Original Research Article

The result of treadmill test in asymptomatic type 2 diabetes mellitus

Anil Shrinivasrao Joshi*, Chandrakant Gunaji Lahane, Akshay Arvind Kashid

Department of Medicine, Govt. Medical College, Aurangabad, Maharashtra, India

*Correspondence:
Dr. Anil Shrinivasrao Joshi
E-mail: jyotianil.joshi71@gmail.com

ABSTRACT

Background: To study the prevalence of silent myocardial ischaemia in asymptomatic patients with type 2 DM.
Methods: The present study was conducted in the Govt. Medical College and Hospital Aurangabad. During December 2012 to November 2014 with 50 patients. It was two year cross sectional study with the patients of asymptomatic type 2 diabetes mellitus without clinical and electrocardiographic evidence of coronary artery disease.
Results: 12 (24%) out of 50 subjects had positive TMT. It correlated with years of duration of diabetes (9 positive TMT cases with duration of diabetes more than 10 years). 5 (25%) out of 20 had serum cholesterol levels >240, Number of positive TMT were higher in patients with LDL >160 [5 (25%) out of 20].
Conclusions: Diabetic patients are at very high risk for cardiovascular morbidity and mortality. Early detection of IHD is very important so that pharmacological therapy, which may improve outcome, can be established. Tread mill exercise TMT being a non-invasive test with high safety, has an important role in early detection of IHD. It is recommended that TMT should be a part of routine management in asymptomatic patients with type II DM.

Keywords: Type 2 DM, TMT, CHD, Bruce protocol

INTRODUCTION

Type 2 DM (DM) is the important disease of the modern society and along with coronary heart disease (CHD) represents serious health threat to the modern society. DM is also an important independent and modifiable risk factor for development of the coronary heart disease. Mortality related to cardiovascular disease is doubled in diabetic men and quadrupled in diabetic women over that in their non-diabetic counter parts.[1] Hyperglycaemia, a hallmark of diabetes correlates well with severity of micro vascular and macro vascular complications and improving hyperglycaemia reduces this risk.

The prevalence of CHD in India earlier varied from 15-65/1000 population, but now it has increased about 80-120/1000, making it a major cause of morbidity and mortality.[2] CHD silently progresses over years in the diabetics. Diabetic individual appears to be less able to perceive some of the symptoms and signs of ischemia or may have asymptomatic 'classic silent ischemia'. This may eventually present with sudden death, myocardial infarction, arrhythmias or heart failure leading to premature deaths. Thus, screening for early detection of asymptomatic CHD in type 2 diabetes may be helpful to prevent these catastrophic cardiac events and consequent deaths. However, periodical thorough clinical examination and resting ECG are not useful for this purpose as many times these methods fail to detect asymptomatic coronary artery disease. Also, invasive tests are highly expensive so are not cost effective for screening purpose.

Exercise electrocardiograph is a sophisticated non-invasive test which can be carried out on OPD basis. It can identify the majority of patients likely to have significant ischaemia during their daily activities and

remain the most important screening test for significant CAD.[3] Therefore; the present study was designed to demonstrate the usefulness of exercise electrocardiograph for early detection of asymptomatic CHD in type 2 diabetic individuals. Also, this study evaluates the silent myocardial ischaemia in asymptomatic type 2 diabetic patients by exercise tread mill test.

METHODS

The present study was conducted in the Government Medical College and Hospital, Aurangabad (Maharashtra) during December 2012 to November 2014. The patients in the age range of 35-65 years of either sex were enrolled. Firstly, Type 2 DM patients without previous evidence of CAD and cerebrovascular accident with normal 12 lead resting ECG were identified. Out of these patients who had previous history of myocardial infarction, angina, congestive heart failure, hypertension, anaemia, left bundle branch block, left ventricular hypertrophy, renal disorders, febrile illness, severe osteoarthritis or other disabilities were excluded from the study.

