EEG Studies in Pilots Flying High Performance Aircraft

BY -

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Abstract

Electroencephalographic studies were carried out on some 583 pilots who reported to the Institute of Aviation Medicine, Indian Air Force for their assessment of fitness to fly High Performance Aircraft.

The standard International 10 - 20 system was followed in fixing electrodes for recording EEG during the studies. Electroencephalograms were recorded in the 8 channel and 16 channel EEG machines both during resting and provocative conditions.

The findings have been discussed.

Introduction :

The value of electroencephalographic studies as a clinical aid and as a research tool is well known. In some of the Air Forces of the world EEG study is also used for aircrew and astronaut selection. [3, 4, 5 & 8] Thorner and Gibbs[9] have justified this use, stating. that proper function of the cerebral cortex is necessary for competence in aviation and since the electroencephalogram Is an indicator of cortical function, it might be supposed that it could be used to indicate fitness of candidates for flying instructions. EEG screening helps in the detection of latent and potential epileptics. EEG studies are also carried out at the Institute of Aviation Medicine in the case of pilots who are required to fly High Performance aircraft.

A pilot declared fit for flying high performance aircraft in Dec. '69 was subsequently invalided out of service on account of Epilepsy (Grand mal type of seizures) in Nov. '71. He had been flying a high performance aircraft for sometime before he got the epileptic attack.

This episode necessitated carrying out a retrospective study and analysis of the EEGs recorded for these types of pilots, the object being to learn lessons, if any. The paper under review has been processed out of such recorded EEG data.

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Materials and Methods:

A total of 583 pilots from among those who reported to our Institute for their assessment of fitness to fly high performance aircraft were randomly selected for this study. These pilots were all healthy and recommended for flying the high performance aircraft. They were subjected to a thorough general and systemic examinations by specialists of various disciplines. In addition, several other investigations were carried out, as per regulations, and their results were also within normal limits. EEG recording was also carried out on them as a routine procedure. The recordings were carried out an hour after a good breakfast. They were also advised not to have late nights and also not to take alcohol or drugs, prior to EEG recording.

Most EEGs were recorded in a 16 channel EEG machine (Grass Model 6), with the subject lying in a recumbent position on a comfortable couch in the EEG recording room. Some of the earlier EEGs were recorded in another 8 channel EEG machine (Grass Model 6). The International 10 - 20 system was followed in the placement of the electrodes on the scalp which was suitably prepared earlier for this occasion. 21 electrodes were placed on the head and 2 on each ear lobe. Bipolar and monopolar montages were selected for the EEG recording. Anteroposterior and transverse runs were taken in the bipolar montage.

Resting record for all the montages were taken for two minutes with visual stimulation. Thereafter routine activation procedures e.g. Hyperventilation and photic stimulation were undertaken. In the anteroposterior ipolar run, the subject was asked to hyperventilate for three minutes, and simultaneous EEG recording was done. The EEG recording continued for two minutes after the stoppage of hyperventilation. Proper hyperventilation technique was demonstrated to the subject by the EEG recordist before they were asked to hyperventilate.

Intermittent photic stimulation was routinely employed with varying flash flicker frequencies by the photic stimulator (Grass Model PS 2). The duration of each exposure to the flash flicker was 5 - 6 seconds. The subjects were asked to keep their eyes open at this time.

Total EEG recording time was about 25 to 35 minutes in each subject.

In the borderline cases, the EEG recordings were repeated and if necessary, some of the special activation procedures e.g. ocular and carotid compression, hypoxia, sleep deprivation, sleep, I. V. methahexitone etc further resorted to, for arriving at some conclusion. In our centre, we have stopped using Megimide and Metrazol as activating agents owing to the possible undesirable effect on the subjects.

The recorded EEGs were all subjected to a visual examination by more than one person as per standard technique and the results were then analysed. As per the

interpretation of the electroencephalograms, the records were classified as NORMAL, BORDERLINE and ABNORMAL.

The criteria of evaluation followed are as under e.g. :—

(a) **Normal**

Dominant alpha rythm posteriorly with no "excess" slow or fast activity. No asymmetry. No local or paroxysmal abnormalities.

(b) **Borderline**

Dominant alpha with slight excess Theta and Minor asymmetries. No clear local or paroxysmal abnormalities.

(c) **Abnormal**

Excess or dominant theta and delta rhythm. Distinct asymmetry., local or paroxysmal abnormality.

The age groups of the subjects are shown in Table I :

TAELE I

Age in years	No. of subjects	%
20 - 24	260	45%
25 - 29	222	38%
30 - 34	48	8%
35 - 39	42	7%
40 – 44	11	2%
Total	583	100%

This table shows the preponderance of the two age groups of 20 to 24 years and 25 to 29 years. This finding is understandable, considering the fact that younger age group is usually recommended and encouraged to fly high performance aircraft.

The service period of the subjects is shown in Table II :—

TABLE II

Total Service in years	No. of Subjects	%
1 - 5	300	67%
6 - 10	100	17%
11 - 15	54	9%
16 - 20	34	6%
21 - 25	5	1%
Total	583	100%

It is seen that the earlier service groups of 6 to 10 and 1 - 5 years constitute the majority of subjects. This is explained by the fact that the younger pilots have naturally less years of service and it is they who report for flying high performance aircraft.

Results :

The numbers of normal, borderline and abnormal EEGs are shown in Table III :—

TABLE III

	Normal	Borderline	Abnormal	Total
No. of subjects	389	118	76	583
Percentage	67%	20%	13%	100%

The figures of the borderline EEGs are somewhat higher probably due to our cautious and strict approach in assessing the EEGs of these particular category of pilots.

