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Laboratry profile in management of Diabetes Mellitus

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Abstract:
Background: *Diabetes mellitus is a group of metabolic disorder of carbohydrate metabolism in which glucose is under utilized producing hyperglycaemia. Prolonged period of hyperglycaemia leads to various acute and chronic complications. Long term glycaemic control is assessed by measuring glycosylated haemoglobin.*
Aims And Objective: *To evaluate the values of laboratory tests like fasting blood sugar, postprandial blood sugar and glycosylated haemoglobin in diabetic subjects and correlate them in complicated cases of diabetes mellitus.*
Material And Methods: *A study of Glycosylated haemoglobin and blood sugar was conducted in a total number of 100 subjects participated in the present study in which 15 control subjects who were non-diabetic at the time of study and 85 diabetic patients who were on treatment were studied.*
Observation: *There were 100 subjects with mean age of 49±9. The mean of FBS, PP2BS and Glycosylated haemoglobin of diabetes subjects were 160±52, 230±72 and 9.4±2.1 respectively which is higher than mean value of FBS, PP2BS and Glycosylated haemoglobin of non diabetics which were 90±10, 119±11 and 6.26±0.38 respectively. The increase is highly significant for fasting blood glucose, glycosylated haemoglobin, post prandial blood glucose ($p < 0.001$). diabetic patients with long term complications were peripheral neuropathy (20%), retinopathy (15%), cardiovascular complications(14%), nephropathy(11%) and peripheral vascular disease(10%) with mean HbA1c was 11±2.1. FBS, PP2BS and HbA1c hav positive correlations with p value <0.001.*
Conclusion: *Study conclude that diabetic subjects had higher value of FBS, PP2BS and HbA1c than non diabetic subjects. Long term diabetic complications were more related to glycosylated haemoglobin. Correlation coefficient of postprandial blood sugar with HbA1c is more than correlation of fasting blood sugar with HbA1c.*
Key words*: glycosylated haemoglobin, long term diabetic complications, fasting blood sugar, postprandial blood sugar.*

I. Introduction

Diabetes Mellitus is a group of metabolic disorder of carbohydrate metabolism in which glucose is underutilized, producing hyperglycemia. Prolonged period of hyperglycemia leads to various acute and chronic complications. The chronic complications affect eyes, kidneys, nerves and blood vessels. The various complications of diabetes are due to long standing metabolic derangement which is associated with irreversible functional and structural changes in cells of the body. Long term glycaemic control is assessed by measuring the Glycosylated haemoglobin level in people with diabetes mellitus.[1] The disease is classified into several categories. Type I diabetes mellitus known as insulin dependent diabetes mellitus or juvenile onset diabetes mellitus is caused by autoimmune destruction of b cells of pancreas, rendering the pancreas unable to synthesize and secrete insulin. Type II diabetes mellitus known as non insulin dependent diabetes mellitus or adult onset diabetes results from a combination of insulin resistance and inadequate insulin secretion. Other type of diabetes are rare. Type II is the most common form accounting for 90-95% of diabetes in developed countries.[2]The long term therapy emphasizes monitoring the blood glucose level to prevent occurrence of acute complications such as ketoacidosis and hyperglycaemia. In addition to these the long term damage such as retinopathy, neuropathy, nephropathy and cardiovascular diseases can be limited by effective control of blood glucose level. Measurement of specific haemoglobin component elevated in diabetics was first described by rahbar et al in 1968.[3] The component later named as HbA1c (Glycohaemoglobin) is formed by the non enzymatic glycation of free amino groups at the N terminal amino acid valine of the HbA beta chain. The attachment of glucose molecule is dependent on blood glucose concentration and the duration of the exposure of the erythrocytes to the blood glucose i.e. The red cell life span. The measurement of Glycohaemoglobin serves as a powerful tool in the evaluation and management of patients with diabetes mellitus. Providing a means of assessing long term glycaemic control and correlates well with the risk for the development of chronic complication related to diabetes. The diabetes control and complication trial confirmed the direct relationship between the degree of glycaemic control as estimated by Glycohaemoglobin determination and the development and progression of long term complication in insulin dependent diabetes mellitus. On the basis of these findings the need for high precision and accuracy of HbA1c determination for glycaemic control in the diabetic patients has been recommended for monitoring these patients.[4]The method most widely employed are the ion exchange

