Original Article

Neuroendocrine Response of IAF Test Pilots During Power-on Stall Lesson Units

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Post Flight urinary catecholamines (CA), Epinephrine (E) Nor-Epinephrine (NE) and NE/E ratio changes were evaluated in five instructors and eight student test pilots after power-on stall and spin recovery lesson units of 40 min duration. The urinary CA mobilisations were similar in both instructor/student test pilots. The pre flight urinary values of E and post flight rise of urinary E were higher for the student test pilots whereas the instructors showed a higher post flight urinary levels of NE. The pre and post flight urinary values of NE/E ratio were significantly lower for the student test pilots than in instructors. In addition, student test pilots showed a significant post flight reduction in the urinary NE/E ratio. The data suggest dominance of psychological stress in the student test pilots, whereas the instructors showed a more aggressive reaction. The changes may be interpreted as an event specific reaction and may be pre-requisite for the optimal task performance.

Keywords : Catecholamines (CA), Epinephrine (E), Non-epinephrine (NE), NE/E Ratio.

Introduction

Post flight catecholamine (CA) determinations have been used to assess the sympatho-adrenomedullary (SAM) response of pilots after different types of missions in a fighter aircraft[1-8]. The degree of SAM response perceived by the pilots are altered by the intensity and duration of flying stress. Flights of even 40 min duration in various difficult to fly in situations elicit a SAM response of fairly high magnitude. The intensity of stress perceived by the students showed a reduction by the amount of flying experience gained. The magnitude of stress perceived by the students was higher while performing various difficult learning lesson units than in the Instructors . The power-on stall and spin recovery lesson units constitute one such difficult flying lesson units wherein high components of stressors are involved [1-8]. The present study analyses the intensity of stress perceived by the student pilots during power- on stall and spin recovery lesson units while being trained as test pilots and differentiates it from that perceived by the Instructor test pilots while performing the similar lesson units in view of their repeated exposure to this type of mission and a greater flying experience.

Material and Methods

The investigation was carried on five instructor test pilots (age : 35 ± 5 yrs, flying experience : 4290 ± 446 hrs) and eight student test pilots (age : 25 ± 5 years, flying experience : 844 ± 102 hrs).

A power-on stall spin recovery lesson unit with a flight duration of 40 min were flown both by the Instructor and Student test pilots in a Mig-21 aircraft. The student test pilots performed the mission after being trained adequately to perform the sortie independently but being watched by the Instructor test pilot to evaluate their inflight performance. The stress response of the Instructor test pilots was evaluated when they were flying the mission but in the process student pilots were instructed regarding the various aspects of flying the power-on stall and spin recovery lesson units. Pre and post flight urine samples were obtained from the student/Instructor test pilots just prior to flight and after the completion of mission. Subjects emptied their bladder completely and drank 250 ml of water. Pre flight urine samples were obtained after 45 min of rest and the post flight urine samples were obtained 20 to 30 min after the completion of mission.

The exact length of time elapsed between the collection of pre and post flight urine samples and their total volume were also noted. The urine samples were immediately stabilized by adjusting the pH to 3 with 2N hydrochloric acid and were frozen. The urine samples were immediately

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analysed for CA, E, NE by fluorimetric technique using trihydroxyindole reaction[10].

In urinary CA determinations, accurate measurements of time between voiding, sample volume and immediate stabilization are essential for good experimental practice [1-9]. In our studies, these were strictly adhered to and wherever possible, duplicate analyses were carried to ensure the reproducibility of the results. The concentration of each analyte was multiplied by volume, divided by time and expressed as excretion rate in ng/min[3,7].

Statistical analyses were done by paired and unpaired 't' tests.

Results

Table I & II presents mean, pre and post flight excretion levels of CA, E, NE (Ng / min) and the NE/E ratio. Post flight urinary levels of amines were significantly higher in the Instructor and Student test pilots than their pre flight excretion levels. The rise in the levels of CA were similar

TABLE I : Urinary Catecholamine Excretion Response of IAF Student test pilots (n=8) (values expressed as ± SEM)

	CA ng/min	E ng/min	NE ng/min	NE/E Ratio
Preflight	26.0 ± 2.73	8.8 ± 1.61	17.2 ± 2.42	2.40 ± 0.52
Post Flight	85.9 ± 16.8	33.8 ± 7.35	52.1 ± 15.8	1.94 ± 0.69
Δ	59.9 ± 16.9	25.0 ± 7.53	34.9 ± 14.3	-0.47 ± 0.11
% Change	253.8 ± 72.4	345.8 ± 92.9	188.8 ± 70.3	—
P Value	< 0.01	< 0.02	< 0.05	NS

