

Research Article

GALL BLADDER FUNCTION IN DIABETES MELLITUS: A CLINICAL PROSPECTIVE STUDY

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Abstract

Introduction: Diabetes mellitus (DM) is a complex, systemic metabolic disorder characterized by chronic hyperglycemia resulting from defects in insulin secretion, insulin action, or both.¹ While microvascular and macrovascular complications are well-recognized long-term sequelae of diabetes, the impact of chronic hyperglycemia on autonomic regulation and gastrointestinal smooth muscle dynamics particularly within the biliary system represents a critical yet frequently under diagnosed clinical domain.

Materials and methods: 65 Diabetic patients and 30 controls attending to the medical OPD/Wellness clinic of KIMS Hospital, Secunderabad (Study period of 24 months) and meeting the inclusion and exclusion criteria were studied. Initial history was directed towards obtaining details of duration of diabetes, hypertension and symptoms of dyspepsia if any. Laboratory investigations like fasting and post prandial blood sugar levels, HbA1c, lipid profile were done. The weight and height are recorded and BMI calculated. Autonomic neuropathy was determined by

using simple non invasive bedside tests like postural hypotension, Heart rate variability with Valsalva. After an overnight fast of 8 hours, the gall bladder parameters like length (L), transverse diameter (w) and AP diameter or height (H) are measured using ultrasonography. The subject was given a standard meal and gall bladder parameters were assessed after one hour.

Results: A total of 95 subjects are taken into the study. Among them 65 subjects are diabetics and 30 subjects (31.6%) are controls. Of the diabetic group 31 patients (47.7%) are males and 34 (52.3%) are females. In the control group both are equal. Of the diabetic subjects 24(36.9%) are obese, 30(46.2%) are over-weight and 11(16.9%) are non obese. Among 30 controls (20%) are obese and 19(63.3%) are over-weight. The number of subjects who are not obese is equal in diabetic and obese group. Glycemic control in cases of diabetes with autonomic neuropathy is poor. Among 32 cases with autonomic neuropathy 3(9.4%) have HbA1C <7, 10 (31.2%) have between 7-8 and 19(59.4%) have poor glycemic control >8. In 33 cases of diabetes without autonomic

neuropathy, 13(39.4%) have HbA1C<7 i.e good glycemic control, 18(54.4%) have HbA1C between 7-8 and 2(6.1%) have poor glycemic control.

Conclusion: Gall bladder dysfunction (as indicated by higher fasting volume and less ejection fraction) is directly proportional to the duration of diabetes and inversely proportional to the glycemic control. Incidence of gall stones and biliary sludge is higher in diabetics compared to controls (21.5% Vs 10%) for gallstones and (24.6% Vs 13%) for sludge. Mean fasting gall bladder volume is higher in diabetic cases with and without autonomic neuropathy (26.2cc and 23.3cc respectively) compared to non diabetic controls (17.5cc). Mean Gallbladder ejection fraction is lower in diabetics compared to controls (45.6% Vs 61.6%). Diabetics with autonomic neuropathy have lower EF than diabetics without autonomic neuropathy (41.3% Vs 49.8%).

Key Words: Diabetes mellitus, hypertension, HbA1c, lipid profile, autonomic neuropathy.

INTRODUCTION

Diabetes mellitus (DM) is a complex, systemic metabolic disorder characterized by chronic hyperglycemia resulting from defects in insulin secretion, insulin action, or both.¹ While microvascular and macrovascular complications are well-recognized long-term sequelae of diabetes, the impact of chronic hyperglycemia on autonomic regulation and gastrointestinal smooth muscle dynamics particularly within

the biliary system represents a critical yet frequently under diagnosed clinical domain.²

Since long time diabetes mellitus is one of the most common endocrine disorder and now a day it is on the rise due to advancing modern life style; characterized by multiple metabolic abnormalities which leads to long-term multi organ complications involving hepatobiliary system, kidneys, gastrointestinal tract, nerves, and blood vessels, thereby causing serious morbidity and mortality. Few previous studies had pointed towards an increased prevalence of gall bladder dysfunctions and its complications in diabetics.³

Those have been attributed to cholecystomegaly and impaired motility of gall bladder, mainly due to autonomic neuropathy commonly seen in chronic diabetics. Though prolonged bile stasis is the most important factor for gallstone formation but other risk factors i.e. age, sex, obesity, genetic predisposition, drugs, parity, diet, hyperlipidaemia, and ileal resection also contribute in it.⁴

In addition to different manifestations in many other systems of body, autonomic neuropathy is responsible to various manifestations in the gastrointestinal tract such as nocturnal diarrhoea, oesophageal dysmotility, gastropathies, constipation and gallbladder dysfunction which is consequence of vagal neuropathy and leads to decreased gastrointestinal motility.⁵ The duration of diabetes mellitus has significant positive correlation with prevalence of gallbladder disease. Type of therapy for

treatment has no significant association and the fasting plasma glucose level is inversely associated with gall bladder disease.⁶

OBJECTIVES OF THE STUDY

To study gall bladder function in diabetes mellitus.

In relation to controls, in correlation with parameters such as age, sex, BMI, hyperlipidemia and autonomic neuropathy

MATERIALS AND METHODS

Study area:

Krishna Institute of Medical Sciences is a 500 bedded, multispecialty hospital, located centrally on a sprawling campus at minister road, between secunderabad and Hyderabad. The centre specializes in multidisciplinary approach to various infectious and systemic diseases through departments of medicine & allied super specialities.

Study population:

65 Diabetic patients and 30 controls attending to the medical OPD/Wellness clinic of KIMS Hospital, Secunderabad (Study period of 24 months) and meeting the inclusion and exclusion criteria were studied.

Sample size and sampling technique:

It's a "prospective comparative study", in which 65 confirmed Diabetic cases were

compared with age sex related controls for gall bladder parameters fasting and post prandial.

Data collection technique and tools:

65 Diabetic patients and 30 controls attending to the medical/Surgical OPD/Wellness clinic of KIMS Hospital, Secunderabad between July 2012 to July 2014 (Study period of 24 months) and meeting the inclusion and exclusion criteria were studied.

Initial history was directed towards obtaining details of duration of diabetes, hypertension and symptoms of dyspepsia if any. Laboratory investigations like fasting and post prandial blood sugar levels, HbA1c, lipid profile were done.

The weight and height are recorded and BMI calculated.

Autonomic neuropathy was determined by using simple non invasive bedside tests like postural hypotension, Heart rate variability with Valsalva.

After an overnight fast of 8 hours, the gall bladder parameters like length (L), transverse diameter (w) and AP diameter or height (H) are measured using ultrasonography. The subject was given a standard meal and gall bladder parameters were assessed after one hour.

