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Original Research Article

A Comparative Study of 2D Echo and Treadmill Test in Identifying Ischemic Heart Disease in Asymptomatic Type 2 Diabetes Mellitus

Anjali Shankar[1], Amoghasiddha S Jyoti[2], Arun. K[3]

[1]Senior Resident, Department of General Medicine, Shivamogga Institute of Medical Sciences
[2]Senior Resident, Department of General Medicine, Shivamogga Institute of Medical Sciences
[3]Senior Resident, Department of General Medicine, Shivamogga Institute of Medical Sciences

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Corresponding Author: Dr. Amoghasiddha S Jyoti
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Abstract

Background and Objectives: Diabetes mellitus (DM) is a modern-day disease with micro and macrovascular problems that have an impact on a person's quality of life. The condition stays undiscovered due to its asymptomatic nature. A screening method for identifying CAD in asymptomatic type 2 diabetes mellitus patients is required. This study aims to assess the accuracy of two-dimensional echocardiography and treadmill tests in diagnosing asymptomatic coronary artery disease in type 2 diabetes mellitus patients.

Materials and Methods: The present cross-sectional study was conducted at a Tertiary care centre of Davangere. After receiving ethical committee approval, 101 consecutive individuals with type 2 diabetes mellitus who were either hospitalised or attending amount patient department who were asymptomatic for coronary artery disease were recruited and data was collected from JULY 2020 to AUGUST 2021. All study participants underwent thorough clinical examination and necessary laboratory tests. All individuals with normal resting ECG were followed up with a 2D echocardiography and treadmill test.

Results: TMT was positive in 32 (31.8 percent) of the 101 individuals in this study, and negative in 69. (68.31 percent). LVDD was found in 14 of the participants. TMT was positive in 11 (34.4%), 17 (53.1%), and 4 (12.5%) patients with diabetes for less than five years, five to ten years, and more than ten years.

Conclusions: Silent myocardial ischemia prevalence in current study was 31.8 percent of asymptomatic type 2 diabetes mellitus patients. Longer duration of diabetes, socioeconomic characteristics, delay in diagnosis, presence of autonomic neuropathy, peripheral neuropathy, dyslipidemia, and HbA1C levels are all strong clinical predictors of silent myocardial ischemia inasymptomatic type 2 diabetes mellitus.

Keywords: Diabetes Mellitus, Coronary Artery Disease, 2D Echocardiography, Treadmill Test, Asymptomatic-coronary Artery Disease.

Introduction

Diabetes mellitus is a metabolic condition characterised by chronic hyperglycemia, which causes problems with carbohydrate, lipid, and protein metabolism due to defect in insulin secretion, action, or both.[11] The deleterious effects of diabetes include long-term damage and dysfunction of various organs, mainly the heart, kidneys, nervous system, vascular system, and eyes. [2] Diabetes due to its associated complications has become the leading cause of end-stage renal disease, a major cause of non-traumatic amputations, and is responsible for 30% of preventable blindness and a leading cause of cardiovascular mortality.[3]

Indians are more prone to develop diabetes mellitus due to their genetic makeup, and due to globalization and sedentary lifestyle habits, the cases in the country are upscale. Increasing diabetes cases has given the country the distinct title of "the diabetic capital of the world." [4] One in six people with diabetes in the world is an Indian. With an estimated diabetic population of 77 million as on 2000 stats, this number is to rise to an estimated mark of 134 million by 2045.[5]

A build-up of atheromatous plaques within coronary arteries causes a reduction in the heart's blood supply, resulting in coronary artery disease. Diabetes is one of the leading causes of atheromatous plaque acceleration, causing diabetics to develop coronary artery disease (CAD) at a younger age than their non-diabetic counterparts.[6]

Furthermore, CAD in diabetes is asymptomatic for a long time, owing to the autonomic dysfunction that occurs as a result of the condition. According to studies, the prevalence of CAD in India ranges from 2-4 percent in urban areas to 1-2 percent in rural areas, with exponential growth in cases over

the last six decades.[7]

