

Original article

Prevalence of diastolic heart failure in patients with type 2 Diabetes mellitus in a tertiary care hospital: A study from Kolkata

Dr. Vishal Bhalerao¹, Dr. Pravin Bhagat², Dr. Yogesh Chaodhary³, Dr. Anant A. Takalkar⁴

^{1,2}Assistant Professor, Department of General Medicine, MIMSR Medical College, Latur, Maharashtra, India

³Specialist, General Medicine, ID 84843 MOH OMAN, NIZWA Hospital.

⁴Professor, Department of Community Medicine, MIMSR Medical College, Latur, Maharashtra, India.

Corresponding author: **Dr. Yogesh Chaodhary**

Received: 29-05-2024/ Revised: 07-06-2024/ Accepted Date: 02-07-2024

Abstract

Introduction: Heart failure is one of the most common reasons for hospital admission in those aged 65 and over with consequent high costs for the healthcare system. Despite improvements in the treatment of patients with chronic HF with reduced EF, the survival of the patients hospitalized for HF remains poor, with one-year mortality of 30% and 5-year mortality up to 50%. **Objective:** To determine the prevalence of diastolic heart failure in patients with type 2 Diabetes mellitus in a tertiary care hospital. **Methodology:** This study was hospital based Cross-sectional observational study conducted in In-patient and outpatient department of Apollo Gleneagles Hospitals Kolkata involving 85 patients between 40-65 years of age both males and females from the general medical inpatient and outpatient pool of Apollo Gleneagles Hospitals Kolkata. **Results:** Prevalence of diastolic dysfunction was 63.5% among the patients with type-2 DM. Only 14.8% and 7.4% of the patients had Grade-III and Grade-IV DD respectively. Chi-square test showed that there was significant association between age and Diastolic Dysfunction of the patients ($p < 0.0001$). Chi-square test showed that there was significant association between gender and DD of the patients ($p = 0.019$). Chi-square test showed that there was significant association between obesity and DD of the patients ($p = 0.002$). **Conclusion:** There was significant association between age and diastolic dysfunction of patients ($p < 0.0001$). Obesity is a strong risk factor for heart failure. Chi-square test showed that there was significant association between obesity and DD of patients ($p = 0.002$). There was significant association between level of HbA1c and DD of the patients. Prevalence of DD increases with value of HbA1c.

Key words: diastolic heart failure, type 2 Diabetes mellitus

Introduction:

It has been known for several years that heart failure can occur in patients in whom left ventricular systolic function appears to be normal when measured by ejection fraction. Since systolic function was presumed to be normal in these patients, this form of heart failure was thought to be due to diastolic dysfunction or abnormal filling and hence was labeled diastolic heart failure. However there has been increasing evidence that systolic function is not entirely normal in these patients and hence the term HFPEF has been used as preferred term.¹

In the latest consensus document by European working group, the diagnosis of HFPEF requires: 1. Presence of symptoms and signs of congestive heart failure. 2. Presence of normal or mildly abnormal LV systolic function. 3. Evidence of LV diastolic dysfunction¹

The prevalence of patients with both HF and DM in the general population is estimated at 0.5% in men and 0.4% in women.² The public health burden of HF and DM is substantial: HF afflicts 1-2% of the general population rising to >5-10% in subjects aged >65 years,³ whereas the prevalence of Diabetes Mellitus Type 2 worldwide is estimated at 5-6%⁴ and it is predicted to

increase to >8 % of the adult population by 2030.⁵ The prevalence of both diseases is increasing worldwide with the aging of the general population: 1.5 to 2% of individuals over the age of 65 have both HF and DM and the prevalence is expected to grow exponentially in the next decades.⁶ In addition, these prevalence figures tend to underestimate the true impact as they do not adequately account for undiagnosed HF in patients with preserved ejection fraction (EF) or impaired fasting glucose.⁷

Objective: To determine the prevalence of diastolic heart failure in patients with type 2 Diabetes mellitus in a tertiary care hospital.

MATERIAL AND METHODS

STUDY SITE -This study was conducted in In-patient and outpatient department of Apollo Gleneagles Hospitals Kolkata.