The eligible patients fulfilling the above mentioned criteria and who consented for participation were included in the present study. All participants were interviewed in detail to obtain demographic information like name, age, sex, residence, occupation and detailed personal history with special emphasis on duration of DM. The participants were further evaluated for routine haemogram, glycosylated haemoglobin, fasting and post prandial blood sugar, lipid profile, blood urea and serum creatinine along with exercise tread mill test. The exercise treadmill test was performed in each participant according to the Bruce protocol. The Bruce multistage maximal treadmill protocol has 3 minutes period to allow achievement of steady state before workload is increased. The results of TMT were categorized as below.

Positive test

- Horizontal / down sloping ST segment depression of ≥0.1 mv.
- ST elevation of ≥0.1 mv
- Up sloping ST segment depression of ≥0.2 mv even after 0.08 sec from the J point.
- Frequent premature ventricular contractions (PVCs), multifocal PVCs, ventricular tachycardia at mild exercise. (<75% of maximum heart rate).
- Complaints suggestive of angina or grade IV breathlessness associated with clinical signs of failure.

Equivocal test

In cases with unifocal PVCs, atrial tachyarrhythmias, development of hemiblocks, bundle branch block, 1st or 2nd degree AV block, results were labelled as equivocal

Interpretable test

Some patients appeared on physical examination to be a good exercise candidate but were unable or unwilling to complete exercise test.

Negative test

Simple lack of any of the above findings indicated that the test is negative.

The data of each study subject were recorded in the proforma, coded into a chart and analysed in detail.[4]

RESULTS

Out of 12 (24%) subjects, who had positive TMT, 11 showed significant ST depression, 1 subject who developed multifocal PVC's at heart rate less than 70% of maximal heart rate was also labelled as having positive TMT. Out of 3 (6%), patients in whom TMT was labelled as equivocal, all of them had unifocal PVC's at peak exercise, one of them developed LBBB. Two subjects (4%) simply failed to complete exercise due to anxiety, these tests were uninterpretable. 33 (66%) subjects, who completed TMT uneventfully without significant ST segment changes had negative TMT (Table 2).

Out of 50 cases studied, Out of 5 patients in age group of 35 - 45 years none had positive TMT. Out of 21 patients in age group of 46- 55 years 4(19.04%) had positive TMT. Out 24 patients in age group of 56-65 years 8 (33.33%) had positive TMT (Table 3).

Out of 50 cases studied 28 (56%) were males and 22 (44%) were females. Out of 28 males 8 (28.56%) had positive TMT. Of 22 female 4 (18.18%) had positive TMT (Table 4).

Out of 11 patients, who had ST depression, 3 had horizontal ST depression, 4 had down sloping ST depression, 4 had up sloping ST depression. 10 (20%) patients were unable to exercise beyond 6 minute. 40 (80%) patients were able to exercise beyond 6 minutes. None of the patients had systolic drop of blood pressure. 9 (18%) patients could not attain (85%) of their target heart rate. Supraventricular arrhythmias were the most common arrhythmias observed i.e. in 9 (18%) patients.

Out of 10 patients with duration of diabetes between 0-5years, none had positive TMT. Only 3 (23.07%) out of 13 with diabetes duration of 6 - 10 years had positive TMT. Number of cases who had positive TMT with duration of diabetes between 11-15 years and 16 - 20 years were 4 (28.57%) out of 14 and 5 (38.46%) out of 13 respectively (Table 6).

Only one (20%) of 5 patients with very poor control of blood sugar had positive TMT. None of the patients with

HbA1c <6.6% had positive TMT. Number of patients with satisfactory and poor blood sugar levels who had positive TMT were 8 (28.57%) out of 28 and 3 (21.43%) out of 14 respectively (Table 7).

Table 1: Preliminary data of all patients.

Sr. No.	Variable	Mean	Standard deviation
1	Age (years)	54.78	6.68
2	Duration of diabetes (years)	10.18	5.27
3	Maximum heart rate (beats/min)	157.08	26.21
4	BMI (kg/m^2)	27.86	4.71
5	Waist hip ratio	0.98	0.17
6	Hb (gm%)	11.83	1.34
7	BUL (mg/dl)	27.34	9.23
8	Serum creatnine (mg/dl)	1.11	0.33
9	HbA1c (%)	8.19	1.65
10	Triglyceride (mg/dl)	183.26	50.58
11	Serum cholesterol (mg/dl)	222.10	35.96
12	HDL (mg/dl)	39.10	16.28
13	LDL (mg/dl)	135.46	20.73
14	Duration of exercise	7.79	2.22

Table 2: Interpretation of results of TMT.