CAD is the leading cause of death in diabetes mellitus patients. It often remains asymptomatic due to the fact presence of autonomic dysfunction in most diabetes patients. It is a well-known fact that 'Hyperglycemia' along with fluctuating blood sugar levels, causes worsening of diabetes and leads to micro and macrovascular complications. [8] Framingham's study has shown that the presence of diabetes leads to a poor prognosis of cardiovascular diseases. Studies have shown that diabetic males are two times more prone, and female diabetics are four times more prone to develop CAD than their regular non-diabetic counterparts.[9]

CAD in diabetes presents a varied spectrum of acute myocardial infarction, arrhythmia, sudden cardiac death, and heart failure. Due to the asymptomatic nature of the disease for a long duration of time, there is a necessity to detect the disease at the earliest possible course of time. [10] Routine clinical examination and resting electrocardiograph turn out to be expected in most diabetes with CAD until it turns out to be overt. Hence-forth there is a need to develop a simple non-invasive testing modality to detect silent CAD in diabetics. [11]

2D Echo cardiography (2D-ECHO) and Treadmill testing are the routinely used non-invasive tests used in the cardiological evaluation of an individual. 2D-ECHO plays a vital role in knowing structural abnormality and function limitation of an individual's cardiovascular system before, during, and after acute myocardial infarction.[12] Exercise electrocardiographs can identify the majority of patients likely to have significant ischemia during their daily activities and remain the most important screening test for significant CAD.[13]

Material and Methodology

The present study is a two-year cross-sectional study conducted on type 2 diabetic patients who are asymptomatic for cardiovascular disease and have a normal resting electrocardiogram. In the current study, a total of 101 individuals were in the study population.

Inclusion Criteria

All patients of type 2 diabetes mellitus of either sex asymptomatic for ischemic heart disease between 18 to 60 years with or without Hypertension will be included in the study.

Exclusion Criteria

1. Patients have a history of Ischemic Heart Disease, Congenital Heart Disease, and Arrhythmias.
2. Patients having abnormal baseline ECG that is suggestive of coronary artery disease.
3. Patients of Chronic Kidney Disease, Chronic Liver Disease, Severe Osteoarthritis, Thyroid dysfunction, Familial hypertriglyceridemia, Dyslipidemia, Hyperhomocysteinemia.
4. Patients with proliferative diabetic retinopathy.
5. Haemodynamically unstable patients.

Investigations

All study individuals underwent the following investigation at the time of inclusion into the study.

- Routine hemogram.
- Glycosylated hemoglobin.
- Fasting and postprandial blood sugar.
- Lipid profile (total cholesterol, trigIycerides, LDL,HDL).
- Blood urea and serum creatinine.
- Thyroid profile (T3, T4, TSH).
- Serum homocysteine.
- Fundus examination.
- Resting Electrocardiogram.
- 2-Dimensional Echocardiography.
- Treadmill testing.

The technique of treadmill test

The individuals were told not to eat or drink caffeinated refreshments three hours preceding testing and to wear agreeable shoes and loose and comfortable garments. After a brief physical examination before the test, all study individuals were briefed about the procedure, and written informed consent was taken.

A 12 lead electrocardiogram was taken analyzed, following which a torso ECG was obtained in the supine position and the sitting or standing position. Following this, study subjects' blood pressure was recorded taking all essential precautions in both supine and standing positions. A standard multistage maximal exercise test was done on a mechanized treadmill as indicated by Bruce protocol. The heart rate, blood pressure, and electrocardiograms were recorded towards the finish of each phase of the exercise, preceding and succeeding the halting of the exercise and for every minute for at least around 5 to 10 minutes in the recovery stage. The exercise test was terminated either following the achievement of the target heart rate or abnormal ischemic response. This was defined as the occurrence of 0. 10 mV (1 mm) of J point depression measured from the PQ junction, with a relatively flat ST segment slope (<lmV/sec), depressed ≥ 0.10 mV 60 to 80 msec after the J point in three consecutive beats with a stable baseline.

