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An Analysis of Non Specific ECG Abnormalities Amongst Indian Air Force Officers

N RATTAN

A retrospective study of ECG abnormalities amongst IAF Officers was undertaken. A total of 403 cases were studied. T wave abnormalities were the most common findings and they have a tendency to regress with exercise. Most of the abnormalities relate to inferior wall. T and ST abnormalities are statistically related to an increased risk to develop IHD. Non specific ECG abnormalities could be early indicators of myocardial ischaemia. A systematic approach to cardiovascular evaluation of an individual with ECG abnormality is recommended.

Introduction

Ischaemic Heart Disease (IHD) is today one of the most important causes of morbidity amongst the non infectious group of diseases. It is well established that IHD has reached epidemic proportions in the developed countries and even in developing countries like ours the disease is becoming increasingly prevalent.

The reported incidence of IHD in Indian Air Force (IAF) officers between 1964 to 1968 was 1.49 per thousand, this increased to 2.87 per thousand in 1971-1974 period. In 1981 the annual incidence of IHD was 3.44 per thousand[1, 2].

Occult Coronary Artery Disease (CAD) can prove to be hazardous in a flying environment which is replete with physical, physiological and psychological stresses. While actual fatal aircraft accidents due to pilot incapacitation in the air due to IHD are rare, incidents are not uncommon.[2] In a recent USAF report on sudden incapacitation in the air between 1970-1980, 146 cases were known to have occurred, out of which 5 cases were of suspected Myocardial Infarction (MI)[3]. Recently an IAF helicopter pilot aged 35 years on completion of a sortie landed back and about 15 minutes thereafter collapsed and died of MI. Reports from member nations of ICAO mention that one or two pilots each year suffer from complete incapacitation in flight due to CAD, though the accident rate is less due to other aircrew[4]. However, CAD may not be the only cardiac condition which could lead to sudden incapacitation while flying ; Disorders of cardiac rhythm and structural abnormalities of the

Sqn. Ldr. N. Rattan, Dip. Av. Med. Graded Specialist
Air Force Station. Halwara.

heart can be aggravated to a serious degree on exposure to aviation stress. We stand to lose expensive aircraft and even more so, highly trained and experienced aircrew.

It is towards the detection of Occult CAD as well as other cardiac conditions that relatively healthy and pre-selected Air Force Population are subjected to routine periodic electro-cardiographic screening as a part of their medical examination. A normal ECG by no means excludes heart disease in all cases. Patients with extensive coronary artery disease may have a normal or slightly abnormal basal record. However, patients with significant narrowing (50-70%) of coronary arteries may have a normal basal ECG but reveal ischaemic changes on subjecting them to stress[5]. Such screening electrocardiograms in asymptomatic individuals often reveal abnormalities from which a firm diagnosis of CAD cannot be made. This is especially true for non specific ST segment and T wave changes.

Unexplained abnormalities of the resting electrocardiogram frequently lead to the erroneous clinical diagnosis of CAD[6]. There are certain physiological causes of ECG abnormalities as misplaced electrodes, physiological elevation of ST segment, post prandial alterations in T waves, anxiety, persistence of juvenile patterns, Hyperventilation, ST/T changes related to ethnic groups[7]. Certain other cardiac conditions that can possibly result in exercise induced abnormal ST segment depression without the presence of CAD are Valvular heart disease, Congenital Heart Disease, Pericardial disorders, Drugs like Digitalis, electrolyte abnormalities, Anaemia, Hypertension, Mitral Valve Prolapse, Pre-Excitation syndromes, Vasoregulatory abnormalities. Left ventricular hypertrophy with Strain and Bundle Branch Block[8].

Non Ischaemic degenerative and inflammatory diseases of the heart may also mimic ECG changes of ischaemic origin.

In those cases of unresolved ECG abnormality, after exclusion of all possible non ischaemic cardiac causes, the diagnosis of "Non Specific ECG Abnormality" (ECG) is given. Such cases with asymptomatic borderline abnormalities are presently being subjected to extensive cardiological evaluation mainly non-invasive in nature, which includes Echocardiography, Ambulatory Monitoring, Biotelemetery, Treadmil Stress Testing and Stress Testing (DMT) under Hypoxic environment. In spite of such elaborate investigations at times the diagnosis remains unresolved. Such cases are kept under long term surveillance as a particular record may not be conclusive but a changing pattern may unfold over subsequent reviews.

