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Total Blood Sulfhydryl Group Changes During Flight Trials

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Laboratory studies have proved, that the estimation of total blood-SH group is a simple, repeatable method for assessing stress. under various conditions as compared to other presently available complicated hormone estimation in blood and urine. A preliminary study was therefore undertaken to prove the usefulness of this test in assessing the stress involved during various flight trials 7 pilots participated in the transport/fighter aircraft flying. Pilots flying transport aircraft did not show any change whereas the pilot flying the fighter aircraft showed a significant drop in the the total blood –SH group ($P < 0.01$). Usefulness of this test in the flight stress evalution and the biochemical aspects of change in blood—SH group during transport/fighter aircraft are discussed.

Inrcduction

A number of stimuli or conditions of unusual stress elicit in the body. a typical series of events in which hypophyseal-Sympatho adrenocortical (H—SAC) system plays an important role (16). The nature of this reaction is nonspecific. In aviation, stress encountered in the form of heat,hypoxia, acceleration and vibration often elicit such reaction, involving adrenomedullary system in some, the adrenocortical system in others while some evoke a mixed reaction (11. 17).

Activation of sympatho-adrenocortical system manifested as change in the blood/urinary level of catecholamines and corticosteroids after various stresses have been studied (17). These hormones are also known to produce profound metabolic changes (11).

Total sulfhydryl groups occupy an important position in various metabolic processes, because of their intimate association with the problem of protein metabolism and their role in various enzymatic oxidation-reduction process, during normal and stressful condition (11). It is hypothesized that in response to stress, blood level of these groups may show a change. Laboratory trials relating to the effect of heat, hypoxia, acceleration and vibration on the change in total blood—SH

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groups have already been conducted (11). The present study, is further aimed, to find out the effect of flying stress, on the percentage change in total bl-SH groups using this as a stimulant of H-SAC axis.

Methods

Seven pilots from ASTE participated in various flight trials as per the profile given below :

Trials on the fighter aircraft : Two pilots participated in the trial No. 1. Pilot 1 flew a Kiran aircraft alongwith pilot 2 at an altitude of 6096 m. The cruising speed of the aircraft was around 273 knotts/h. The total flight duration was 50 min. Pilot 1 was a trainee test pilot and the pilot 2 was an experienced test pilot.

Trial No. 2. This flight trial was conducted by an experienced test pilot who flew an MIG aircraft at an altitude of 12192 m Cruising speed of the aircraft was around 476 knott/h. Total duration of the flight was 1 hr.

Trial No. 3 This flight trial was conducted on a Canberra aircraft by an experienced test pilot at an altitude of 6096m. Speed of the aircraft was around 330 knotts/hr. Duration of the flight was 70 min. During the flight a hard 3 Gz turn was also executed.

Trials on the transport aircraft

Trial 4 & 5 : In the flight trial 4 and 5a transport Devon aircraft was flown at an altitude of 1524-2939m. Speed of the aircraft was around 120 knott/h. In the flight trial 4, two pilots participated. Pilot 1 who flew the aircraft was an experienced test pilot and took part in a three consecutive flight trials for a total flight duration of 3h and 15 min and the other who was a trainee test pilot participated in one flight trial of 1h and 15 min. duration.

In the flight trial 5 only one experienced test pilot participated for a total flight duration of 1h and 25 min.

Blood samples were obtained from the tip of index finger before and immediately after exposure to each one of the flight profile. Total bl-SH groups were estimated by the method of Ellman (4) using 55' dithiobis (2 nitrobenzoic acid) as a colouring agent.

Result :

Table 1 Shows the effect of flight trial on the percentage changes in the total bl-SH groups. Changes from pre to post flight value among fighter pilots were highly significant ($P<0.01$) with an average fall of 37.1%. In the first fighter sortie jointly conducted by two pilots the percentage fall was more in the pilot 1 who was flying the aircraft than in pilot 2 who was a copilot

Changes from pre to post flight value amongst the transport pilots were not significant.

Discussion : Among the important cellular constituents that contain nonprotein SH groups are glutathione, cysteine, pantothenic acid, coenzyme[1] and reduced Lipoic acid (10, 11). The role of glutathione in regulating the oxidative-reductive processes in the cell, the function of cysteine as a carrier of groups in transfer reaction and the participation of coenzyme[1] in a number of metabolic processes are some of the important function of nonprotein sulfhdryl groups which are well documented (7, 10, 11). The SH groups of many enzyme notably oxidoreductase are essential for enzymatic activity (7, 10, 11). Oxidation (dehydrogenation) of these groups brought about by many oxidizing agents results in loss of activity (7, 10, 11).

