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STUDY ON THE EFFECT OF IRON DEFICIENCY ON GLYCATED HAEMOGLOBIN IN NON DIABETICS

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Abstract

Aim: To determine whether HbA1c levels are increased among iron deficient patients without diabetes and to determine whether there is any difference in HbA1c levels in iron deficient patients once anemia is corrected. **Methods:** One hundred patients and one hundred controls who attended K.R. hospital with iron deficiency anaemia between January 2017-December 2017 were taken by convenience sampling and subjected to complete haemogram and iron studies and followed up for 3 months to assess the outcome. **Results:** The mean baseline HbA1c level in IDA group (5.39+/-0.32%) was significantly higher than that in the control group (4.53+/-0.27%, P<0.05). A significant decrease was observed in the patients' HbA1c levels at 3 months after treatment compared to that of IDA group (4.48+/-0.3%, P <0.05) **Conclusions:** The present study showed that HbA1c levels were significantly high in patients with iron deficiency anaemia which falls significantly once the iron deficiency is treated. Hence, HbA1c is not affected by the blood sugar levels alone; there are various confounding factors when HbA1c is measured, especially iron deficiency, which is the commonest of the deficiency diseases worldwide. It is hence necessary to rule out iron deficiency anaemia before making a therapeutic decision, based on the HbA1c levels.

Keywords: Iron Deficiency Anemia, Hemoglobin A1c, HbA1c, Glycated Hemoglobin.

INTRODUCTION

The dramatic rise in the prevalence of type 2 diabetes makes it one of the greatest public health threats of the 21st Century[1]. An additional half billion people are expected to be at high risk[2]. Therefore, the means by which diabetes is defined and, in particular, the utility of haemoglobin A1c (HbA1c) as a diagnostic tool, are major issues for discussion[3].

In 2009, an International Expert Committee recommended that it also be used in diagnosis, triggering much debate regarding the potential benefits and limitations of such a move[4]. This recommendation has recently been adopted by the World Health Organization(WHO)[5].

Hemoglobin A1c (HbA1c) is a glycated hemoglobin that can be used as an indicator of a patient's glycemic status over the previous 3 months[6]. Glycated haemoglobin is produced by a ketoamine reaction between glucose and the N terminal valine of both beta chains of the haemoglobin molecule[7]. The major form of glycated haemoglobin is HbA1c.

HbA1c levels are altered by various other coexisting factors especially that of iron deficiency anaemia which is a major public health problem in countries like India[8].

According to the World Health Organization (WHO), iron deficiency is the commonest of the deficiency diseases worldwide[9]. Increased glycation of proteins have been

documented in some non diabetic pathological states like iron deficiency anaemia. The glycation reaction apart from the traditional chronic hypergycaemia can be modulated by the iron status of the patient.

METHODOLOGY

Source of Data and Sampling: Primary Source of Information is collected from non diabetic patients with iron deficiency anaemia attending the medical OPD and in-patients at tertiary care teaching hospital, Mysore, during January 2017 to may 2018 by direct interview method using pretested semistructural questionnaire adapted from WHO step approach after taking informed consent from the study subjects. Secondary source of information from published articles, journals, books, related websites are used in planning, developing synopsis and during dissertation as a supporting documents.

Study Design: Case control study

Total Study Period: 18 months (January 2017 to May 2018)

Data Collection Time: 1 year (January 2017 to Dec 2017)

Sample Size: 100

Place of Study: Tertiary Care Hospital, Mysuru.

Type of Study: Case control study

Sampling: simple random sampling

Statistical Methods

Sample size: Using estimation set up technique for the level of significance =5% and allowable error over 10%, the inflated sample size is estimated at 78, using the formula n=4PQ/d2.

Where P is the prevalence, Q is 1-P and d=10%=.01(margin of error). Both descriptive and inferential statistics were employed for data analysis. The attrition rate was assumed to be 20 % and hence the sample size was fixed as 100.

The **Descriptive statistics** procedure displays uni-variate summary statistics for several variables in a single table and calculates standardized values. Variables can be ordered by the size of their means alphabetically, or by the order in which the researcher selects the variables. In the present study the following descriptive statistics have been employed.

Frequencies

Percentages

Mean

Standard deviation

Inferential statistics Crosstabs (Cramer's V)

The crosstabs procedure forms two-way and multi-way tables and provides a variety of tests and measures of association for two-way tables. The structure of the table and whether categories are ordered determine what test or measure to use. Cramer's V as a measure of association between rows and columns was employed.

The Statistical software namely SPSS 19.0 and MedCalc 9.0.1 were used for the analysis of the data and Microsoft word and Excel have been used to generate graphs, tables etc**.** The results were analysed using following statistical methods: Descriptive statistical analysis has been carried out in the present study. Chi square test was done for studying association. Student t test (paired and Unpaired)were used for quantitative data. Pearsons correlation co-efficient was used for variables.

P<0.05 is considered as statistically significant.

