Original Article

Effects of 100% oxygen breathing on cardiovascular functions during high altitude acclimatisation

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The main stimulus for acclimatisation on exposure to high altitude is hypoxia. Aircrew operating from bases at high altitude breathe supplemental oxygen while flying. The hypoxic stimulus is thus removed for this period. It was hypothesised that adaptation of the cardiovascular system to hypoxia amongst aircrew may thus be slower. This hypothesis was tested with the help of two groups of subjects. Group-I consisted of eleven freshly posted in ground crew (NIGC) and Group-II had six freshly posted in helicopter aircrew (NIAC). All the subjects were followed up from day one to 30. Echocardiography, orthostatic tolerance and haemogram were done on five occasions, ie., days 0, 3, 7, 15 and 30 in each of the subjects. Body surface area, haemoglobin, TRBC and haematocrit were found to be significantly higher in aircrew. As the acclimatisation progressed ejection fraction, pulmonary artery hypertension, haemoglobin, TRBC and haematocrit showed a rising trend, whereas cardiac index and heart rate did not reveal any specific trend. Haemoglobin, haematocrit and TRBC did not show any rise between days 15 to 30 amongst aircrew, whereas other parameters have shown a similar pattern in both the groups. The changes on day zero when compared with day 30, in both the groups, were not found to be significant. Orthostatic tolerance improved second week onwards. Based on these results, it was concluded that cardiovascular functions are not affected by supplemental oxygen breathing, whereas haemoglobin and erythrocyte rise are adversely affected. The results have been discussed in this paper.

Keywords : Acclimatisation, High altitude, Oxygen breathing.

Most of our aircrew population live at sea level or at low altitude and their physiology is in harmony with partial pressure of oxygen in the ambient air at sea level. When such individuals make temporary incursions in to the high altitude (HA) environment they have to adjust to the low partial pressure of altitude. Tactical and operational reasons have forced the IAF to have permanent bases in HA areas. The term HA generally applies to a terrain height of 3000 m and above as at this height a majority of low landers start showing signs and symptoms associated with altitude. The height of 5800 m. marks beginning of extreme high altitude. No acclimatisation can be attained above this altitude and progressive deterioration in overall physiology occurs during prolonged stay [1, 2]

Aircrew at HA are exposed to the

deleterious effects of hypoxia, cold and decompression, hypoxia being the main problem. The process by which body succeeds in preventing the oxygen deficient conditions of hypoxia at altitude is called acclimatisation [3,4]. The main brunt of HA stress falls on the cardiovascular and respiratory system which undergo immediate changes to help in the process of acclimatisation. The main stimulus for the process of acclimatisation is low partial pressure of oxygen [2,3,5,6]. This stimulus is interrupted during supplemental oxygen breathing at the time of flying in aircrew. It was therefore hypothesised that the process of acclimatisation will be slower and will attain a lower level in aircrew as compared to ground crew over a given period of time. In this paper effects of 100% oxygen breathing on cardiovascular functions and haemogram during HA acclimatisation have been discussed.

Material and methods

This study was carried out at Air Force Station Leh situated at an attitude of 3300 m between the months of May and August. The study sample consisted of a total of 17 subjects who were exposed to HA for the first time and were categorised in two groups :

Group I : Newly Inducted Ground Crew (NIGC). This group comprised of 11 Air Force Airmen freshly inducted at high altitude. Their age ranged between 23 to 29 years (mean age 26 ±1.80 years). All the subjects except two were smokers.

Group II: Newly Inducted Aircrew (NIAC). This group comprised of 6 freshly posted-in helicopter aircrew. Their age ranged between 23 and 26 years (mean age 25 ±1.0 years). All the subjects except one were smokers.

Testing Protocol : Subjects belonging to both the groups, i.e., NIGC and NIAC, were studied for 30 days, the day of induction at HA being labeled as D-0. During this period each subject was exposed to physiological testing (vide infra) on five occasions, i.e., D-0,. D-3, D-7, D-15, D-30. Testing was done during the same period in the mid morning between 9.30 to 11.30 hours so as to eliminate any potential diurnal variations. Care was taken to ensure that the subjects had adequate sleep on the night prior to the experiment and no alcohol was consumed.