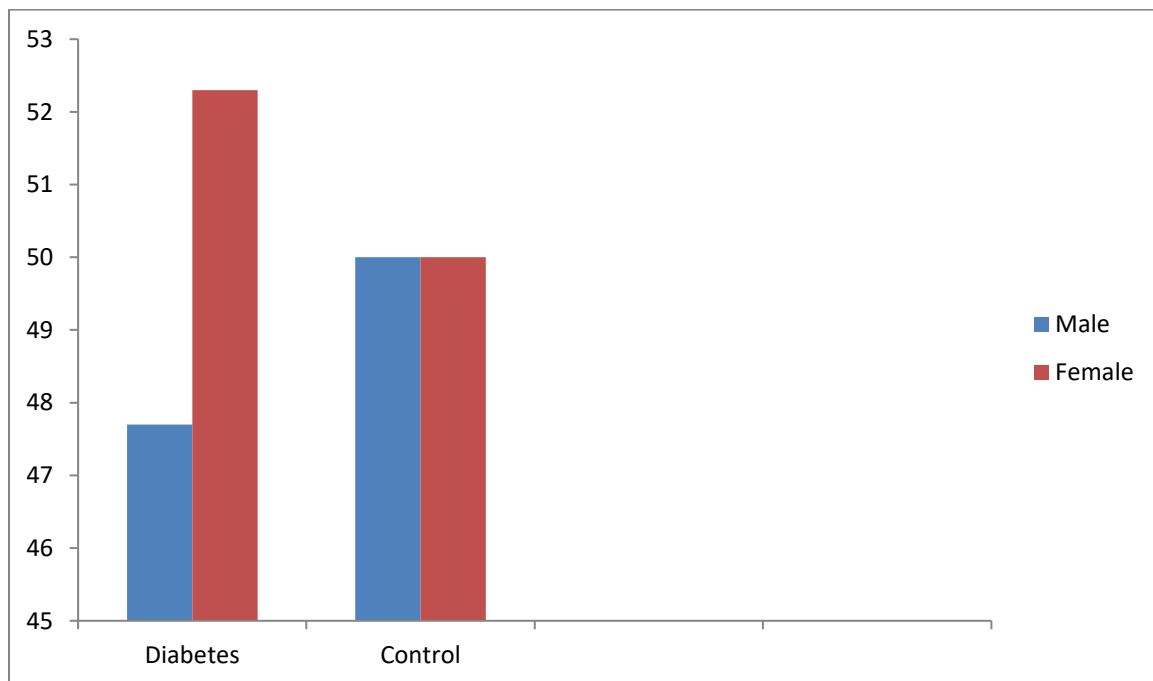
Data Analysis:

Data, charts and graphs were analyzed using Microsoft office Excel 2007.

RESULTS**Table 1: Diabetic and Control Distribution**

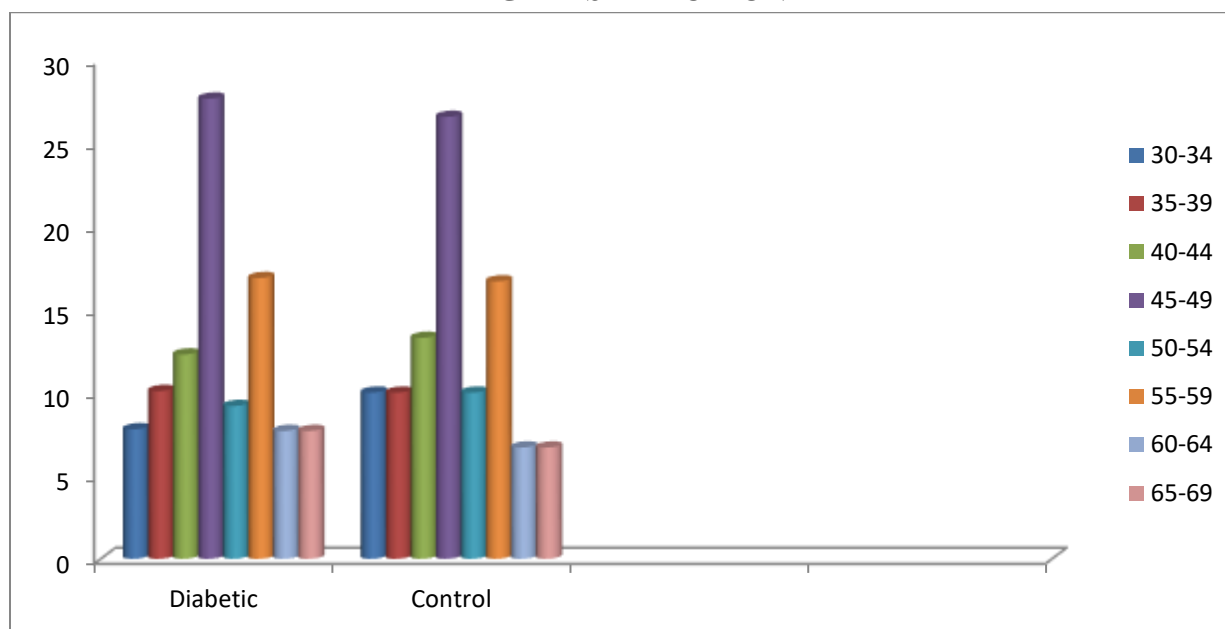
	No. of Patients	Percentage
Diabetes	65	68.4%
Control	30	31.6%

A total of 95 subjects are taken into the study. Among them 65 subjects are diabetics and 30 subjects (31.6%) are controls.

Distribution of Males and Females**Table 2: Distribution of Males and Females subjects**

	Diabetes	Controls
Male	31 (47.7%)	15(50%)
Female	34(52.3%)	15(50%)

Of the diabetic group 31 patients (47.7%) are males and 34 (52.3%) are females. In the control group both are equal.

AGE DISTRIBUTION**Table 3: Age distribution**

Age	Diabetic	Control
30-34	5 (7.8%)	3(10%)
35-39	7(10.1%)	3(10%)
40-44	8(12.3%)	4(13.3%)
45-49	18(27.7%)	9(26.6%)
50-54	6(9.2%)	3(10%)
55-59	11(16.9%)	5(16.7%)
60-64	5(7.7%)	2(6.7%)
65-69	5(7.7%)	2(6.7%)

Table 4: Incidence of Obesity in subjects with diabetes and control

	BMI	Diabetes	Control
Obese	> 30	24(36.9%)	6(20%)
Over weight	25-29.9	30(46.2%)	19(63.3%)
Non Obese	< 25	11(16.9%)	5(16.7%)

Of the diabetic subjects 24(36.9%) are obese, 30(46.2%) are over-weight and 11(16.9%) are non obese. Among 30 controls (20%) are obese and 19(63.3%) are over-weight. The number of subjects who are not obese is equal in diabetic and obese group.

