Estimation of Glycosylated Hemoglobin Levels in Diabetes Mellitus and Impaired Glucose Tolerance

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Glycosylated Hemoglobin (HbA1c) levels were estimated in normal, diabetic and impaired glucose tolerance (IGT) cases in aircrew and non-aircrew personnel. The modified colorimetric procedure of Fluckiger and Winterhalter was employed for estimating HbA1c levels. Simultaneous blood sugar levels, fasting and post prandial (PP) were also measured. Mean HbA1c levels obtained for normal subjects were, aircrew : 5.2 ± 0.6% of total Hb, non-aircrew : 5.2 ± 0.6% of total Hb. In diabetic subjects mean values obtained were, air crew : 8.5 ± 2.5% non-aircrew : 9.4 ± 22% and in IGT cases the mean value of HbA1c was 6.8 ± 1.0%.

Keywords: Diabetic control, medical evaluation of aircrew.

A host of studies have shown that glycosylated hemoglobin level, HbA1c fraction in particular, reflects the carbohydrate status of the diabetic patients over the preceding weeks to months[1-6]. Estimation of HbA1c has been extensively used for the assessment and monitoring of the degree of metabolic control in diabetic patients[7-9]. Bhalla et al[9] had used a simple chemical method[10] to estimate HbA1c and recommended the use of HbA1c estimation for assessing diabetic control for medical categorization in defence services.

The present study employed the chemical method of HbA1c estimation in finding out its levels in the normal and the diabetics in aircrew as compared to non-aircrew. It also studied the utility of HbA1c estimation in the assessment of cases labelled as Impaired Glucose Tolerance (IGT).

Material And Methods

A total of 70 male volunteers in the age group of 20 - 57 years were subjects of this study. They comprised of service aircrew, civil aircrew and service personnel of branches other than flying. Clinically they made 3 groups, ie., normal (aircrew n =15, non aircrew n = 15), diabetic (aircrew n = 9, non - aircrew n = 11) and IGT (n = 20). The mean age of normal subjects were 35.5 and 34.2 yrs in the aircrew and non-aircrew groups respectively. In diabetics, aircrew had a mean age of 42.0 yrs and non-aircrew 44.0 yrs. The mean age in IGT cases was 39.3 yrs.

Twenty five of the patients were on medication for 3 principal disabilities viz., diabetic mellitus, hypertension and IHD. All subjects were within their normal range of body weight.

HbA1c level was chemically estimated by the modified Fluckiger and Winterhalter method[10]. Simultaneous levels of blood sugar, fasting and post prandial (PP), were estimated by King Asatoor's method[11].

HbA1c values in diabetic and IGT was compared to those in normal subjects using unpaired 't' test. HbA1c values in aircrew and non aircrew groups were also similarly compared. Spearman's rho test was employed in finding out the correlations between HbA1c and blood glucose levels, fasting and PP, in the normal, diabetic and IGT groups separately.

Results

The mean values of HbA1c for normal, diabetic and IGT cases are presented in Table I. Normal subjects were found to have a mean value of 5.1% HbA1c, with no significant differences seen between the aircrew (5.1%) and non aircrew group (5.2%). In the diabetic group, aircrew subjects had a relatively lower value (8.2%) as

	Normal		Diabetics		IGT
	Ac(n=15)	Non-Ac(n=15)	Ac(n=9)	Non-Ac(n=11)	(n=20)
Blood sugar					
Fasting	79.7(6.3)	81.1(7.3)	114.6(60.6)	120.7(51.0)	93.2(9.5)
PP	84.9(7.4)	84.6(12.4)	167.1(110.3)	187.0(66.4)	123.9(25.7)
HbA$_{1c}$	5.1(0.7)	5.2(0.6) [NS]	8.2(2.5)	9.4(2.2) [NS]	6.8(1.0)
Group mean	5.1(0.6)		8.8(2.5) [***]		6.8(1.0) [***]

NS = No significant difference between Ac and Non-Ac.   Ac = Aircrew
*** p < 0.001 as compared to Normal

compared to nonaircrew (9.4%), the difference not being significant though. The group mean value of HbA$_{1c}$ in the diabetics (8.8%) was found to be highly significantly raised compared to normal subjects (p < 0.001). The IGT group had a mean HbA$_{1c}$ value of 6.8% which was significantly higher than that in the normal and significantly lower than the values for the diabetic group.

