

Salivary electrolyte changes in response to flying stress

Dr EM Iyer*, Sqn Ldr ML Thambi⁺

ABSTRACT

Changes in salivary K⁺, Na⁺ and K/Na⁺ ratio were investigated in twenty pilots after a test flight of 45 min. Fighter pilots (FP, n = 14) performed the mission in MiG-21 supersonic aircraft whereas helicopter pilots (HP, n=6) performed the sorties in Mi-17 helicopter. Pre flight salivary K⁺ and K/Na⁺ ratio of all pilots did not show any significant post flight change. However, pre and post flight salivary K⁺ and K/Na⁺ ratio were found to be significantly related to aircraft types (AC) and flying experience (FE). In FP, salivary K⁺ showed significant post flight rise while in HP no such changes were noted. In pilots with FE of <2370 h preflight salivary K⁺ showed a post flight rise while in pilots with FE of >2370 h, salivary K⁺ showed no significant change. The rise in the delta value of K/Na⁺ ratio in pilots with <2370 h of FE were significantly higher than the reduction in the delta value of K⁺/Na⁺ ratio noted in pilots with >2370h of FE. Pilots with FE of >2370 h exhibited a significantly higher pre flight K⁺, and K/Na⁺ ratio than the pilots with <2370 h of FE. Results show usefulness of salivary K⁺, Na⁺, K⁺/Na⁺ ratio for assessing the stress response of pilots in relation to AC and FE

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Various studies have demonstrated that the measurement of salivary K⁺ and Na⁺ level could be used as practical method for - monitoring the change in sympatho-adreno-corti-cal activity (SACA). Enhanced SACA as caused by acute stressor results in rapidly increased secretion of K⁺ and some lowering of Na⁺ in the saliva [1-14].

Significant relative changes in the ionic concentration of salivary K⁺ and Na⁺ have been reported following experimental task demands in the form of university work, lectures in the final examination, academic work in students, increased arousal in anesthetics in operation theatre and in pilots after exposure to simulated air combat manoeuvre (SACM) [3, 4, 8, 12, 15].

Salivary K⁺ has mainly been linked with psychological stressor, while salivary Na⁺ has been related to physical stressor [3, 4, 8, 15, 16]. Aviation stress has a component of both the stressors hence measurement of salivary K⁺ and Na⁺ could serve the purpose of assessing psycho physiological variation in the stress response of pilots during a flight trial.

* Sc F, Dept. of Biochemistry, 1AM, IAF, Vimanapura, Bangalore-560 017

+ Graded Specialist (Av Med), AF Station, Panagarh

Methods

Twenty healthy male Air Force pilots (Mean age : 31.3 yrs. ht: 173.3 cm. wt: 66.7 kg) with a mean flying experience (FE) of 2370 ± 751 h participated in this study. An informed consent was obtained from each subject. They performed a test flight mission of 45 min. The test flight included sorties such as system testing, performance testing, flight quality testing, directional flying and spin exercise. The basic purpose of the test flight was to evaluate the effect of any addition or alteration in the aircraft system. During the sorties the fighter pilots (FP) were exposed to acceleration (+Gz) forces which did not exceed +5Gz. All the sorties were

performed between 0900 to 1300 h. FP (n=14) performed the mission in MiG-21 supersonic aircraft whereas the helicopter pilots HP (n=6) performed the sorties in Mi-17 helicopter. Salivary samples were collected twice, once before the start and another after completion of the mission in a wide mouthed plastic centrifuge tube. Subjects were asked to dribble only that saliva which was in the mouth. They were instructed not to produce any saliva by mouth manipulation. Salivary samples were analysed for K^+ and Na^+ by flame photometry (EEL, London). Students paired and unpaired 't' test were applied for analysing the statistical significance for the changes in salivary electrolytes.

Table 1

Flying experience (FE), pre and post flight, difference of salivary K^+ , Na^+ and K/Na^+ ratio of all pilots (AP), fighter pilots (FP), helicopter pilots (HP), less experienced pilots (LEP) and more experienced pilots (MEP). All values are expressed as mean \pm SD.

