Original Research Article

A study of diastolic dysfunction in normotensive type 2 diabetes mellitus above 60 years of age

Rucha Sane[1*], Shriraj Kane[2], T. K. Biswas[3]

[1]Junior Resident, [2]Lecturer, [3]Professor and HOD
Dept. of Geriatrics, MGM Medical College & Hospital, MGM University of Health Sciences (Deemed University), Navi Mumbai, Maharashtra, India
[*]Corresponding author email: **ruchasane19@gmail.com**

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Abstract

Background: Nowadays, diabetes has become the one of the most important health problem and has large impact on the health care system mainly due to long term complications of diabetes involving all organs including heart. There have been few studies that have evaluated the development of systolic and diastolic LV dysfunction in normotensive type 2 DM patients, particularly in elderly age group. The present study was undertaken to make further inroads into this aspects of diabetes that will have implications in managements of diabetes as a whole.

Aim: To assess the relationship between diabetes mellitus and variables like increasing age, BMI and glycemic control with the development of diastolic dysfunction in normotensive patients of more than 60 years age.

Materials and methods: A cross sectional study was conducted consisting of all the patients fulfilling the inclusion criteria attending as outpatient or inpatient in the department of Geriatric Medicine in MGM Medical College and Hospital with valid informed consent with sample size 100.

Results: The present study showed 48% prevalence of diastolic dysfunction in patients of Normotensive type 2 diabetes mellitus without any co-morbidities. Increasing age and duration of diabetes, elevated BMI, poorly controlled diabetes was associated with statistically significant increase in diastolic dysfunction. Gender, smoking, alcohol and treatment taken for diabetes did not play any significant role in contributing to diastolic dysfunction.

Conclusion: Mortality and morbidity associated with diastolic dysfunction in elderly diabetics can be prevented by controlling preventable variables like BMI and HbA1c with strict glycemic control and exercise. By early detection of diastolic dysfunction by regular evaluation with non-invasive

echocardiography and doppler, early interventions and management could be initiated and the process can be reversed to an extent.

Key words

Diastolic dysfunction, Type 2 diabetes mellitus, Body mass index, HbA1c, Alcohol, Smoking, Non-invasive echocardiography.

Introduction

Nowadays, diabetes has become the one of the most important health problem and has large impact on the health care system mainly due to long term complications of diabetes. As diabetic complications may involve all organs, diabetic patients are examined regularly for possible development of organ dysfunction. However, little attention is paid for the study of heart function in diabetic patients.

There have been few studies that have evaluated the development of systolic and diastolic LV dysfunction in type 2 DM patients, who are normotensive and have no cardiac symptoms particularly in elderly age group [1]. By early detection of diastolic dysfunction with regular evaluation by non-invasive techniques early interventions can be done & the process can be reversed to an extent. The present study is undertaken to make further inroads into this aspects of diabetes that will have implications in managements of diabetes as a whole.

Aim

To assess the relationship between diabetes mellitus and variables like increasing age, BMI & glycemic control with the development of diastolic dysfunction in normotensive patients of more than 60 years age.

Materials and methods

Source of data: Patients with type 2 diabetes mellitus admitted or visited as out-patient in MGM Hospital, Kamothe.

Methods of collection of data: 100 cases of type 2 diabetes mellitus, admitted or attended as out-patients, in MGM Hospital Kamothe, during the period April 2019 to September 2020.

Inclusion criteria

- A case of Type 2 Diabetes Mellitus.
- Age: above 60 years
- Blood pressure: $\leq$ 140/90 (at least 3 recordings with the highest recording taken into consideration)

Criteria of diabetes mellitus type 2 includes:

- Patients were already known diabetic on oral hypoglycaemic agents or insulin.
- Symptoms of diabetes mellitus with random blood sugar $\geq$200mg/dl.
- Fasting plasma glucose $\geq$ 126mg/dl
- Two hour plasma glucose $\geq$200 mg/dl
- HbA1c $\geq$6.5

Exclusion criteria

Patients with:

- Systemic hypertension (BP >140/90) or history of hypertension on anti-hypertensives.
- Ischemic heart disease (abnormal E.C.G. and / or RWMA on ECHO)
- Congestive heart failure
- Congenital or Acquired valvular heart disease
- Chronic renal failure
- Age <60 years of age
- Blood urea >40 mg/dl and serum creatinine >1.2 mg/dl

Results

100 cases of normotensive diabetics fulfilling the inclusion criteria were taken in the cross sectional study. Out of 100 patients included, 60 were female and 40 were male (**Table - 1**).