After initial rest for two days NIGC started their routine duties and NIAC also started routine flying with the use of supplemental oxygen. Each aircrew on an average flew about 12 to 16 hours in a week.

Physiological Tests : Echocardiography, Passive Standing Test and complete haemogram were the tests selected for this study.

Echocardiography was done with the help of SIM - 7000 model of echo-cardiography machine produced by ESAOTEBIOMEDICA. It is a real time ultra sound imaging system with a flow analysis system designed for multiple applications. Following parameters were computed: Cardiac Output (CO), Heart Rate (HR), Pulmonary Valve Flow Profile (PVFP), Pulmonary Valve Peak and Mean Velocity (PVPVE & PVMVE) and Pulmonary Valve Peak and Mean Gradient (PVPG & PVMG)

Passive standing testing is a simple and practical test under field conditions for eliciting cardiovascular responses to postural stress. The Passive Standing Test (PST) used here has been recommended and used earlier by Hyatt et al [7]. Room temperature was made as comfortable as possible by available means. To avoid any disturbance, telephones were not permitted and nobody else other than observer and his assistant were permitted.

Complete haemogram for all the subjects was done on D-0, D-7, D-15, D-30 days mostly by the same lab technician.

Results

Descriptive Statistics - Physical characteristics (Table I) : The mean age of NIGC subjects was 26 ±1.80 years with the range of 23 to 29 years, whereas in NIAC group the age varied between 23 to 25 years with mean values of 25 ±1 years. The mean weight of NIGC was 62 ± 5.13 kg and for aircrew group was 67.66 ±3.45 kg. A reduction of 0.2 kg and 0.5 kg was observed over the period of one month in NIGC and NIAC respectively. The mean body surface area (BSA) for ground crew was 1.648 ± 0.77 m², and that of aircrew group was 1.798 + 0.66 per m² Height ($p<0.01$), weight ($p<0.001$) and BSA for NIAC were found to be significantly higher compared with NIGC.

Echocardiography - Ground crew and Air crew (Table II and III and Fig 1, 2, 3). Echocardiography findings for NIGC and NIAC on day 0,3,7,15 and 30 of stay at HA are shown in tables II and III. Cardiac index (CI) on D-0 in NIGC was 1.90 ±0.38 L/ m², which was found to be lower than that in NIAC (2.27 + 0.31 L/m² of BSA). NIGC group on D-3 had shown an increase in CI whereas on D-15 and D-30 it was found to be slightly higher than D-0 value. On the other hand NIAC were found to have lower CI on D-7 and thereafter D-15 onwards have shown increase with D-30 values being marginally lower than D-0. HR among ground crew had shown increase from 71.7 ± 11.6 bpm at the time of induction to 77.0 ± 9.5 bpm one month thereafter. The decrease in HR from 83.8 to 69.3 bpm was seen in the NIAC group. HR among ground crew on D-0 was unexpectedly low which probably has resulted in the low CI recorded.

Table I : Descriptive Statistics : Physical characteristics ground crew and asircrew

Parameters	Group 1 (n = 11) Mean ± SD	Range Min	Range Max	Group 2 (n = 6) Mean ± SD	Range Min	Range Max
Age (yrs)	26.0 ± 1.80	23	29	25 ± 1.00	23	26
Weight (kg)						
Day0	62.0 + 5.13	53	70	67.7 ± 3.45	62	72
Day30	61.8 ± 5.03	54	70	67.2 ±3.29	62	72
Height (cms)	165.5 ± 5.31	153	173	172.0 + 4.89	166	178
BSA (m²)	1.684 + 0.08	1.513	1.801	1.798 ± 0.06	1.689	1.882

Table II : Echocardiography ground crew (n = 11)