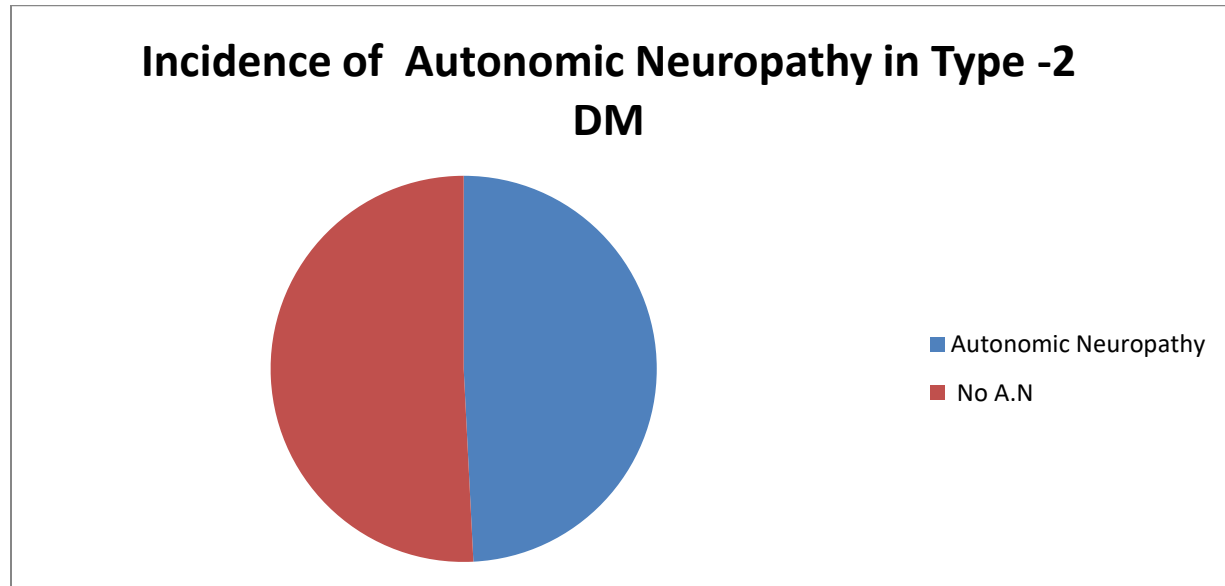


Table 5: Incidence of Autonomic Neuropathy in subjects with Diabetes

	No. of subjects	Percentage
Autonomic Neuropathy	32	49.2%
No	33	50.8%

Among 65 patients of diabetic subjects 32(49.2%) have autonomic neuropathy.

Table 6: Incidence of BMI <25 and > 25 in study group

	BMI <25	BMI ≥25
DM with autonomic neuropathy	4(22.2%)	28(36.4%)
DM without autonomic neuropathy	8(44.5%)	25(32.5%)
Control	6(33.3%)	24(31.1%)
Total	18	77

Table 7: Glycemic control in cases of DM

HbA1c	DM with Autonomic Neuropathy	DM without Autonomic Neuropathy
<7	3(9.4%)	13(39.4%)
7-8	10(31.2%)	18(54.5%)
≥8	19(59.4%)	2(6.1%)

Glycemic control in cases of diabetes with autonomic neuropathy is poor. Among 32 cases with autonomic neuropathy 3(9.4%) have HbA1C <7, 10 (31.2%) have between 7-8 and 19(59.4%) have poor glycemic control >8. In 33 cases of diabetes without autonomic neuropathy, 13(39.4%) have HbA1C<7 i.e good glycemic control, 18(54.4%) have HbA1C between 7-8 and 2(6.1%) have poor glycemic control.

Duration of Diabetes in correlation with Autonomic Neuropathy

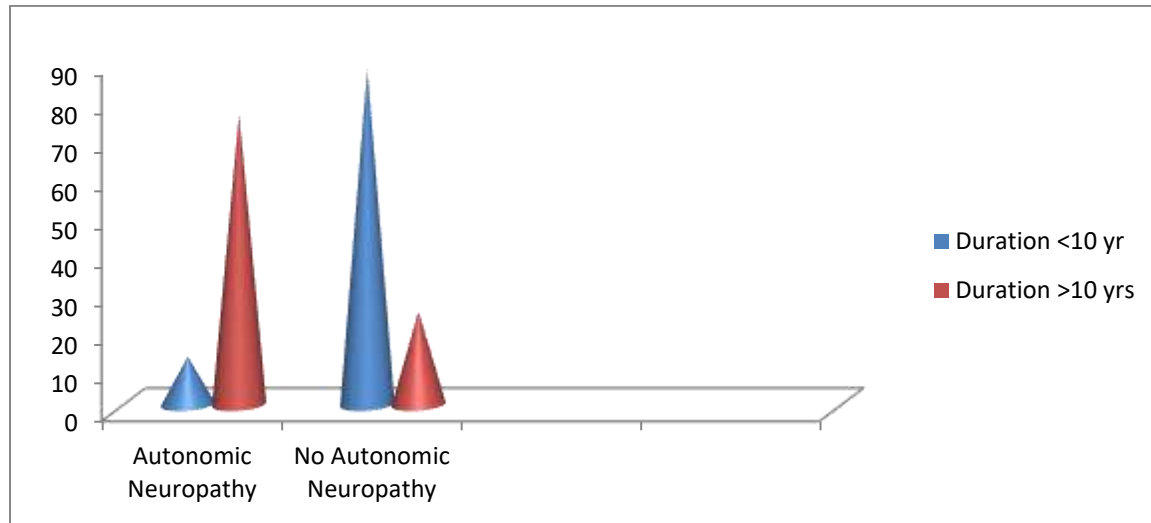


Table 8: Duration of Diabetes in correlation with Autonomic Neuropathy

Duration	Autonomic Neuropathy	No Autonomic Neuropathy
<10 yrs	4(12.5%)	25(75.7%)
>10 yrs	28(87.5%)	8(24.3%)

Among 32 diabetics with autonomic neuropathy, 28(87.5%) had diabetes for >10 years. While 4(12.5%) having autonomic neuropathy had diabetes for <10 years. Duration of diabetes >10 years was seen in only 8(24.3%) of the subjects without autonomic neuropathy.