There is thus considerable ambiguity associated with the diagnosis of "Non Specific ECG Abnormality". Pilots stand to lose their flying status. On the other hand interests of flight safety are paramount. Further, the early diagnosis of the disease would help in the institution of preventive treatment and control in associated risk factors with the long term aim of improving the quality of life in such patients.

It is toward resolving some of the problems associated with ECG abnormalities that this retrospective study amongst IAF officers has been undertaken. The aims of the study were to establish :

a) The common abnormalities observed.
b) The relationship of risk factors to these ECG abnormalities.
c) The incidence of ECG abnormality in different leads.
d) To examine if ECG improves, deteriorates or remains stationary over a period of time and finally :
e) To determine whether these abnormaiities do predispose to the development of IHD.

Materials & Methods

ECG reports of 403 cases were studied. The period covered was 1978 to 1983. Data was collected for all cases bearing the diagnosis of Myocardial Infarction (MI)/Acute Coronary Insufficiency/Angina Pectoris/Asymptomatic IHD/Silent MI/ECG abnormality (ECG Abn). The data included Service No, Branch, Type of Aircraft flown, No. of flying hours,

date of first ECG in service and its result, age and date at the time of first detection of the ECG abn, associated Risk factors and significant clinical findings. The risk factors were Obesity, smoking, Hypertension, Diabetes Mellitus/Impaired Glucose tolerance (IGT)/Hypercholesterolaemia more than 225mgm% and Family History of IHD. The ECG findings were recorded leadwise in the initial and final profile. The initial profile comprised of the findings of the first recorded abnormal ECG and the follow up included all the normal and abnormal ECG findings at all the subsequent reviews till Oct '83. Abnormal Axis Deviations, if present and abnormal segment and wave changes for each lead were recorded for resting, DMT, Stress and Hypoxia test whenever applicable and information was available. The quantum of change and also nature of change was also recorded whenever the data was available in the case records. The data and diagnosis was based on the observations of the examining physician as recorded in the case documents. It is noted that ECG's are reported in adequate detail in the individual Medical Case Sheets and Medical Board proceedings. However, whenever documentary reports warranted check and clarification, original tracings/reports were studied. The initial and final category, duration of follow up, final diagnosis, time to final diagnosis, time to permanent category, final outcome and the results of special investigations, if any were also recorded for each case. For the purpose of comparison, in the follow up, one ECG record of resting, DMT and Stress test respectively was taken which had a bearing on the final diagnosis.

The data thus collected was collated and analysed.

Results

The 403 cases studied were divided into two main groups. The Test group and the IHD group (Table-I).

TABLE I

Distribution of Test and IHD Group Cases

	Aircrew (No. of cases)	Ground Duties
ECG Abnormality	151	129
IHD Symptomatic and Silent MI Cases	26	97
Total	177	226

The Test group comprised of 280 cases and was subdivided as follows (Table-II) :

a) Which were initially diagnosed as ECG abn and remained as ECG abn (Sub group 'A')

b) Which were initially diagnosed as IHD and were subsequently cleared as ECG abn cases (Sub group 'B').

c) Those case of ECG abn which were diagnosed as asymptomatic IHD based on ECG evidence of exercise induced myocardial ischaemia (Sub group 'C').

d) Those cases of ECG abn who at a later stage developed asymptomatic IHD (Sub group 'D').

e) Those cases of ECG abnormalities who were subsequently detected to have developed Valvular Heart Disease (Sub group 'E').

TABLE II

Distribution of Test Group Cases

A	ECG Abn	ECG Abn	=200 cases
B	IHD	ECG Abn	
C.	ECG Abn	IHD Asymptomatic	=55 cases
D.	ECG Abn	IHD Symptomatic	=17 cases
E.	ECG Abn	Valvular Heart Disease	=8 cases

The IHD group comprised of 123 cases. These cases had no ECG abn but subsequently developed Symptomatic IHD. This group also includes those

cases who had unequivocal ECG evidence of MI : The Silent MI cases.