	Days at HA				
Parameters	0	3	7	15	30
CI (Lm²)	1.90 ± 0.38	2.16 ± 0.52	1.91 + 0.41	2.21 + 0.83	2.03 ± 0.85
HR (beats /min)	71.7 + 11.6	73.8 + 12.0	76.2 + 6.4	74.2 ± 10.2	77.0 ± 9.5
EF (%)	46.7 - 7.2	54.5 + 4.6	51.4 + 5.1	58.6 +/- 10.2	58.9 ± 5.3
PVFF (Units)	0.161 - 0.02	0.151 + 0.02	0.136 + 0.02	0.137 ± 0.02	0.137 ± 0.02
PVPVE (m/sec)	0.817 - 0.09	0.821 + 0.11	0.793 + 0.07	0.730 ± 0.05	0.741 ± 0.10
PVMVE (m/sec)	0.5 + 0.06	0.51 + 0.06	.495 + 0.06	0.532 ± 0.02	0.467 ± 0.06
PVPGR (mm Hg)	1.21 ± 0.35	1.28 ± 0.34	1.22 ± 0.29	1.38 ± 0.15	1.06 ± 0.30
PVMGR (mm Hg)	2.73 ± 0.39	2.74 ± 0.71	2.57 ± 0.49	2.8 ± 0.41	2.25 ± 0.62

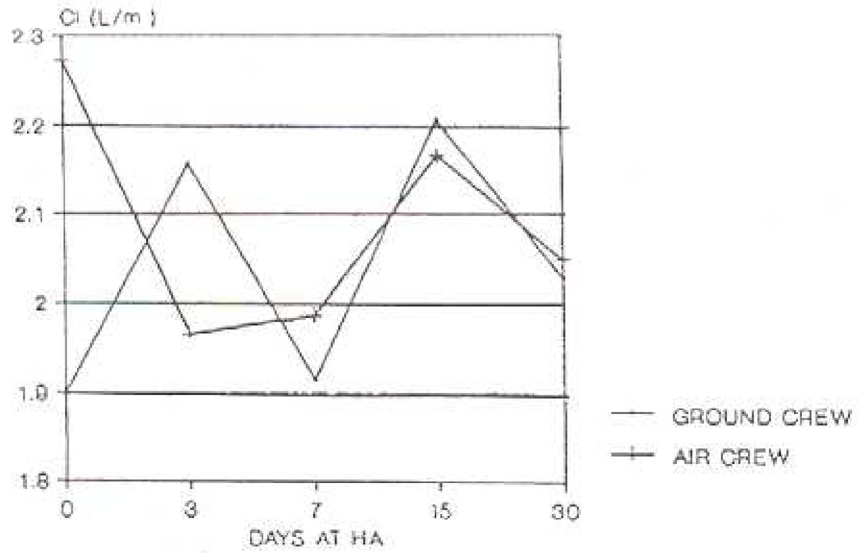
Table III: Echocardiography air crew (n = 6)

	Days at HA				
Parameters	0	3	7	15	30
CI (Lm²)	2.27 - 0.31	1.97 ± 0.18	1.99 ± 0.31	2.17 ± 0.23	2.05 ± 0.40
HR (beats /min)	83.8 + 7.4	75.0 ± 4.0	71.3 ± 2.1	75.3 ± 12.7	69.3 ± 4.1
EF (%)	46.4 + 7.9	67.0 + 0.0	52.0 ± 14.5	51.5 ±3.5	55.7 ± 8.2
PVFF (Units)	0.164 - 0.03	0.160 + 0.01	0.153 ± 0.03	0.156 ± 0.02	0.140 ± 0.02
PVPVE (m/sec)	0.808 ± 0.09	0.790 + 0.05	0.743 ± 0.08	0.816 ± 0.09	0.733 ± 0.14
PVMVE (m/sec)	0.52 ± 0.05	0.53 ± 0.02	0.493 + 0.05	0.543 + 0.05	0.476 + 0.07
PVPGR (mm Hg)	1.28 ±0.26	1.30 ± 0.10	1.03 + 0.18	1.43 ± 0.25	1.13 ± 0.42
PVM GR (mm Hg)	2.54 ± 0.52	2.55± 0.35	2.23 + 0.54	2.73 + 0.62	2.26 + 0.84