chromatography and automated high performance liquid chromatography (HPLC) and affinity chromatography. These methods are a bit too expansive for the patients in developing countries. The manual colorimetric method by fluckinger and winterhalter was recommended because of its cost effectiveness but standardization being one of the limitations.[5] The Ion exchange chromatography method was used along with the laboratory profile in the management of diabetes mellitus during the present study.

The accurate measurement of glucose in whole blood, serum and plasma has achieved increased importance during the past 15 years. The concept that improvement in glucose level results in reduced diabetes complication took firm hold in 1993 with publication of the diabetes control and complication trial (DCCT) for type 1 diabetes. In 1979, the national diabetes data group produced a consensus document standardizing the nomenclature and definitions for diabetes mellitus. This classification was adopted later on by the WHO in 1980 and later modified in 1985.[13] The two major types of diabetes mellitus were given names descriptive of their clinical presentation**. "insulin-dependent diabetes mellitus(IDDM) and non-insulin dependent diabetes mellitus(NIDDM)".**

Diagnostic criteria: Accurate glucose values also play an important role in the diagnosis of diabetes since 1997, when expert committee on the diagnosis and classification of diabetes changed the definition of diabetes by reducing the required fasting plasma glucose(FPG) level from >140mg/dl to >126mg/dl. This committee also established a new diagnostic category of diabetes referred to an impaired fasting glucose (IFG), representing glucose values between 110 to 125mg/dl.[12] In 2003, the expert committee further reduced the definition of the normal FPG level from 110 to 100mg/dl, making the glucose levels between 100 and 126 mg/dl definitive of IFG. Thus the categories of the FPG values are as follows.

FPG < 110mg/dl = normal fasting glucose
FPG > 110 and < 126mg/dl = IFG
FPG > 126 mg/dl = provisional diagnosis of diabetes.

Criteria for diagnosis of diabetes mellitus

1. Symptoms of diabetes plus casual plasma glucose concentration 200mg/dl (11.1 mmol / L). Casual is defined as any time of day without regard to time since last meal.
2. FPG > 126mg/dl (7.0 mmol / L). Fasting is defined as no caloric intake for at least 8 hours.
3. 2-h PG > 200 mg/dl during an OGTT. The test should be performed described by the WHO, using a glucose containing the equivalent of 75 grams of anhydrous glucose dissolved in water.

In the absence of unequivocal hyperglycaemia with acute metabolic decompensation, these criteria should be confirmed by repeat testing on different day. The FPG is more convenient, more reproducible, less costly and easier to administer than 2-h OGTT. The third measure of OGTT is not recommended for routine clinical use. The FPG is therefore the recommended initial screening test.[1]

Complications of diabetes mellitus : It includes acute and late complications. The acute complication include hypoglysemia and ketoacidosis. Diabetic ketoacidosis characterized by hyperglycemia, ketosis, metabolic acidosis and many metabolic derangement. It result from relative and absolute insulin deficiency combined with glucagon excess. The decreased ratio of insulin to glucagon promotes gluconeogenesis, glycogenolysis and ketone body formation in liver and increase in substrate delivery from fat and muscle to liver.[2] The morbidity associated with long-standing diabetes of either type results from a number of serious complications, involving both large- and medium-sized muscular arteries (macrovascular disease), as well as capillary dysfunction in target organs (microvascular disease). Macrovascular disease causes accelerated atherosclerosis among diabetics, resulting in increased risk of myocardial infarction, stroke, and lower-extremity gangrene. Microvascular diseases are most profound in the retina, kidneys, and peripheral nerves, resulting in diabetic retinopathy, nephropathy, and neuropathy, respectively. Diabetes is the leading cause of blindness and end-stage renal disease. [16]Metabolic syndrome is described as clusters of abnormalities including abdominal obesity, insulin resistance, hypertension, hypertension, hyperglycaemia, increased triglyceride and decreased high density lipoprotein.