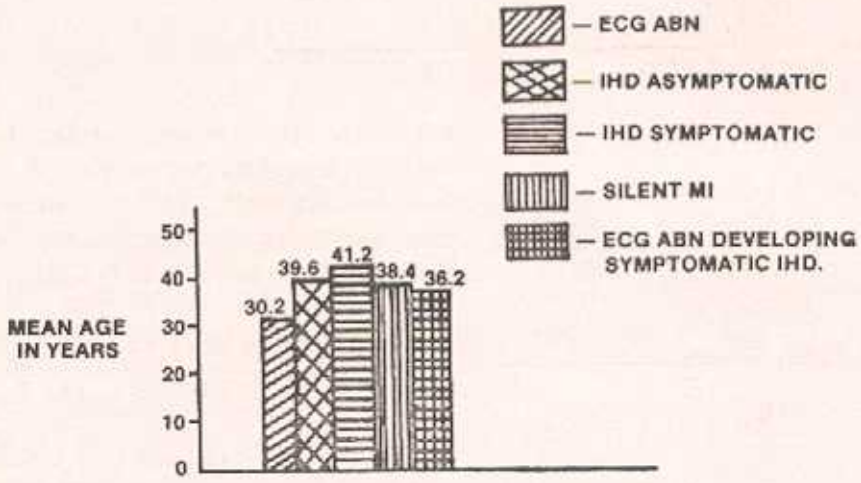
There was no specific distiction observed between aircrew and ground duties officers in the test and IHD group except in the age distribution, Ground duty officers both in the test and IHD group are affected at a higher age group than aircrew probably ECGs are more frequently taken in aircrew and at a younger age than in ground duty officers.

Age distribution amongst test and IHD groups is as shown in Fig. 1.

ECG abn to develop symptomatic and asymptomation IHD was not found to be statistically significant.

Amongst ECG abn cases it is seen that percentage abnormalities on initial and follow up ECG's (Resting and DMI) decrease over the follow up period (Figure-3) 159/200 (79.5%) had abnormalities in the resting ECG initially and 129/200 (04.5%) had abnormalities in the follow up (mean follow up period in these cases was 4.7 yrs). This reduction in abnormality on resting ECG was found to be statistically significant ($P<0.05$).

AGE DISTRIBUTION AMONGST TEST AND IHD GROUPS IS AS SHOWN IN FIG — 1



It is seen that ECG abn cases occur more in the younger age group. The remaining cases of IHD are more frequently observed in the middle age group when IHD is most expected.

The percentage of cases with risk factors in the test and IHD groups is similar and around 50% (Figure 2). The association of risk factors with

Similarly, 129/178 (72.4%) ECGs after DMT were abnormal initially and on follow up 75/200 (37.5%) ECG were abnormal. This reduction in abnormalities after DMT was found to be statistically significant.

The abnormalities noticed on initial Resting and DMT ECGs on the ECG abn cases are listed below :

Fig.2 - Frequency of Risk Factors

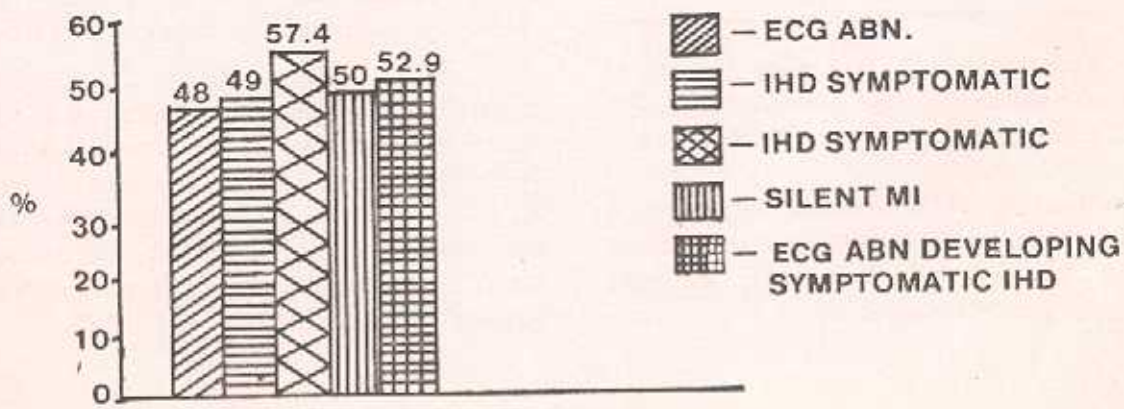


FIG — 3 PERCENTAGE OF ABNORMALITIES ON INITIAL AND FOLLOW UP ECG — RESTING AND DMT.