Ejection Fraction (EF) showed a rise on D-3 in both the groups. The value in NIGC increased from 46.7 to 54.5 % and in NIAC it increased from 46.4 to 67%. Therefore EF decreased in both the group on D-7 and later on trend was similar. It was observed that in both the groups there was a decreasing trend in PVFP. In NIGC there was reduction of PVFP from 0.161 to 0.137 units and in NIGC the reduction was from 0.164 to 0.137 units. Thus it can be said that during acclimatisation both the groups under study developed pulmonary artery hypertension (PAH).

PVPVE and PVMVE in both the groups had decreased on D-30 as compared to D-0 values. PVPG and PVMG in NIGC had decreased from 1.21 to 1.06 mm of Hg and from 2.73 to 2.25 mm of Hg respectively. In NIAC these values had declined from 1.28 to 1.13 mm of Hg and 2.54 to 2.26 mm of Hg respectively. Changes in all parameters mentioned above on D-30 when compared to D-0 values of the same group were not found to be statistically significant. HR on D-0 and EF on D-3 were found to be significantly higher in NIAC, p (<0.05) and (<.01) respectively.

Fig-1: Cardiac index at HA during 30 days at HA



Passive standing test and Orthostatic Tolerance (Tables IV and V) : Mean base line Systolic Blood Pressure (SBP) in NIGC showed decline from 125 mm of Hg on D-1 to 121 mm of Hg on D-30. A similar fall was noticed in NIAC from 120 to 114 mm of Hg. Mean Diastolic Blood Pressure (DBP) readings in NIGC did not show much variations whereas in NIAC it had shown a fall of 5 mm of Hg on D-30 as compared with D-0. Mean Arterial Pressure (MAP) did not show much variations in NIGC with least value at D-7. In NIAC it decreased from 90 to 85 mm of Hg. DBP and MAP on D-0, D-15 and D-30 were recorded to be significantly lower in NIAC. Pulse Pressure (PP) had shown mild decrease in both the groups.

It can be seen from table IV and V that the response to orthostatic stress during passive standing test (PST) is in the form of rise in DBP in both the groups except on D-7 where no change was recorded in DBP. The NIGC group on D-0 and D-7, on immediate standing, had Orthostatic Arterial Anemia (OAA), i.e. for a slight fall in BP there was a substantial rise in HR. In NIAC group also on D-0 and D-15, on immediate standing, and on D-15 after 5 minutes had shown a similar OAA response. Individually