STUDY POPULATION- Age between 40-65 years of age both males and females from the general medical inpatient and outpatient pool of Apollo Gleneagles Hospitals Kolkata.

STUDY DESIGN- Hospital based Cross-sectional observational study.

SAMPLE SIZE- 85 subjects were enrolled in the study.

STUDY PERIOD AND DURATION- Study was carried out in the period September 2015 to November 2016, in duration of 15 months.

INCLUSION CRITERIA:

- Both male and female patients aged between 40-65 years.
- Patients satisfying criteria for diabetes mellitus

EXCLUSION CRITERIA:

- Patients with Age less than 40 years and above 65 years
- Patients with coronary artery disease diagnosed by symptoms, electrocardiogram or regional wall motion abnormality on echocardiogram and subjects with evidence of valvular disease.
- Patients with Heart rate < 50 or > 100 per minute and 1° AV block, atrial fibrillation of any other cardiac arrhythmias diagnosed by clinical examination and electrocardiogram, as they would interfere with Doppler studies.
- Patients with already diagnosed with heart failure and on diuretics plus other medications.
- Hypertensive patients on antihypertensive agents and/or angiotensin-converting enzyme (ACE) inhibitors and subjects with poor transthoracic echo window.
- Patients with LV systolic dysfunction apart from heart failure.

Methods of data collection

This study was done on 85 patients with Diabetes mellitus (as per diagnostic criteria), who will be in-patient and outpatient department of Apollo Gleneagles Hospitals Kolkata, over a period of fifteen months. All subjects were determined to be having type 2 Diabetes Mellitus as per diagnostic criteria. Biochemical investigations in the form of blood fasting blood sugar, post-prandial blood sugar, HbA1C, NT-Pro BNP and standard 12 lead electrocardiogram and a transthoracic echocardiogram in a "M" mode will also be carried out.

Statistical methods:

Statistical Analysis was performed with help of Epi Info (TM) 3.5.3. EPI INFO is a trademark of the Centers for Disease Control and Prevention (CDC). Descriptive statistical analysis was performed to calculate the means with corresponding standard deviations. A p<0.05 was taken to be statistically significant.

Results

Table-1: Distribution of Diastolic Dysfunction of the patients

Diastolic Dysfunction	Number	%
Present	54	63.5%
Absent	31	36.5%
Total	85	100.0%

Out of 85 patients with type-2 DM 54(63.5%) of the patients were having diastolic dysfunction. Thus the prevalence of diastolic dysfunction was 63.5% among the patients with type-2 DM.

Table-2: Distribution of grades of Diastolic Dysfunction of the patients

Grades of Diastolic Dysfunction	Number	%
I	18	33.3%
II	24	44.4%
III	8	14.8%
IV	4	7.4%
Total	54	100.0%

Out of 54 patients with DD 54(63.5%) most of the patients were having Grader-II DD (44.4%) followed by Grade-I DD (33.3%). In overall proportion of patients with Grade-I & II DD (77.7%) was significantly higher ($Z=8.92;p<0.0001$). Only 14.8% and 7.4% of the patients had Grade-III and Grade-IV DD respectively.

Table3: Distribution of age and Diastolic Dysfunction of the patients

Age (in years)	Diastolic Dysfunction		TOTAL
	Present	Absent	
<55	36	7	43
Row %	83.7	16.3	100.0
Col %	66.7	22.6	50.6
≥55	18	24	42
Row %	42.9	57.1	100.0
Col %	33.3	77.4	49.4
TOTAL	54	31	85
Row %	63.5	36.5	100.0
Col %	100.0	100.0	100.0

$\chi^2 = 15.31$; $p < 0.0001$; S-Significant

Chi-square test showed that there was significant association between age and Diastolic Dysfunction of the patients ($p < 0.0001$).

The risk of having Diastolic Dysfunction was 6.85 times more among the patients with age ≥ 55 years as compared to the patients with age < 55 years and the risk was significant [OR-6.85 (2.48, 18.90); $p < 0.0001$].

