Symposium - HIGH SUSTAINED G FORCES

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ROLE OF CENTRIFUGE TRAINING IN COMBATING HIGH SUSTAINED G FORCES

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HUMAN centrifuges have been in use in many places to assess aircrew and +Gz protective systems, to indoctrinate aircrew and medical officers, to carry out research in protective systems and to establish norms for human tolerance. Their role as a training tool for improving the combat effectiveness of frontline pilots has been realised only recently and has already been implemented in the Netherlands, USA and West Germany as per current information.

This potential of the human centrifuge was known but was never exploited since it was presumed that the cumulative training achieved by a fighter pilot during his initial operational training on different types of aircraft was quite adequate to prepare him for the combat flight environment. Now it is being realised that training of pilots in operational aircraft does prepare the majority of them but some are still unable to cope with the requirements, resulting in a high incidence of G-LOC. The centrifuge is a useful equipment for imparting training in +Gz protection techniques.

Centrifuge Training

The objectives are understanding of physiologic mechanisms of G stress and G tolerance, recognition of symptoms, skill in improving G tolerance and confidence in the ability to sustain high G stress. The benefits are greater safety during combat manoeuvres and greater effectiveness in high G combat.

In the USAF, centrifuge training for operational pilots of the Tactical Air Command started on a trial basis in April 1983. Since January 1985, regular courses are being conducted at USAF SAM for pilots flying a number of different types of aircraft including F-16, F-4, F-15, AT-10, AT-38 and F-5 with encouraging results. Information available from other NATO countries also indicate a major thrust in this direction.

In the initial part of the course, briefing/lectures are conducted to explain the hazard of G-LOC, physiologic mechanisms of G stress and protection. Demonstration of the effective personal protective techniques like M-1 and L-1

manoeuvres are carried out and practised before and during +Gz exposure on the human centrifuge.

Personal Protective or Straining Manoeuvres

Most protective techniques against G forces involve tensing of body musculature, crouching and respiratory effort to raise intrathoracic pressure. It may take the form of yelling/shouting or grunting. However, it has been proved that well co-ordinated and practised manoeuvres could increase the human tolerance to +Gz by +2 G over relaxed values. On the other hand, improper techniques can give benefit of only 1 G or less. Some pilots follow wrong methods and actually reduce their tolerance as is found sometimes among trainees.

M-1 and L-1 Manoeuvres:

These manoeuvres have been known since 1940 and were extensively practised by American pilots prior to the introduction of anti-G suits and later on along with the suits.

The M-1 and L-1 manoeuvres consist of crouching forwards, straining of abdominal, arm and leg muscles and certain breathing practices. In the M-1, the pilot takes in a short breath and breathes out against a semiclosed glottis producing repeated grunts, whereas in the L-1 the pilot takes a short breath in and breathes out against a closed glottis. In both these techniques the intrathoracic pressure is raised by 30-100 mm Hg. This raised intrathoracic pressure is maintained for short periods of time only, thus avoiding any effect on the venous return. The raised intrathoracic pressure raises the arterial pressure at the level of the arch of aorta thus maintaining a higher perfusion towards the head against the hydrostatic pressure due to high G.

The M-1 and L-1 manoeuvres can be executed repeatedly during a high G exposure but are fatiguing and also require some effort and concentration by the pilot. Some pilots may initially find these very distracting from their primary task of flying the aircraft. To achieve ideal coordination and habitual repetition of these manoeuvres, extensive training is required. This training could be carried out first in a class room and later assessed in the human centrifuge. A well trained pilot can perform these manoeuvres repeatedly and gain an advantage of about +2 G over his relaxed tolerance.

Centrifuge Profiles

The centrifuge run profiles used were:

a. Gradual onset run (GOR) to determine relaxed G tolerance and straining G tolerance.

b. Rapid onset run (ROR) practice run.

c. ROR to determine relaxed tolerance and straining G tolerance.

d. Training ROR runs to improve protective techniques and better tolerance.

e. Simulated air combat manoeuvres (SACM) for training for the particular aircraft type.

At the end there is a debriefing and discussion along with video tape replays to explain the individual behaviour and performance during centrifuge training. This helps the pilot to understand his strengths and weaknesses during +Gz exposures.

Results of USAF SAM Training

Performance summary for 741 pilot trainees is given below (7):

Average relaxed GOR Tolerance		: 5.2G
Average straining GOR tolerance		: 8.3G
Reached Peak G on GOR		:40.8%
Completed 8 G ROR	(n = 739)	:99.7%
Completed 9 G ROR	(n = 697)	:94.1%
Attempted 9 G SACM	(n = 40)	: 5.4%

Course results as assessed by trainee pilots were as follows:

Total respondents	:	382
Outstanding	:	110 (28.8%)
Positive	:	169 (44.2%)
Neutral	:	95 (24.9%)
Negative	:	7 (1.8%)
Worthless	:	1 (0.3%)

Conclusion

The potential problem of G-LOC is already with us. The high peak G and the high rates of onset prevalent in modern aircraft should awaken us to this requirement. Training of pilots in human centrifuge is being widely accepted as a norm in many western countries. The need to introduce similar training for our aircrew is considered urgent.

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