Inclusion criteria

1) Patients with haemoglobin < 11 gm/dl
2) Serum iron levels < 40 ug/dl for women
3) Serum iron levels < 55 ug/dl for men
4) Non diabetic individuals

Exclusion criteria

1) Diagnosed cases of diabetes mellitus
2) Patients with impaired glucose tolerance
3) Haemoglobinopathies
4) Haemolytic anaemias
5) Chronic alcohol ingestion
6) Chronic renal failure
7) Acute infections
8) Pregnant females

Method of Collection Sampling procedure

The diagnostic approach used is to determine the HbA1c levels in non diabetic individuals with iron deficiency anaemia. Patients with iron deficiency anaemia according to WHO definition of the same, satisfying the inclusion and exclusion criteria are registered in the study group. 100 cases and age and sex matched 100 controls were selected in accordance with the above mentioned inclusion and exclusion criteria. The purpose of study was explained to the subjects and consent was taken. All those patients were asked to provide a detailed history and were subjected to physical examination. Venous blood was collected and sent for complete haemogram, serum iron levels, HbA1c levels, fasting and postprandial glucose levels, blood urea and serum creatinine.

The levels of hemoglobin, mean corpuscular hemoglobin (MCH), hematocrit, mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC), platelet count, total leucocyte count (TLC), and differential leucocyte count (DLC) were measured by an automated counter (SYSMEX, Japan). Peripheral blood smear examinations to define the anaemia type, as well as all other investigations, were conducted in our Pathology Department. On the basis of hemoglobin levels, patients were categorized as having mild, moderate, or severe anemia[10] Those with predominantly microcytic indices (MCV<80 fL) and hypochromic indices (MCH<26 pg/cell) with peripheral smear showing microcytic hypochromic pattern were

considered to have iron deficiency anemia, which was then also confirmed by low serum iron levels (<40 ug/dL in female and <55 ug/dL in male patients) and iron studies. The case group was given iron replacement therapy and was followed up for next 3 months. All the values were repeated at the end of 3 months to determine the difference in HbA1c following the correction of anaemia. During the follow up period of 3 months, 86% of the cases returned for follow up and the rest 14% were lost to follow up. At the end of 3 months the iron deficiency was not corrected in 4 patients due to non compliance.

RESULTS

Table: Age and sex distribution of study subjects in control group and IDA group

Group				Sex	
				Male	Female
Control	Age (Binned)	<= 25	Count	9	4
			% within Age (Binned)	69.2%	30.8%
		26 - 50	Count	33	23
			% within Age (Binned)	58.9%	41.1%
		51 - 75	Count	17	10
			% within Age (Binned)	63.0%	37.0%
		76+	Count	1	3
			% within Age (Binned)	25.0%	75.0%
		Total Age (Binned)	Count	60	40
			% within Age (Binned)	60.0%	40.0%
Anaemia	Age (Binned)	<= 25	Count	9	7
			% within Age (Binned)	56.2%	43.8%
		26 - 50	Count	26	21
			% within Age (Binned)	55.3%	44.7%
		51 - 75	Count	18	16
			% within Age (Binned)	52.9%	47.1%
		76+	Count	0	3
			% within Age (Binned)	0.0%	100.0%
		Total	Count	53	47
			% within Age (Binned)	53.0%	47.0%

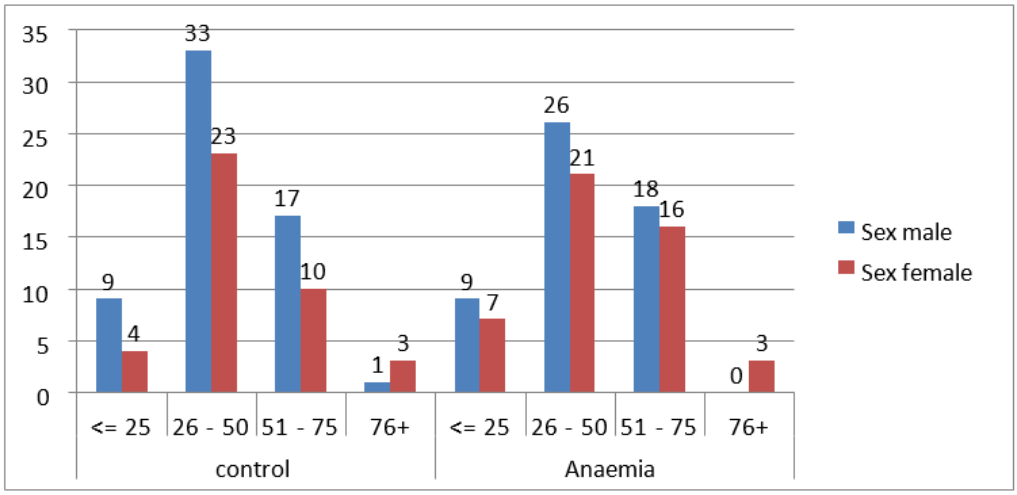

Figure: Age and sex distribution of study subjects in control group and IDA group

Among the cases 53% were males and 47% were females. In the age group < 25 years 56.2% were males and 43.8% were females. In the age group 26 to 50 years 55.3% were males and 44.7% were females. In the age group 51 to 75 years 52.9% were males and 47.1% were females. In the age group > 75 years 53% were males and 47% were females. Among the controls 60% were males and 40% were females. In the age group < 25 years 69.2% were males and 30.8% were females. In the age group 25 to 50 years 58.9% were males and 41.1% were females. In the age group 50 to 75 years 63% were males and 37% were females. In the age group > 75 years 25% were males and 75% were females.