Lipid Profile in Diabetic and Controls

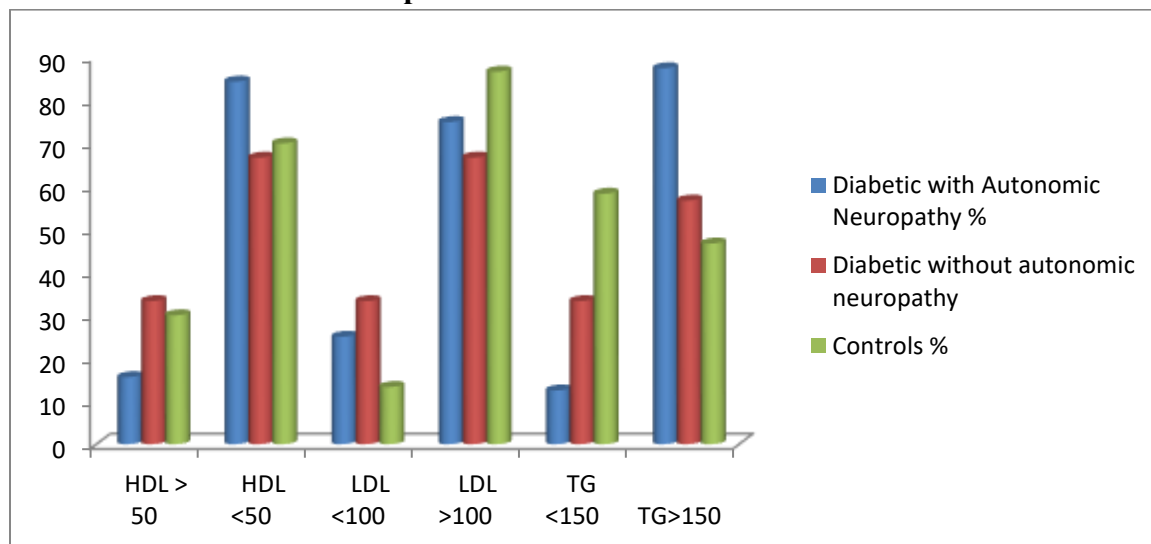


Table 9: Lipid Profile in Diabetics and Controls

	Diabetics with Autonomic neuropathy		Diabetics without autonomic neuropathy		Controls	
	No. of patients	Percentage	No. of Patients	Percentage	No. of Patients	Percentage
HDL						
>50	5	15.6%	11	33.3%	9	30%
<50	27	84.4%	22	66.7%	21	70%
LDL						
>100	8	25%	11	33.3%	4	13.3%
<100	24	75%	22	66.7%	26	86.7%
TG						
>150	4	12.5%	11	33.3%	16	58.3%
<150	28	87.5%	22	66.7%	14	46.7%

In diabetic subjects with autonomic neuropathy, 4(12.5%) have HDL, LDL and TG according to ADA and AHA recommendations. In diabetic subjects without autonomic neuropathy 11(33.3%) have HDL, LDL and TG according to ADA & AHA recommendations. In control group -4 (13.3%) subjects have HDL, LDL and TG according to ADA and AHA recommendations. Triglyceride level > 150 was seen in 28(87.5%) of diabetics with autonomic neuropathy and 22(66.7%) of diabetics without autonomic neuropathy. In control group TG < 150 in 16(53.3%) and > 150 in 14(46.7%) of subjects.

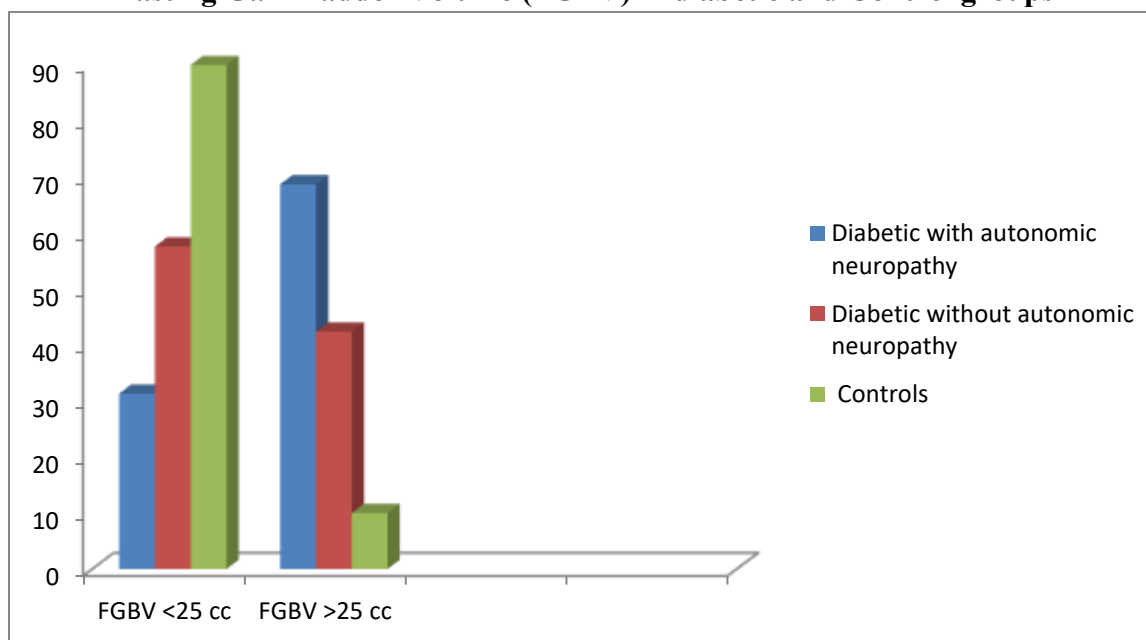
Fasting Gall Bladder Volume (FGBV) in diabetic and Control groups

Table 10: Fasting Gall Bladder Volume (FGBV) in Diabetic and Control Groups

	Diabetics with Autonomic neuropathy	Diabetics without autonomic neuropathy	Controls
< 25 cc	10(31.3%)	19(57.6%)	27(90%)
> 25 cc	22(68.7%)	14(42.4%)	3(10%)

Among 65 diabetics, 36(55.4%) have fasting gall bladder volume ≥ 25 cc. Among 30 controls, 3(10%) have a fasting gall bladder volume ≥ 25 cc and 27 (90%) have FGBV < 25 cc. Among diabetics with autonomic neuropathy 22 (68.7%) have FGBV ≥ 25 cc and 14 (42.4%) diabetics without autonomic neuropathy have FGBV ≥ 25 cc.

