Original Article

Retrospective study of coronary arteriogram in IAF personnel

Sqn Cdr BKU Kumar^s Gp Capt RR Kapur$^@$

158 coronary arteriogram (CART) reports of IAF personnel obtained during 1989-91 included Aircrew, Ground crew and Other Ranks with mean age of 46.02±5 yrs. These were studied for analyzing the arteries involved, in number, dominance and association of risk factors. 31% of the reports revealed normal CART. Abnormal ECG was associated with 81.6% of abnormal CART. With normal CART, only 63.2% had normal ECG. 93% of the individuals exhibiting inferior lead positivity were asymptomatic. A definite statistical correlation between smoking and abnormal CART was established (P < 0.01). Abnormal CART could not show positive correlation with any other coronary risk factor or positive family history of the latter. Single vessel disease (SVD) was present in 33% of aircrew and 31% of ground crew. Double vessel disease (DVD) was present in 48% of aircrew and 31% in ground crew. There was dominant involvement of right coronary artery (83%) over the left coronary artery (17%). Diffuse lesions were present in 21%. None of the aircrew had shown the involvement of left main coronary artery possibly due to better regular screening of the pilots.

Keywords: CART, aircrew fitness, coronary risk factors, coronary dominance.

Coronary arteriography is the ultimate invasive investigation in detecting coronary artery disease. Coronary artery disease forms one of the major causes of morbidity and mortality. Defence personnel are no exception to this. Almost 50 to 60% of flying personnel in US Air Force lose their flying status because of cardiovascular disabilities [1].

Military aviation personnel are at risk for sudden death not only because of this hazardous profession but also because of coronary artery disease. CAD is an insidious process whose mortality figures multiply more than a hundred fold from 25-50 years of age. Myocardial infarction has been causally implicated in less than 0.05% of military aircraft accident fatalities, as the recognised phenomenon of inflight incapacitation. The incidence of coronary arterial lesions in autopsied flight personnel [2-4], and the special consideration of life and property in the military aviation continue to make cardiac evaluation of a pilot more than a casual exercise.

Exercise stress testing is a very important tool in evaluating ECG abnormalities and in patients with typical and atypical chest pain. Exercise

stress testing is also a mandatory requirement in case of Air Force personnel above the age of 40 years during annual medical examinations [5].

Coronary arteriography has been accepted as a standard for evaluating the diagnostic accuracy of exercise stress test. This permits almost immediate confirmation or rejection of the diagnosis provided by the exercise test. Additionally the outcome is directly applicable to the management of the subject being studied.

Exercise stress testing has got poor diagnostic ability in the presence of repolarisation abnormalities. [6]

Coronary arteriography facilities have been extended to service personnel and families through private hospitals in the country. This not only involves cost for the state but also individual risk for the patient, who is exposed to this invasive procedure.

Material and Methods

Coronary arteriogram (CART) reports accumulated over a period of three years (1989-91) at Air HQ RK Puram, constituted material for this study. These CARTs were opined by the Cardiologists of respective hospitals. Artery involved, number and dominance of the artery, and risk factors were also analysed.

An attempt is made to analyse all the available coronary arteriogram reports and correlate with ECG and risk factors. Detailed analysis of the coronary arteriogram is also included in this study.

Indication for CART

This could be because of previous Myocardial Infarction, positive stress test, preexisting valvular heart disease or cardiomyopathies.

Site and type of lesion

CART was analysed to know the type of lesion, whether focal or diffuse and site of involvement proximal or distal segment.

Artery involved and number

Involvement of left or right coronary artery and their named branches namely Left Circumflex (LCx), Left anterior descending (LAD), Obtuse marginal (OM), Septal (S) were specifically noted. Angiograms were also screened for single, double or triple vessel disease.

Dominance of the artery

Left or right coronary system dominance was also noted. After analysing the CART report, individuals' AFMSF-1 were thoroughly screened for pre existing cardiovascular disorder and type of ECG abnormality. It also provided a source for analysing the risk factors in each case. Risk factors were taken as contributable when they satisfied the following criteria. These criteria were derived from that opined by Stamler and Lillifield [7]: -

(a) *Smoking:* It was taken as risk factor when the individual smoked more than one packet (10 cigarettes) per day.

(b) *Hypercholestremia:* When cholesterol level exceeded more than 250 mg/dl. Lipid profile was not taken for this study because of non availability of lipid profile in every case.

(c) *Diabetes Mellitus:* Diabetes with or without medication was also taken as risk factor for analysis.

(d) *Hypertension:* Almost all cases who had hypertension with or without medication were found to be of primary hypertension which was also taken as risk factor. Level of blood pressure was taken to be hypertensive if recordings of blood pressure exceeded 140/90 mm Hg.

(e) *Family History:* Family history of IHD (Ischemic Heart Disease), Hypertension and Diabetes Mellitus was considered as a risk factor.

