Chronotropic Incompetence is Predictor of Silent Myocardial Ischemia in Type 2 Diabetes Patients

Dr. Ajeet Singh¹, Dr. Suresh Yadav²

¹Senior Specialist, Department of Medicine, SMS Medical College and hospital, Jaipur(Raj.)India

²M.D.(Physiology) Jaipur (Raj.) India

Abstract: Myocardial ischemia occurs when myocardial oxygen supply unable to meet myocardial oxygen demand. Silent Myocardial Ischemia (S.M.I.) is defined as objective documentation (E.C.G. changes) of Myocardial ischemia in the absence of angina or angina equivalents.. The present study compare the mean maximum heart rate during exercise in S.M.I. and non ischemic type 2 diabetes patients during T.M.T.150 type 2 diabetic patients were taken and they undergone T.M.T. Present study observed that mean maximum heart rate in S.M.I. group was significantly lower than heart rate recovery in non-ischemic group. So it can be concluded that mean maximum heart rate during T.M.T. in S.M.I. group could be due to autonomic nervous system dysfunction.

Keywords: Silent Myocardial Ischemia, mean maximum heart rate, autonomic nervous system dysfunction

1. Introduction

Diabetes mellitus is complex metabolic disorder in which there is relative or absolute deficiency or ineffectiveness of insulin leading to chronic hyperglycemia with or without glycosuria. This hyperglycemia causes several complications of Diabetes mellitus and among them , Coronary Artery Disease is most important.¹

Myocardial ischemia occurs when myocardial oxygen supply not able to meet myocardial oxygen demand which is usually caused by obstructive atheromatous plaque in the epicardial coronary arteries .Due to inadequate perfusion there is shifting from aerobic to anaerobic metabolism, diminished myocardial contraction and electrophysiological changes. Myocardial ischemia can present with angina or angina equivalent or silent ischemia.²⁻⁴

Silent myocardial ischemia is defined as objective documentation of Myocardial ischemia in the absence of angina or angina equivalents as evidenced in E.C.G changes.⁵ Patient with diabetes mellitus have an increased risk for cardiovascular diseases, Myocardial infarction and increased mortality risk after acute myocardial infarction. Acute myocardial infarction in diabetic person may present without pain or with acute acidosis, vomiting sudden hypotension, syncope, cerebral vascular accident or sudden death.⁶

Chronotropic incompetence (CI) in a broader sense defined as the inability of the heart to increase its rate proportionate with increased activity or demand and commonly seen in cardiovascular disease and it results in exercise intolerance and impaired quality of life and it is an independent predictor of major adverse cardiovascular events and overall mortality.⁷

2. Materials and Methods

The study had been conducted in C.T.M.T cell of S.M.S. Hospital of Department of Cardiology and Department of Endocrinology, SMS Medical College and Hospital, Jaipur. 150 type 2 diabetic subjects of either sex had undergone treadmill test (T.M.T) according to inclusion and exclusion criterion. Subjects were classified as exercise induced myocardial ischemia on the basis of down sloping or horizontal depression in ST-segment of T.M.T report. Subjects having downsloping or horizontal depression in ST-segment > 1mm without experiencing pain were considered as Silent myocardial ischemic subjects and subjects with no down sloping or horizontal depression in ST-segment were considered as non-ischemic subjects. Proportion of cases with Silent Myocardial Ischemia in total cases and maximum heart rate during exercise in Silent myocardial ischemic subjects and non-ischemic subjects were compared and analysed according to statistical analysis.

3. Results

Table 1:	Distribution	of study	population	according to
	Pre	esence of	SMI	

ECG finding	Ν	Percentage					
SMI	57	38					
Non Ischemic	93	62					
Total	150	100					

Present table no.1 shows that the proportion of Silent Myocardial Ischemia (SMI) in patients of type 2 Diabetes Mellitus cases is 38%.

Table 2: Comparison	of mean	Resting	HR in	1 SMI	and	Non
	Ischemic	group				

			0	ſ						
	Group	Ν	Mean	Std. Deviation						
	SMI	57	92.02	11.94						
	Non Ischemic	93	79.86	12.16						
Q/	P_{1} at df $1/8$, P_{2} 0.001									

t = 5.984 at df 148; P<0.001

Present table no.2 shows that mean resting Heart rate was higher in Diabetic patients in SMI group (92.02 beats /min) as compared to Non Ischemic group (79.86 beats/min), and application of t test showed that this difference was statistically significant (P<0.001).