Table 11: Ejection fraction of gall bladder in diabetics and controls

	Diabetics with Autonomic neuropathy	Diabetics without autonomic neuropathy	Controls
< 45 %	19(59.4%)	8(24.2%)	4(13.3%)
45-55%	12(37.5%)	19(57.6%)	5(16.7%)
≥ 50	1(3.1%)	6(18.2%)	21(70%)
Total	32	33	30

In diabetics with autonomic neuropathy, EF < 45% in 19(59.4%), 12 subjects (37.5%) have EF 45-55% and 1(3.1%) has EF $\geq 55\%$.

Among diabetic without autonomic neuropathy 8(24.2%) have EF < 48%, 19 (57.6%) have EF between 45-55% and 6(18.2%) have EF > 55%.

In control group 4(13.3%) have EF < 45%, 5 (16.7%) have EF between 45-55% and 21 (70%) have EF > 55%.

Glycemic Control and fasting gall bladder volume

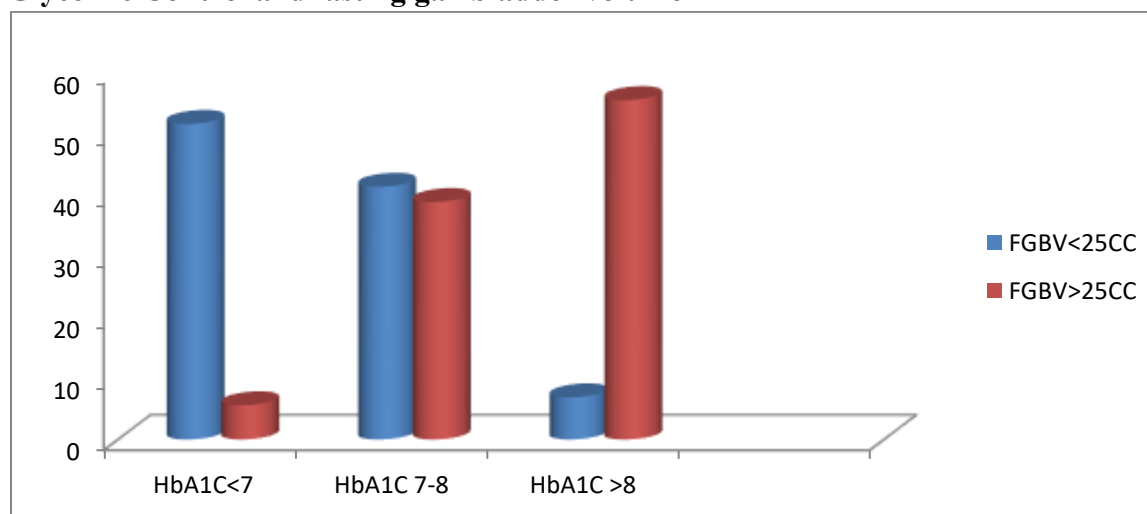
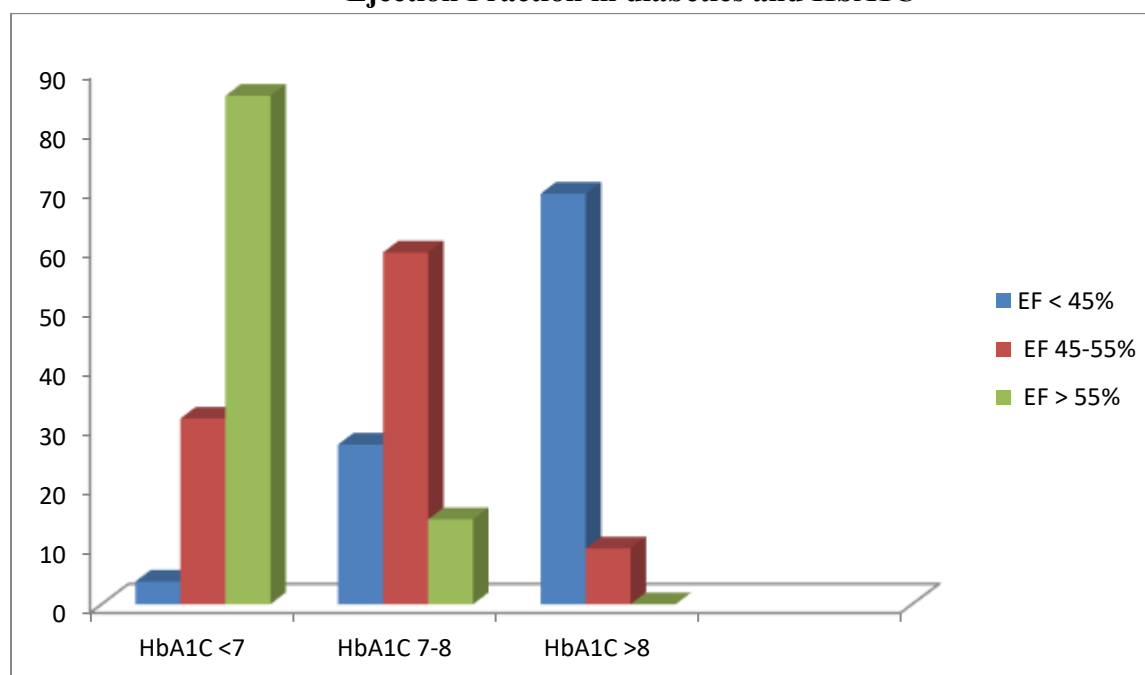


Table 12: Glycemic control and fasting gall bladder volume

HbA1c	FGBV < 25 cc	FGBV ≥ 25 cc
< 7	15(51.7%)	2(5.6%)
7-8	12(41.4%)	14(38.9%)
≥ 8	2(6.9%)	20(55.6%)

Among the 29 diabetic cases with FGBV < 25 cc, 15(51.7%) have HbA1c <7, 12(41.4%) have HbA1c between 7-8 and 2(6.9%) have HbA1c ≥ 8 i.e. poor glycemic control. Among 36 diabetics with FGBV ≥ 25cc only 2(5.6%) have good glycemic control i.e. HbA1c < 7, 14 (38.9%) have HbA1c between 7-8 and 20 (55.6%) have poor glycemic control i.e. HbA1c ≥ 8.