(f) *Obesity:* Individuals with more than 20% of the ideal weight were considered to have this as one of the risk factors.

Clinical analysis of individuals

Clinically, individuals were classified into four groups namely Asymptomatic, with Angina, with Atypical chest pain and Infarction. Definition of these cases were as follows [5]: -

(a) *Asymptomatic:* This group consisted of individuals who were evaluated for abnormal electrocardiograms, new murmurs, or miscellaneous conditions.

(b) *Angina Pectoris:* Group of patients with substernal discomfort associated with activity relieved by rest or nitroglycerine.

(c) *Atypical chest pain:* This group consisted of those patients with chest pain either unrelated to activity, unrelieved by nitroglycerine at rest or apparently non cardiac in origin because pain did not fit the description of angina pectoris.

(d) *Post Myocardial Infarction:* Prior infarction was documented by appropriate historical and enzymatic or ECG evidence.

Stress test analysis

Stress test reports were scrutinised thoroughly which were present in the AFMSF-1 or medical history. Their positivity was noted in various leads such as inferior, lateral, anterior and combination of the leads.

Observations

A total of 158 CART reports from 158 serving personnel were analysed in this study. Their distribution is given in Table 1.

Table 1: Distribution of Subjects (n=158)

Aircrew	51
Groundcrew	
- Officers	52
- Other Ranks	55
Total	158

Age distribution of service personnel versus CART reports is depicted in Table 2.

Mean age of service personnel was 46.02±5 years. Out of 158 service personnel who underwent CART, 49 were found to have normal CART (31%). Distribution of Aircrew and Ground crew

14

in terms of normal and abnormal CART is given in Table 3.

Table 2: Age distribution of individuals

	Age	NormalCART	AbnormalCART	Total
1	30-34	4	3	7
2	35-39	6	2	8
3	40-44	9	15	24
4	45-49	24	54	78
5	50-54	6	32	38
6	55-60	-	3	3
	Total	49	109	158

Table 3: Comparison of aircrew and groundcrew

	Distribution	Normal CART	Abnormal CART	Total
1	Aircrew	24	27	51
2	Ground Crew-Offrs	15	37	52
3	Other Ranks	10	45	55
	Total	49	109	158

All individuals were classified in four clinical groups namely Asymptomatic, With Angina, With atypical chest pain and With infarction. Distribution of the same is given in Table 4.

32.9% of individuals, who underwent CART were asymptomatic, 34.3% individuals had Myocardial Infarction, 19.6% had Angina and 13.3% atypical chest pain. A higher percentage of aircrew - 47% (24 out of 51) - were asymptomatic as compared to the ground crew 26% (28 out of 107). Myocardial Infarction was more prevalent among the ground crew 44% (49 out of 107) as compared to aircrew where it was only 9% (5 out of 51).

NYHA Classification and CART

NYHA classification of individuals with abnormal CART is depicted in Table-5.

Table 5: NYHA classification of individuals with abnormal CART

		Aircrew	Groundcrew
1.	NYHA CL I	24	72
2.	NYHA CL II	03	10

There were only 13 individuals in CL II NYHA and all of them had abnormal CART. There was no significant difference between aircrew and groundcrew.

On correlating CART with ECG, 63.2% of individuals with normal CART had resting ECG normal and 36.8% had abnormal ECG. In case of abnormal CART, abnormal resting ECG was seen in 81.6% and normal ECG was found in only 18.3%. (Table 6).

On analysing type of resting ECG abnormality

Table 4

		Normal CART		Abnormal CART		% of total
		Aircrew	Groundcrew	Aircrew	Groundcrew	
1.	Asymptomatic	21	22	03	06	32.9
2.	Angina	02	02	10	17	19.6
3.	Atypical chest pain	01	01	09	10	13.3
4.	Infarction	-	-	05	49	34.2

in individuals with normal CART, 20% had T wave abnormalities, ST changes were present in 6% and an equal percentage had Right bundle branch block. Other abnormalities of ECG included a sinus bradycardia in one aircrew and Hypertrophic obstructive cardiomyopathy with Left ventricular hypertrophy in one ground crew with normal CART. In case of individuals with abnormal CART the commonest resting ECG abnormality was infarction pattern and was seen in 67% (60 out of 89). T wave changes were seen in 16.8% (18 out of 107). Their distribution is given in Table 7.

Response to ECG stress testing

All except four individuals were subjected to CART on the basis of their stress test response, which was considered positive. Four individuals did not undergo Tread mill testing because of poor left ventricular function. Exercise stress testing of all individuals had either horizontal or downsloping ST depression 80 msec after J point.

Response was more than 1mm downsloping and more than 2mm horizontal, which is considered strongly positive for coronary artery disease. However there was 31% false positivity of response and was again divided into positivity in various leads. ST depression had occurred during the test in most of the cases, and before 5 min of recovery in rest of the cases. The distribution is given in Table 8.