	AP (n = 20)	FP (n = 14)	HP (n = 6)	LEP (n = 10)	MEP (n = 10)
FE (h)	2370 + 751	2182 \pm 533	J2809 \pm 1036		1762 \pm 265
Salivary K^+ (mmol/l)					
Pre	22.3 \pm 7.5	20.9 \pm 8.3	25.8 + 3.9		18.4 \pm 7.8@
Post	27.3 \pm 8.2	28.5 \pm 7.9	24.4 \pm 8.8		28.4 \pm 9.0 10.0
Difference	5.0 \pm 11.9	7.6 \pm 12.7*	-1.4 \pm 6.9		\pm 13.4*
Salivary Na^+ (mmol/l)					
Pre	8.5 \pm 4.7	8.9 \pm 5.2	7.6 \pm 3.6		9.0 \pm 4.0 12.0
Post	9.8 \pm 7.4	11.0 \pm 8.6	7.1 \pm 2.7		\pm 10.2 3.0 \pm
Difference	1.3 \pm 6.6	2.1 \pm 7.8	-0.5 \pm 1.6		7.5
K/Na^+ ratio					
Pre	3.7 \pm 2.9	3.6 \pm 3.2	4.1 \pm 2.1		2.4 \pm 1.2@ 3.9
Post	3.7 \pm 1.8	3.7 \pm 2.0	3.6 \pm 1.3		\pm 2.4
Difference	0.0 \pm 3.3	0.1 \pm 3.7	-0.5 \pm 1.9		1.4 \pm 2.5*
					2979 \pm 546
					26.3 \pm 5.0@
					26.2 \pm 7.7 -0.1
					\pm 7.9
					8.0 \pm 5.5 7.7 \pm
					1.6 -0.3 \pm 5.4
					5.0 \pm 3.4@ 3.5
					\pm 1.1 -1.6 \pm
					3.4*

Results

Salivary K^+ and Na^+ and K/Na^+ ratio of all pilots did not show any significant post flight changes. The FE of all pilots ranged from 1248-4147h. Their mean flying experience (MFE) was 2370 ± 751 h. The salivary K^+ , Na^+ and K^+/Na^+ ratio were found to be significantly affected by aircraft type (AC) and FE. In FP salivary K^+ showed a significant post flight rise. In HP this was insignificant. In less experienced pilots (LEP) with FE <2370 h with MFE of 1762 ± 265 h, salivary K^+ exhibited a significant post flight rise. In more experience pilots (MEP) with FE >2370h with MFE of 2979 ± 546 h salivary K^+ showed no significant post flight change. The rise and reduction observed in the delta value of K/Na^+ ratio for LEP and MEP were significantly higher for one group than the other. The MEP had a significantly higher pre flight K^+ and K/Na^+ ratio than the LEP. The rest of changes in salivary ionic constituents between the various group of pilots were not significant (Table-1).

Discussion

The composition of saliva is subject to hormonal modulation by adrenocortical steroids [2, 5, 13, 17, 18]. The adrenocortical steroids act directly on the salivary glands to increase the reabsorption of Na^+ and secretion of K^+ . Increased activity of sympathetic system as caused by acute stressor also results in rapidly enhanced secretion of K^+ and some lowering of Na^+ in saliva [3, 4, >. 12, 15]. As flying stress is likely to be associated with significant increase in the SACA, a post flight increase in the secretion of salivary K^+ and reabsorption of Na^+ were expected, but no such changes were noted in all group of pilots, demonstrating adaptation of SACA to flying stress.

In this study the level of salivary K^+ and K/Na^+ ratio appeared to be influenced by AC and FE. In FP, flight induced significant post flight rise in salivary K^+ while in HP no such changes were noted. The post flight rise in salivary K^+ in FP may be related to greater stress associated with high +GZ exposure. The unresponsiveness in HP indicates reduced physiological activity or diminished SACA due to adaptation to flying. In the LEP, flight induced significant elevation in salivary K^+ and greater rise in the delta value of K/Na^+ ratio than MEP. As compared to the above in MEP post flight variations in salivary K^+ and Na^+ were indistinct while the delta value of K^+/Na^+ ratio showed a greater reduction than LEP. This difference apparently relates to FE and shows that as the FE increases the response of SACA diminish in magnitude. The diminished response of SACA in

MEP may be an indicator of higher flight proficiency and greater flight capability [6, 9, and 11].

This study has also demonstrated significantly higher pre flight salivary K^+ and K^+/Na^+ ratio in MEP than in LEP. March banks et al [9, 10] and Kramer et al [7], have reported a higher preflight urinary level of neither epinephrine (E), nor epinephrine (NE) and 17-hydroxycorticosteroid (17-OHCS) in fliers than in non-fliers. Burton et al [1] have reported that the pilots engaged in aerial combat manoeuvres (ACM), who were regularly subjected to high +Gz exhibited a significantly higher urinary levels of E, NE and 17-OHCS both on flying and non flying days as against the controls. They further observed that the preflight urinary levels of these parameters in ACM pilots were even higher than the pilots engaged in lengthy flights without any significant increase in G load. Our observation of significantly higher preflight salivary K^+ and K^+/Na^+ ratio in MEP indirectly demonstrated the presence of heightened SACA in them. These findings suggest adaptive changes in SACA and may be the result of repeated exposure to flying stress in MEP.

It can thus be summarized, that the determination in the variability of salivary ionic composition could be used as a practical method for assessing the effects of 'real life' stressors under various conditions.

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