

Evaluating mental stress test in coronary artery disease treadmill positive patients

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Abstrak

Evaluasi dari penyakit arteri koroner (PAK) lebih rutin dilakukan dengan uji treadmill (Treadmill test, TMT, i.e. beban fisik) daripada beban mental yang lebih sering terjadi. Oleh karena itu, direncanakan penelitian untuk mengukur kemungkinan terjadinya iskemi dengan berbagai tugas mental pada pasien dengan TMT positif. Tiga puluh penderita terpelajar dengan TMT positif dimonitor selama 24 jam. Dalam waktu tersebut, penderita diukur dengan uji mental (Mental stress test, MST) melalui berbagai tugas mental : a) uji beban waktu; b) uji beban mental dalam menghitung; c) uji baca; d) uji efek Zeigarnik disertai observasi kecepatan denyut jantung, tekanan darah dan respon iskemi/aritmi. Hasil penelitian menunjukkan bahwa rasio pria : wanita adalah 14 : 1 dengan umur rata-rata 57 ± 8.03 tahun. Selama MST, ditemukan perubahan dalam : a) kecepatan denyut jantung $9.16 (SD \pm 1.24)$ /menit; b) SBP $8.86 (SD \pm 1.32)$ mmHg; c) rate pressure product 82×10^3 yang secara statistik lebih rendah ($p < 0.001$) dibandingkan dengan perubahan hemodinamik pada TMT. Iskemia terinduksi pada hanya 1 penderita yang diuji dengan MST dan tidak ada peningkatan terjadinya aritmi selama dilakukan MST. Rendahnya induksi iskemi tersebut mungkin karena respon hemodinamik yang lemah yang dicapai MST bila dibandingkan dengan TMT ($p < 0.001$). Disimpulkan bahwa beban mental menghasilkan perubahan iskemik. Diperlukan MST yang lebih kuat dan berlangsung lama yang dapat menyebabkan perubahan hemodinamik untuk menginduksi iskemi seperti yang dihasilkan dengan TMT. (*Med J Indones 2002; 11: 36-40*)

Abstract

Evaluation of CAD is more routinely done by treadmill test (TMT i.e. physical strain) than the more frequently occurring mental strain, so a study was planned to assess the provocability of ischaemia by various mental tasks in patient with positive TMT. Thirty educated subjects, positive on TMT were put on a 24 hour holter monitoring. During this time, subjects were assessed by Mental Stress Test (MST) by subjecting to various mental tasks – (a) Time stress test (b) Mental arithmetic test (c) Reading test (d) Zeigarnik effect test and observed for heart rate, blood pressure and ischaemic/arrhythmia responses. The results showed that the male : female ratio was 14:1 with a mean age of 57 ± 8.03 years. The mean change produced during MST in (a) heart rate was $9.16 (SD \pm 1.24)$ /min (b) SBP was $8.86 (SD \pm 1.32)$ mmHg (c) rate pressure product was 82×10^3 ; which were statistically low ($p < 0.001$) when compared to haemodynamic changes with TMT. Ischaemia was inducible in only one subject by MST and no increased incidence of arrhythmias during MST was noticed. The low yield of inducible ischaemia by MST when compared to TMT could be due to poor haemodynamic responses achieved by MST when compared to responses of TMT ($p < 0.001$). It is concluded that mental stress does produce ischaemic changes. More intense and sustained MST's which could bring about significant haemodynamic changes are required for inducing ischaemia as by TMT. (*Med J Indones 2002; 11: 36-40*)

Keywords: coronary, ischaemia, mental task, stress test, treadmill

CAD has been of epidemic proportion (as per WHO) for past few decades.¹ Increased life expectancy of people of Indian subcontinent, following better control of infectious diseases, has been associated with higher incidence of CAD.² Increasing population

growth has led to even harder competition in day to day life for survival and success which has created a stressful existence for the people living here. People with Type-A personality under these circumstances may become more vulnerable to CAD.¹⁻³ Problem of stress is further compounded by emigration of highly motivated professionals from India to places, where they have little political power but a lot of stress to endure in order to succeed in a highly competitive environment, which may indeed put them at an added risk for CAD.³

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Not many studies in India have been attempted to study the impact of mental strain on ischaemic burden of the heart. This mental strain in day to day life might be more common than the physical strain (as is tested routinely with treadmill). So a study was planned to assess the provocability of ischaemia by various mental tasks in patient of positive exercise stress test.

METHODS

Thirty subjects (less than 75 years of age) were included in the present study. All subjects included were positive for provokable ischaemia on exercise treadmill test (defined as horizontal or downsloping ST depression >1 mm at 0.8 seconds after the J point). All these subjects were at least matriculate by educational qualification and were able to read, write and understand English. The subjects were detailed about the test and then after seeking the consent, subjects were hospitalized for 24 hours in department of Medicine, Pt. B.D. Sharma PGIMS, Rohtak.