The relationship between the abnormal EEG and age group is shown in Table IV :-

TABLE IV

Age Group in years	20 - 24	25 - 29	30 - 34	35 - 39	40 – 44	Total
Nos. of abnormal EEGs	25	35	4	10	2	76

It is seen that the subjects from the two age groups of 20 to 24 and 25 to 29 show the maximum incidence of abnormality in their EEGs. It is also to be noted that a large percentage of our subjects belong to these age groups.

TABLE

Age group in years	Observed number of		Total
	Abnormal EEG	Normal EEG	
20 – 24	25	235	260
25 - 29	36	187	222
*30 - 44	16	85	101
Total	76	506	583

* Pooled to obtain a larger number for calculation of x^2.

Chisquare test was applied to find out whether the incidence of abnormal EEG occurs equally proportional in all the 3 age groups. The value of x^2 obtained (=4.95) falls short of the table value of x^2 (=5.99) at P = 0.05, in order to be significant. This shows age does not influence the distribution pattern of EEG abnormality.

The types of the abnormal EEG finding are shown in Table V :—

TABLE V

Pattern of activities	Voltage	Focal			Diffuse			Paroxysmal		
		Low	Mode-rate	High	Low	Mode-rate	High	Low	Mode-rate	High
Theta		—	—	—	12	50	12	—	—	—
Delta	—	—	—	—	—	—	1	—	—	—
Spike & Waves	—	—	—	—	—	—	—	—	—	—
Sharp Waves	—	—	—	—	—	—	1	—	—	—
		In numbers			12	50	14	Total = 76		

This table shows that the majority of the abnormal EEG findings belong to the category of non-specific diffuse slow wave theta of medium voltage.

The relationship between the types of abnormal EEGs and the different age groups is shown in Table V ;—

TABLE VI

Pattern of Activities	Voltage	Age group (in years) 20 - 24	25 - 29	30 - 34	35 - 39	40 - 44	Type Total
Theta	Low	1.3	6.6	1.3	3.9	2.8	15.0
	Moderate	27.8	25.0	3.9	9.2	—	65.9
	High	3.9	11.7	—	—	—	15.6
Delta	High	—	1.3	—	—	—	1.3
Sharp waves	High	—	1.3	—	—	—	1.3
Age total (3)		33.0	45.9	5.2	13.1	2.8	100.0

This table shows that the subjects from the younger age groups have manifested an increased incidence of abnormality. However, subjects from the younger age group also constitute the majority. The main abnormality is seen as diffuse slow wave theta activities of medium voltage and non-specific nature. The incidence of high voltage slow waves are not much. The abnormality mainly consists of non-specific diffuse slow wave theta activity of moderate voltage The incidence of high voltage delta activity of the same type is less. High voltage delta activity sharp wave bursts are seen in one case each, No spike and or wave activity is seen. Neither focal or paroxysmal activities are seen. The incidence of borderline EEG is 20% and that of normal EEGs 67%. Most of the abnor malities were brought out during hyperventilation. Photic stimulation did not bring out any abnormalities These findings are understandable considering the physical and mental fitness of our population sample.

Discussion

Our findings in this study show that 13% of the EEG records are abnormal.

In a study of the EEGs of 1, 332 flying personnel Bennet[1] found the incidence of abnormalities to be 8%. O' Connor[6] in a study of 500 EEGs of RAF aircrew cadets found the incidence of abnormal EEGs to be 10%. Buchtal and Lennox[2] studied EEGs in 682 volunteers for Danish Air Force and found the incidence of abnormality to be of 20.5%. On elimination of cases with suggestive evidence of neurological disease, the incidence of abnormality dropped to 15.9%. Raboutet and Soussen's[7] study of 6,700 EEGs on flying personnel revealed the incidence of normal to be 80% borderline to be 17.5% abnormal to be 2.5%. Our findings conform in general to the works of these workers except that of Raboutet and Soussen. His criteria of abnormality was the finding of spike and or wave complex and very high voltage theta and delta activities in the posterior channals. We know that there are certain inherent difficulties in any comparative study e.g. varying criteria of abnormality in other series and age of subjects involved. So any comparison with other series becomes interesting but not necessarily conclusive.

The pilot mentioned earlier had shown high voltage theta activity, diffuse and non-specific in nature. His EEG was considered abnormal. However, as it was non-specific and diffuse in nature and also because of negative past and family histories, absence of abnormal findings clinically, he was declared fit. Also attempts to correlate non-specific EEG patterns with predisposition to epilepsy or syncope have thus far been fruitless[1]. Again such less diagnostic EEG abnormalities are also found in approximately 10-15% of the normal population[1] They cannot be considered specific for epilepsy nor as evidence of an epileptic diasthesis[1]. Picard states that the best pilots were those who had normal EEG tracings but Grey Waltea claims that certain specific mild abnormalities were uniformly found in successful Fleet Air Arm Pilots[1].

Taking into consideration all these factors, we feel our policy of the evaluation of EEG of the pilots is by and large correct. The only additional recommendation is to take cognisance, also of the EEG record, showing high voltage slow wave activities of diffuse and non-specific nature, in view of our recent experience. While it may be a counsel of perfection to ground all flying personnel with an EEG abnormality alone, it might be more prudent to ground them temporarily and repeat their EEGs at periodic intervals before arriving at a final decision

We do not recommend flying definitely if the subjects show

(a) Excess delta activity,

(b) definite and consistent asymmetry

(c) repetitive paroxysmal abnormality, especially spikes, sharp waves or spike and wave activity.

We also recommend recording of preselection electroencephalogram and also the development and use of EEG recording under inflight conditions to be more realistic.

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