Fig-2: Ejection fraction during 30 days at HA

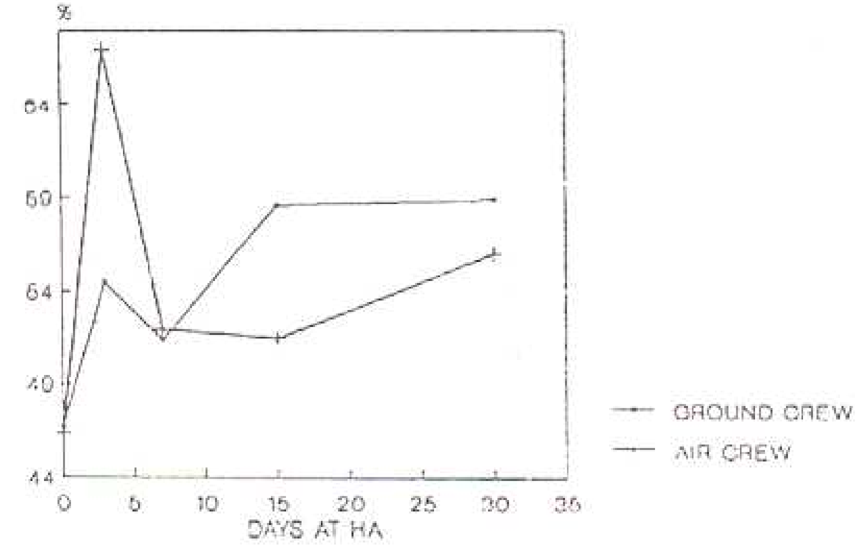
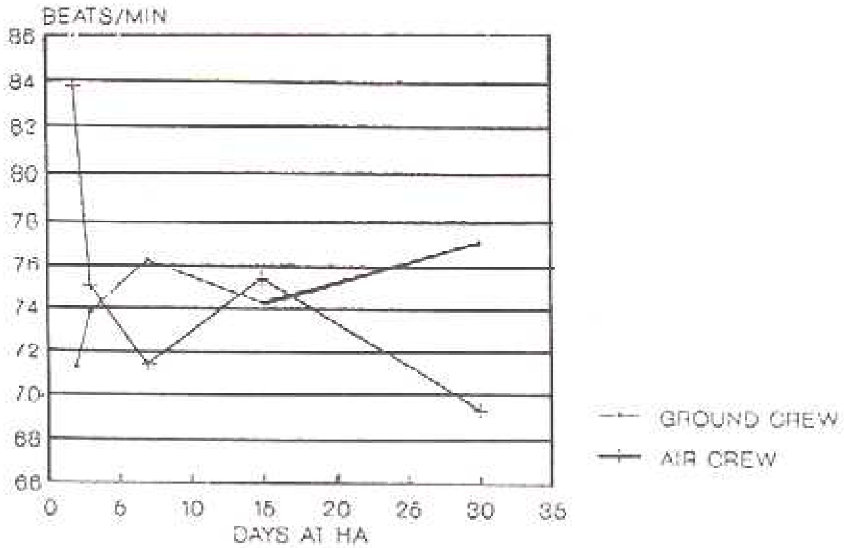


Fig-3: Heart rate during 30 days at HA



two subjects in NIGC had decompensation of the cardiovascular system after two and three minutes of stress on D-3 and D-0 respectively. In subject NIGC-6, SBP dropped from 104 to 94 mm of Hg with the rise of DBP from 70 to 82 mm of Hg and pulse recorded was 96/min. In NIGC - 10, fall in SBP was recorded from 130 to 100 mm of Hg. DBP also showed fall from 86 to 80 mm of Hg and pulse was 78/min. These two subjects also had symptoms in the form of uneasiness, feeling of being unwell, narrowing of visual fields and there were signs of perspiration. None of the NIAC subjects reported such symptoms. Thus these two subjects of NIGC during first week showed evidence of decreased orthostatic tolerance which improved subsequently.

Haemogram (Table VI and VII) during the period of observation NIGC showed a rise of haemoglobin (Hb) from 14.4g/dl to 16.2g/dl whereas in NIAC there was a similar rise from 16.0 to 18.8 g/dl. It is pertinent to note that Hb, Total Red Blood Cell Count (TRBC) and Packed Cell Volume (PCV) values in NIAC were significantly higher than in NIGC ($P<.001$) at the time of induction. After 5 days the NIAC group did not show any rise in Hb. The rise in TRBC

Table IV : Blood Pressure and heart rate ground crew (n = 11)