Age: The study population was divided in 4 groups age wise within 60 – 80 years. Out of the

studied population, majority were in the age group of 66-75 (49 %) (**Table - 2, Chart - 1**).

Smoking: Out of the 40 male patients, 47% were smokers and 53% were nonsmokers. All female patients in this study were nonsmokers (**Table - 3**).

Alcohol: Out of the 40 male patients, 37.5% were alcoholics and 62.5% were non alcoholics. No female patients in this study were alcoholic (**Table - 4**).

Duration of diabetes: The study population was divided into 3 groups based on duration of diabetes since detection. Majority of the population was within first 10 years of detection of diabetes (82%) (**Table - 5**).

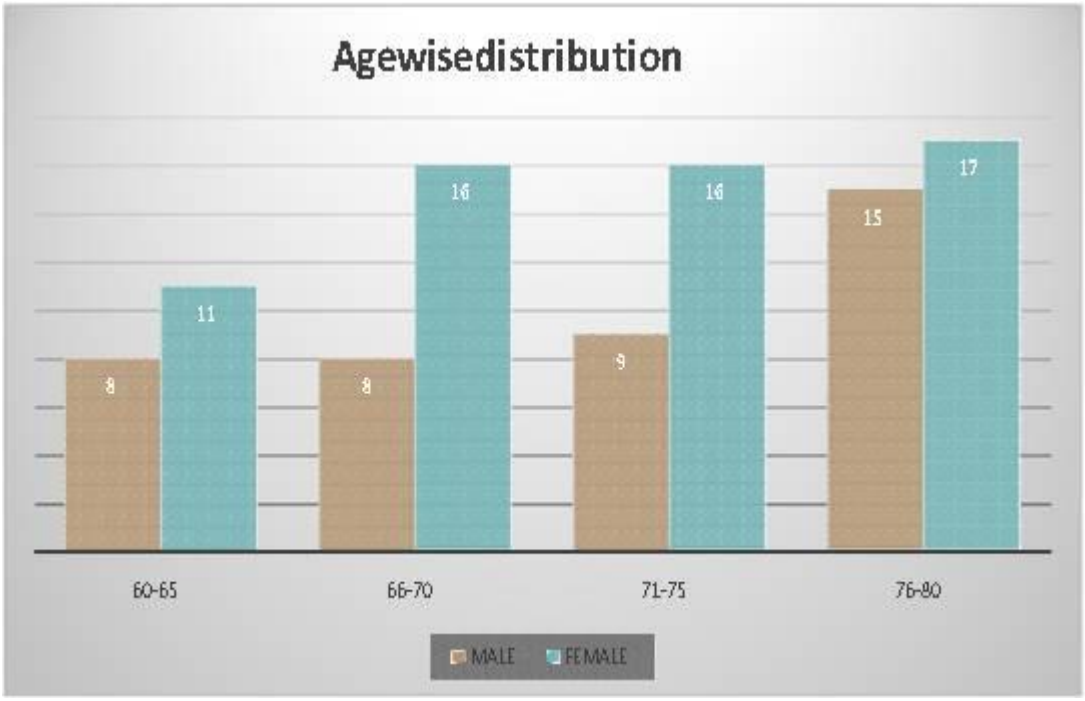
Table - 1: Gender wise distribution of cases.

No of cases	Male	Female
100	40	60

Table - 2: Age wise distribution of cases.

Age (Years)	60-65	66-70	71-75	76-80	Total
Male	8	8	9	15	40
Female	11	16	16	17	60
Total	19	24	25	32	100

Chart – 1: Age wise distribution of cases.



Treatment taken: Out of the study population, patients were divided according to treatment taken. The study population included majority of the cases taking OHA (71%) as the treatment option (**Table - 6, Chart - 2**).

BMI: Weight and height measurements of the study population were taken and BMI calculated accordingly. They were divided into 3 groups based on BMI as normal, over weight and obese. Majority of the population was in overweight group (BMI25-29.9) (**Table - 7**).