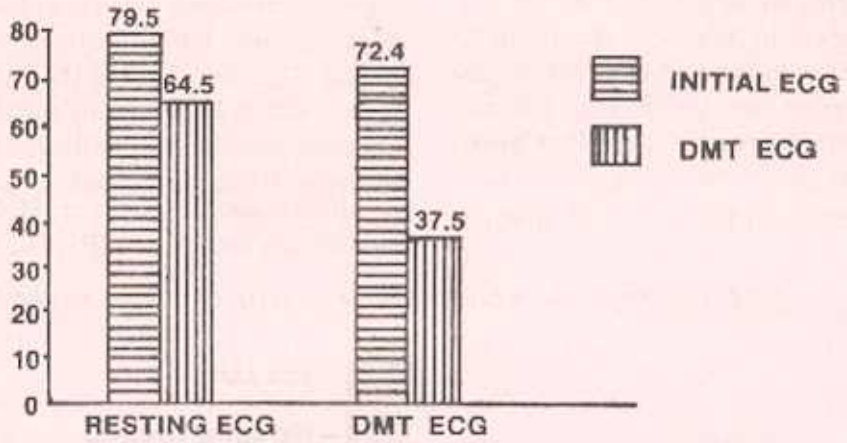


TABLE III

Abnormalities Observed in ECG Abn Cases

	Initial Resting (n=200)	Initial DMT (n—178)
Abnormal Axis Deviation	9	—
P Wave changes	4	—
P-R Inverval Prolonged	2	—
Q Wave Present	2	—
J Depression	1	6
ST Segment Changes	14	61
T Wave changes	93	48
U Wave present	—	2
Premature Beats	10	12
Conduction Defects	19	—
Pre-Excitation Syndromes	8	—
Normal	38	49

T-wave abnormalities by far were the most common abnormalities observed in the initial resting ECG and ST changes were more in the DMT ECG.

It is seen that there is a decrease in incidence of T wave abnormalities on DMT which was found to be statistically significant (P=<0.01). However there is a significant increase in ST segment abnormality. This brings out the fact that DMT is useful in evaluting non specific T wave abnormalities reducing their incidence while more ST segment anomalies, as expected, are brought out and these are more specific in the diagnosis of IHD.

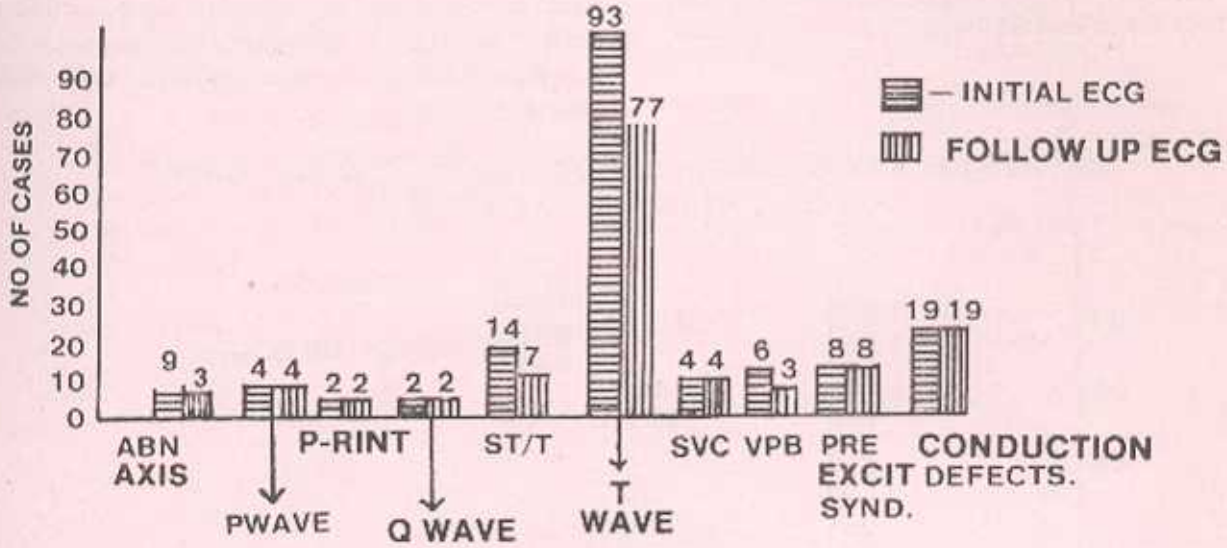
The changes observed on initial and follow up Resting ECG is presented in Fig. 4.