Days AT HA	Parameters		SBP (mm Hg)	DBP (mm Hg)	PP (mm Hg)	MAP (mm Hg)	HR (beats / min)
0	Basal	(after 10 min)	12 ± 9.9	84 ± 7.6	41 ± 7.2	98 ± 7.7	78 ± 7.7
	Passive Standing	0 min	125 ± 12.5	85 ± 8.7	40 ± 14.4	99 ± 7.5	89 ± 8.5
		5 min	117 ± 11.9	85 ± 8.7	32 ± 10.5	95 ± 8.6	89 ± 8.9
3	Basal	(after 10 min)	120 ± 10.3	84 ± 8.6	36 ± 2.2	96 ± 9.2	78 ± 5.5
	Passive Standing	0 min	123 ± 14.0	87 ± 10.4	36 ± 9.8	99 ± 10.7	97 ± 8.6
		5 min	116 ± 12.1	92 ± 9.4	24 ± 6.5	100 ± 9.9	97 ± 10.4
7	Basal	(after 10 min)	114 ± 9.3	82 ± 6.7	32 ± 6.1	93 ± 7.1	74 ± 8.0
	Passive Standing	0 min	111 ± 9.5	82 ± 8.9	29 ± 2.1	91 ± 8.9	91 ± 13.4
		5 min	112 ± 11.1	83 ± 7.9	29 ± 11.3	93 ± 7.7	90 ± 12.4
15	Basal	(after 10 min)	120 ± 9.8	85 ± 9.3	35 ± 6.1	97 ± 9.0	79 ± 5.7
	Passive Standing	0 min	114 ± 11.2	87 ± 8.5	28 ± 8.3	96 ± 8.6	98 ± 14.2
		5 min	112 ± 10.0	88 ± 9.9	24 ± 7.9	96 ± 9.2	97 ± 16.7
30	Basal	(after 10 mnin)	121 ± 8.6	85 ± 8.8	35 ± 4.7	97 ± 8.5	77 ± 9.5
	Passive Standing	0 min	116 ± 11.3	87 ± 10.6	29 ± 5.8	96 ± 10.4	97 ± 8.5
		5 min	119 ± 9.2	88 ± 11.5	23 ± 7.5	96 ± 10.2	98 ± 12.4

Table V : Blood Pressure and heart rate air crew (n = 6)

Days At HA	Parameters		SBP (mm Hg)	DBP (mm Hg)	PP (mm Hg)	MAP (mm Hg)	HR (beats / min)
	Basal	(after 10 min)	120 + 6.0	75 ± 2.9	45 ± 8.5	90 ± 1.4	73 ± 8.7
0	Passive Standing	0 min	116 ± 5.1	78 ± 3.2	39 ± 7.5	91 + 1.6	81 + 10.2
		5 min	114 ± 7.1	77 + 3.8	37 - 9.0	89 + 2.9	87 + 5.6
	Basal	(after 10 min)	112 ± 2.0	76 + 2.0	36 - 4.0	88 + 10.7	70 ± 10.0
3	Passive Standing	0 min	105 + 5.0	77 = 3.0	28 ± 2.0	86 ± 3.87	83 ± 7.0
		5 min	101 + 1.0	77 ± 3.0	24 ± 2.0	85 ± 2.3	85 + 7.04
	Basal	(after 10 min)	118 ± 5.1	78 ± 6.1	41 + 5.9	91 + 5.0	70 ± 5.9
7	Passive Standing	0 min	108 + /- 14.4	79 + 8.3	29 + 10.6	89 ± 9.5	88 ± 5.6
		5 min	109 + 14.6	79 ± 7.7	30 ± 10.7	89 ± 9.2	81 + 6.7
	Basal	(after 10 min)	115 + 8.1	73 ± 5.4	43 ± 8.6	87 ± 12.8	75 - 8.9
15	Passive Standing	0 min	110 = 12.5	78 ±4.8	32 = 12.2	88 + 5.9	99 ± 7.7
		5 min	112 ± 14.2	77 + 6.1	36 + 12.8	89 ± 7.5	93 ± 6.8
	Basal	(after 10 min)	114 ± 3.0	70 + 5.5	44 ± 7.6	85 ± 3.2	77 = 8.7
30	Passive Standing	0 min	112 ± 9.2	72 + 4.6	40 ± 12.1	85 ± 3.1	100 - 6.8
		5 min	118 = 15.3	76 ± 3.9	41 ± 14.7	90 + 6.3	94 ± 8.2

and PCV showed a similar trend as Hb in both the groups. The D-30 readings when compared with D-0 were not found to be significantly higher.