II. Laboratory Diagnosis Of Diabetes Mellitus:

1. Blood glucose monitoring
2. Urine glucose monitoring :
3.Glycated hemoglobin :

- Formation of Glycosylated hemoglobin :
- Clinical importance of HbA1c values:
- Limitations of HbA1c
- Effects of variables on Glycated Hemoglobin assay:

1.Blood Glucose Monitoring :

A . Self monitoring of blood glucose (SMBG): Use of SMBG by patients has revolutionized the management of diabetes. SMBG can help diabetic patients to achieve and maintain specific glycaemic goals.

B .Laboratory monitoring of blood glucose: With the availability of SMBG and glycated protein tests, routine laboratory blood glucose testing should no longer be used to assess glycaemic control except to test the accuracy of SMBG. However, a bimonthly fasting Blood glucose (FBG)level correlate well with glycosylated Hb.[21]

Studies showing direct correlation between the degree of plasma glucose control and the risk of late renal, retinal and neurological complications. This correlation demonstrated for both type I & type II diabetes. Person with type I diabetes who maintained lower average plasma glucose have significantly lower incidence of microvascular complications.[22]While meta analysis suggests that intensive glycaemic control in type II diabetes reduces cardiovascular risk. [23]

2. Urine Glucose Monitoring :

Urine glucose determination are useful to monitor blood glucose levels above a renal glucose threshold, which is variable (i.e. 150-350 mg%) in both normal and diabetic patients. Benedict's test, Clinitest and Glucose oxidase reagent strips are the commonly used method. These tests permit a semiquantitiative measurement of urine sugar, but the interpretation of urine glucose levels depends on the flow of urine and correlates poorly with blood levels. Urine glucose measurements are useful for screening and for cases when blood glucose monitoring is impractical.[24]

Limitations of urine sugar test

- No correlation with blood sugar from person to person
- Variable correlation in same subject on different occasions
- Lowering of the renal threshold with treatment.
- Cannot detect hypoglycemia.
- False positive in Nondiabetic mellituria and in the presence of other reducing agents in the urine like Vitamin C. aspirin, cephalosporin, etc.

3.GLYCATED HEMOGLOBIN : Glycosylated Hemoglobin reflect the degree of glycemic control over the preceding 2-3 months. The rate of formation of glycated hemoglobin (gHb) is directly proportional to the ambient glucose concentration. Since erythrocytes are freely permeable to glucose, gHb levels reflect the glycemic history of 120 days, i.e. the life span of RBC. Glycohemoglobin is formed in vivo by the nonenzymatic attachment of glucose to hemoglobin (Hb). HbA_{1c} is a stable minor hemoglobin variant separated by charge that is composed primarily but variably of glycohemoglobin. A clinical relationship between HbA_{1c} and fasting plasma glucose, peak plasma glucose on the glucose tolerance test, the area under the curve of the glucose tolerance test, and mean glucose concentrations over the preceding several weeks was elucidated in the mid-1970s. [25]In Diabetes Control and Complication Trial, an HbA1c of 6% corresponded to an increase in mean plasma glucose level of 135mg/dl.[26] One caveat in interpreting the linearity of this relationship is that HbA1c does not reflect blood glucose levels equally over previous 120 days. Rather, recent changes in glycemic control are overrepresented in HbA1c. about 50% of HbA1c is determined by glycemia during the 1 month preceding the measurement, 25% from the 30 to 60 days before the measurement, and 25% from the 60 to 120 days prior to the measurement.[27]

Clinical importance of HbA1c values:

It was noted that 24% of the clinicians estimates of glucose control , which were based on historical and laboratory data, differed more than +/-75 mg/dl from the actual mean blood glucose (MBG) levels as calculated from HbA1c. These clinicians used the traditional historical and clinical data such as nocturia, polydypsia, blurred vision and values of home urine test. These tests were found to have a poor predictive value and a low sensitivity and specificity rate. Thus it may be concluded that the HbA1c assay provides information that is not otherwise obtainable in the usual clinical setting.[30]Kaplan used a scale to estimate the degree of metabolic control. This scale is based on urinary glucose patterns, episodes of hypoglycemia and diabetic ketoacidosis, symptoms of glycosuria, growth and therapeutic compliance. The correlation between the scale of control and the results of GHB acids was 0.981.[31]HbA1c assay provides a measurement of metabolic control over time which is not obtainable by the previously used data. Although refinement of the indices of short term glucose control lead to a better appreciation of long term control ,no currently available single assessment is as informative about long term control as the HbA1c assay. HbA1c value is used to estimate the mean blood glucose(MBG) level over the last 60 days. To estimate the MBG from the HbA1c value use the linear regression equation: MBG Estimate= 33.3 (HbA1c)-86.[3]

III. Materials And Methods

A study of Glycosylated haemoglobin and blood sugar was conducted in diabetic subjects and controls from Dhiraj General Hospital , Pipariya. Each gave an informed consent and the study was approved by the ethical and research committee of S.B.K.S. Medical College, Pipariya, to use human subjects in the research study. The patients and controls voluntarily participated in the study. A total number of 100 subjects participated in the present study in which 15 control subjects who were non-diabetic at the time of study and 85 diabetic patients who were on treatment were studied. The selected subjects included both males and females in the age group of 15 years to 70 years. Clinically diagnosed cases of diabetes mellitus, both Type I and II were selected. Detailed medical history and relevant clinical examinations were carried out in these patients. Patients with gestational Diabetes were excluded from the study.

Collection of blood samples : The normal range for glucose in whole blood will vary with hematocrit, hense it is preferable to perform glucose determination on plasma or serum, in which normal fasting range of glucose is 70-110 mg/dl. Due to glycolysis by RBC enzymes, average decreased in serum glucose by about 7 percent in 1 hour. So fluoride is used to prevent glycolysis as it is enzyme inhibitor. Venous blood of about 5 mL was collected from selected subjects under aseptic precautions from a large peripheral vein after overnight fasting. Of that 2Ml was collected in a fluoride vial and 3mL in EDTA vial. And 2-3 ml of blood after 2 hours of lunch was collected in fluoride bulb.

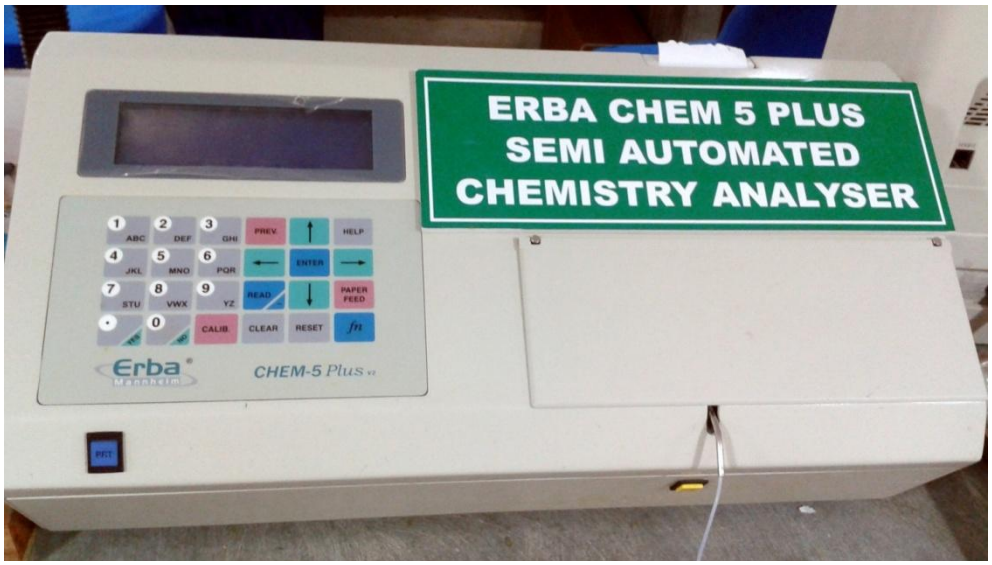
Parameters : The following parameters were taken for the present study.