From Fig. 4 it is seen that 93/200 (46.6%) cases had T wave abnormalities these regress to 77.200 (39 5%) over the years. This regression was not found to be statisticdally significant.

Fig. 5 shows the nature of T changes observed in various lead groups initially in the follow up. It is noted that initillay the T changes were of a similar nature in the various leads constituting lead groups but on follow up the T wave was variable in the same leads of a lead group probably signifying the benign nature of T changes in these cses.

Amongst the 55 cases diagnosed as IHD asymptomatic (based on positive Treadmill Stress Tests) 34/55 (61.8%) cases had T changes en initial resting ECG. The number of T wave abnormality cases not developing asymptomatic IHD were 77/200 (38.5%). The significance of T wave abnormality to develop IHD asymptomotic is P<0.05.

Fig.4 - Changes observed on Initial and Follow UP Resting ECG - ECG Abn Cases

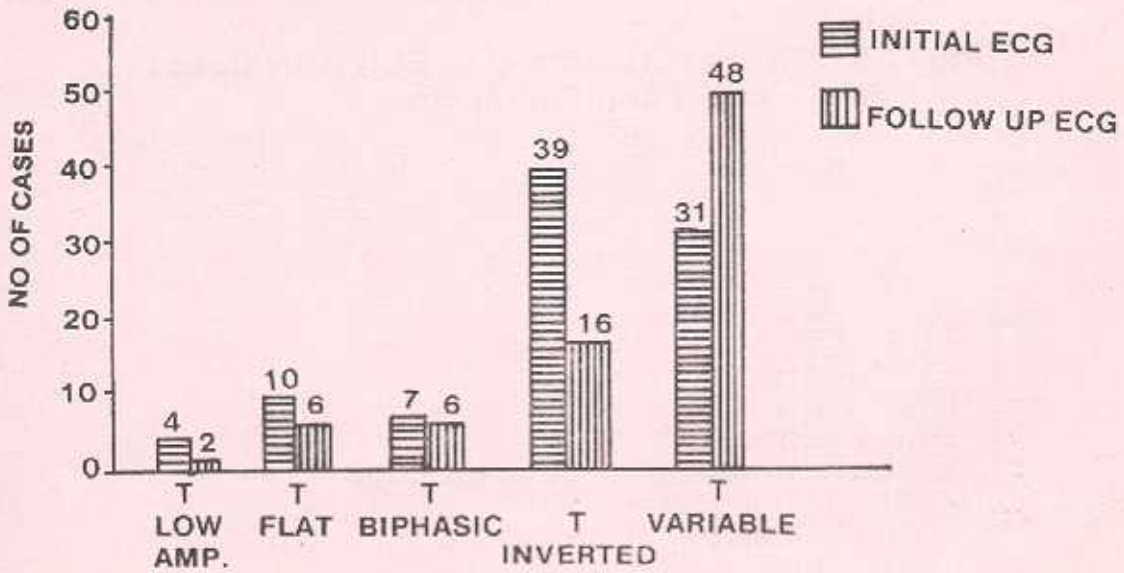


T Wave abnormalities and the Resting ECG :

Of the ECG abn cases which subsequently developed Symptomatic IHD, 11/17 (76.5%) cases who did not develop IHD but had T wave abnormality. The significance of T wave abnormality to develop IHD symptomatic is $P<0.05$.

4 cases of ECG abn with non specific T changes were later detected to have Valvular Heart Disease (MPV) when echo cardiography was done on them.