Table: Distribution of the study population according to severity of anaemia

Group				Anaemia			Total
			Normal	Mild Anaemia	Moderate Anaemia	Severe Anaemia	
control	Sex	male	60				60
			100.0%				100.0%
		female	40				40
			100.0%				100.0%
	Total		100				100
			100.0%				100.0%
Anaemia	Sex	male	0	3	14	36	53
			0.0%	5.7%	26.4%	67.9%	100.0%
		female	0	4	10	33	47
			0.0%	8.5%	21.3%	70.2%	100.0%
	Total		0	7	24	69	100
			0.0%	7.0%	24.0%	69.0%	100.0%
Anaemia after treatment	Sex	male	43	1			44
			97.7%	2.3%			100.0%
		female	41	0			41
			100.0%	0.0%			100.0%
	Total		84	1			85
			98.8%	1.2%			100.0%
Total	Sex	male	104	3	14	36	157
			66.2%	1.9%	8.9%	22.9%	100.0%
		female	81	4	10	33	128
			63.3%	3.1%	7.8%	25.8%	100.0%
	Total		185	7	24	69	285
			64.9%	2.5%	8.4%	24.2%	100.0%

Among the cases, 7% have mild anaemia; 5.7% are males and 8.5% are females. In the study population 24% have moderate anaemia; among them 26.4% are males and 21.3% are females. In the study population 69% have severe anaemia; among them 67.9% are males and 70.2% are females.

Table: Comparison of mean MCV levels between IDA group, control group and IDA after treatment group

Groups	Mean MCV(fl)
IDA group	65.46 +/-6.11
Control group	82.47+/-3.12
IDA after treatment group	91.58 +/- 7.45

Mean MCV in the IDA group is 65.46 +/- 6.11 fl. Mean MCV in the control group is 82.47+/-3.12 fl. Mean MCV in the IDA group following treatment is 91.58 +/- 7.45 fl.

Table: Comparison of mean MCH levels between IDA group, control group and IDA after treatment group

Groups	Mean MCH levels(pg)
IDA group	18.72 +/- 1.94
Control group	29.55+/-1.60.
IDA after treatment group	30.01 +/- 1.37

Mean MCH in the IDA group is 18.72 +/- 1.94 pg. Mean MCH in the control group is 29.55+/- 1.60 pg. Mean MCH in the IDA group following treatment is 30.01 +/- 1.37 pg.

Table: Comparison of mean serum iron levels between IDA group, control group and IDA after treatment group

Groups	Mean serum iron levels(mcg/dl)
IDA group	28.70 +/- 8.90
Control group	104.03+/-23.20
IDA after treatment group	114.57 +/-17.91

Mean serum iron levels in the IDA group is 28.70 +/- 8.90 mcg/dl. Mean serum iron levels in the control group is 104.03+/-23.20 mcg/dl. Mean serum iron levels in the IDA group following treatment are 114.57 +/-17.91mcg/dl.

Table: Comparison of mean serum ferritin levels between IDA group, control group and IDA after treatment group

Groups	Mean serum ferritin levels(mcg/l)
IDA group	8.25 +/- 1.66
Control group	130.01+/-55.65
IDA after treatment group	44.94 +/- 15.64

Mean serum ferritin levels in the IDA group is 8.25 +/- 1.66 mcg/l. Mean serum ferritin levels in the control group is 130.01+/-55.65 mcg/l. Mean serum ferritin levels in the IDA group following treatment is 44.94 +/- 15.64 mcg/l.

Table: Comparison of mean TIBC levels between IDA group, control group and IDA after treatment group

Groups	Mean TIBC levels(mcg/dl)
IDA group	485.54 +/- 15.18
Control group	341.10+/- 64.01
IDA after treatment group	411.74+/- 29.63

Mean TIBC in the IDA group is 485.54 +/- 15.18 mcg/dl. Mean TIBC in the control group is 341.10+/- 64.01 mcg/dl. Mean TIBC in the IDA group following treatment is 411.74+/- 29.63 mcg/dl.

Table: Comparison of mean HbA1c levels between IDA group, control group and IDA after treatment group

Groups	Mean HbA1c(%)
IDA group	5.39 +/- 0.32
Control group	4.53+/-0.27
IDA after treatment group	4.48 +/-0.3

Mean HbA1c in the IDA group is 5.39 +/- 0.32%. Mean HbA1c in the control group is 4.53+/- 0.27%. Mean HbA1c in the IDA group following treatment is 4.48 +/-0.3%.