1. Fasting blood glucose
2. Postprandial blood glucose
3. Urine sugar – both fasting and 2 hour of postprandial
4. Glycosylated Hemoglobin

- ESTIMATION OF GLUCOSE BY GLUCOSE OXIDASE AND PEROXIDASE METHOD[42]
- ESTIMATION OF GLYCOSYLATED HAEMOGLOBIN BY CATION – EXCHANGE RESIN METHOD[43]

PHOTO:1

The Photograph Showing The Reagents Used For Estimation Of Ghb By Cation Exchange Resin Method (Accucare Kit). Photo:2



The Photograph Of Erba Chem Plus Semi Automated Chemistry Analyser

Determination of Urine Glucose:-

Urine sugar test result correlate well with plasma glucose level, so it is important aspect for quality control in laboratory. In normal individual renal threshold for glucose is 150-170 mg/dl, when blood glucose level exceeds 170 mg/dl glucose appear in urine. Increased concentration of glucose in urine indicated as +, ++, +++, ++++ by quantitative tests.

Test:-

1) Benedicts qualitative test :- non specific
2) Glucose Strip test.
3) **OBSERVATION**

The present study was carried out at Dhiraj General hospital and SBKS Medical institute and research centre at pipariya., Ta. Waghodia, Dist. Baroda from January 2010 to may 2011. During the period under observation 100 subjects were studied as follows. Total 100 subjects were divided into two groups of which 15 were control group and 85 were known diabetic patients. All the 100 subjects were studied with age and sex distributions, the patients were diagnosed as diabetic and the subjects having diabetes with complications of diabetes mellitus. The laboratory parameters available during the present study were

1. fasting blood sugar,
2. postprandial blood sugar
3. glycosylated haemoglobin
4. urine sugar

The above test were carried out in all the 100 subjects and the observations made are depicted in the tables. The total 100 subjects were studied out of them 85 were diabetic patients and 15 were healthy individuals. Among the diabetic patients group 34 were females and 51 were males that is 51% were male and 34% were female In the control group of healthy individual out of 15 seven were female and 8 male subjects that is 8% were male and 7% were female as shown in table No 1.

Table 1:- Table Showing The Sex Distribution Of Controls And Diabetic Subjects In Present Study

SEX	CONTROL	PERCENT	DIABETICS	PERCENT
Female	7	46	34	40
Male	8	54	51	60
TOTAL	15	100	85	100

The table no 1 showing the sex distribution of healthy control group and the diabetic subjects.

Table 2:- The Table Showing The Age Distribution Of Diabetes Subjects In Present Study

SEX	Age group I (18-30 Yrs.)	Age group II (31-50 Yrs.)	Age group III (>51 Yrs.)	TOTAL(percent)
MALE	01	35	15	51(60%)
FEMALE	02	17	15	34(40%)

Table 2 showing the age distribution of diabetic patients in which out of total 85 patients 60% were males (51 males) and 40% were females (34). 1% of the patients were within age group of 18-30yrs, 69% of them were within 31-50yrs, and 30% of them were more than 50 years of age. So maximum numbers of patients were clustered between 31-50yrs of age group. Mean age was found to be 49.6±9.4. None of the patients were above 85 years. This observation is consistent with the study carried out at Sheffield, UK by Gill et al.[51]

Table : 3 The Table Showing The Comparison Of Blood Glucose Level In Control Group And The Diabetic Patients In Present Study