Isolated inferior lead positivity was seen in 83.3% (20 out of 24) of individuals who had normal CART in contrast to inferior lead positivity in only 8.5% (9 out of 105) of individuals with abnormal CART. Positive response in combination of leads was seen in only one individual with normal CART. Another finding was that 93% (47 out of 51) of individuals, who showed inferior lead positivity were asymptomatic.

Analysis of the above data using Chi square test showed no correlation between inferior lead positivity and normal CART. Calculated value was much greater than observed values hence the response is independent.

Table 6: Correlation of CART with ECG

		Normal CART		% of	Abnormal CART		% of
		Aircrew	Groundcrew	Total	Aircrew	Groundcrew	Total
1.	Normal ECG	16	15	63.3	11	09	18.3
2.	Abnormal ECG	08	10	36.7	16	73	81.6

Table 7: Abnormal ECG Versus CART

		Normal CART		Abnormal CART	
		Aircrew	Groundcrew	Aircrew	Groundcrew
1.	T-wave changes	05	05	03	15
2.	ST changes	01	02	02	07
3.	RBBB	01	02	-	01
4.	LBBB	-	-	01	-
5.	Infarction	-	-	10	50
6.	Others	01	01	-	-
	Total	08	10	16	73

Table 8: Response of exercise stress test as positivity

		Normal CART		Abnormal CART	
		Aircrew	Groundcrew	Aircrew	Groundcrew
1.	Inferior lead	20	18	03	06
2.	Lateral lead	02	02	06	34
3.	Anterior lead	01	05	10	09
4.	Combination	01	-	08	29
	Total	24	25	27	78

Table 9: Coronary risk factors and CART

		Normal CART		% of	Abnormal CART		% of
		Aircrew	Groundcrew	Total	Aircrew	Groundcrew	Total
1.	Smoking	13	12	30	17	58	68
2.	Hypertension	01	08	18	04	23	23
3.	Hypercholestrolemia	03	02	10	08	27	26
4.	Diabetes	02	-	04	03	17	18
5.	Obesity	05	03	16	05	07	11
6.	F/H/O DM IHD, HT	01		02	02	03	04
7.	Combination of Risk factors	05	04	18	08	37	41

The distribution of risk factors such as smoking, hypercholestremia, diabetes, hypertension, and obesity and family history of IHD, diabetes, hypertension is given in Table-9.

Definite statistical correlation (p < 0.01) in case of smoking and hypercholestrolemia and abnormal CART has been established. Smoking is the commonest of all the risk factors and was present in 61% of those who underwent CART. Prevalence of smoking was 58% among those who had abnormal CART compared to 30% who had normal CART. Next commonest risk factor was hypercholestrolemia, which was present in 26% with abnormal CART compared to 10% with those people, who had normal CART. There was no definite statistical relation established in case of obesity and in individuals with family history of IHD, diabetes and hypertension. This could be because of small sample size. There was no attributable risk factor in 205 individuals with normal CART. However all the individuals with abnormal CART had one or more risk factors.

Table 10: CART reports: Distribution of coronary lesions arterywise

1.	LMCA	-	0.3%	5.	OM1	-	11%
2.	LAD	-	72%	6.	OM2	-	06%
3.	LCX	-	41%	7.	OM3	-	04%
4.	RCA	-	65%	8.	S1	-	03%

On analysis of abnormal CART reports, the involvement of arteries depicted in Table-10. Left anterior artery was most frequently involved (72%). Next commonest artery was right coronary artery (65%). Ramus intermedius was present in only three individuals out of whom two had stenosis more than 50%.

Table 11: CART reports: Details of coronary lesions - arterywise

	Single vessel disease			Double vessel disease			Triple vessel disease	Left main
	LAD	LCX	RCA	LAD-LCX	LAD-RCA	LCX-RCA	LAD-LCX-RCA	coronary artery
Aircrew	03	02	04	04	05	04	05	-
Gr Crew	17	04	05	07	15	04	24	06

On analysis of CART in case of Aircrew and ground-crew for single and double vessel disease it was found that single vessel disease was present in 33% of aircrew and 31% of ground crew. Double vessel disease was seen in 48% aircrew compared to 31% groundcrew. Triple vessel disease was found in 18% of aircrew and 29% ground crew. Left main coronary artery was involved in none of aircrew and 7% of ground crew. This is depicted in table-11.

Dominance of coronary artery

Right artery dominance was seen in 83% and 17% had left coronary artery dominance.

In individuals with abnormal CART 79% had focal lesions and diffuse lesions were present in 21%. Diffuse lesions were present in individuals with hypertension and hypercholestrolemia.