Fig.5 - Nature of T changes observed in initial and Follow up Resting ECG

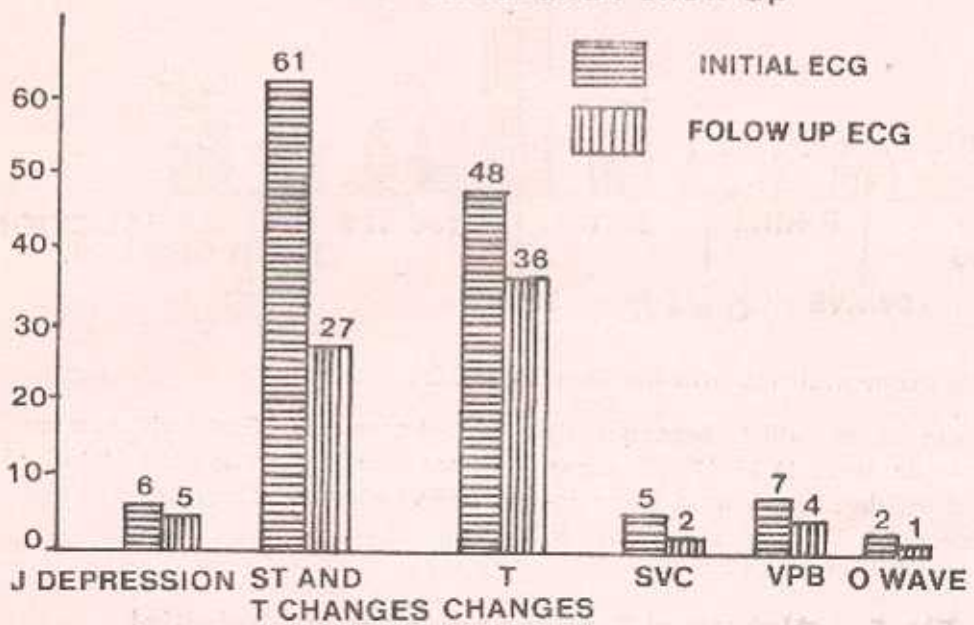


ST Segment changes on DMT

When data pertaining to DMT ECGs was analysed further 45/178 (25%) cases had ST depression of more than 0.5 mm but in the follow up only 16/200 (8%) cases had ST depression of more than 0 5 mm.

The number of cases with ST depression of more than 0.5 mm in those cases who developed assmptomatic IHD were 20/35 (57.1%) and the number of cases who had ST depresion of equal magnitude and did not develop asymptomatic IHD ard 39/178 (21.9%). The statistical significance of ST depression of 0.5 mm to develop asymptomatic IHD is $P<0.05$.

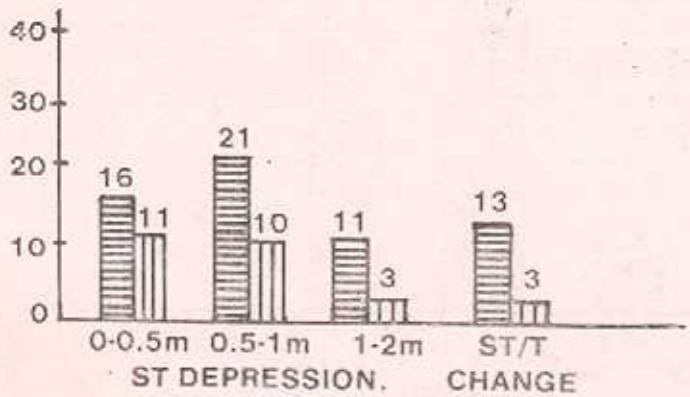
Fig.6. - ECG changes observed in ECG Abn Cases on DMT - Initial and Follow Up



There is thus significant reduction in ST segment changes as present on DMT over a period of time.

Further 8/12 (66.6%) cases of ECG abn who developed symptomatic IHD 5/17 did not undergo DMT initially) had ST depression on DMT between

Fig. 7 ST Changes Observed in ECG ABN Cases on DMT - Initial and Follow Up



0.5-1 mm as compared to 39/178 (21.9%) cases of ECG Abn with ST depression of equal magnitude on DMT but did not develop. The statistical significacent of ST depression between 0.5-1 mm to develop IHD is highly significant.

Other abnormalities like conduction defects and pre-excitation syndromes tend to remain static over a period of time. ECG Abn cases having ventricular premature beats were also not significantly associated with the development of symptomatic and asymptomatic IHD. However, 2 cases of ventricular pre-mature beats present initially were subsequently diagnosed as asymptomatic IHD on the basis of post extrasystolic ST depression.

