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ABSTRACT

Masters' two step exercise test (DMT) forms the mainstay in the field screening of the cardiovascular status of personnel in the Indian Air Force. Of late, owing to the availability of better techniques, most of the Cardiologists consider it totally out dated, mainly because of inadequate workload, poor sensitivity and specificity and also the blind nature of the procedure. Some of the common causes of poor post-exercise heart rate (PEHR) response in DMT are known. Even by removing these errors, the PEHR is considered inadequate. Hence, the next best option is to augment the workload by increasing the quantum of the exercise to an extent where the Heart Rate (HR) response is adequate yet within safer limits. These augmented steps were worked out to be 18-25 % over and above the steps laid down in the standard DMT protocol. A Total of 132 apparently healthy Air Force Personnel were subjected to the augmented exercise protocol who revealed a mean PEHR of 138 bpm against the resting HR of 72 bpm, with a 91 % rise. The post exercise ECG revealed a total of 4 inducible ischaemia. AH these cases tested positive on Treadmill Test (TMT) also. All the subjects could complete the test in the prescribed time without any symptom of myocardial ischaemia. This paper brings out the need for an effective and safe revised DMT exercise test protocol that could be more relevant to the process of field screening for inducible myocardial ischaemia.

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KEYWORDS: DMT, Augmented DMT, Post exercise heart rate, PEHR, Cardiac screening, Cardiac workload.

Masters' two step exercise test, also known as DMT, forms the mainstay in the field screening of the cardiovascular status of apparently healthy personnel in Indian Air Force. It is an age old technique to evaluate, and to some extent, predict the inducible myocardial ischaemia. It has been a widely used method of exercise testing in the yester years. However, it has lately gone out of utility mainly because of the availability of better facilities like cycle ergometer, Treadmill Test (TMT) and Stress Thallium. **These days, most of the cardiologists consider the DMT as totally out dated because of inadequate**

workload (and hence heart rate response), poor sensitivity and specificity and also the blind nature of the procedure. Whereas the TMT has an objective end point and online ECG monitoring of all 12 leads, DMT has no such provision. Some of the common causes of poor post-exercise heart rate (PEHR) response in DMT are as follows [1] :-

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- (a) Inadequate number of trips specified in Masters' chart.
- (b) Long delay of 40-60 sec in recording the 0 - minute tracing after completing the exercise. It should be <30 sec.
- (c) Baseline shift of post-exercise ECG complex due to respiratory excursion / poor lead contact thus causing time delay.
- (d) Poor technique of recording, delay in connecting leads after exercise.
- (e) Individuals with high vagal tone or occasional patient on B-blocker.

The quantum of exercise specified in DMT has number of trips to be performed in a period of 3 minutes. In a retrospective study undertaken at a premier Institute, a randomly picked ECG (Resting and DMT) showed a mean 0 - min PEHR Of 94 bpm (SD 22 bpm) against the resting HR 76 bpm (SD 14 bpm), although an occasional individual achieved approx 90% of the Predicted Heart Rate (PHR) of the Bruce Protocol. It undoubtedly was an inadequate HR response [1]. Since the DMT is a blind protocol without any on-line monitoring, safety factor for not exposing the individual to unduly high workload but yet achieving a reasonable PEHR response is paramount. Some authors consider a PEHR>120 bpm as a satisfactory response as it corresponds to approx 6.5 METs of work (end of stage II Bruce) which has at least some acceptable value of diagnostic significance in exercise testing [2]. This value may not be adequate for a person whose resting HR is > 100 bpm.

Aim

The aim of this study is to lay down the exercise protocol of an augmented exercise of an order where the PEHR response is adequate.

Methods

The subjects for the study were Air Force (AF) Personnel at Air Force Station, Bidar reporting for their routine ECGs from the period Jun 1999 to Dec 2001. This included all officers reporting for annual medical examination and personnel with obesity or non-specific resting ECG abnormalities for further investigation. Otherwise, the subjects were not found to have any clinical abnormality

The study was undertaken in 3 phases spread over 2.5 years.