Table: Comparison between the investigation profile of IDA group and control group

	group	N	Mean	Std. Deviation	t	P
MCV(fl)	control	100	82.479	3.1279	24.765	.000
	Anaemia	100	65.468	6.1155		
MCH(pg)	control	100	29.551	1.6031	42.944	.000
	Anaemia	100	18.729	1.9443		
serum iron levels(mcg/dl)	control	100	104.030	23.2003	30.311	.000
	Anaemia	100	28.709	8.9026		
serum ferritin levels(mcg/l)	control	100	130.010	55.6525	21.867	.000
	Anaemia	100	8.259	1.6635		
TIBC(mcg/dl)	control	100	341.10	64.019	-21.953	.000
	Anaemia	100	485.54	15.180		
HbA1c(%)	control	100	4.539	.2726	-20.067	.000
	Anaemia	100	5.396	.3287		
FBS(mg/dl)	control	100	95.50	14.217	1.281	.202
	Anaemia	100	92.91	14.375		
PPBS(mg/dl)	control	100	113.33	13.374	-.681	.497
	Anaemia	100	114.52	11.242		

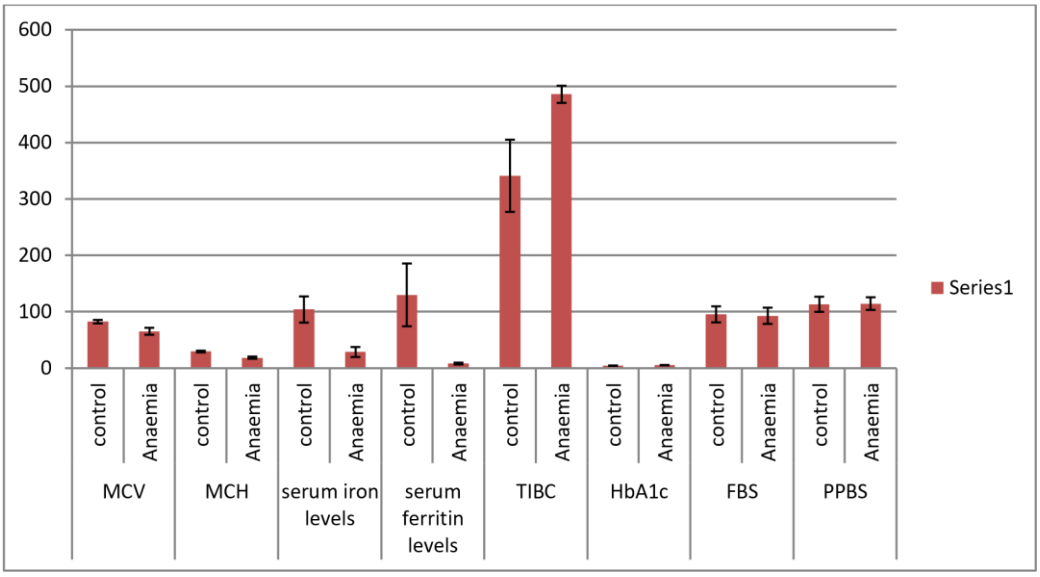

Figure: Comparison between the investigation profile of IDA group and control group

Mean MCV in the IDA group is 65.46 +/- 6.11 fl. Mean MCV in the control group is 82.47+/3.12 fl. P value is < 0.05. Mean MCH in the IDA group is 18.72 +/- 1.94 pg. Mean MCH in the control group is 29.55+/1.60 pg. P value is < 0.05. Mean serum iron levels in the IDA group is 28.70 +/- 8.90 mcg/dl. Mean serum iron levels in the control group is 104.03+/-23.20 mcg/dl. P value is < 0.05. Mean serum ferritin levels in the IDA group is 8.25 +/- 1.66 mcg/l. Mean serum ferritin levels in the control group is 130.01+/-55.65 mcg/l. P value is < 0.05. Mean TIBC in the IDA group is 485.54 +/- 15.18 mcg/dl. Mean TIBC in the control group is 341.10+/- 64.01 mcg/dl. P value is < 0.05. Mean HbA1c in the IDA group is 5.39 +/- 0.32%. Mean HbA1c in the control group is 4.53+/-. 0.27%. P value is < 0.05. Mean FBS in cases is 92.91 +/- 14.37 mg/dl. Mean FBS in the control group is 95.50+/-14.21 mg/dl. Mean PPBS in cases is 114.52 +/- 11.24 mg/dl. Mean PPBS in the control group is 113.33+/- 13.37 mg/dl.

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Table: Comparison between investigation profile of IDA group and IDA after treatment group

Parameters	Group	Mean	Std. Deviation	t	P
MCV(fl)	Anaemia	65.468	6.1155	-3.450	.001
	Anaemia after treatment	91.589	7.54535		
MCH(pg)	Anaemia	18.729	1.9443	-44.854	.000
	Anaemia after treatment	30.012	1.3704		
serum iron levels(mcg/dl)	Anaemia	28.709	8.9026	-42.199	.000
	Anaemia after treatment	114.576	17.9174		
serum ferritin levels(mcg/l)	Anaemia	8.259	1.6635	-23.302	.000
	Anaemia after treatment	44.941	15.6459		
TIBC(mcg/dl)	Anaemia	485.54	15.180	21.777	.000
	Anaemia after treatment	411.74	29.631		
HbA1c(%)	Anaemia	5.396	.3287	19.476	.000
	Anaemia after treatment	4.485	.3030		
FBS(mg/dl)	Anaemia	92.91	14.375	2.689	.008
	Anaemia after treatment	88.33	6.848		
PPBS(mg/dl)	Anaemia	114.52	11.242	-4.898	.000
	Anaemia after treatment	122.48	10.752		