Sr. No.	Interpretation	No of cases	Percentage
1	Positive TMT	12	24%
2	Negative TMT	33	66%
3	Equivocal TMT	03	06%
4	Uninterpretable TMT	02	04%
	Total	50	100%

Table 3: Outcome of TMT results with reference to age of the subjects.

Sr. No	Age (years)	35-45	46-55	56-65	Total
1	Positive	0	4	8	12
2	Negative	5	16	12	33
3	Equivocal	0	1	2	3
4	Uninterpretable	0	0	2	2
Total		5	21	24	50

Table 4: Analysis of TMT results with reference to sex of the subjects.

Sr. No	Sex	Male	Female	Total
1	Positive	8	4	12
2	Negative	18	15	33
3	Equivocal	2	1	3
4	Uninterpretable	0	2	2
Total		28	22	50

Number of cases that were positive for TMT with waist hip ratio less than 1 and >1 in males were 4 (28.57%) each. Number of cases in females who had positive TMT with waist hip ratio less than 0.85 and >0.85 were 1 (10%) and 3 (25%) respectively (Table 8).

Number of cases that were positive for TMT with class I obesity, class II obesity and class III obesity were 5 (27.77%), 3 (23.07%o) and 1 (25%) respectively (Table 9).

Out of 11 patients who had HDL cholesterol levels >60, only one (9.09%) had positive TMT. Number of cases who had positive TMT with HDL levels in between 46-60 were 1 (11.11%) out of 9. Number of cases who had positive TMT with HDL levels in between 30 - 45 were 3

(30%) out of 10. Number of positive TMT were higher in patients with HDL levels of < 30 i.e. 7 (35%) out of 20 (Table 10).

Out of 15 patients who had serum cholesterol levels <200, only 2 (13.33%) had positive TMT. Number of cases who had positive TMT with serum cholesterol levels in between 200-240 were 5 (25%) out of 20. Out of

15 patients who had serum cholesterol levels >240, only 5 (33.33%) had positive TMT (Table 11).

Out of 24 patients who had LDL levels <130, only 4(16.66%) had positive TMT. Number of cases who had positive TMT with LDL levels in between 130-160 were 3 (18.75%) out of 16. Number of positive TMT were higher in patients with LDL >160 were 5 (50%) out of 10 patients (Table 12).

Table 5: Observation of TMT variables.

Sr. No.	Observation	No. of patients
A	Morphology of ST segment	
	• Horizontal ST depression	3
	• Down sloping ST depression	4
	• Up sloping ST depression	4
B	Exercise duration	
	• Less than 6 min.	10
	• More than 6 min.	40
C	Systolic drop of BP	-
D	Target heart rate	
	• >85% of T.H.R.	41
	• <85% of T.H.R.	9
E	Arrhythmias	
	• SVP's	9
	• Bundle branch block	1
	• Unifocal PVC's	2
	• Multifocal PVC's	1

Table 6: Outcome of TMT in relation to the duration of diabetes.

Sr. No.	Duration (years)	0-5	6-10	11-15	16-20	Total
1	Positive	0	3	4	5	12
2	Negative	9	10	8	6	33
3	Equivocal	0	0	2	1	3
4	Uninterpretable	1	0	0	1	2
Total		10	13	14	13	50

Table 7: Outcome of results of TMT with glycosylated Hb levels.

Sr. No.	HbA1c	Less than 6.6%	6.7% to 8.8%	8.9% to10%	More than 10%	Total
1	Positive	0	8	3	1	12
2	Negative	2	19	8	4	33
3	Equivocal	1	0	2	0	33
4	Uninterpretable	0	1	1	0	2
Total		3	28	14	5	50

Table 8: Outcome of TMT with waist hip ratio.