Subjects having unstable angina, recent infarction (in 6 weeks), significant arrhythmia were excluded. Also were excluded those having bundle branch block, absence of normal sinus rhythm, left ventricular hypertrophy and WPW syndrome on electrocardiogram. No subject had significant congestive heart failure (ejection fraction $<35\%$) or valvular abnormality. Subjects having electrolyte disturbance or those on digoxin/antiarrhythmic drugs (Class I and III) were also excluded. No subjects had any visual or hearing defect or were having a history of mental disturbance in the past.

All subjects had routine biochemical/haematological tests done. All subjects had their 12 lead electrocardiogram, chest roentgenogram and echocardiogram (if indicated). All subjects selected (after excluding as per exclusion criteria) were then subjected to a 24 hour holter monitoring with the help of a Delta 3 channel holter cassette recorder by Advance Med Inc. USA. To ensure optimum quality, recorder head was cleaned before use and new batteries with new cassette were used for each recording. The subjects were asked to make all entries pertaining to the 24 hours activity during their holter monitoring. All subjects were requested to stop betablockers (48 hour prior) and calcium channel blocker/nitrates just before the start of the test. However, nitrates were given on as and when required basis during 24 hours observation.

The mental stress was planned in the morning hours between 9 to 11 am. The subjects refrained from food, caffeine and nicotine for at least two hours before initiation of mental stress testing. Each subject was then familiarised with the laboratory.

Subjects then were evaluated by Jenkin's Activity Survey to ascertain the personality type (A/B) based on the score.⁴ Subjects orientation to time and place were also duly ascertained before the start of mental stress test.

Each subject was detailed about various mental tasks. They were also told that they are being numerically evaluated by a score for each mental task so that the total score at the end of mental stress test would directly refer to their personality/intelligence/work aptitude. During the mental stress test, the subjects were introduced to various mental tasks each lasting for a fixed time. All subjects had their mental task given in the same order. Variables like pulse rate and blood pressure changes were made by using BP electronic (Cx5060020) apparatus at the start and end of each mental task. A rest period of 5 minutes was allowed between each task. The subjects were requested for fullest cooperation during various mental tasks and at any time if any symptoms were perceived, the subjects would narrate it to the examiner.

The mental tasks assigned were in the following order:

Time Stress test (TST)

A test done to judge vigilance and concentration of a subject, in which he was asked to complete standard 'letter cancellation task' within fixed five minutes.

Again the subject was asked to complete the above same task as quickly as possible but without fixed time-frame.

Mental Arithmetic test (MAT)

This test was used for standard cognitive mental challenge. Each subject was instructed to subtract 7's started from a four digit number for five minutes as quickly and as accurately as possible. He was periodically prompted to increase speed and accuracy.

This was followed by five minutes mathematical substitution exercise.

Reading Test (RT)

The first part of the test was used to assess physiological effect of impersonal speech. The subject was asked to read loudly the front page of the day's newspaper for five minutes.

After this, the subject was given 3 minutes to compose a honest but specific speech on a personal/emotional disturbing event while he was alone in the chamber. The subject was then asked to speak loudly on the same for at least five minutes.

Zeigarnik effect (ZE)

This task was used to induce a sense of incompleteness (tension in psychological field) due to uncalled interruptions. The subject was then administered a written questionnaire presented to him in two sets. Difficult and easy questions were interspread. The test was suddenly stopped and the subject was asked to perform the second set which was again terminated abruptly, however, the subject was instructed that the incomplete tasks would be taken for completion later on.

After the various mental task and at the end of 24 hours, the recording cassette was removed and subsequently scanned and analysed using D5000 3 channel computerised holter analysis system by Advance Med Inc. USA. Electrocardiographic ST segment depression was measured at 0.08 seconds from the J point and abnormal response was taken as ST segment depression (downsloping/horizontal) of >1 mm lasting at least 60 seconds.

All numerical variables of various mental tasks were compared to treadmill exercise results by using standard statistical analysis method (Student' t' test).

RESULTS

All subjects included in the study were positive on treadmill stress test (TMT).

Demographic Profile

The mean age of the study group was 57 (SD + 8.03) years with youngest being 42 years and oldest was 72 years (Table 1).

The male: female ratio of the study was 14:1 as there were twenty eight males and two females.

Table 1. Age distribution of the subjects

| Age in years | No. of Subjects | % |
|--------------|-----------------|----|
| 40 - 50 | 7 | 23 |
| 51 - 60 | 12 | 40 |
| 61 - 70 | 10 | 33 |
| 71 - 80 | 1 | 4 |

Personality type

The personality type of subject was measured by using Jenkins Activity Survey (JAS).⁴ Out of the thirty subjects, seventeen subjects (57%) had type A personality while thirteen subjects (43%) had type B personality.

Mental Stress Response

(a) Haemodynamic response

The mean change in heart rate was 9.16 (SD + 1.24)/minute while mean change in systolic blood pressure was 8.86 (SD + 1.32) mm of Hg. The details of the response are shown in table 2.