Table - 3: Distribution of males with relation to smoking.

Smokers	Non-smokers	Total
19(47%)	21(53%)	40

Table - 4: Distribution of males with relation to alcohol consumption.

Alcoholics	Non-alcoholics	Total
15(37.5%)	25(62.5%)	40

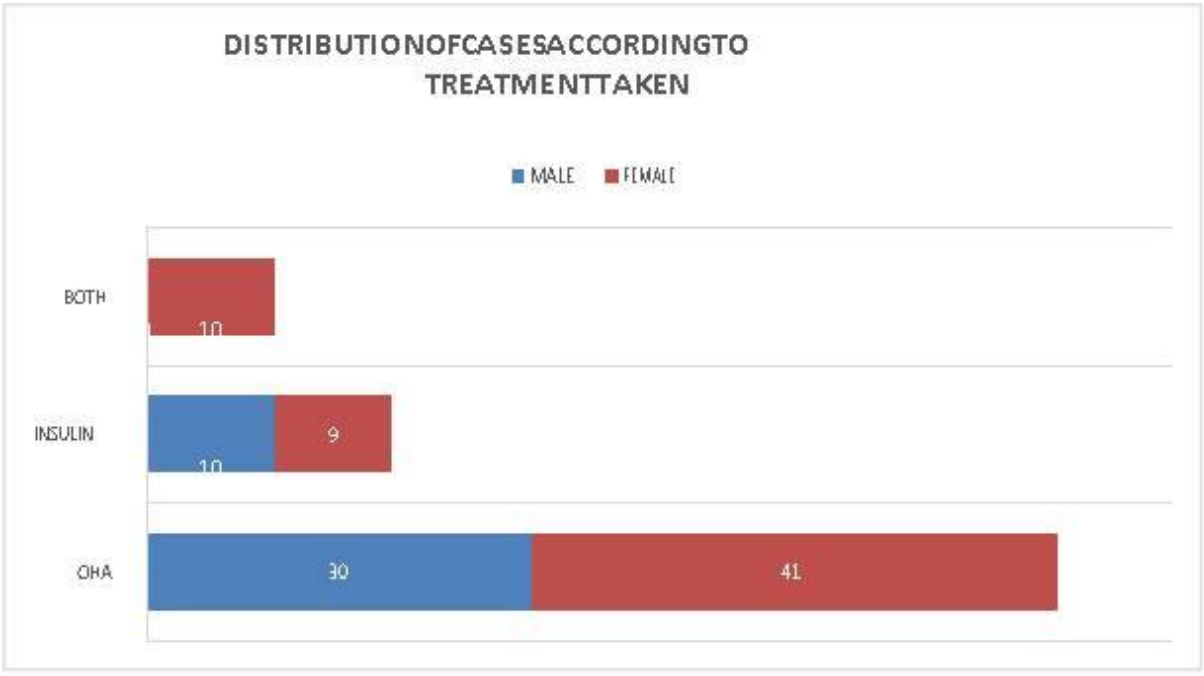
Table - 5: Distribution of population according to duration of diabetes.

Duration	0-5 years	6-10 years	>10 years	Total
Male	19	16	05	40
Female	25	22	13	60
Total	**44**	**38**	**18**	**100**

Table - 6: Distribution of cases according to treatment taken for diabetes.

Treatment	OHA	Insulin	Both	Total
Male	30	10	0	40
Female	41	9	10	60
Total	**71**	**19**	**10**	**100**

Chart – 2: Distribution of cases according to treatment taken for diabetes.



HbA1c: The glycemic control of the study population was measured by correlating with the HbA1c level. The cases were divided into three groups according to the HbA1c levels. Majority of the study population had HbA1c levels above 7 (92%) (**Table - 8**).

Diastolic dysfunction (DD) in diabetes mellitus type 2: Out of 100 cases taken, diastolic dysfunction was present in 48 cases (48%) (**Table - 9**).

Gender wise distribution: Out of 40 males taken in study population, diastolic dysfunction

was present equally among the cases. 20 (50%) male diabetic patients had diastolic dysfunction. Out of 60 females taken in study population, diastolic dysfunction was present in 28 females (47%). Gender wise distribution showed no statistical significance in relation with diastolic dysfunction (P value- 0.744: statistically not significant) (**Table - 10**).