BLOOD GLUCOSE LEVEL	CONTROL GROUP		CASE GROUP		CASE VS CONTROL	
	MALE n = 8	FEMALE n = 7	MALE n=51	FEMALE n = 34	t value	P value
FBS	93.5±9.97	86.57±10.45	149±51	171.8±54.35	4.9	<0.001
PP2BS	120.87±10.83	117.28±11.24	226±61	236.7±86.05	5.9	<0.001
HbA1c	6.37±0.43	6.12±0.27	9.2±1.9	9.6±2.401	5.6	<0.001

[Students 't' test,$p < 0.001$, HS (Highly significant)]

Table 3 shows comparison of fasting blood glucose, postprandial blood glucose, glycosylated haemoglobin, between controls and diabetic subjects.

It is seen from the table that fasting blood glucose, post prandial blood glucose, glycosylated haemoglobin in diabetic male were 149±51, 226±61, 9.2±1.9 and in female 171.8±54.35, 236.7±86.05, 9.6±2.40 respectively. The estimated fasting blood glucose, , post prandial blood glucose, glycosylated haemoglobin percent in control subjects are in the range of 93.5±9.97, 120.87±10.83, 6.37±0.43 in male and 86.57±10.45, 117.28±11.24, 6.12±0.27 in female respectively.

It is evident from the table that levels of fasting blood glucose, post prandial blood glucose, glycosylated haemoglobin are increased in diabetic subjects as compared to controls. The increase is highly significant for fasting blood glucose, glycosylated haemoglobin, post prandial blood glucose ($p < 0.001$). In our study this observations made are similar to the observations mad by Shaharam and Ghazaleh t al.[44]

Table 4: The Table Showing The Values Of Test Results In Diabetic Subjects With Various Complications

BLOOD GLUCOSE LEVEL	**RETINOPATHY n=13(15%)**	**NEPHROPATHY n = 10(11%)**	**PERIPHERAL NEUROPATHY n = 17(20%)**	**CARDIOVASCULAR & HYPERTENSION n = 12(14%)**	**PERIPHERAL VASCULAR n = 9(10%)**
FBS	183±52.9	198 ± 61	171 ± 50	152.2 ± 41.52	172 ± 47.7
PP2BS	264±91	279 ± 73	240 ± 86.5	225.7 ± 50.12	276± 98.5
HbA1c	11±1.8	11.2 ± 1.7	10.5 ± 2.1	9.6 ± 1.39	10.5 ± 1.9

Table 4 shows the association of long term microvascular and macrovascular complications like retinopathy, nephropathy, peripheral neuropathy, cardiovascular complication, hypertension, peripheral vascular disease with mean of fasting blood sugar, postprandial blood sugar and Glycosylated haemoglobin. 15% cases have retinopathy with mean fasting blood sugar 183±52.9, postprandial blood sugar 264±91 and HbA1c 11±1.8 Total 10(11%) cases of nephropathy with mean fasting blood sugar 198 ± 61, postprandial blood sugar 279 ± 73 and HbA1c 11.2 ± 1.7. 20% cases have peripheral neuropathy with fasting blood sugar 171 ± 50, postprandial blood sugar 240 ± 86.5 and HbA1c 10.5 ± 2.1. 10% cases have peripheral vascular disease with

mean fasting blood sugar 172 ± 47.7, postprandial blood sugar 276 ± 98.5 and HbA1c 10.5 ± 1.9. Cases of macrovascular complications like hypertension amd cardiovascular complications are 12(14%) with mean of fasting blood sugar 152.2 ± 41.52, postprandial blood sugar 225.7 ± 50.12 and HbA1c 9.6 ± 1.39, which is lower than other microvascular complications. This results are equivocal to that of the observations made by Ramachandran et al.[49]

Table : 5 Pearson's Correlation Co-Efficient (R) Of Various Test Results In Diabetic Subjects Under Study

Correlation between	'r' value
Fasting blood sugar and $HbA1_c$	+0.64
Post prandial blood sugar and $HbA1_c$	+0.66
Fasting blood sugar and post prandial blood sugar	+0.69