Table-4: Distribution of gender and Diastolic Dysfunction of the patients

Gender	Diastolic Dysfunction		TOTAL
	Present	Absent	
Female	35	12	47
Row %	74.5	25.5	100.0
Col %	64.8	38.7	55.3
Male	19	19	38
Row %	50.0	50.0	100.0
Col %	35.2	61.3	44.7
TOTAL	54	31	85
Row %	63.5	36.5	100.0
Col %	100.0	100.0	100.0

$\chi^2 = 5.42$; $p = 0.019$; S-Significant

Chi-square test showed that there was significant association between gender and DD of the patients ($p = 0.019$). The risk of having DD was 2.91 times more among the female patients as compared to the male patients and the risk was not significant [OR-2.91 (1.17, 7.27); $p = 0.019$].

Table-5: Distribution of BMI and Diastolic Dysfunction of the patients

BMI (kg/m ²)	Diastolic Dysfunction		TOTAL
	Present	Absent	
≥ 25 (Obese)	36	10	46
Row %	78.3	21.7	100.0
Col %	66.7	32.3	54.1
< 25 (Normal)	18	21	39
Row %	46.2	53.8	100.0
Col %	33.3	67.7	45.9
TOTAL	54	31	85
Row %	63.5	36.5	100.0
Col %	100.0	100.0	100.0

$\chi^2 = 9.39$; $p = 0.002$;

S-

Significant

Chi-square test showed that there was significant association between obesity and DD of the patients (p=0.002). The risk of having Diastolic Dysfunction was 4.20 times more among the patients with BMI \geq 25 kg/m² as compared to the patients with BMI<25 kg/m² and the risk was significant [OR-4.20 (1.63, 10.77); p=0.002].

Table-6: Distribution of level of HbA1c and Diastolic Dysfunction of the patients

Level of HbA1c (in %)	Diastolic Dysfunction		TOTAL
	Present	Absent	
>6.5	50	13	63
Row %	79.4	20.6	100.0
Col %	92.6	41.9	74.1
\leq 6.5	4	18	22
Row %	18.2	81.8	100.0
Col %	7.4	58.1	25.9
TOTAL	54	31	85
Row %	63.5	36.5	100.0
Col %	100.0	100.0	100.0

$\chi^2 = 26.34$; p<0.0001; S-Significant

Chi-square test showed that there was significant association between level of HbA1c and DD of the patients (p<0.0001). The risk of having DD was 17.30 times more among the patients with level of HbA1c >6.5% as compared to the patients with level of HbA1c \leq 6.5% and the risk was significant [OR-17.30 (4.99, 60.01);p<0.0001].

Discussion

This is a single centered hospital based cross sectional study undertaken among inpatients and outpatients of Apollo Gleneagles hospital Kolkata. This study was carried out in a time period of 15 months. Heart failure is one of the common reasons for admission in hospital.

Previously it was thought that heart failure is because of decreased pumping action of ventricles that is EF but over the time it was shown that patients present to hospital with heart failure but EF was normal. Then the concept came into action that is Diastolic heart failure. Diabetes is a common risk factor for diastolic heart failure. The prevalence of patients with concomitant heart failure (HF) and diabetes mellitus (DM) is growing exponentially with the aging of the general population. Approximately 40% of patients hospitalized with HF and reduced ejection fraction (EF) have Diabetes Mellitus Type 2 with an important epidemiologic, clinical, and economic impact. Diabetes was an independent predictor of CV morbidity and mortality in patients with HF, regardless of EF. The relative risk of CV death or HF hospitalization conferred by diabetes was significantly greater in patients with preserved when compared with those with low EF HF.⁸

The prevalence of diastolic dysfunction increases with age and it is more common in females. The age group of patients in our study is 40-65 yrs. There was significant association between age and diastolic dysfunction of patients (p<0.0001).The risk of having diastolic dysfunction was 6.85 times more among the patients with age group of >_55 yrs as compared

the patients with age of <55yrs and risk was significant. In this study 54 patients were having diastolic dysfunction, amongst which 36 patients were age of <55 yrs and 18 were above the age group of >55 yrs. Mean age group of patients with DD is 56.46 ± 4.60 yrs and those without DD mean age group is 51.03 ± 5.64 yrs ($p < 0.0001$). These findings were consistent with the finding from study by Patil et al.⁹ They have strongly concluded that prevalence of diastolic dysfunction increases with age.