Discussion

It is seen from our retrospective study that aircrew are evaluated with CART more frequently as compared to ground crew. This is due to the basic requirement of flight safety and potential hazard of sudden incapacitation amongst aircrew with ECG abnormality.

On persual of clinical findings from the records it was observed that high percentage of asymptomatic individuals (32.9%) and post MI patients underwent CART (34.2%). Aircrew were mostly asymptomatic and most of the ground crew had a positive history of MI. Most common resting ECG abnormality associated with CART evaluations was T wave and ST segment abnormalities. Nearly 27% of individuals with normal CART had ST and T wave abnormalities.

It requires proper interpretation of Exercise ECG in cases with ST segment and T wave changes as these tend to get exaggerated during exercise. ST segment and T wave changes can lead to false positive stress tests [3]. Exercise stress testing is known to be positive in individuals with Right Bundle Branch Block even in the absence of Angiographically demonstrable disease [9].

Response to stress testing in our study gave a very high percentage of false positive (31%) results. These figures vary from study to study as also in a single study. Predictive value of positive stress testing in asymptomatic individuals was 61% compared to 14.3% of Bukendrof [10] and the predictive value of positive exercise stress testing for MI cases was 100% and is similar in other studies.

Response to stress testing in various leads has given an insight that inferior lead positivity is most commonly associated with normal CART. Although this finding is not statistically significant it would be probable that in these cases there might be associated other disorders such as mitral valve proplapse and electrolyte disturbances which are subclinical. It is also seen that subclinical mitral valve prolapse usually gives rise to ECG abnormality and positivity on stress

testing [10]. Another probable reason can be that abnormality of inferior wall which is supplied by right coronary artery might exist in these individuals.

It is established that Exercise tests are the best available non traumatic method for detecting myocardial ischemia and for coronary artery disease. The occurrence of myocardial ischemia during exercise stress testing can occur in number of other conditions besides coronary artery disease. True incidence of false positive stress test in asymptomatic individuals has not been established in any study.

On analysis of various risk factors it was found that smoking was the most common risk factor constituting 61% of individuals who underwent CART, which is consistent with the findings of Rath et. al [11]. Hypercholestrolemia was the next common risk factor, which was seen in 26% compared to 19% of Patton and Vogal [7]. Smoking is the commonest risk factor in our study group in contrast to obesity in US military population.

Analysis of CART revealed 31% as normal studies. This could be because of the following reasons: -

(a) Observer variability as CART was done at different private hospitals and opined by different cardiologists.

(b) Coronary spasm may be present in individuals who subsequently failed to show any abnormality of coronary arteries.

Observer variability can be overcome by establishing a CART library so that all CART reports are opined by a single experienced Service Cardiologist.

Even though CART is a traumatic procedure and there are reported complications, our study does not reveal any complication because of the procedure itself. This reflects the safety of the technique.

Left Anterior Descending Artery was the most frequent artery to be involved in our study group. This can be explained by the fact that 40-60% heart muscle receives its blood supply from LAD. This correlates with the findings of other studies [7].

References

1. Mc Granaham GM Jr et al. Minimal coronary artery disease and continuation of flying status. *Aviat Space Environ Med.* 1983;54:548-551
2. Rayman RB, Mc Naughton. Sudden incapacitation: USAF Experience 1970-1980. *Aviat Space Environ Med.* 1983;54(2):161-164.
3. Schienman HZ. Coronary atherosclerosis in Military Pilots: Relation to flying and aviation accidents. *Clinical Aviation and Aero Space Medicine.* 1968;39:1348-51.
4. Pettyjohn FS, MacMeenkin RR. Coronary artery disease and preventive Cardiology in Aviation Medicine. *Aviat Space Environ Med* 1975;46:1299-1304.
5. Indian Air Force. Manual of medical examination and medical board. IAP-4303. 2nd ed. New Delhi. 1987.
6. Linhart JW, Turnoff HB. Maximal treadmill exercise test in patients with abnormal control electrocardiograms. *Circulation.* 1974;49:667-73.
7. Patton JF, Vogel A. Prevalence of coronary heart disease risk factors in a young military population. *Aviat Space Environ Med.* 1980;51(5):510-4.
8. Goldschlager N, Selzer A, Cohn K. Treadmill stress test as indicators of presence and severity of coronary artery disease. *Ann Int Med.* 1976;85:277.
9. Frolicher VF, Thompson, Wolthersons R. Cardiac cathetrisation of asymptomatic aircrewmen. *Am J Cardiol.* 1976;38:812-20.
10. Bukendorf W, Warren SE, Vieweg WVR. Suspected coronary artery disease among military aviation personnel. *Aviat Space Environ Med.* 1980;51(10): 1153-8.
11. Rath PK, Krishnamurthy S, Padmakumar P, Dave SH.Risk from risk factors in Coronary artery disease. *Ind Heart J.* 1985;37(4):222.