Table - 7: Distribution of cases according to BMI.

BMI	**19-24.99**	**25-29.99**	**30**	**Total**
Male	2	19	19	40
Female	16	31	13	60
Total	**18**	**50**	**32**	**100**

Table - 8: Distribution of cases according to HbA1c levels.

HbA1c	**6.5-7**	**7.1-8**	**>8**	**TOTAL**
Male	3	17	20	40
Female	5	29	26	60
Total	**8**	**46**	**46**	**100**

Table - 9: Distribution of diastolic dysfunction.

DD	**Present**	**Absent**	**Total**
No. of cases	48	52	100

Table - 10: Gender wise distribution of diastolic dysfunction.

DD	**Present**	**Absent**	**Total**
Males	20(50%)	20(50%)	40
Females	28(47%)	32(53%)	60

Table - 11: Age wise distribution of diastolic dysfunction.

Age in years\DD	**Present**	**Absent**	**Total**
60-65	3(15.8%)	16(84.2%)	19(100%)
66-70	12(50%)	12(50%)	24(100%)
71-75	09(36%)	16(64%)	25(100%)
76-80	24(75%)	08(25%)	32(100%)

Table - 12: Correlation of diastolic dysfunction between smokers vs non-smokers.

DD	**Present**	**Absent**	**Total**
Smokers	11(57.9%)	8(42.1%)	19(100%)
Non-smokers	9(42.9%)	12(57.1%)	21(100%)

Table - 13: Correlation of diastolic dysfunction between alcoholics vs non alcoholics.

DD	**Present**	**Absent**	**Total**
Alcoholic	8(53.3%)	7(46.7%)	15(100%)
Non alcoholic	12(48%)	13(52%)	25(100%)

Age wise distribution: Out of 32 cases in the age group of 76-80 years, 24 (75%) cases had diastolic dysfunction whereas 3 cases (15.8%) out of 19 in 60-65 age group had diastolic dysfunction. The percentage of DD increased in the older age groups (P value - 0.001: Statistically significant) (**Table - 11**).

Table - 14: Correlation with duration of diabetes with diastolic dysfunction.

DD\Duration	Present	Absent	Total
0-5	15(34.1%)	29(65.1%)	44(100%)
6-10	20(52.6%)	18(47.4%)	38(100%)
>10	13(72.2%)	05(27.8%)	18(100%)

Table - 15: Correlation of treatment taken with diastolic dysfunction.

DD\Treatment	Present	Absent	Total
OHA	28(39.4%)	43(60.6%)	71(100%)
Insulin	13(68.4%)	06(31.6%)	19(100%)
Both	07(70%)	03(30%)	10(100%)

Table - 16: Correlation of BMI with diastolic dysfunction.

DD\BMI	Present	Absent	Total
19-24.9	1(5.6%)	17(94.4%)	18(100%)
25-29.9	22(44%)	28(56%)	50(100%)
>=30	25(78.1)	07(21.9%)	32(100%)

Table - 17: Correlation of HbA1cwith diastolic dysfunction (DD).

DD\HbA1c	Present	Absent	Total
6.4-7	2(25%)	6(75%)	8(100%)
7.1-8	13(28.3%)	33(71.7%)	46(100%)
>8	33(71.7%)	13(28.3%)	46(100%)

Smoking: Out of the 40 male patients, 19 were smokers out of which 57.9% had diastolic dysfunction; whereas out of 21 non-smokers 42.9% had diastolic dysfunction (P value – 0.52: not statistically significant). In the present study, smoking shows no association with diastolic dysfunction (**Table - 12**).

Alcohol: Out of 40 male patients, 15 were alcoholic out of which 53.3% had diastolic dysfunction whereas out of 25 nonalcoholic patients 48% had diastolic dysfunction. In the present study, alcohol had no significant association with diastolic dysfunction (P value – 0.74 : not statistically significant) (**Table - 13**).

Duration of diabetes: Out of 18 cases with duration of diabetes >10 years, 13 cases (72.2%) had diastolic dysfunction as compared to 15 cases (34.1%) out of 44 with duration between 0-5 years had diastolic dysfunction. The present study showed significant correlation between duration of diabetes detection and diastolic dysfunction. As the duration from detection of diabetes mellitus increased, the percentage of DD increased (P value – 0.019: statistically significant) (**Table - 14**).