In this study it is found that diastolic dysfunction is more prevalent in females. There are 47 females in this study amongst which 35 female patients had diastolic dysfunction and there are 38 male patients amongst which 19 had diastolic dysfunction. Chi-square test showed that there was significant association between gender and diastolic dysfunction (67).¹⁰ The risk of having DD was 2.91 times more among female patients as compared to male patients and the risk was not significant ($p = 0.019$). So concluding that DD is more prevalent in females in our study which is in accordance to that suggested in study by Ferreira RG et al (67) and Shim CY et al.¹¹ Heart failure with preserved ejection fraction is more common in women. Arterial stiffness has been suggested as a significant contributor to the development of heart failure.¹¹ Women with diabetes appeared to be especially vulnerable and, irrespective of coronary disease status, had twice the frequency of congestive heart failure as men.¹²

Obesity is a risk factor for heart failure. Patients in this study above the BMI of ≥ 25 were total 46. Amongst 46 patients, 36 had diastolic dysfunction and those with BMI of < 25 were total 39, amongst which 18 showed DD. Chi-square test showed that there was significant association between obesity and DD of patients ($p = 0.002$). Risk of having DD was more among the patients with BMI of > 25 as compared with BMI of < 25 and risk was significant (OR-4.20), ($p = 0.002$). Mean BMI for patients with DD 25.93 ± 2.87 kg/m² and those without DD mean BMI is 25.7 ± 2.62 kg/m². These findings are consistent with the study done by Nichols GA et al¹³ and Patil VC et al⁹. They strongly concluded that obesity is a strong risk factor for diastolic heart failure. Subjects with high waist circumference and high waist to hip ratio had statistically significant diastolic dysfunction.⁹

In this study, the level of HbA1c value correlates with the diastolic dysfunction. The Number of patients with HbA1c value $> 6.5\%$ were 63, amongst which 50 patients had DD. Those patients with HbA1c value of $\leq 6.5\%$ were 22, amongst which 4 patients had DD. Chi-square showed that there was significant association between level of HbA1c and DD of the patients ($p < 0.0001$). Risk of having DD was 17.30 times more among the patients with level of HbA1c $> 6.5\%$ as compared to the patients with level of HbA1c $\leq 6.5\%$ and risk was significant (OR-17.30) ($p < 0.0001$). Mean level of HbA1c in patients with DD was $7.70 \pm 1.07\%$ and mean level for those without DD was $6.53 \pm 0.61\%$. ($p < 0.0001$). So, prevalence of Diastolic dysfunction is associated with HbA1c. As the value of HbA1c increases, risk of DD increases. Patil V C⁹ strongly concluded that prevalence of DD increases with value of HbA1c. The patients with elevated blood glucose levels at hospital admission are more likely to die acutely (49). The HbA1C at the time of diagnosis, higher will be the incidence of LVDD.¹⁴

Duration of diabetes is an important factor in heart failure prevalence. In this study it was found that patients with duration of diabetes ≥ 10 yrs were total 10 patients, amongst which 9 patients had DD. And patients with duration of < 10 yrs were total 75 patients amongst which 45 showed DD. Risk of having DD was 6 times more among the patients with duration of ≥ 10 yrs as compared to the patients with duration of < 10 yrs but risk was not significant ($p = 0.06$). So, the prevalence of DD in the group of patients with duration of diabetes of ≥ 10 yrs is more as compared to the patients with duration of diabetes of < 10 yrs. These findings are consistent with findings from study of Patil V C⁹, they concluded that prevalence of DD is more in the group of patients with duration of diabetes is more. The prevalence of diastolic dysfunction

increased with longer duration of diabetes. There was a linear progression of diastolic dysfunction with the increase age group.