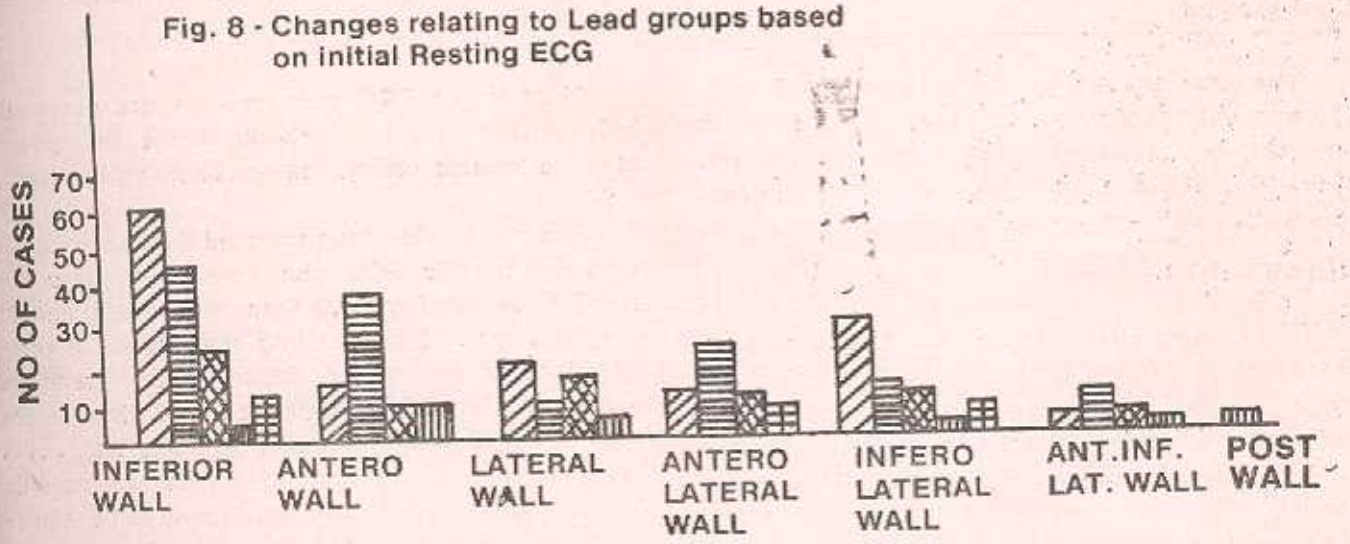
When the ECG changes were analysed lead group wise it was seen that the inferior leads were most commonly involved, Inferolateral and lateral wall were the next most commonly involved. In the IHD group also there were more cases of inferior wall MI as well as other changes relating to the Inferior wall. However, the next most commonly involved wall is the anterior wall.

(23.5%) underwent Treadmill test of which 2/4 (50%) were abnormal. Among the IHD group 63/123 (51.2%) cases underwent Treadmill Stress Testing and 42/63 (66.6%) cases were abnormal. Thus 36/162 (21.6%) cases of ECG Abn had abnormal Stress test compared to 42/63 (66.6%). IHD cases who had abnormal Stress test.

Hypoxia test results in the various groups show that in the ECG Abn group 8/32 (25%) were abnormal. In sub group 'C' 16/23 (69.6%) were abnormal and in sub group 'D' 2/4 (50%) cases showed borderline abnormalities. In the IHD group 11/36 (30/5%) cases had an abnormal hypoxia test.

The averaged duration of follow up in aircrew with ECG abn was 4.0 years, range 6 months to 14 years, 108/118 (91.5%) cases of ECG abn were allowed to resume flying duties. 83.8% cases were reflighted within a period of 2 years. In case of ground duties officers the average period of follow up was 5.4 years (range 3 months-15 yrs). 81.7% ground duty officers were restored to full ground category or category higher than A4 G3. Finality

Fig. 8 - Changes relating to Lead groups based on initial Resting ECG



116/200 (56%) cases of ECG abnormality underwent Treadmill Stress testing and 7/1116 (6%) were abnormal. In the IHD asymptomatic group 42/55 cases had stress tests and 26/42 (61%) were abnormal consistant with the diagnosis. In the group of ECG abn cases who developed IHD 4/17 cases

wars reached within 2 years in 65.2% cases and 2-4 years in 17.8% cases, Thus it can be seen that 87.5% of all cases with ECG Abn were restored flying category and higher ground category (higher than A4 G3). While from earlier data it is seen that 64.5% resting ECGs and 37.5% DMT ECGs still

remained abnormal, but were considered by the examining physician to be non specific these cases were cleared on the basis of normal Stress tests.