Volume 6 Issue 10, October 2017 www.ijsr.net

Licensed Under Creative Commons Attribution CC BY

Tab	le 3:	Co	mparison	of	mean	N	laximum	HR	in	SMI	and
-----	-------	----	----------	----	------	---	---------	----	----	-----	-----

	Non Ischemic group							
	Group	Ν	Mean	Std. Deviation				
	SMI	57	141.09	13.07				
	Non Ischemic	93	152.68	15.14				
t = 4.7	= 4.787 with 148 degrees of freedom; P=0.001							

This table shows that Maximum heart rate during exercise was significantly lower in diabetic patients in SMI group (141.09 beats/min) as compared to Non Ischemic group (152.68 beats/min); P=0.001.



4. Discussion

The integrated effect of sympathetic activation and vagal withdrawal during exercise leads to increase in heart rate . These autonomic changes are mediated by both somatic exercise reflexes and central command mechanisms. When we stop exercise the increased heart rate decreases rapidly and this rapid recovery appears to be an important mechanism for avoiding excessive cardiac work after exercise and vagal reactivation plays an important role during this recovery phase.⁸

Diabetic patients with or without signs of autonomic neuropathy have a lower vagal activity (and hence a relatively higher sympathetic activity) during night hours and at the same time of the day during which a higher frequency of cardiovascular accidents has been reported.⁹

Chronotropic incompetence, reduced heart rate recovery and increased heart rate at rest are the predictors reflecting cardiac autonomic nervous system dysfunction.¹⁰⁻¹¹

Heart rate related measures like resting heart rate, maximum heart rate during exercise and heart rate recovery which are simply obtained during a routine exercise treadmill test, may serve as an early warning sign for the development of cardiac autonomic neuropathy, a widely under-diagnosed complication of diabetes with significant prognostic implications.¹²

Cardiac autonomic neuropathy, in the setting of diabetes, is defined as the dysfunctioning of autonomic control of the cardiovascular system when we exclude other causes.¹³ Its prevalence significantly rises with age, poor glycaemic control and diabetes duration. Due to its high prevalence various experts recommends screening for cardiac autonomic dysfunction in asymptomatic type 2 diabetes, and clinical diagnosis is established on finding of at least two abnormal CART tests(cardiovascular autonomic reflex test), which are based on HR (heart rate) and blood pressure response to several manoeuvres¹³.Despite of the fact that CART-based diagnosis is easy to perform for screening patients with diabetes and it can be performed at the bedside, it is not broadly applied in clinical practice. Due to high burden of significant cardiovascular morbidity and mortality associated with the diabetes we requires additional tools that are simple to perform and commonly applied in diabetes for diagnostic and prognostic utility. For this exercise stress test may serve as an appropriate modality for these objectives and can serve our purpose. Reduced heart rate recovery, resting tachycardia and, chronotropic incompetence are early indicators associated with cardiac autonomic dysfunction, which we can easily measured during routine exercise treadmill testing. Each of these HRrelated parameters were reported in various researches to be associated with prognosis in type 2 diabetes. The inability of the HR to rise in proportion to an increase in activity or metabolic demand is often clinically ignored by medical community, although it is not uncommon in patients with type 2 diabetes. The mechanism for this chronotropic incompetence is that the repeated activation of sympathetic nerves leads to downregulation of betaadrenergic receptors in the sinus node, and this resulting in post-synaptic desensitisation and inappropriate HR response during exercise¹⁴. The etiology is probably complex and it is thought to be due to impaired baroreflex sensitivity and cardiovascular autonomic neuropathy and it requies further studies. Chronotropic incompetence is suggested to be significantly more prevalent in type 2 diabetes than in healthy individuals ^{15,16}

Volume 6 Issue 10, October 2017 <u>www.ijsr.net</u> Licensed Under Creative Commons Attribution CC BY

5. Conclusion

Type 2 diabetes patients with Silent myocardial ischemia (SMI) have high resting heart rate and mean maximum heart rate during exercise was lower in SMI group of diabetic patients than in non-ischemic group of diabetic patients which could be due to autonomic nervous system dysfunction.