Table 2. Haemodynamic response of subjects during mental stress tests

| Mental Stress | Personality type | Change in HR beat/min | Change in SBP (mm of Hg) |
|---------------|------------------|-----------------------|--------------------------|
| MAT | A | 8.8 | 7.0 |
| | B | 9.8 | 8.9 |
| TST | A | 8.0 | 7.6 |
| | B | 11.9 | 10.4 |
| RT | A | 8.2 | 8.1 |
| | B | 8.6 | 9.1 |
| ZE | | 8.8 | 10.9 |
| Mean | | 9.16 ± 1.24 | 8.86 ± 1.32 |

(b) Ischaemic and arrhythmia profile

The evidence of arrhythmia or ST depression was slightly more (statistically significant, p-value <0.05) during 24 hours than during MST (Table 3).

Table 3. Arrhythmia and ST depression profile during 24 hours monitoring and during mental stress test

| Events | Number of Subjects | | p-value |
|--------------------------------------|--------------------|----------------------|---------|
| | During 24 hours | During Mental Stress | |
| Supraventricular ectopics | 29 | 18 | 0.05 |
| Ventricular premature beat | 22 | 12 | 0.05 |
| Ventricular ectopic pair | 5 | 1 | 0.05 |
| Ventricular tachycardia | 3 | 0 | NS |
| Quantity of pauses more than 2.5 sec | 3 | 0 | NS |
| ST depression | 5 | 1 | 0.05 |

TMT versus MST

Only one subject showed evidence of inducible ischaemia with MST when compared to all thirty subjects inducible for ischaemia with TMT (p-value <0.001). Table 4 shows that the haemodynamic changes induced with MST were significantly lower (p-value <0.001) when compared to the changes affected by TMT.

Table 4. Comparison of TMT and MST influence on ST depression and haemodynamic parameters

| Parameters | MST | TMT | p-value |
|---------------------------------|------|--------|---------|
| ST depression (no. of subjects) | 1 | 30 | 0.001 |
| Changes in | | | |
| Heart rate per minute | 9.16 | 39.4 | 0.001 |
| SBP mm of Hg | 8.86 | 26.4 | 0.001 |
| Rate pressure product | 82 | 1114.5 | 0.001 |

DISCUSSION

Coronary artery disease (CAD) of epidemic proportion is a major public health problem both in industrialized as well as in developing countries like India for past few decades.¹ In India, prevalence of CAD is higher in urban India than in rural India and among other causes, emotional stress/anxiety is one of the important cause of such difference of prevalence in rural/urban population.^{1,4-7} The present study has been done to know the effects of mental stress on CAD patients proved positive on treadmill stress test (TMT).

Out of thirty subjects, seventeen subjects (57%) were found to have type A while thirteen subjects (43%) were having type B personality as assessed by JAS.⁴ Type A individuals are more prone to CAD than the calmer and philosophical type B individuals.¹ However, more recent studies have shown equivocal or negative evidence about association between type-A personality and incidence of CAD.^{1,8-12}

Silent ischaemia was produced by MST in only one case in the present study which could be due to poor haemodynamic responses achieved when compared to the responses with TMT (p value <0.001). These observations are similar to the results of other study which favour physical stress as a better predictor for inducing ischaemia than mental stress.¹³⁻¹⁶ Further Guibbani et al studied the perfusion defects induced by mental and exercise stress tests using SESTAMIBI scintigraphy and found that the effect of mental stress is less severe than that produced by exercise.¹⁷

Ischaemic episodes on electrocardiogram induced by day to day stimuli or by mental stress test have been difficult to reproduce in a laboratory.¹⁸ Interestingly, radioisotope investigations have detected a high incidence of transient regional myocardial perfusion or wall motion abnormalities in patients with CAD undergoing mental stress test.¹⁹⁻²² It is possible that in the laboratory, mental stress induced ischaemic episodes are subtle and of shorter duration so are difficult to be detected by ECG than as detected by sensitive radionuclide ventriculography.²³ But physical exercise does produce sustained and intense episodes of ischaemia in the laboratory thus making it more reproducible on ECG (i.e. TMT).²³ The low ECG sensitivity on mental stress tests remains unexplained as whether an 'ischaemic threshold' plays some kind of role which may be related to less extensive or severe myocardial ischaemia induced by mental stress or because of any inadequacy of common ECG criteria used to interpret ischaemia.¹⁸

Our observation of poor sensitivity of ST depression during MST just support the fact that ECG ischaemia changes are too subtle to be detected. It may also be possible that MST ascribed in our protocol was too less intense and sustained to detect the desired change (if any) during mental stress in laboratory setting as has been the observation of other workers.^{13-18,23-25}

We conclude that further studies are needed so that the mental stress test ascribed in the protocols are more intense and sustained, in order to produce

significant pulse and blood pressure changes which would bring about inducible ischaemic changes as are produced by TMT.

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