Conclusion

- HFPEF is a new entity but its very common and accounts for about 50% of the all cases of heart failure. HFPEF has not been studied as extensively as HFREF. Diabetes was an independent predictor of CV morbidity and mortality in patients with HF, regardless of EF. In the present study diastolic heart failure was more common in diabetes and prevalence of diastolic heart failure was 63.5%. There was significant association between age and diastolic dysfunction of patients ($p < 0.0001$). The risk of having diastolic dysfunction was 6.85 times more among the patients with age group of ≥ 55 years as compared the patients with age of < 55 yrs and risk was significant. Chi-square test showed that there was significant association between gender and diastolic dysfunction. The risk of having DD was 2.91 times more among female patients as compared to male patients and the risk was not significant. In this study diastolic dysfunction was more common in females.
- Obesity is a strong risk factor for heart failure. Chi-square test showed that there was significant association between obesity and DD of patients ($p = 0.002$). Risk of having DD was more among the patients with BMI of ≥ 25 as compared with BMI of < 25 . and risk was significant. There was significant association between level of HbA1c and DD of the patients. Prevalence of DD increases with value of HbA1c.
- Prevalence of DD in the group of patients with duration of diabetes of ≥ 10 years is more as compared to the patients with duration of diabetes of < 10 yrs.
- The prevalence of diastolic dysfunction increased with longer duration of diabetes.

Conflict of interest: Nil

Source of funding: Self funded

References

1. Nieminen MS, Brutsaert D, Dickstein K, Drexler H, Follath F, Harjola VP et al. EuroHeart Failure Survey II (EHFS II): a survey on hospitalized acute heart failure patients: description of population. *Eur Heart J* 2006;27:2725–36.
2. Thrainsdottir IS, Aspelund T, Thorgeirsson G, Gudnason V, Hardarson T, Malmberg K et al. The association between glucose abnormalities and heart failure in the population-based Reykjavik study. *Diabetes Care* 2005;28(3):612-16.
3. National Heart Lung and Blood Institute. People Science Health. What is heart failure? <http://www.nhlbi.nih.gov/health/health-topics/topics/hf/>. Accessed February 2012.
4. King H, Aubert RE, Herman WH. Global burden of diabetes, 1995-2025: prevalence, numerical estimates, and projections. *Diabetes Care* 1998;21:1414-31.
5. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. *Diabetes Care* 2004;27:1047-53.
6. Bonow RO, Gheorghide M. The diabetes epidemic: a national and global crisis. *Am J Med* 2004;116 Suppl 5A:2S-10S.
7. Davies M, Hobbs F, Davis R, Kenkre J, Roalfe AK, Hare R et al. Prevalence of left-ventricular systolic dysfunction and heart failure in the Echocardiographic Heart of England Screening study: a population-based study. *Lancet* 2001;358:439–44.
8. MacDonald MR, Petrie MC, Varyani F, Ostergren J, Michelson EL, Young JB, et al. Impact of diabetes on outcomes in patients with low and preserved ejection fraction heart failure:

- an analysis of the Candesartan in Heart failure: Assessment of Reduction in Mortality and morbidity (CHARM) programme. *Eur Heart J* 2008;29:1377-85.
9. Patil VC, Shah KB, Vasani JD, Shetty P, Patil HV. Diastolic dysfunction in asymptomatic type 2 diabetes mellitus with normal systolic function. *Journal of cardiovascular disease research*. 2011 Oct 1;2(4):213-22.
 10. Ferreira RG, Worthington A, Huang CC, Aranki SF, Muehlschlegel JD. Sex differences in the prevalence of diastolic dysfunction in cardiac surgical patients. *Journal of cardiac surgery*. 2015 Mar 1;30(3):238-45.
 11. Shim CY, Park S, Choi D, Yang WI, Cho IJ, Choi EY, Chung N, Ha JW. Sex differences in central hemodynamics and their relationship to left ventricular diastolic function. *Journal of the American College of Cardiology*. 2011 Mar 8;57(10):1226-33.
 12. Kannel WB, Hjortland M, Castelli WP. Role of diabetes in congestive heart failure: the Framingham study. *Am J Cardiol*. 1974 Jul;34(1):29-34.
 13. Nichols GA, Gullion CM, Koro CE, Ephross SA, Brown JB. The incidence of congestive heart failure in type 2 diabetes: an update. *Diabetes Care* 2004;27:1879–84
 14. Chaudhary AK, Aneja GK, Shukla S, Razi SM. Study on Diastolic Dysfunction in Newly Diagnosed Type 2 Diabetes Mellitus and its Correlation with Glycosylated Haemoglobin (HbA1C). *Journal of clinical and diagnostic research: JCDR*. 2015 Aug;9(8):OC20-2.