References

- The Expert Committee on the Diagnosis and Classification of Diabetes Mellitus: Report of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus. Diabetes Care.1997; 20:1183–1197.
- [2] Weiner DA, Ryan TJ, Parsons L, Fisher LD, Chaitman BR, Sheffield LT,et al. Significance of silent myocardial ischemia during exercise testing in patients with diabetes mellitus: a report from the Coronary Artery Surgery Study (CASS) registry. Am J Cardiol.1991;68:729–34
- [3] Zellweger MJ, Hachamovitch R, Kang X, Hayes SW, Friedman JD, Germano G et al. Prognostic relevance of symptoms versus evidence of coronary artery disease in diabetic patients. Eur Heart J. 2004;25:543–50.
- [4] Zellweger MJ, Weinbacher M, Zutter AW, Jeger RV, Mueller-Brand J, Kaiser C et al. Long-term outcome of patients with silent versus symptomatic ischemia six months after percutaneous coronary intervention and stenting. J Am Coll Cardiol. 2003;42:33–40.
- [5] Peter F. Cohn, Kim M .Fox, Daly C. Silent Myocardial Ischemia Circulation .2003; 108:1263-1277.
- [6] Stamler J, Vaccaro O, Neaton J, Wentworth D. Diabetes, other risk factors, and 12-year cardiovascular mortality for men screened in the Multiple Risk Factor Intervention Trial. Diabetes Care.1993; 16:434-44.
- [7] Peter H.Brubaker, and Dalane W.Kitzman, Chronotropic Incompetence: Causes, Consequences, and Management . Circulation. 2011; 123(9): 1010–1020.
- [8] Forjaz CLM, Matsudaira Y, Rodrigues FB, Nunes N & Negrão CE. Post-exercise changes in blood pressure, heart rate and rate pressure product at different exercise intensities in normotensive humans. Brazilian Journal of Medical and Biological Research.1998; 31: 1247-1255.
- [9] Bernardi L, Ricordi L, Lazzari P, Soldà P, Calciati A, Ferrari MR, Vandea I, Finardi G, Fratino P. Impaired circadian modulation of sympathovagal activity in diabetes: a possible explanation for altered temporal onset of cardiovascular disease. Circulation. 1992;86:1443-1452.
- [10] Ho PM, Maddox TM, Ross C, Rumsfeld JS, Magid DJ . Impaired chronotropic response to exercise stress testing in patients with diabetes predicts future cardiovascular events. Diabetes Care .2008; 31: 1531– 1533.
- [11] Stettler C, Bearth A, Allemann S, M. Zwahlen & L. Zanchin & M. Deplazes et al. QTc interval and resting heart rate as long-term predictors of mortality in type 1 and type 2 diabetes mellitus: a 23-year followup.Diabetologia. 2007; 50(1): 186–194.
- [12] Barak Zafrir, Mali Azencot, Idit Dobrecky-Mery, Basil S Lewis, Moshe Y Flugelman and David A Halon : Resting heart rate and measures of effort-related cardiac

autonomic dysfunction predict cardiovascular events in asymptomatic type 2 diabetes.European Journal of Preventive Cardiology 2016;Vol. 23(12) 1298–1306.

- [13] Tesfaye S, Boulton AJ, Dyck PJ,Freeman R,Horowitz M,Kempler P, et al. Diabetic neuropathies: update on definitions, diagnostic criteria, estimation of severity, and treatments. Diabetes Care 2010; 33:2285–2293.
- [14] Keytsman C, Dendale P and Hansen D. Chronotropic incompetence during exercise in type 2 diabetes: aetiology, assessment methodology, prognostic impact and therapy. Sports Med. 2015; 45(7): 985–995.
- [15] Hansen D and Dendale P. Modifiable predictors of chronotropic incompetence in male patients with type 2 diabetes. J Cardiopulm Rehabil Prev 2014; 34(3): 202– 207.
- [16] Ho PM, Maddox TM, Ross C, John S. Rumsfeld and David J. Magid. Impaired chronotropic response to exercise stress testing in patients with diabetes predicts future cardiovascular events. Diabetes Care 2008; 31: 1531–1533.

Volume 6 Issue 10, October 2017 <u>www.ijsr.net</u> Licensed Under Creative Commons Attribution CC BY