G in the different subjects.

It thus appears that, in concordance with previous hydrostatic anti-G suits, the L-suit affords a G-protection of <1.5 G, which is not adequate for use in a 9-G aircraft.

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