The average duration of follow up of aircrew cases with IHD asymptomatic is 8.7 years (with a range of 1 to 20 years). The mean follow time for such cases in ground duty officer was 8.4 years, (range 1-18 years). The mean time to final diagnosis was 3.36 years in aircrew officers and 1.8 years in ground duty officers. All aircrew cases except one were grounded.

Amongst the cases of ECG abn who developed symptomatic IHD the age distribution was as given in table IV.

Table IV

Age distribution of ECG Abn Cases who developed symptomatic IHD (No. of cases)

Age in year	21-25	26-30	31-35	36-40	41-45	46-50	51-55
At time of Initial ECG	2	3	4	3	2	2	1
At time of Cardiac event	—	1	2	3	5	3	3

The mean age at time of first detection of ECG abn was 36.6 years with a range of 22 to 53 years and mean age at time of cardiac event was 40.6 yrs, range 29 to 54 yrs. The Mean time to cardiac event was 6.2 yrs with a range of 3 months to 13 yrs.

DISCUSSION

The Resting ECG is being used as a screening procedure for CAD in almost all the Air Forces of the World. It is an inexpensive easily accomplished and sensitive test for detecting latent CAD. These ECGs which are periodically taken, often reveal certain borderline abnormalities which are, in the absence of any other causative factor labelled non specific.

In this study amongst ECG abn cases 'T' wave abnormality was found to be the most common. Similar findings are also reported from earlier studies elsewhere 9, 10, 11.

In the present study, of the 280 cases of ECG abn which were studied, the incidence of abnormalities was found to be more in the younger age group (30-40 yrs). While in the IHD group the cases were mainly in the age group above 40 yrs.

As regards influence of risk factors it is seen that the Test and IHD groups had more or less similar percentage of risk factors which was not statistically significant.

There is general regression of abnormalities (except conduction defects and pre-excitation syndromes). This is significant and justifies the follow up that is presently advocted in such cases and corelates well with an earlier such study in the IAF 13.

It is seen that T wave abnormalities tend to regress with exercice. Smith et al have advocated the use of graduated exercise over a period of time to assess the validity of the T changes. He feels that these T changes may be associated with hypokinetic Heart disease, in which exercise by increasing myocardial blood supply would rectify these abnormalities[14].

Most of the EGG abnormalities are observed in leads relating to Inferior wall. In the IHD group also the Inferior wall was most commonly involved.

Various studies have revealed that those cases with non specific ECG abn have 3 to 10 times the risk of developing CAD than those with normal results[15], [16], [17]. Stress testing may detect a compromised coronary circulation. The predictive value of routine ECG is enhanced 3-7 times more than subjects with a negative exercise test. This study has brought out that cases with non specific T wave abnormalities have been found to be statistically more prone to develop IHD. Further DMT, in the setting of ECG abn, is a useful test in evaluating non specific T changes, in that, these changes have been found to regress after exercise in the benign cases and the same time if significant ST depression is noted there apapers to be an increased risk to develop IHD

CONCLUSION

From the foregoing. it is seen that ECG abnormality appears at a younger age group than IHD some abnormalties particularly T and ST abnormalties may regress over a period of time. T wave abnormalties have a tendency to regress with exercise. Most of the abnormalties relate to the inferior wall and it is seen that IHD is also more commonly present in the inferior wall. T and ST abnormalties are statisticalls related to an increased risk to develop IHD. Thus, it appears that non specific ECG Abn could be early indicators of myocardial ischaemia and they are not all that innocuous. On the other hand they certainly do not appear to represnt a significant degree of CAD being present in an individual. Such cases need to be asseessed from all aspects with special references to history, associated coronary risk factors. clinical findings, effort tolerance and the response to various Stress tests. The use of certain non invasive techniques like echocardiography may help in certain cases, as has been brought out in this study that 4 cases of ECG abn were diagnosed as Mitral valve prolapse which might have otherwise been labelled as IHD. A follow up of ECG Abn cases is considered necessary and if the abnormallity persists or deteriorates further tests are indicated and one may need to apply the "goid standard" of coronary arteriography in such cases.

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