The Exercise test was also terminated if study individuals developed symptoms of dyspnea, fatigue, or chest pain. SPSS (Statistical Package for Social Sciences) version 20. (IBM SPASS statistics [IBM corp. released 2011] was used to perform the statistical analysis

- Data was entered in the excel spreadsheet.

- Descriptive statistics of the explanatory and outcome variables were calculated by the mean, standard deviation for quantitative variables, frequency, and proportions for qualitative variables.
- Inferential statistics like
- A Chi-square test was applied for qualitative variables to find the association between 2D echo and TMT.
- The level of significance is set at 5%

Results

Table 1: Mean Age Distribution of the Subjects

	N	Minimum	Maximum	Mean	S.D
Age	101	30	65	48.05	8.450

Table 2: Distribution of the Subjects Based on Age Groups

Age groups	Frequency	Percent
30 to 40 yrs	24	23.8
41 to 50 yrs	35	34.7
>50 yrs	42	41.6
Total	101	100.0

In the present study, the majority of the study subjects were more than 50 years (41.6%), followed by 41-50 years (34.7%) and 30-40 years (23.8%). The mean age was 48.05 $\pm$ 8.45 years.

Table 3: Distribution of the Subjects Based on Gender

Gender	Frequency	Percent
Females	42	41.6
Males	59	58.4
Total	101	100.0

Males were more (58.4%) as compared to females (41.6%) in the present study.

Table 4: Mean Duration of DM (In Years)

	N	Minimum	Maximum	Mean	S.D
Duration of DM (yrs)	101	.50	20.00	5.029	3.562

The mean duration of diabetes mellitus was 5.029 $\pm$ 3.562 years

Table 5: Mean Scores

	N	Minimum	Maximum	Mean	S.D
BMI	101	15.55	39.40	27.04	5.42
WHR	101	0.63	1.13	0.99	0.08
SYS BP	101	100.00	150.00	128.55	9.88
DIAS BP	101	60.00	102.00	82.91	9.02
Pulse	101	70.00	111.00	85.61	9.24
HBAIC	101	5.40	15.60	8.58	2.10
FBS	101	83.00	263.00	161.21	42.92
PPBS	101	105.00	329.00	203.02	52.33
CHOL	101	117.00	263.00	198.40	31.54
TGL	101	78	386	157.28	55.853
LDL	101	42.00	175.00	110.60	30.75
S. Creatinine	101	0.52	1.41	0.76	0.23
HDL	101	20.00	52.00	35.71	6.59
TSH	101	0.67	5.83	2.43	1.14
LPA	101	2.00	46.10	12.96	15.12
S. HSCRP	101	0.30	40.00	8.10	10.67

Table 6: Cross Tabulation of a With 2d Echo and TMT

			AN		Total	Chi-square value	p value
			-	+			
2D echo	LVDD	Count	9	5	14	1.04	0.306
		%	64.3%	35.7%	100.0%		
	N	Count	67	20	87		
		%	77.0%	23.0%	100.0%		
	-	Count	60	4	64		
		%	93.8%	6.2%	100.0%		

TMT	+	Count	13	19	32	32.98	0.00*
		%	40.6%	59.4%	100.0%		
	INC	Count	3	2	5		
		%	60.0%	40.0%	100.0%		
TOTAL		Count	76	25	101		
		%	75.2%	24.8%	100.0%		

*significant

Out of 25 subjects having positive AN, 5 subjects had LVDD in 2D echo and 19 subjects had positive TMT. In 76 subjects having negative AN, 67 had a normal 2D echo and 60 subjects had negative TMT. A Chi-square test was applied to find the association between AN and 2D echo, AN, and TMT. The Chi-square test showed no statistically significant association between AN and 2D echo (p=0.306) whereas, a statistically significant association was seen between AN and TMT (p=0.00).

Discussion

We found that 59 were male and 42 were female amongst the study population with the mean age being 48.05 years and a standard deviation of 8.45 years. Amongst study individuals, 15 (14.9%) were overweight, 32 (31.7%) were obese, 30 (29.7%) were morbidly obese with 5 (5%) being underweight, and the remaining were having normal BMI. Indicating most of the study individuals were on the higher scale of BMI.