It is observed from the above table of correlation coefficient of between fasting blood glucose, postprandial blood sugar and glycosylated haemoglobin. The correlation coefficient of fasting blood glucose and $HbA1_c$ was r=0.64 correlation coefficient of postprandial plasma glucose and $HbA1_c$ was r=0.66 and correlation of fasting blood glucose and postprandial blood sugar was r=0.69. It is evident from the table that correlation between fasting blood sugar and postprandial blood sugar is highly significant ($p < 0.001$).
It is evident from the table that fasting blood glucose and glycosylated haemoglobin, Postprandial blood sugar and $HbA1_c$ have positive correlation and they are statistically significant.

IV. Discussion

Our study indicate that postprandial blood glucose level increased in all 85 cases of diabetes and has strong relationship with the rising HbA1c level. Increasing of HbA1c shown more dependency with postprandial blood glucose as compared to with fasting plasma glucose level. A number of studies have demonstrated that HbA1c has more relation to postprandial plasma glucose level, than fasting glucose[44,45,46] but on the contrary, bonora et al., have observed that HbA1c has close relation to fasting plasma glucose and not to the postprandial plasma glucose level[47] According to many studies, HbA1c is the best criterion for control of diabetes and for preventing diabetes complications. A reduction of 1% of HbA1c could prevent 30-35% of microvascular and 14-16% of macrovascular complications.[44] Complication of diabetes thought to occur late in course of the disease. Type 2 diabetes is an insidious illness with a long preclinical asymptomatic phase. Patients may be exposed to the ill-effects of asymptomatic hyperglycaemia for many years before they are diagnosed.[48]In our study diabetic patients with poor glycaemic control had long term diabetic complications like peripheral neuropathy , retinopathy, nephropathy with more than 11% of HbA1c and macrovascular complications with 9.5% of HbA1c, as shown in table no 5 in the chapter of observation of the test. Prevalence of retinopathy is high among Indian diabetic subjects and diabetic nephropathy is one of the leading cause of chronic renal failure in india. A study by Ramachandran et al showed prevalence of 23% of retinopathy, 5.5% of nephropathy, 27% peripheral neuropathy, 11% cardiovascular disease and 4% peripheral vascular disease.[49] During the present study it was observed that majority of the diabetic patients had higher than the recommended fasting plasma glucose levels which co-relates well with the studies carried out at other centre.[51]It was noted that the increase in the values of postprandial plasma glucose (more than 200mg/dl) correlates well with the increase in the HbA1c (more than 9%) as also observed by Shahram and Ghazaleh et al at Hamadan, Iran.[44] The efficacy of the glycosylated haemoglobin(HbA1c) was less in fasting blood sugar as compared to the postprandial plasma sugar studied in the diabetic subjects.

V. Conclusion

A total number of 100 subjects were studied which comprised of 15 controls and 85 diabetic subjects. In all the subjects fasting blood glucose, postprandial blood glucose, glycosylated haemoglobin percentage were analyzed. Results show that the mean values of fasting blood glucose, postprandial blood glucose, glycosylated haemoglobin percentage are significantly increased in diabetic subjects when compared to controls. ($p < 0.001$). Correlation coefficient of postprandial blood sugar with glycosylated Haemoglobin is more than correlation of fasting blood sugar with glycosylated Haemoglobin. Long term micro vascular and macro vascular complications were related to glycosylated Haemoglobin value, mean of glycosylated Haemoglobin in control group were 6.26±0.38 whereas in diabetics with complications mean of glycosylated Haemoglobin is 11±2.1. The socio economic factor along with health education in respect of diabetes mellitus and their complications observed plays an important role in our Indian strategy. Along with routine investigations for diabetes mellitus viz. glycosuria, plasma glucose and the glycosylated haemoglobin, the correlation of fasting and postprandial glucose when correlated well with glycosylated haemoglobin (HbA1c) is an important indicator for treatment,

monitoring of the treatment and for prevention of complications of diabetes mellitus. But the cost factor limits the scenario.

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