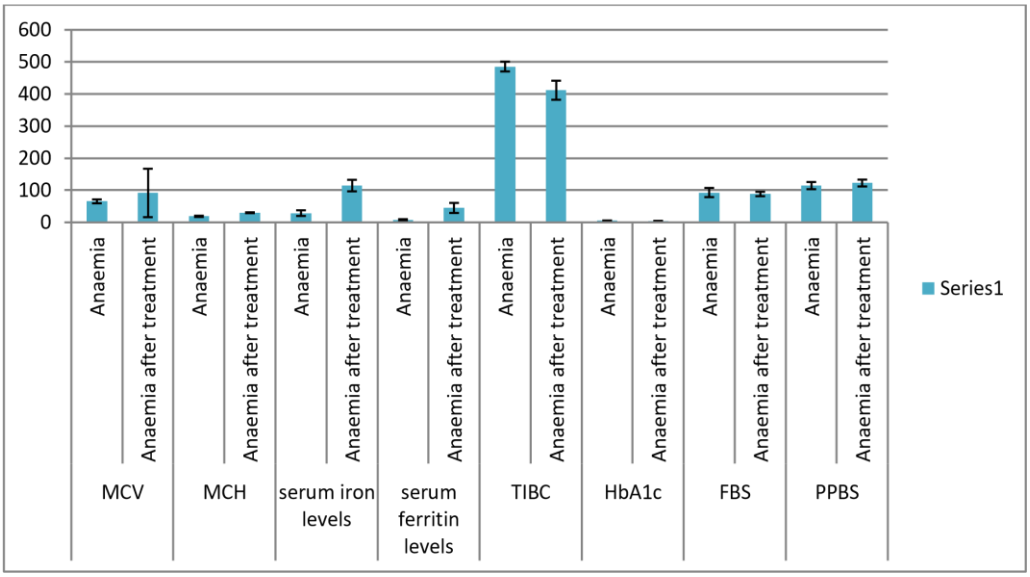

Figure: Comparison between investigation profile of IDA group and IDA after treatment group

Mean MCV in the IDA group is 65.46 +/- 6.11 fl. Mean MCV in the IDA group following treatment is 91.58 +/- 7.45 fl. P value is < 0.05. Mean MCH in the IDA group is 18.72 +/- 1.94 pg. Mean MCH in the IDA group following treatment is 30.01 +/- 1.37 pg. P value is < 0.05. Mean serum iron levels in the IDA group is 28.70 +/- 8.90 mcg/dl. Mean serum iron levels in the IDA group following treatment are 114.57 +/-17.91 mcg/dl. P value is < 0.05. Mean serum ferritin levels in the IDA group is 8.25 +/- 1.66 mcg/l. Mean serum ferritin levels in the IDA group following treatment is 44.94 +/- 15.64 mcg/l. P value is < 0.05. Mean TIBC in the IDA group is 485.54 +/- 15.18 mcg/dl. Mean TIBC in the IDA group following treatment is 411.74+/- 29.63 mcg/dl. P value is < 0.05. Mean HbA1c in the IDA group is 5.39 +/- 0.32%. Mean HbA1c in the IDA group following treatment is 4.48 +/-0.3%. P value is < 0.05. Mean FBS in cases is 92.91 +/- 14.37 mg/dl. Mean PPBS in cases is 114.52 +/- 11.24 mg/d.

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Table: Pearson's Correlations in IDA group