Discussion

In this study the process of acclimatisation in ground crew and helicopter aircrew on induction to HA was compared. The rationale of such a strategy was to see the effects of intermittent 100% SOB on cardiovascular functions during acclimatisation. Echocardiography studies, orthostatic tolerance and haemogram were done on D-0, D-3, D-15, and D-30. The D-0 readings were taken upto 24 hours after arrival at HA. Physical characteristics of the two groups of subjects showed statistically significant difference in terms of higher height, weight and BSA for aircrew. This is expected as minimum acceptable standards for aircrew are higher than for ground crew and the former generally belong to a higher socio-economic status. This difference was taken into consideration while analysing the results.

On induction to HA, cardiac output increases then starts declining. With the process of acclimatisation Hb rises [6]. Hoon [8] and Sims [9] found that on arrival of low landers at HA, cardiac output (CO) starts falling till D-3 and there is secondary fall on D-10. Increase in CO on exposure to

HA has also been observed by Fuico [10]. Hulgren [11] found that administration of 100% percent oxygen to acclimatised person did not change the cardiac output but the heart rate is found to decrease whereas Rotta [12] observed a decrease in HR as well as CO. But these studies were carried out in acclimatised subjects. The BSA of two groups were significantly different therefore the comparison was made between cardiac index (CI) which is CO per m^2 of BSA. Initial high CI and HR found in the aircrew group is expected on induction to HA [6]. However, it is difficult to explain the low CI in ground crew on induction. These findings are partly in agreement with the findings of Hoon [8]. In ground crew the low HR had shown a rise on D-3 and D-7 which explains the rise in the CO. Subsequently the changes in CO were of a similar pattern in both the groups. As expected HR in aircrew has shown a decreasing trend during the process of acclimatisation. Ground crew did show an insignificant rise from 71 to 77 bpm. Induction to HA increases sympathetic activity [3,13] hence EF is expected to increase. This was corroborated in the present study in that EF rose in both groups from D-0, to D-3 and later decreased by D-7. Thereafter the response in both the groups is similar. Due to hypoxic vasoconstriction of pulmonary vasculature on induction to HA there is development of PAH [2, 6, 14]. The response is reversible in the early stages when oxygen is administered but later only partially reversible due to pulmonary artery muscular hypertrophy [2,11]. PVFP as measured in echocardiography, will decrease as PAH develops due to increase in resistance of flow. The peak and mean velocity will similarly reduce due to the same reason. As the pulmonary artery pressure increases the difference between this pressure and right ventricular pressure narrows and this is reflected in lower mean and peak pressure gradient. The findings in both the groups of subjects are expected changes. Further any of these parameters on D - 30 when

Table VI : Haemogram Ground Crew (n = 11)

	Days at HA			
Parameters	0	7	15	30
Hb (g/dL)	14.4 ± 0.88	15.2 ± 0.79	15.6 ± 1.14	16.2 ± 1.24
TRBC (% 100/cumm)	4.52 ± 0.33	4.66 ± 0.21	5.62 ± 0.65	5.12 ± 0.46
PCV (%)	43.7 ± 2.42	45.8 ± 2.40	47.0 ± 3.00	48.9 ± 4.14
Reticulocytes (%)	0.84 ± 0.59	1.20 ± 0.65	0.85 ± 0.74	0.55 ± 0.51
MCHC (%)	32.7 ± 0.62	31.4 ± 4.23	33.5 ± 0.30	34.0 ± 1.86
MCV (cu micron)	96.5 ± 5.58	97.8 ± 5.07	84.0 ± 7.48	95.4 ± 8.61
MCH (pcg)	31.7 ± 1.81	32.4 ± 1.85	28.2 ± 1.64	31.2 ± 1.84

Table VII : Haemogram Ground Crew (n = 6)