On dividing the diabetic group into 3 levels of metabolic control matching with the WHO criteria of blood glucose levels for normal, IGT and diabetes, the differences in HbA$_{1c}$ values within those 3 levels of controls were compared by analysis of variance and were found highly significant (Table II). Also, it was only in the diabetic group, Spearman's rho test indicated strong positive correlations between HbA$_{1c}$ values with fasting (0.81) and PP (0.78) blood sugar

Table - II   *Blood sugar (mg%) and HbA$_{1c}$ (%) in 3 levels of Metabolic Control in Diabetics: mean(±sd)*

	Level of control [@]		
	Good (n = 6)	Fair (n = 6)	Poor (n = 8)
Blood sugar			
Fasting	78.3(12.4)	88.7(8.3)	169.6(51.5)
PP	98.3(17.5)	153.8(20.8)	255.1(85.4)
HbA$_{1c}$	5.8(1.0) [**]	8.6(0.5)	11.3(1.0) [**]

** p < 0.01

[@] Control	Blood Sugar	
Good	Fasting < 100 mg%,	PP < 120 mg%
Fair	Fasting 100-180 mg%,	PP 120-180 mg%
Poor	Fasting > 120 mg%,	PP> 180 mg%

levels. In normal subjects and IGT cases, HbA$_{1c}$ had no significant correlations with fasting and PP blood sugar levels.

Discussion

Glycosylated hemoglobin is formed slowly and almost irreversibly by the condensation of two abundant reactants within the red blood cell: glucose and hemoglobin. With continuous accumulation of HbA$_{1c}$, it is evident that the amount of this component should be a reflection of the accumulative mean of plasma glucose to which the red blood cells were exposed during their life span. Direct evidence for this relationship has been established [4].

The modified chemical method of Fluckinger and Winterhalter employed in this study is reliable and has several advantages over the other techniques employed for the estimation of HbA$_{1c}$ levels. It is a cheap method, the cost comparable to that of 2 to 3 blood glucose estimations[9]. This method estimates the stable form of HbA$_{1c}$ only, which is particularly suited to assess long term glycemic control[12]. It is not affected by the presence of HbF, labile HbA$_{1c}$ and hemoglobin variants [5,13].

Estimation of HbA$_{1c}$ levels is convenient because of its lack of acute dependence of such variables as patient's co-operation, time of day, stress, exercise, food intake and renal threshold. Besides, it has the advantage of an one time measurement and thus is more acceptable to the patients.

In the present study, mean HbA_{1c} levels obtained for normal subjects compared well with the previous estimates of other workers[1,2]. In diabetics, a two to three fold increase in HbA_{1c} above the normal has been reported in literature[2,14]. The diabetic subjects in the present study showed a mean HbA_{1c} level of 8.8 ± 2.49% of the total Hb. No significant differences were seen in HbA_{1c} levels between the aircrew and non aircrew groups, both in the normal as well as diabetic subjects.

On studying the three levels of metabolic control, it was seen that 6 diabetics who had achieved a good control, with blood sugar values fasting 78.3 ± 12.4 mg% and PP 98.3 ± 17.5 mg % had a mean HbA_{1c} level of 5.8 ± 1.0%. These results are consistent with those of other workers[7] who documented a reduction in HbA_{1c} from 9.8 – 10.1% to 5 – 6 %, as optimal metabolic control is achieved in diabetic subjects.In the poorly controlled group, with the blood sugar level, fasting 169.6 ± 51.5 mg% and PP 255.1 ± 85.4 mg%, the HbA_{1c} values were 11.3 ± 1.0%.

In 6 diabetic subjects who had blood sugar values falling within the IGT range, mean HbA_{1c} level was found to be 8.5 ± 0.5%. This was significantly higher than the good control group and lower than that for the poorly control individuals. These values match up to those of Santensanio et al [8] and Raheja et al [6].

In the IGT group the mean HbA_{1c} level obtained was 6.8 ± 1.0%. This result is in close agreement with that of Bolli et al[4] who obtained HbA_{1c} value of 6.3 – 9.6% in 67 subjects with IGT. Other workers also have observed such levels of HbA_{1c} in IGT cases[3]. However, 9 out of 20 subjects with IGT were found to have HbA_{1c} values within normal limits. These results are in agreement with earlier studies which showed that the measurement of HbA_{1c} failed to demarcate those individuals with mild impairment of glucose tolerance from those with normal glucose values, and that HbA_{1c} was elevated above the normal in only half the patients diagnosed as IGT.[15,16]

Also, while strong positive correlations were observed between HbA_{1c} and blood sugar values in the diabetic group, no significant correlation was found between fasting and PP blood sugar values with HbA_{1c} levels in the IGT group. Similar findings have been put forth by Bolli et al [4].

To conclude, estimation of HbA_{1c} levels provides a useful index of cumulative control of blood glucose and has distinct advantages over the presently employed laboratory techniques in the evaluation of Diabetes Mellitus, in medical categorisation and also as a screening test. However, HbA_{1c} levels fail to demarcate IGT cases from those with a normal glucose tolerance.

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