Sr. No.	Waist hip ratio	<1	<0.85	>1	≥0.85	Total
		M	F	M	F	
1	Positive	4	1	4	3	12
2	Negative	9	6	9	9	33
3	Equivocal	1	1	1	0	3
4	Uninterpretable	0	2	0	0	2
Total		14	10	14	12	50

Table 9: Outcome of TMT with BMI.

Sr. No.	BMI (kg/m^2)	20 to 24.9	25 to 29.9	30 to 34.9	35 to 40	Total
1	Positive	3	5	3	1	12
2	Negative	12	10	9	2	33
3	Equivocal	0	2	1	0	3
4	Uninterpretable	0	1	0	1	2
Total		15	18	13	4	50

Table 10: Outcome of TMT with HDL.

Sr. No.	HDL (mg/dl)	<30	30-45	46-60	>60	Total
1	Positive	7	3	1	1	12
2	Negative	11	6	8	8	33
3	Equivocal	1	0	0	2	3
4	Uninterpretable	1	1	0	0	2
Total		20	10	9	11	50

Table 11: Outcome of TMT with serum cholesterol levels.

Sr.No	Serum cholesterol (mg/dl)	<200	200-240	>240	Total
1	Positive	2	5	5	12
2	Negative	12	11	10	33
3	Equivocal	0	3	0	3
4	Uninterpretable	1	1	0	2
Total		15	20	15	50

Table 12: Outcome of TMT with LDL cholesterol levels.

Sr no	LDL cholesterol (mg/dl)	<130	130-160	>160	Total
1	Positive	4	3	5	12
2	Negative	18	11	4	33
3	Equivocal	2	1	0	3
4	Uninterpretable	0	1	1	2
Total		24	16	10	50

Table 13: Outcome of TMT with triglyceride levels.

Sr. No	Triglyceride (mg/dl)	<150	150-200	>200	Total
1	Positive	2	4	6	12
2	Negative	12	14	7	33
3	Equivocal	1	1	1	3
4	Uninterpretable	0	1	1	2
Total		15	20	15	50

Out of 15 patients who had triglyceride levels <150, only 2 (13.13%) had positive TMT. Number of cases who had positive TMT with triglyceride levels in between150-200 were 4 (20%) out of 20. Number of positive TMT were higher in patients with triglyceride levels of >200 i.e. 6 (40%) out of 15 patients (Table 13).

DISCUSSION

Exercise TMT is widely being used in clinical cardiology for the diagnosis and evaluation of patients with cardiac disease. Its use can be extrapolated in predicting sub-clinical IHD in asymptomatic subjects who have risk factors for IHD and thereby utilize it for preventive aspect of IHD.

Fifty patients with type II DM attending OPD and IPD at Tertiary care hospital during the period from December 2012 to November 2014 was included in the study.

In our study it was positive in 24% of patients. In various studies, carried out to detect prevalence of silent myocardial ischemia in asymptomatic type II DM patients, the exercise TMT was positive for 12.1% to

29.41% of patients. This broad range is probably due to, difference in the population study (age of the patients, inclusion and exclusion of the patients and with other high risk factors for IHD).

Outcome of TMT in relation to age

In our study 8 patients (33.33%) who had positive TMT aged between 56-65 years. None of the patient between ages of 35-45 years had positive TMT. 4 (19.04%) subjects aged between 46 - 55 years had positive TMT. mean age of patients with positive TMT was 58±5 years while that in patients with negative TMT, mean age was 53±7 years.

In study by Gerald et al, mean age of patients with eventful TMT was 67±9 years, while that in patients with uneventful TMT mean age was 58±8 years.[5] Also findings in the study done by Kim et al are similar with our study in which main significant differences between the patients with significant stenosis and those with a negative TMT was age (63.1±9.4 vs. 53.7±10.1 years).[6]

Outcome of TMT in relation to sex

It is quite clear that prevalence of silent myocardial ischaemia is higher in male sex, with the fact that 28.56% of total males had positive TMT as compared to 18.8% females with positive test.