Treatment taken: Out of the study population,71% were on OHA; out of which 39.4% had diastolic dysfunction.19 % were on insulin out of which 68% had DD and 10 were on both out of which 70% had DD. The present study showed no significance between treatment taken and diastolic dysfunction (P value 0.07: not statistically significant) (**Table - 15**).

BMI: Out of the study population, 32% were obese out of which 78.1% (25 cases) had diastolic dysfunction. 44% of the overweight group had diastolic dysfunction whereas only 5.6% of the normal weight group had DD. Our study showed statistically significant correlation between BMI and diastolic dysfunction. Elevated BMI increased the incidence of diastolic

dysfunction (P value – 0.001: statistically significant) (**Table - 16**).

HbA1c: Out of 46% cases with HbA1c levels >8, 71.7% (33 cases) had diastolic dysfunction whereas out of 46% cases with HbA1c 7.1 to 8; 28.3% (13 cases) had diastolic dysfunction and 25% (2 out of 8 cases) with HbA1c 6.4to 7 had DD. The study showed statistically significant correlation between diastolic dysfunction and HbA1c levels. The poorer the glycemic control, more the incidence of diastolic dysfunction (P value 0.001: statistically significant) (**Table - 17**).

Discussion

100 cases of normotensive diabetes mellitus type 2 fulfilling the inclusion criteria attending the outpatient or inpatient department of Geriatric Medicine at MGM Medical and College Hospital were included in the study. Out of the 100 cases in study population, 48 cases (48%) were detected to have diastolic dysfunction. Numerous studies have shown that impairment of the LV diastolic function may be detected in patients with diabetes. Regan, et al. [2] demonstrated in normotensive, diabetic patients without coronary artery disease and without clinical evidence of heart failure, increased left-ventricular end-diastolic pressure, a decreased left-ventricular end-diastolic volume with a normal ejection fraction. Paul Poirieretal [3] in 2001evaluated 40 diabetic patients without clinical evidence of cardiac disease by Doppler Echocardiography and came to conclusion that diastolic function in diabetic patients was impaired even in patients with normal systolic function. In our study most of the patients had duration of diabetes less than 10 years. This was because, as the duration of diabetes increased, other associated co-morbid diseases like hypertension, IHD, would also appear and hence could not be included in our study. So the patients with duration of diabetes more than 15 years were less. When the treatment profile was evaluated most of the patients were on OHAs / OHAs with insulin, most of the subjects had poor glycemic control, reasons are multifactorial viz., poor compliance of the patient with reference to treatment, lifestyle modifications, inadequate doses, poor regular checkup. Left ventricular diastolic dysfunction was found in 48% cases in our study which was comparable to most other studies (**Table – 18).**

Table – 18: Comparison of diastolic dysfunction with other studies.

Studies	Percentage
Poirier, et al. Study [3]	60
Faden, et al. [4]	64
Markuszewsk, et al. [5]	43
Virendra Patil, et al. (2011) [6]	54.33
Present study	48

Gender wise distribution of cases suggested that 47% of females had diastolic dysfunction whereas 50% of males had diastolic dysfunction. The gender wise distribution was not statistically significant and comparable to various other studies. Out of the cases, history regarding smoking and alcohol was enquired and correlated. None of the females had any addictions. 47% male were smokers and 53% were non-smokers. Out of the 40 male cases, 37.5% were alcoholic and 62.5% were non-alcoholic. Smoking and alcohol had no direct correlation with diastolic dysfunction and was found to be statistically insignificant.

Out of the 100 cases, 75% cases in the age group of 76-80 years; 36% in the age group of 71-75 years; 50% in the age group of 66-70 had diastolic dysfunction whereas only 15.8% in 60-65 age group had diastolic dysfunction. The incidence of diastolic dysfunction was highest in the age group 70- 80 years. This finding was statistically significant (P value 0.001). Thus older the age group, more is the diastolic dysfunction. Similar results were found in, Virendrapatil, et al. (2011) [6] who concluded that diastolic dysfunction was significantly higher in age >45 years compared to age <45 years (p value < .05).