Pearson's Correlations in IDA group												
		present_ anaemia	Grades of anaemia	serum iron levels	Serum ferritin levels	TIBC	HbA1 c	FBS	PPBS	Hb	MCV	MCH
present_anaemia	r	1	.406**	.118	-.021	-.076	-.124	-.190	-.076	-.221*	.142	.105
	p		.000	.242	.838	.451	.218	.058	.451	.027	.160	.297
	N	100	100	100	100	100	100	100	100	100	100	100
anaemia	r	.406**	1	-.186	.062	.059	-.201*	.029	-.059	-.771**	-.074	-.097
	p	.000		.064	.542	.557	.045	.777	.559	.000	.467	.336
	N	100	100	100	100	100	100	100	100	100	100	100
serum iron levels	r	.118	-.186	1	-.131	.057	-.270**	-.204*	-.051	.368**	.761**	.804**
	p	.242	.064		.194	.571	.007	.042	.617	.000	.000	.000
	N	100	100	100	100	100	100	100	100	100	100	100
serum ferritin levels	r	-.021	.062	-.131	1	.044	-.017	-.006	-.115	-.030	-.170	-.137
	p	.838	.542	.194		.661	.866	.955	.253	.765	.091	.174
	N	100	100	100	100	100	100	100	100	100	100	100
TIBC	r	-.076	.059	.057	.044	1	.023	.169	.189	.033	-.005	.055
	p	.451	.557	.571	.661		.821	.093	.060	.742	.965	.590
	N	100	100	100	100	100	100	100	100	100	100	100
HbA1c	r	-.124	-.201*	-.270**	-.017	.023	1	-.076	.233*	.151	-.053	-.189
	p	.218	.045	.007	.866	.821		.453	.020	.133	.598	.060
	N	100	100	100	100	100	100	100	100	100	100	100
FBS	r	-.190	.029	-.204*	-.006	.169	-.076	1	.022	-.025	-.247*	-.176
	p	.058	.777	.042	.955	.093	.453		.831	.806	.013	.081
	N	100	100	100	100	100	100	100	100	100	100	100
PPBS	r	-.076	-.059	-.051	-.115	.189	.233*	.022	1	.101	.007	.054
	p	.451	.559	.617	.253	.060	.020	.831		.319	.948	.595
	N	100	100	100	100	100	100	100	100	100	100	100
Hb	r	-.221*	-.771**	.368**	-.030	.033	.151	-.025	.101	1	.301**	.289**
	p	.027	.000	.000	.765	.742	.133	.806	.319		.002	.004
	N	100	100	100	100	100	100	100	100	100	100	100
MCV	r	.142	-.074	.761**	-.170	-.005	-.053	-.247*	.007	.301**	1	.751**
	p	.160	.467	.000	.091	.965	.598	.013	.948	.002		.000
	N	100	100	100	100	100	100	100	100	100	100	100
MCH	r	.105	-.097	.804**	-.137	.055	-.189	-.176	.054	.289**	.751**	1
	p	.297	.336	.000	.174	.590	.060	.081	.595	.004	.000	
	N	100	100	100	100	100	100	100	100	100	100	100

Table: Pearson's Correlations in IDA group after treatment

Pearson's Correlations in IDA group after treatment												
		present_ anaemia	anaemia	Hb	MCV	MCH	serum iron levels	serum ferritin levels	TIBC	HbA1c	FBS	PPBS
present_ anaemia	r	1	1.000**	-.143	-.019	.135	.119	-.119	.057	-.139	-.101	.138
	p		.000	.191	.862	.217	.278	.279	.607	.203	.356	.208
	N	85	85	85	85	85	85	85	85	85	85	85
anaemia	r	1.000**	1	-.143	-.019	.135	.119	-.119	.057	-.139	-.101	.138
	p	.000		.191	.862	.217	.278	.279	.607	.203	.356	.208
	N	85	85	85	85	85	85	85	85	85	85	85
Hb	r	-.143	-.143	1	-.205	-.030	.078	.204	-.044	.015	-.047	.050
	p	.191	.191		.059	.784	.477	.061	.687	.894	.673	.653
	N	85	85	85	85	85	85	85	85	85	85	85
MCV	r	-.019	-.019	-.205	1	.029	-.033	-.171	-.049	.146	.169	.077
	p	.862	.862	.059		.795	.764	.117	.654	.182	.121	.486
	N	85	85	85	85	85	85	85	85	85	85	85
MCH	r	.135	.135	-.030	.029	1	.125	-.236*	.104	.013	.209	.185
	p	.217	.217	.784	.795		.252	.030	.343	.908	.055	.090
	N	85	85	85	85	85	85	85	85	85	85	85
serum iron levels	r	.119	.119	.078	-.033	.125	1	-.076	-.218*	.014	.122	-.041
	p	.278	.278	.477	.764	.252		.490	.045	.898	.266	.713
	N	85	85	85	85	85	85	85	85	85	85	85
serum ferritin levels	r	-.119	-.119	.204	-.171	-.236*	-.076	1	-.058	.043	-.050	-.130
	p	.279	.279	.061	.117	.030	.490		.596	.698	.650	.237
	N	85	85	85	85	85	85	85	85	85	85	85
TIBC	r	.057	.057	-.044	-.049	.104	-.218*	-.058	1	.019	-.101	-.072
	p	.607	.607	.687	.654	.343	.045	.596		.864	.356	.510
	N	85	85	85	85	85	85	85	85	85	85	85
HbA1c	r	-.139	-.139	.015	.146	.013	.014	.043	.019	1	-.046	.059
	p	.203	.203	.894	.182	.908	.898	.698	.864		.674	.590
	N	85	85	85	85	85	85	85	85	85	85	85
FBS	r	-.101	-.101	-.047	.169	.209	.122	-.050	-.101	-.046	1	.182
	p	.356	.356	.673	.121	.055	.266	.650	.356	.674		.096
	N	85	85	85	85	85	85	85	85	85	85	85
PPBS	r	.138	.138	.050	.077	.185	-.041	-.130	-.072	.059	.182	1
	p	.208	.208	.653	.486	.090	.713	.237	.510	.590	.096	
	N	85	85	85	85	85	85	85	85	85	85	85
**. Correlation is significant at the 0.01 level (2-tailed).												
*. Correlation is significant at the 0.05 level (2-tailed).												