Ejection Fraction in diabetics and HbA1C

**Table 13: Ejection fraction in diabetics and HbA1c**

HbA1c	EF < 45%	EF 45-55%	EF ≥ 55%
< 7	1(3.8%)	10(31.3%)	6(85.7%)
7-8%	7(26.9%)	19(59.3%)	1(14.3%)
≥ 8	18(69.2%)	3(9.4%)	0

In 26 diabetics with EF < 45%, 1(3.8%) have HbA1C < 7 (26.9%) have HbA1c between 7 and 8, 18(69.2%) have HbA1C ≥ 8. Among 32 diabetics having Ejection fraction between 45% and 55%, 10(31.3%) have HbA1C <7, 19(59.3%) have HbA1C between 7 and 8 and 3(9.4%) have HbA1C <8. Among 21 diabetics with EF between 45-55% 14(66.7%) have FBS < 110 mg% and 7 (33.3%) have FBS > 110 mg%. Among 7 diabetics with EF ≥ 55%, 6(85.7%) have HbA1C < 7 i.e. good glycemic control and 1(14.3%) has HbA1C between 7 and 8.

Comparison of mean fasting gall bladder volume and mean ejection fraction between subjects of diabetes and controls

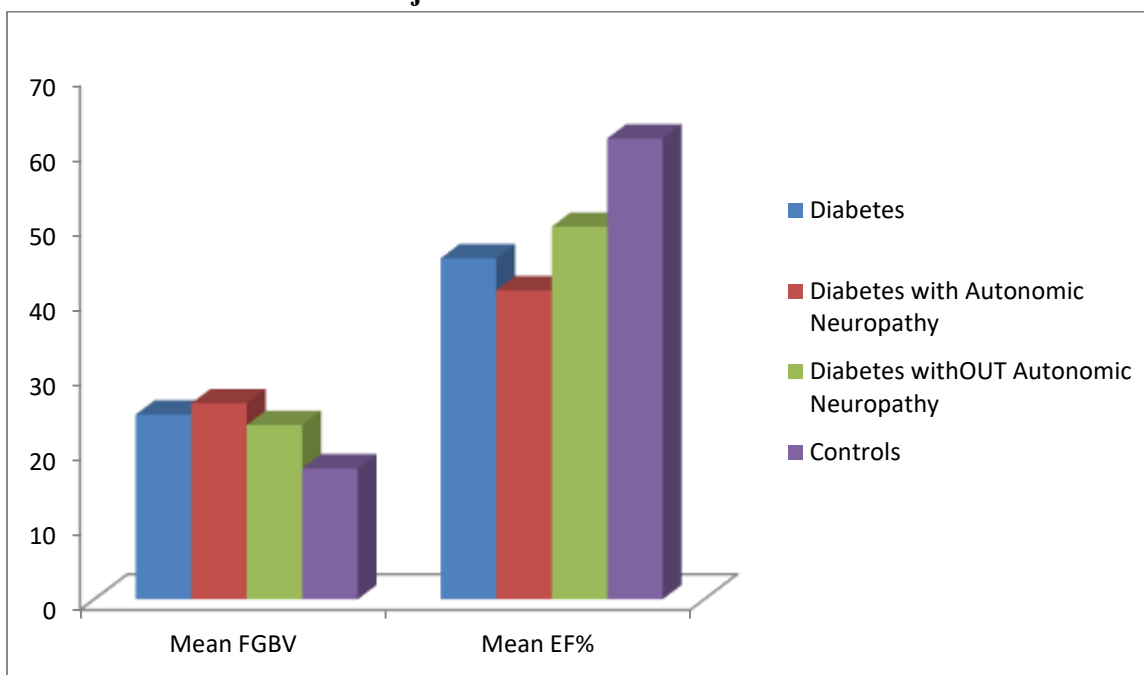


Table 14: Comparison of mean fasting gall bladder volume and mean ejection Fraction between subjects of diabetes mellitus and controls

	Mean FGBV	Mean EF (%)
Diabetes	24.7 cc	45.6%
Diabetics with Autonomic Neuropathy	26.2 cc	41.3%
Diabetics without autonomic neuropathy	23.3 cc	49.8%
Controls	17.5 cc	61.6%

In subjects of diabetes with autonomic neuropathy mean FGBV is 26.2 cc and mean EF is 41.3%. In diabetics without autonomic neuropathy mean FGBV is 23.3 CC and mean EF is 49.8%. In control group mean FGBV is 17.5 cc and mean EF is 61.6%.

Gall Bladder Stones in Diabetes and Controls

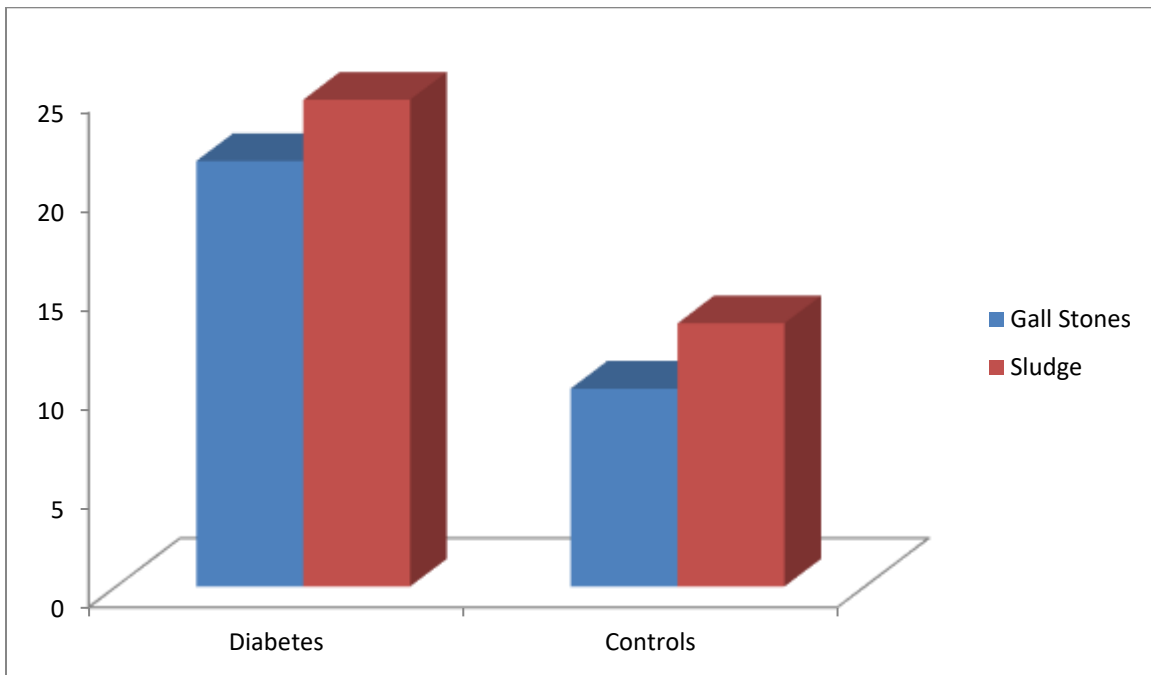


Table 15: Gall bladder stones in diabetics and controls

	Gall stones	Sludge
Diabetes	14(21.5%)	16(24.6%)
Controls	3(10%)	4(13.3%)

Among 65 diabetic subjects, 14 (21.5%) have gallstones and 16(24.6%) have sludge. In control group, of 30 subjects, 3(10%) have gallstones and 4(13.3%) have sludge.