TABLE II : Urinary Catecholamine Excretion Response of IAF Instructor test pilots (n=5) (values expressed as ± SEM)

	CA ng/min	E ng/min	NE ng/min	NE/E Ratio
Preflight	23.4 ± 2.77	4.9 ± 0.59	18.5 ± 2.41	3.85 ± 0.42
Post Flight	87.9 ± 20.7	16.6 ± 2.00	70.4 ± 31.5	4.03 ± 0.69
Δ	63.6 ± 20.5	11.7 ± 2.50	51.9 ± 18.3	0.18 ± 0.50
% Change	195.9 ± 126.2	275.9 ± 93.2	288.5 ± 109.4	—
P Value	< 0.05	< 0.01	< 0.05	NS

both in the Instructor and student test pilots but the post flight values of NE were higher in instructors whereas the students had a higher post flight levels of E. In addition, the students had a higher pre flight levels of E than the Instructors. The NE/E ratio showed a higher pre and post flight values in the Instructors than the students. The NE/E ratio showed a significant post flight fall in the students whereas the instructors did not show any significant change.

Discussion

Pre flight levels of urinary CA, E and NE observed in the present study were similar to those reported in literature [1-8].

The post flight urinary CA excretion response of USAF pilots have been studied under different training conditions[3-7]. The lesson units which included power-on stall and spin recoveries, solo and check created highest arousal, anxiety and apprehension[3-4]. The values of urinary CA obtained in this study during power-on stall and spin recovery lesson unit were lower than those reported in USAF student pilots after spin, solo, check lesson units in T-37 flight training programme and after power-on stall and spin recovery lesson unit performed in a simulator before practice on advanced simulator for pilot training (ASPT)[3,4]. The values were however similar to those reported in USAF student pilots when the power-on stall and spin recovery lesson units were performed in simulator after 80 minutes of practice on ASPT[4]. This indicates that the stress perceived during power-on stall and spin recovery lesson units by our pilots is quite high but the post flight values of E and NE suggest an altered stress response wherein a lowered arousal and increased mental activity were in evidence as against those seen in USAF student pilots. This may be due to greater flying experience of our pilots which have resulted in greater flight adaptability.

The role of CA in the performance of different types of task have been exhaustively researched[11-16]. It has been shown that the plasma concentration of E are positively related to capability for "mental work" characterized by low energy expenditure and sustained level of attention[16]. It has been established, using a serial discrimination task that although E secretion initially increases as a result of psycho-physiological mobilisation and then declines in manner related to performance but NE levels are unaffected[11]. In our study, the pre and post flight

levels of E were higher in the student test pilots than those noted in instructors. This indicates higher mental work load and greater psychophysiological mobilisation in the student test pilots both during pre and post flight period. The post flight urinary levels of NE has been associated with attentiveness and task oriented response . The pre flight urinary levels of NE were similar in both the instructor and student pilots. The Instructors however showed a greater post flight rise of urinary NE. This shows that the Instructors were mentally more alert and aggressive than the students . Rise in E excretion is a sensitive index of emotional arousal whereas NE rise has been associated with physical and mental effort. The post flight values of E and NE observed in the present study suggest greater emotional arousal in the student test pilots whereas, the Instructors had a greater mental and physical effort. It has been observed that with flying experience, the post flight levels of E shows reduction whereas NE level shows a rise; such a hormonal balance represents successful coping behaviour. In this study such a hormonal balance was observed in the instructors than in the student test pilots and may be interpreted as a consequence of greater flying experience.

NE/E ratio has been used to assess the flight induced sympathoadrenal stimulation. A high value of NE/E ratio suggest higher work load whereas value approaching unity indicate dominance of psychological stress [3-6,17]. The resting NE/E ratio as high as 11, approaching a value of unity during the post flight period has been recorded in the student test pilots. However the post flight reduction of NE/E ratio was much lower in the experienced pilots [3-6,9]. Our pre and post flight urinary values of NE/E ratio observed in the student/instructor test pilots were lower than 11 but higher than the value of unity and were similar to those seen in the experienced test pilots[3-6,9]. In addition, the student test pilots also had a significantly lower pre and post flight urinary values, of NE/E ratio than in the instructors. The post flight urinary values of NE/E ratio showed a significant fall in the students which however was not noted in the instructors. These findings suggest dominance of psychological stress in the student test pilots.

In summary, the values of urinary CA,NE, E and NE/E ratio in the present study suggest that in terms of CA mobilisation, both the Instructor/Student test pilots experienced similar level of stress during power-on stall and spin recovery lesson unit. The student, however, showed the dominance of psychological stress both during pre and post flight period but the Instructor showed more aggression and mental alertness. The changes observed in the student/instructor test pilots may be event specific and probably are required for optimal performance of the flying task.

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