(a) First Phase: It consisted of correcting the common causes of poor PEHR response as mentioned in Para (b) to (e) above. The first tracing (of the so-called 0-min) was started within 10 seconds by providing additional technician.

(b) Second Phase: It consisted of a trial and error method of gradually increasing the number of trips (steps) from 10% to 25% over and above the standard steps, till the minimum 0-min PEHR (recorded within 20 sec by a single technician) reached at least 50% above the resting rate or > 120 bpm.

(c) Third Phase: For the individuals <40 year, a 20 - 25% increase and for >40 year an increase of 12-20% workload was formulated to be the augmented DMT exercise test protocol (Table 1). The endpoint for the exercise was unchanged i.e. pain chest, giddiness, exhaustion, fatigue or dyspnoea. All individuals could complete the revised steps within 3 minutes without any symptoms.

The technique for augmented DMT exercise involved the standard preparation and the procedure except for the number of trips (steps) which were revised. Due precaution was taken to ensure that the individuals were not on cardioactive drugs, their resting BP did not exceed 140/90 mm of Hg and cardiac resuscitation equipment (including cardiac tray, oxygen and cardiac defibrillator with monitor) were readily available at the bed side.

Table-1 : No of Trips advocated in the augmented protocol (Fig in bracket shows the Masters' original standard trips)

Weight in Kg	30-34 Yrs	35-39 Yrs	40-44 Yrs	45-49 Yrs	50-54 Yrs	55-59 Yrs
50 - 54	62 (52)	60 (50)	58 (50)	56 (48)	54 (46)	52 (46)
54.5 - 58.5	62 (52)	60 (50)	56 (48)	54 (46)	52 (46)	50 (44)
59 - 63	60 (50)	58 (48)	54 (46)	54 (46)	52 (44)	50 (42)
63.5 - 67.5	58 (48)	56 (48)	54 (46)	52 (44)	50(42)	48 (40)
68 - 72	58 (48)	56 (46)	52(44)	50 (42)	48 (40)	46 (40)
72.5 - 76.5	56 (46)	54 (44)	50 (44)	48 (42)	46 (40)	44 (38)
77 - 81	56 (46)	54 (44)	50 (42)	48 (40)	44 (38)	40 (36)
81.5 - 86	54 (44)	52 (42)	46 (40)	44 (38)	42 (38)	40 (36)
86 - 90	52 (42)	50 (42)	46 (40)	44 (38)	40 (36)	38 (34)

Results

A total of 132 tests have been done with the augmented work-load protocol for apparently healthy Air Force Personnel ranging from 24 -57 years of age (mean 38 years). Some of them had risk factors of obesity, smoking, family history of IHD and resting non-specific ECG abnormalities. Resting and Post Exposure (PE) heart rate was 72 and 138 bpm, respectively exhibiting an overall 91 % rise over the resting rate. The mean Post Exercise HR was 75% of the Predicted Heart Rate (PHR) of the Bruce Protocol. Values of PEHR are shown in Table 2. None of the 132 subjects had any difficulty in completing the augmented exercise protocol, nor did any one of them have any symptoms warranting termination of the exercise. Even obese individuals (Grade IV Obesity) could complete the test.

Age group wise HR response is shown in Table-3, which reveals, by and large, a uniform pattern of percentage rise in PEHR ranging from 86 to 96%.

However, there were 21 individuals in the age group 26 to 40 who revealed HR response between 46 to 61 %. One aircrew aged 32 year had PEHR of 96 bpm (against resting HR of 86 bpm) repeated on two occasions. He subsequently cleared the TMT. Age wise distribution of the HR response is shown in Table-3.