Our study population had a mean duration of diabetes mellitus of 5.029 years with a standard deviation of 3.562 years. Amongst study individual's majority of them that is 77 (76.2%) were on oral hypoglycemic agents, 21(20.8%) were on both oral hypoglycemic agents and insulin and a small proportion of 3(3%) individuals were on insulin alone.

Amongst the study population 14(13.8%) had grade 1 left ventricular diastolic dysfunction (LVDD) and none of them had features of myocardial ischemia in resting two-dimensional echocardiography. Out of 101 study individuals, 32(31.8%) had positive treadmill tests suggestive of the presence of silent myocardial ischemia. 16(27.11%) out of 59 male individuals were having positive treadmill tests. 16(38.09%) out of 42 female individuals had positive treadmill tests. By the above, it is inferred that our study had a prevalence of silent myocardial ischemia of 31.8% amongst asymptomatic type 2 diabetes patients with higher occurrence among the female population as compared with male counterparts (38.09% v/s 27.11%). Five individuals amongst the study population had inconclusive treadmill tests due to inability to complete TMT as a result of fatigue, difficulty in breathing, and a fear of continuing test due to increasing speed of the treadmill. Individuals with inconclusive treadmill tests underwent stress echocardiography. Stress echocardiography showed features of myocardial ischemia in two female and one male study participant.

The prevalence of silent myocardial ischemia in type 2 asymptomatic diabetes mellitus was found to be 31.8% (32/101).

The present study findings were in coherence with findings available with below mentioned clinical data. One study [14] concluded that 29% of diabetics asymptomatic for coronary artery disease had features suggestive of silent myocardial ischemia on 24 -hour ambulatory monitoring exercise electrocardiogram.

In a study [15] conducted among diabetics asymptomatic for coronary artery disease, it was found that 31% of them had treadmill test positive, and silent myocardial ischemia was twice common in diabetics as compared with non-diabetics.

A similar study [16] conducted in India inferred that 38.3% of diabetics had silent myocardial ischemia on exercise tests. Another study [17] in India concluded that 50% of diabetics had silent myocardial ischemia on exercise electrocardiogram and 35% on ambulatory monitoring. In study [18] it was found that LVDD is more common among diabetics at the time of diagnosis which occurs irrespective of the presence of hypertension. Another similar study [19] concluded the occurrence of a higher prevalence of silent myocardial ischemia in diabetics as compared to non-diabetics. One more study [20] concluded that 62/500 patients (12.4%) had silent myocardial ischaemia in patients with type 2 diabetes mellitus by using exercise electrocardiogram. Another study [21] concluded that 22% of their study population had silent ischaemia using stress testing in asymptomatic patients with type 2 diabetes mellitus. So, the present study is in agreement with that diabetics have a higher prevalence of silent myocardial ischemia.

Conclusion

1. The prevalence of silent myocardial ischemia in type 2 diabetes mellitus without a history of ischemic heart disease or hypertension is 31.8%.
2. Longer the duration of diabetes, the greater the risk of silent myocardial ischemia.
3. Dyslipidemia i.e., triglycerides were found to be more in diabetics who had a greater prevalence of silent myocardial ischemia on TMT.
4. Socioeconomic factors play a major role in the delay in diagnosis of diabetes mellitus

with a catastrophic initial presentation.
5. Diabetics with clinical signs of autonomic neuropathy and peripheral neuropathy had a higher incidence of silent myocardial ischemia.
6. Duration of diabetes, triglyceride levels, autonomic neuropathy, peripheral neuropathy, and glycosylated hemoglobin are strong clinical predictors of silent myocardial ischemia.
7. Early screening of patients with type 2 diabetes mellitus for evidence of silent myocardial ischemia may prevent catastrophic cardiac events.
8. Thus exercise treadmill test is a better modality for screening asymptomatic diabetics in comparison with 2D-echo and individuals with inconclusive treadmill test stress echocardiography is an easily accessible modality of investigation.

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