Gall stones & Gallbladder sludge in male and female Diabetic & Control

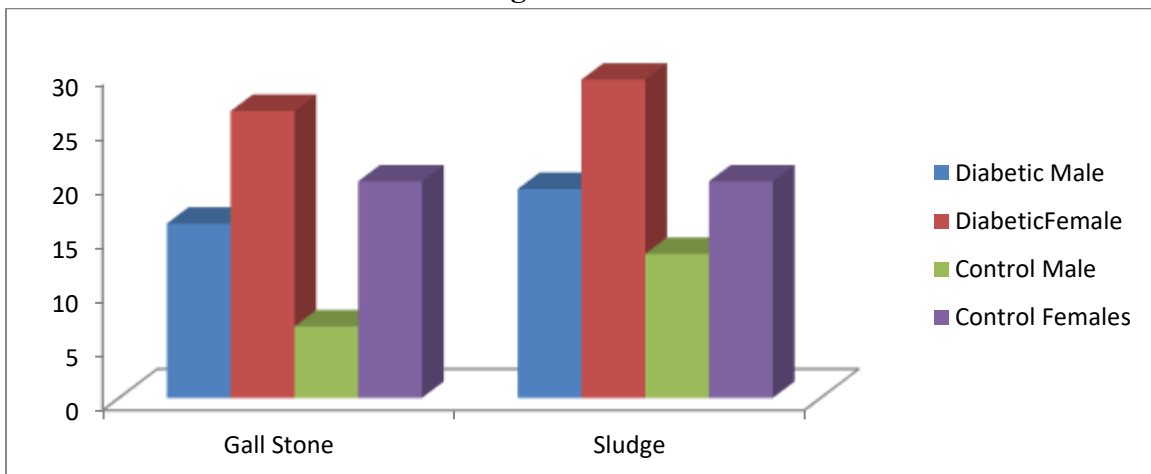


Table 16: Gallstones & Gallbladder sludge in male and female diabetes & controls

	Diabetics		Control	
	Male	Female	Male	Female
Gall stones	5(16.1%)	1(26.5%)	1(6.6%)	3(20%)
Sludge	6(19.3%)	2(13.3%)	2(13.3%)	3(20%)

Among 31 male diabetic subjects, gallstones are seen in 5(16.1%) and sludge in 6(19.3%). Gallstones are seen in 9(25.5%) subjects of 34 diabetic females and sludge is seen in 10(29.4%). Among 15 male controls, 1(6.6%) has gallstones and 1(6.6%) has biliary sludge. Out of 15 female controls 2(13.3%) have gallstones and 3(20%) have biliary sludge. Incidence of gallstones and biliary sludge is higher in female sex both in diabetic group and control group.

Table 17: Lipid profile in subjects with gallstones

	DM with Gallstones	Controls
HDL		
>50	1(7.1%)	0
<50	13(92.9%)	3(100%)
LDL		
<100	1(7.1%)	0
>100	13(92.9%)	3(100%)
TG		
<150	0	2(66.7%)
>150	14(100%)	1(33.3%)

Among diabetic subjects with gallstones, 1 has HDL > 50 and 13 have HDL < 50; 1 has LDL <100 and 13 have LDL > 100, none has a TG < 150 14 have TG > 150. Among controls with gallstones, none has HDL > 50 & LDL < 100. 3 have HDL < 50 & LDL > 100. 2 have TG < 150 & 1 has TG > 150. None of the subjects who have gallstones have lipid profile within the limits recommended by ADA & AHA.

DISCUSSION

This study is conducted in 95 cases of whom 65 are diabetics and 30 are non diabetics, who are attending the General Medicine and Endocrinology outpatient department. In this study among 65 cases of Type 2 Diabetes Mellitus, 31 (47.7%) are male and 34 (52.3%) are females. Among the 30 control group of non diabetics, 15 (50%) are male and 15 (50%) are female. In respect of the study criteria, my observations have been as follows:

Obesity

In 65 cases of Type 2 Diabetes mellitus, 7 (10.8%) are obese, 47 (72.3%) are overweight and 11 (16.9%) are non obese.

In 30 controls, 6 (20%) are obese, 19 (63.3%) are overweight and 5 (16.7%) are non obese. In 54(83.1%) cases of Type 2 diabetes mellitus and 25 (83.3%) of controls. BMI is found to be above the recommendation of ADA & AHA.

Autonomic neuropathy

Autonomic neuropathy determined by various tests like postural drop of blood pressure is seen in 32 (49.2%) of cases of Type 2 DM in the study and 33 (50.8%) cases have no autonomic neuropathy.

BMI and autonomic neuropathy

In 32 cases of Type 2 DM with autonomic neuropathy 4 (25%) have BMI < 25 and 28 (87.5%) have BMI > 25.

In 33 cases of Type 2 DM, without autonomic neuropathy 8 (24.2%) have BMI < 25 and 25 (75.8%) have BMI > 25. In the control group, 6 (20%) have BMI < 25 and 24 (80%) have a BMI > 25. Thus obesity and BMI are matched in diabetic and control group.

Glycemic control

Glycemic control is poor in cases of diabetes with autonomic neuropathy. In 32 cases of diabetes with autonomic neuropathy, 19 (59.4%) cases have poor glycemic control as evidenced by HbA1C > 8. 3 (9.4%) cases have good glycemic control (HbA1C < 7). In diabetes without autonomic neuropathy, only 2 (6.1%) cases have HbA1C > 8 i.e. poor glycemic control. Poor glycemic control indicated by HbA1c > 8 increases the incidence of autonomic neuropathy whereas good glycemic control delays the onset of autonomic neuropathy.

Duration of diabetes

In 65 cases of Type-2 Diabetes Mellitus 29 have diabetes for less than 10 years and 36 have duration of diabetes > 10yrs.

Among the 32 cases of diabetes with autonomic neuropathy 28 (87.5%) cases have a duration of diabetes more than 10 years

and 3 (12.5%) have duration of diabetes < 10 years. In the 33 cases of diabetes without autonomic neuropathy 25 (75.7%) have duration of diabetes less than 10 years and 9 (24.3%) have duration more than 10 years. This shows that as the duration of diabetes increases, the occurrence of autonomic neuropathy increases.