Table: Pearson's correlation co-efficient(r) between HbA1c and other parameters in the IDA group

		Serum Iron Levels	Serum Ferritin levels	TIBC	Hb	MCV	MCH
HbA1c	r	-.270**	-.017	.023	.151	-.053	-.189
	p	.007	.866	.821	.133	.598	.060

Table: Pearson's correlation co-efficient (r) between HbA1c and other parameters in the anaemia Group after treatment.

		Hb	MCV	MCH	Serum Iron Levels	Serum Ferritin levels	TIBC
HbA1c	r	.015	.146	.013	.014	.043	.019
	p	.894	.182	.908	.898	.698	.864

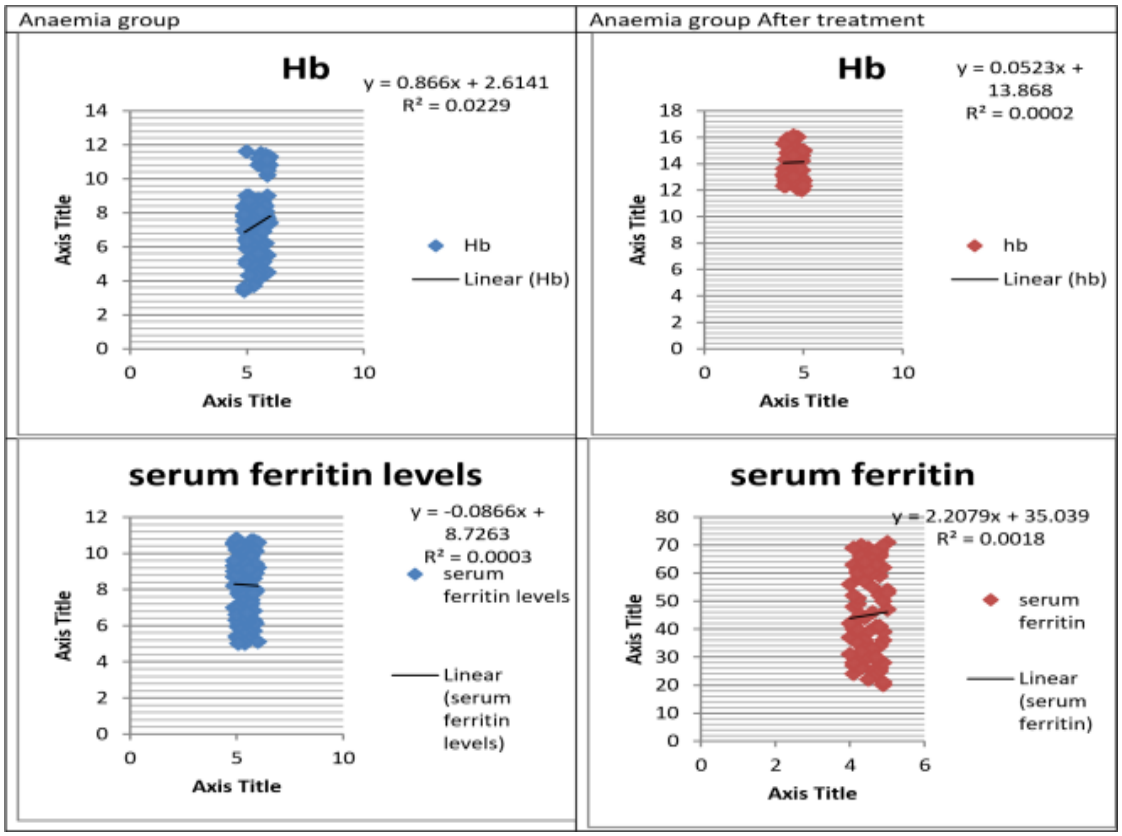

Figure: Correlation between HbA1c (x axis) and anemia parameters - Hb and serum ferritin levels(y axis)

There is an insignificant positive correlation between haemoglobin levels and HbA1c levels in the IDA group. P value > 0.05. There is an insignificant positive correlation between haemoglobin levels and HbA1c levels in the IDA group after treatment. P vaue > 0.05. There is an insignificant negative correlation between haemoglobin levels and serum ferritin levels in the IDA group. P value > 0.05. There is an insignificant positive correlation between haemoglobin levels and serum ferritin levels in the IDA group after treatment. P vaue > 0.05