Also Gani, et al. (2005) [7] concluded that the age of patients had significant correlation with E/A ratio of transmitral Doppler flow ($p<0.01$) i.e. patients with higher age group have more diastolic dysfunction. The prevalence of diastolic dysfunction increased with the duration of disease. In the present study, out of the 100 cases, 44% were having duration of diabetes detection from 0 to 5 years; 38% with duration of diabetes 6-10 years and 18% with duration more than 10 years. Out of the 0-5 years group 34.1% cases; 6 -10 years group 52.6% cases and >10 years group 72.2% cases had diastolic dysfunction. This finding was found to be statistically significant (P value 0.019).The same was concluded by Gani, et al. (2005) [7]; in their study in 114 NIDDM patients, the duration of diabetes was independently associated with diastolic dysfunction. The duration of diabetes had significant correlation with EF ($r = -0.26$, $p<0.01$) and with E/A ratio .Also Virendra Patil, et al. (2011) [6] in their study found that out of 78 (61.41%) subjects with duration of diabetes between 6-10 years, 32 (41.02%) had diastolic dysfunction. Out of 49 (38.58%) subjects, with duration of diabetes between 11-15 years, 37 (75.51%) had diastolic dysfunction.

In the present study, out of the 100 cases, 8% had HbA1c levels between 6.4 -7 %; 46% had HbA1c levels between 7.1 to 8 % and 46% had HbA1c levels >8%. The prevalence of diastolic dysfunction increased as the glycemic control decreased. In the present study, 71.7% of the poorly controlled diabetics (HbA1c >8) had diastolic dysfunction; 28.3% with HbA1c levels between 7.1– 8 had diastolic dysfunction and 25% of the cases with good glycemic control (HbA1c levels 6.4–7) had diastolic dysfunction. The correlation was found to be statistically significant (P value 0.001).

The findings were consistent with previous studies. The study of Virendra Patil, et al. (2011) [6] showed that subjects with HbA1c > 7.5% had diastolic dysfunction. Subjects with HbA1c > 7.5% had more prevalence of diastolic dysfunction, than subjects with HbA1c < 7.5% (P value < 0.02).

Also Madhumathi R, et al. [8] in 2014 found that prevalence of diastolic dysfunction increased gradually with the rise in HbA1c levels and it was statistically significant. Markuszewsk, et al. [5] observed that diastolic dysfunction of the left ventricle was observed in 43% of patients with HbA1c >6.1% comparing to 4.5% of patients in the group with HbA1c $\leq$ 6.1%. Thus the study concluded that HbA1c is a strong independent risk factor in diabetes mellitus causing diastolic dysfunction.

Out of the study population, 32% were obese (BMI >30); 50% were overweight (BMI 25-29.9) whereas only 18% were in normal weight group. In the present study 78.1% of the obese diabetics had diastolic dysfunction; 44% of the overweight diabetics had diastolic dysfunction whereas only 5.6% of the normal weight diabetics had diastolic dysfunction. W AlJaroudi, et al. (2012) [9] in the largest cohort study relating to BMI with diastolic dysfunction showed that as BMI increased, the prevalence of normal diastolic function decreased (P 0.0001). Patil, et al. [6] however showed no significant correlation between BMI and diastolic dysfunction and showed the importance of increased waist- hip ratio and waist circumference being statistically significant with diastolic dysfunction.

Conclusion

The present cross sectional study conducted on 100 elderly Normotensive type 2 Diabetes Mellitus patients showed diabetes as an independent risk factor for diastolic dysfunction. Among the 100 cases, 48% had diastolic dysfunction. Among the other variables, age, elevated BMI and HbA1c were found to be associated with diastolic dysfunction. By comparing the presence and absence of diastolic dysfunction among the diabetic cases, the following variables were found to be statistically significant.

- Age

- Duration ofdiabetes
- Body MassIndex
- HbA1c levels

So by controlling the variables such as BMI and HbA1c which are preventable with strict glycemic control and exercise, we can prevent the mortality and morbidity associated with diastolic dysfunction in elderly diabetics to a greater extent. By early detection of Diastolic Dysfunction by regular evaluation by 2D-Echocardiography and Doppler studies which are non-invasive, early interventions and management could be initiated and the process can be reversed to an extent as Diastolic heart failure often remains asymptomatic in the early stage.

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