Lipid profile

Abnormal lipid profile is seen in Type 2 DM as obesity frequently accompanies it. In 32 cases diabetes with autonomic neuropathy 4 (12.5%) have HDL, LDL and TG according to ADA and AHA recommendations. Of the 33 cases of Type 2 Diabetes, 11 (33.3%) have HDL, LDL & TG according to ADA and AHA recommendations. In the control cases, 4 (13.3%) have lipid profile according to ADA & AHA recommendations.

In majority of cases of Type 2 diabetes, TG level was > 150 mg/dL. 28 (87.5%) of cases with autonomic neuropathy and 22 (66.7%) of cases without autonomic neuropathy and 14 (46.7%) cases in the control group, have TG > 150 mg/dL. Thus triglyceridemia in diabetes mellitus is more common than in non diabetic individuals (87.5% and 66.7% Vs 46.7%). This increased triglyceride level may cause bile in diabetic patients to become lithogenic.

Fasting gall bladder volume

Fasting gall bladder volume (FGBV) was significantly higher in cases of diabetes mellitus compared to controls. Out of 65 diabetics, 36 (55.4%) have FGBV greater than 25 cc. In 32 cases of diabetes with autonomic neuropathy 22 (68.7%) have FGBV greater than 25 cc and in 33 cases of

diabetes without autonomic neuropathy, 14 (42.4%) have FGBV > 25 cc. In 30 controls, 3 (10%) have FGBV > 25 cc and 27 (90%) have FGBV < 25 cc.

In this study mean fasting gallbladder volume (mean FGBV) in cases of diabetes is 24.7 cc. In cases with autonomic neuropathy mean FGBV is 26.2cc in diabetics without autonomic neuropathy mean FGBV is 23.3 cc. Mean FGBV is 17.5 cc in controls.

Mean FGBV is significantly higher in diabetic cases than in controls (24.7 Vs 17.5%). There is no significant difference between cases of diabetes with and without autonomic neuropathy (26.2 and 23.3).

These results correlate with the study done by *Raman PG, Pate IA et al (19)* in which mean fasting gall bladder volume was significantly increased in diabetic subjects (26.2 cm³) as compared to non - diabetic healthy subjects (15.8cm).

In another study, *Hahm JS, Park et al²³* fasting gallbladder volume increased significantly in diabetic group > (21.9 + 9.53 cc) compared with control(16.99+5.7cc).

Ejection fraction of gall bladder

EF is greater than 55% in 1(3.1%) case of Type 2 DM with autonomic neuropathy and 6 (18.2%) diabetics without autonomic neuropathy. EF is greater than > 55% in 21 (70%) of controls.

EF between 45 and 55% is seen 12 (37.5%) of cases with autonomic

neuropathy, 19 (57.6%) of cases without autonomic neuropathy. 5 (16.7%) of controls have EF between 45 - 55%.

EF is less than 45% in 19 (59.4%) of type 2 DM with autonomic neuropathy compared to 8 (24.2%) of type 2 DM cases, without autonomic neuropathy only 4 (13.3%) of controls have EF < 45%.

Mean EF% is reduced in cases of diabetes than in controls (45.6% Vs 61.6%). Cases of diabetes with autonomic neuropathy have lesser EF% than cases without autonomic neuropathy (41.3% Vs 49.8%). The above results are comparable to the study done by *Guliter S, Yilmaz S et al²* in which mean ejection fraction in diabetic subjects was 48.8% and 56.3% in non diabetic subjects which correlates well with the present study.

Glycemic status and fasting gall bladder volume

In 36 cases of diabetes with fasting gallbladder volume greater than 25 cc, 20 (55.6%) have an HbA1C>8 where as 2(6.9%) cases of diabetes with fasting gallbladder volume<25 cc have HbA1C>8. Good glycemic control i.e. HbA1C<7 is observed in 15 (51.7%) cases of diabetes with fasting gall bladder volume<25 cc as compare to only 2 (5.6%) cases of diabetes with higher fasting gall bladder volume i.e. >25 cc. Thus poor glycemic control leads to higher fasting gall bladder volume leading to increased incidence of gall bladder disease.

In a study done by *Yang CC, Sun SS, Lin et al*²⁰, poor glycemic control is associated with 70% of diabetics who have higher fasting gall bladder volume (> 25cc).

Glycemic control and ejection fraction

Cases of diabetes with ejection fraction <45% have a higher HbA1C levels >8.18 (69.2%) cases with EF<45% have HbA1C>8, while only 3(9.4%) cases with ejection fraction between 45% and 55% have HbA1C >8 and none of the diabetics with EF>55% have HbA1C>8. Good glycemic control that is HbA1C<7 is observed in 1(3.8%) of cases with EF<45% and 10(31.3%) cases with EF between 45% and 55%. 6(85.2%) cases with good ejection fraction i.e. >55% have good glycemic control (HbA1C < 7).

Thus poorer the glycemic control, the more severe the gall bladder dysfunction, leading to cholecystoparesis and gallstone formation. Similar results are seen in study done by *Yang CC, Sun SS et al*²⁰ who noticed poor glycemic control in 60% of diabetics with ejection fraction < 40%.

Gall stones and biliary sludge

Gall stones are seen in 14 (21.5%) cases of diabetes mellitus and 3 (10%) controls biliary sludge is seen in 16 (24.6%) cases of diabetes and 4 (13%) controls. Out of 14 cases of diabetes with gall stones, 9 (64.3%) are female and 5 (35.7%) are male.

In a study done by *Raman PG, Patel A, Mathur V*¹⁹, Gall Bladder disorders and type 2 diabetes mellitus - a clinic based study, 32% of diabetic patients had ultrasonographic evidence of gall stones, as

compared to 6.7% in healthy subjects which correlates well with the values found in the present study.

LIMITATIONS OF THE STUDY

- Small sample size
- The fat content in each meal taken by the subjects was not quantified and may vary from subject to subject.

CONCLUSION

Gall bladder dysfunction (as indicated by higher fasting volume and less ejection fraction) is directly proportional to the duration of diabetes and inversely proportional to the glycemic control. Incidence of gall stones and biliary sludge is higher in diabetics compared to controls (21.5% Vs 10%) for gallstones and (24.6% Vs 13%) for sludge.

Mean fasting gall bladder volume is higher in diabetic cases with and without autonomic neuropathy (26.2cc and 23.3cc respectively) compared to non diabetic controls (17.5cc).

Mean Gallbladder ejection fraction is lower in diabetics compared to controls (45.6% Vs 61.6%). Diabetics with autonomic neuropathy have lower EF than diabetics without autonomic neuropathy (41.3% Vs 49.8%).

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