Insignificant change in the bl-SH group during transport aircraft flying shows absence of dehydrogenation and significant change during fighter aircraft flying suggest overall enhancement in the dehydrogenation reaction and further indicates that considerable amount of stress is encountered by the pilots while flying fighter aircraft. The 37.1% fall in the level of bl-SH group noted during fighter aircraft flying were similar to that observed after 45 min exposure to 4572m, and was of same magnitude that resulted after 5 to 10s exposure to peak Gz of 4.3g (11). The fall however was much less than the reported fall of 49% and 61% after 50 min. exposure to hot and dry environment (T db=57°C, rh=25%) and hot and humid environment (Tdb=50°B, rh=50%) (11). The significant utilization observed during fighter aircraft flying suggest that the net effect of combined stress like the individual stress of heat hypoxia and acceleration are stimulant in nature and demonstrate significant stimulation of H-SAC axis. The loss of activity could result from the action of various hormones leading to increased metabolic, enzymatic, oxidation-reduction reaction where these groups act as a cofactor and are partly utilized.

Endocrine-metabolic analysis carried out by several workers suggest that it was possible to appraise flight sensitivity in terms of sympathoadrenal, adrenocortical and metabolic activities (2, 3, 5, 6, 9, 12, 13, 14). Most of the endocrine-metabolic appraisal made during transport aircraft flying is associated with long hours of flying (9, 13, 14). Probably 1.3h of transport aircraft flying could not produce any significant impact on the endocrine-metabolic changes and therefore bl-SH group did not show any significant change. Epinephrine is altered by emotional and other types of stress associated with flying (2, 5, 6) Insignificant change in the bl-SH group during transport aircraft suggest that sympathoadrenal system is well adapted to transport flying and did not evoke any emotional stress (2, 5, 6). Norepinephrine is reported to be influenced by physical factors encountered during flying and is associated with speed and altitude of the aircraft (2). Insignificant change in the bl-SH group during transport aircraft flying and significant change during fighter aircraft flying may be indicative of the fact that speed and altitude of the aircraft which was considerably higher during fighter aircraft flying had a greater impact on fighter pilots. It has also been observed that epihephrine and norepinephrine was higher in pilots who is actually flying the aircraft then the passenger pilot (2). In our studies during one of the fighter sorties greater fall in bl-SH group in pilot 1 (46.5%) and less fall in bl-SH group in pilot 2 (36.5%) further substantiate the above findings. Stresses when they act for the first time induce adrenocortical response of fairly high magnitude (14). However with continued or repeated stimulation these response diminish in magnitude (14). But the values bl-SH group during transport flying are not the consequence of the exhaustion of the adrenocortical system but the adaptation of the system to the transport flying. Significant change in the bl-SH groups in the fighter pilots suggest that system is yet to adapt to flying and involves considerable amount of strain.

It was thought that the exposure to multiple stress as encountered during flying would result in a greater percentage fall in the total bl-SH group but such was clearly not the case. This study indicates. that, multiple stress during flying, does not act in a additive manner. Broadbent pointed out that the interactive effect of stresses when combined could be quite diverse for example two stress with antagonistic mechanism such as depressant and stimulant might cause less impairment than the either stressor alone (1). The less fall in the bl-SH groups noted during flying, probably is a reflection of combinations of various stress which are acting in a antagonistic manner. It can be brought out that during our laboratory trial a significant rise in bl-SH group was observed during vibration demonstrating antagonistic and depressive nature of this stress and suggesting inhibition in the activity of H-SAC axis (1, 8, 11).

Measurement of bl-SH group may thus be useful in evaluating the flying stress that is being encountered during transport and fighter aircraft flying. Though the test may not be able to differentiate between sympathoadrenal and adrenocortical activity but it appears to be a sensitive index of measuring the generalized stress encountered.

TABLE : 1

Effect of exposure to flying stress on the percentage changes in the total blood sulfhydryl group (mmol. lit-1) (n=7).

Sl. No.	Type of the aircraft flown	Blood sulfhydryl group (mmol. lit-1)		
		Pre	Post	% changes
1.	Kiran aircraft (Pilot No. 1)	6.62	3.68	44.5
	Pilot No. 2 (Copilot)	5.89	2.21	37.5
2.	MiG aircraft	51.5	2.94	42.9
3.	Canberra aircraft	77.2	5.89	36.7
	Mean	6.35	4.05	-37.1
	Sd	±1.10	±1.28	± 9.4
	Mean difference	—2.30		
	'T' Value	9.90 (P<0.01)		
4.	Transport Devon aircraft	5.89	5.15	12.5
5.	" "	4.42	3.68	16.7
6.	" "	7.32	5.89	19.5
	Mean	5.89	4.91	-16.3
	Sd	±1.45	±1.12	± 3.5
	Mean difference	—0.97		
	'T' Value	4.22 (N.S.)		

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