	Days at HA			
Parameters	0	7	15	30
Hb (g/dL)	16.0 ± 1.21	16.2 ± 1.02	16.8 ± 1.15	16.8 ± 1.40
TRBC (% 100/cumm)	5.37 ± 0.79	5.40 ± 0.49	5.46 ± 0.68	5.46 ± 0.60
PCV (%)	48.7 ± 3.39	49.7 ± 2.30	51.2 ± 3.71	51.2 ± 4.12
Reticulocytes (%)	0.37 ± 0.05	0.40 ± 0.02	0.42 ± 0.09	0.46 ± 0.10
MCHC (%)	32.8 ± 1.34	32.8 ± 0.80	32.8 ± 0.75	32 ± 0.98
MCV (cu micron)	93.2 ± 9.94	93.2 ± 8.20	94.6 ± 9.02	92.2 ± 4.26
MCH (pcg)	30.3 ± 2.21	30.6 ± 2.21	31.0 ± 2.61	30.6 ± 1.20

compared with D-0 values did not show any significant difference. It could thus be inferred that SOB had not altered these cardiovascular functions in aircrew.

Due to the orthostatic stress at HA, Systolic Blood Pressure SBP tends to fall as a result of poor peripheral vasoconstriction effect caused by hypocapnia [10,13,15,16]. Though there is sympathetic overactivity on exposure to HA, its effect is over shadowed by hypocapnia as far as orthostatic response is concerned [13]. The findings in this study are in line with findings of Malhotra and Selvamurthy [13] who also have found decrease in orthostatic tolerance during the first week which had improved during subsequent weeks. In ground crew during the first week on D-0 the HR increased by 11 bpm immediately after stress but later on the rise in HR on orthostatic stress was to the extent of 17 to 20 bpm. This indicates that orthostatic response was impaired on D-0 but subsequently improved. This is further substantiated by a fall of SBP by 8 mm of Hg after 5 minute stress on D-0. Further in this group two subjects had decompensation in the form of pre syncope during the first week but on subsequent examination these subjects did not reveal any such symptoms indicating improvement in orthostatic tolerance. In case of aircrew also a similar response in respect of HR increase on orthostatic stress was observed. There is rise in the mean value of HR as acclimatisation progressed. The orthostatic tolerance thus has improved in both the groups with the process of acclimatisation which show that supplemental O_2 breathing has probably not had any effect on this aspect of acclimatisation also.

On exposure to HA there is increase of Hb at rate of 1 gm per week and stimulus for this rise is considered to be hypoxia. Complete hematological adaptation takes about 12 weeks [2,6,17,18]. Since aircrew belong to higher socio-economic group and are better nourished their Hb was found to be significantly higher than ground crew. Over a period of 30 days aircrew had shown rise of only 0.8 g/dl where as in ground crew increase in Hb by 1.8 g/dl I was recorded. After 15 days of induction no rise in Hb, TRBC and haematocrit was noticed in aircrew. Though the changes were not significant there has been a definitive trend which is different in ground crew and aircrew. These results indicate that rise of Hb and TRBC may have been affected by supplemental O_2 breathing. To draw a definite conclusion these aspects of acclimatisation will need further studies on similar lines.

From the literature reviewed it was realised that changes in cardiovascular system occurs immediately on exposure to HA [2, 6, 19]. Since in this study the readings were taken upto 24 hrs after induction to HA and are included in D-0 values, these may not have represented the true sea level values. We hope that others would take up the threads and try to replicate our experiment with base line values recorded at sea level. Most of the published studies have compared one group vs another. Wolthuis [20] has studied individual variability of the biological system. This was beyond the scope of this study and only group response was studied. It is suggested that individual data may be analysed to see the individual variability during acclimatisation process.

Conclusion

It can be concluded that during the process of acclimatisation there is a universal development of PAH. Orthostatic tolerance is found to be low during first week of induction in both the groups but does show improvement subsequently. Cardiovascular parameters and haemogram do not show any significant changes in both groups when compared between D-0 and D-30 in either group. Haemoglobin, TRBC and haematocrit did show an increasing trend throughout the period of study in ground crew but did not show any rise, even after 15 days of induction, in aircrew. Apparently intermittent oxygen breathing did not have an adverse effect on the process of acclimatisation as far as cardiovascular functions and orthostatic tolerance is concerned. However, the expected rise in haematocrit in case of aircrew seems to be affected adversely and may have long term effects on the process of acclimatisation in aircrew.

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