Outcome of TMT in relation to the duration of diabetes

In our study, mean duration of DM with positive TMT was 13±4 years, while that in patients with negativel TMT, mean duration was 9±5 years. Our results are similar to Ahuwalia et al study that found that 70% subjects (7/10) with diabetes of more than 5 years duration had associated silent myocardial ischaemia while only 30% subjects (3/10) with diabetes of less than 5 years duration had associated silent myocardial ischaemia.[7]

Results of TMT in relation to BMI

Number of cases that were positive for TMT with BMI class I, class II, class III obesity were 5 (27.77%), 3 (23.07%) and 1 (25%) respectively. In our study mean BMI was 28.4±4.2 and 27.32±5 for positive and negative TMT respectively.

Blandine et al also notice that average BMI in patients with abnormal TMT was 26.4±3.0 while that in patients with normal TMT, it was 27.6±4.8 which is comparable.[8]

Outcome of TMT in relation to dyslipidemia

We found that Number of positive TMT were higher in patients with HDL levels of <30 i.e. 7 (35%) out of 20, with triglyceride levels of >200 i.e. 6 (40%) out of 15 patients, with LDL >160 were 5 (50%) out of 10 patients.

with serum cholesterol levels >240, Five (33.33%) out of 15 patients.

In another study of Agarwal et al, the prevalence of dyslipedemia is high in diabetic population with high serum cholesterol >240 mg/dl was seen in 15%, serum triglycerides >160 mg/dl was seen in 42.41%, raised LDL >130 mg/dl in 45.26%, VLDL >40 mg/dl in 24.09% and low levels of HDL-C <40 mg/dl were seen in 52.27%.[9]

CONCLUSION

Diabetic patients are at very high risk for cardiovascular morbidity and mortality. Early detection of IHD is very important so that pharmacological therapy, which may improve outcome, can be established. Tread mill exercise TMT being a non-invasive test with high safety, has an important role in early detection of IHD. This is evidenced by 24% positivity rate in cases in asymptomatic type 2 DM in this study.

Further studies are clearly needed to investigate the utility of early identification of IHD and risk stratification by cardiac TMT. The management of those identified early also needs to be studied. Until then, our assumption must be that detecting and intervening early in IHD, the major cause of death in all diabetic population, is of benefit. On this assumption, it is recommended that TMT should be a part of routine management in asymptomatic patients with type II DM, especially with age >55 years, duration >10 years and dyslipidaemia.

This may lessen burden on economy of developing countries like ours, from the added cost of treatment and rehabilitation of diabetic patients with IHD.

REFERENCES

1. Kahn RC, Weir CG, King LG, Jacobson MA, Moses CA, Smith JR. Joslin's Diabetes Mellitus 14th Ed. Philadelphia: Lippincott Williams and Wilkins Co; 2005.
2. Park K. Park's text book of preventive and social medicine. 18th Ed. Jabalpur: Banarasi Das Bhanot Publishers; 2005.
3. Zipes PD, Libby P, Bonow OR, Braunwald E. Braunwald's Heart Disease. 7th Edition, Philadelphia; WB Saunders company: 2005.
4. Darrow MD. Ordering and understanding the exercise stress test. Am Acad Fam Phys. 1999;59(2):401-10.
5. Fletcher GF, Suvant RC. The exercise stress test. In: Hursts The Heart. 9th edition. NY: McGraw-Hill; 1998: 522-525.

6. Kim MK, Baek KH, Song KH, Kwon HS, Lee JM, Kang MI, et al. Exercise Treadmill Test in Detecting Asymptomatic Coronary Artery Disease in Type 2 Diabetes Mellitus. Diabetes Metab J. 2011;35:34-40.
7. Ahuwalia V. Incidence of silent myocardial ischemic in non-insulin dependent diabetes mellitus. 1998.
8. Blandine JD, Bernard S, Habib G, Bory M, Vague P, Lassman-Vague V. Silent myocardial ischemia in patients with diabetes: Diabetes Care. 1999;22:1396–400.
9. Agarwal R, Sharma P, Pal M, Kochar A, Kochar DK. Magnitude of dyslipedemia and its association with micro and macro vascular complications in type 2 diabetes; a hospital based study from Bikaner (Northwest India). Diabetes Res Clin Pract. 2006;73(2):211-4.