Post-exercise abnormalities in the ECG are shown in Table-4. Non-specific abnormalities included mostly T-wave changes, ST depression not amounting to ischaemia and Sinus arrhythmia (upto 3 min PE). Of the 28 abnormal ECGs (including non specific changes), 7 were subjected to TMT by the cardiologist. Of these, all 4 cases with ST changes tested positive for inducible ischaemia (including 1 borderline case). Three of them having strongly positive test were subjected to CART, of which two showed evidence of Coronary artery disease. One was operated upon and the other one has been asked for periodic reviews with drugs and control of his risk factors (smoking, obesity) as he was unwilling for surgery at that time. The third, who revealed a normal

Table-2 HR response (n=132)

Post-Ex HR groups	No. of subjects	Resting Mean	Hr sd	Post-Ex Mean	Hr sd	% Rise in Hr
< 100	2	64	6	94	9	46
101-120	19	71	8	114	8	61
121-140	58	73	8	136	10	87
141-160	51	72	9	149	6	108
161-170	2	77	9	165	7	129
Total	132	72		138		91

Table-3 Age vis-a-vis HR response (n=132)

Age Group	No. of subjects	Resting Mean	HR sd	Post-Ex Mean	HR sd	% Rise in HR
18-25	7	73	11	143	14	96
26-30	22	70	12	138	12	95
31-35	26	73	8	140	12	92
36-40	31	73	10	138	9	88
41-45	19	72	10	138	16	92
46-50	21	71	11	137	13	94
51-55	6	74	12	138	12	86
Overall	132	72		138		91

CART, was cleared in full med cat. The borderline TMT positive case was advised a modified life style, drug and periodic reviews in low med cat.

Discussion

Screening of apparently healthy individuals for coronary artery diseases is a contentious issue with some opinion in favor but many against it [3,4,and 5]. For a cardiac screening test that could be undertaken at the

peripheral medical set up like Station Medicare Centre (SMC), procedures like TMT / Stress Thallium is impractical. On the other hand, DMT in the present form perhaps lacks the credibility owing to a very low sensitivity due to inadequate cardiac workload. There is no doubt that if the workload could be increased, it could prove to be a useful cardiac screening tool, but PEHR adequacy is a pre-requisite. Even the Target Heart rate (THR) of 85 % of the PHR has only 50% sensitivity [6]. To obtain an

Table-4
PEHR RISE vis-a-vis Post Ex ECG Abnormality (n=132)

Age Group	% rise in HR N		Post Ex ECG Abnormality		
			Non specific	ST > 2mm	Arrhythmias
18-25	96	7	Nil	Nil	Nil
26-30	95	22	01	Nil	Nil
31-35	92	26	01	Nil	01
36-40	88	31	07	01	02
41-45	92	19	05	Nil	Nil
46-50	94	21	05	02	Nil
51-55	86	6	02	01	Nil

adequate PEHR response, the precautionary measures as mentioned earlier, have proved inadequate. It is also a fact that the quantum of exercise (number of steps) advocated in the Masters' test in the 1920's was designed to be a simple exercise tolerance for general purpose (to screen out the CVS compromised individuals) to which the pre and post ECG was added several years later [7,8]. Hence, for it to succeed as a diagnostic screening test, the number of trips (steps) can always be increased that could increase the workload upon heart. Authors have even suggested achieving 100 % PHR or symptom limited exercise protocol for the Stress test. The increase in PEHR correlates so well with the oxygen consumption that oxygen uptake is not measured even under clinical practice [6], leave alone the screening of apparently healthy serving y personnel. Very fact that all subjects in the study could complete the augmented exercise protocol within 3 minutes achieving a mean PEHR of 75% of the PHR without any complications, the exercise module is considered very much feasible, adequately sensitive and within acceptable limits of safety.

Of the 132 tests with augmented workload, only seven cases showed post exercise ECG abnormalities including 4 post exercise ST changes and 3 post exercise arrhythmia. Of these seven, only 4 (all having ST changes) tested positive on TMT, 2 of them revealing CAD on CART. All cases of Post Exercise cardiac arrhythmia tested negative on TMT.

Conclusions

Masters' two step exercise test has inadequate cardiac workload resulting to poor sensitivity.

The trips (steps) advocated in the Masters' test designed originally to screening out circulatory inefficiency, are not sacrosanct. Revised augmented trips as given in Table-1, could impose an adequate workload that could yield a PEHR in the range 75 - 85% of the PHR, which is practical and a safe compromise.

Simplicity and economy of DMT with augmented workload could make it an effective cardiac

Augmented workload in DMT exercise: VN Jha

screening investigation at the peripheral medical set up for the service personnel.

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