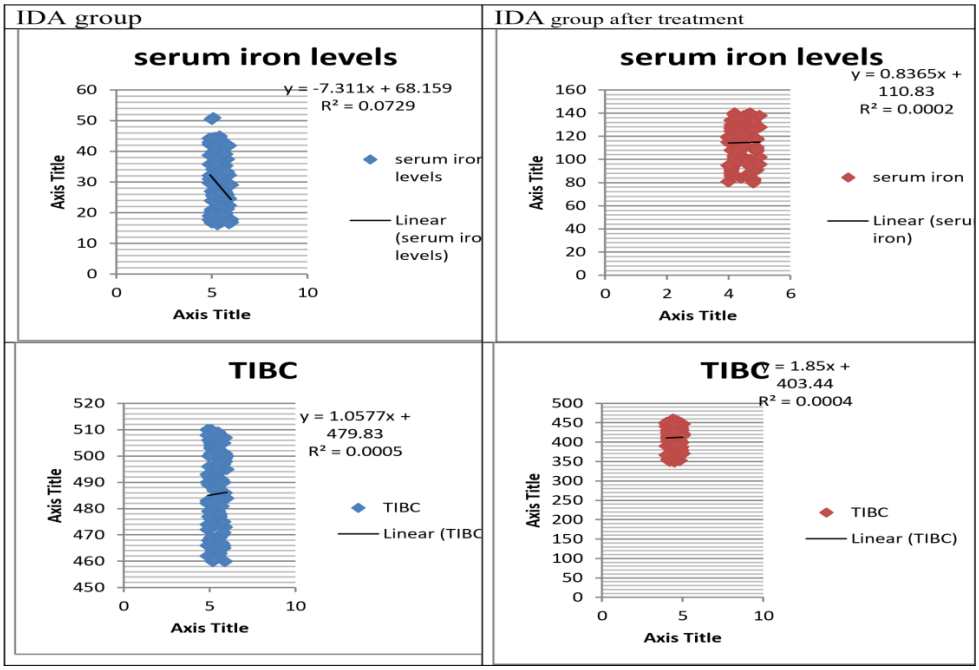

Figure: Correlation between HbA1c (x axis) and anemia parameters – serum iron levels and TIBC(y axis)

There is a significant negative correlation between haemoglobin levels and serum iron levels in the IDA group. P value < 0.05. There is an insignificant positive correlation between haemoglobin levels and serum iron levels in the IDA group after treatment. P vaue > 0.05. There is an insignificant positive correlation between haemoglobin levels and TIBC levels in the IDA group. P value > 0.05. There is an insignificant positive correlation between haemoglobin levels and TIBC levels in the IDA group after treatment. P vaue > 0.05.

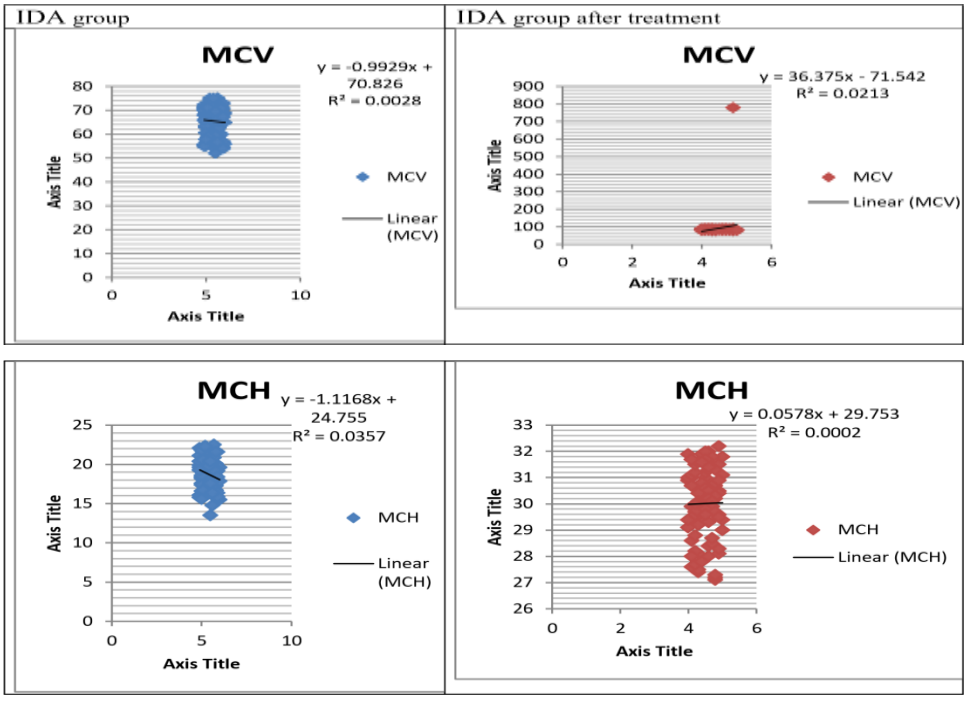

Figure: Correlation between HbA1c(x-axis) and anaemia parameters – MCV and MCH(y-axis)

There is an insignificant negative correlation between haemoglobin levels and MCV levels in the IDA group. P value > 0.05. There is an insignificant positive correlation between haemoglobin levels and MCV levels in the IDA group after treatment. P vaule > 0.05. There is an insignificant negative correlation between haemoglobin levels and MCH levels in the IDA group. P value > 0.05. There is an insignificant positive correlation between haemoglobin levels and MCH levels in the IDA group after treatment. P value > 0.05.

DISCUSSION

The present study which was done to compare and correlate difference in HbA1c levels in non diabetic patients with iron deficiency anaemia before and after correction of anaemia compared to a control group consisting of non diabetic patients without anaemia.

In the present study mean serum HbA1c levels were high among iron deficiency anaemia group is 5.39+/- 0.32; which is significantly high compared to the control group, their mean HbA1c being 4.53+/- 0.27 with p value being <0.05 which is statistically significant.

The mean HbA1c of the iron deficiency group after treatment is 4.48+/-0.30 which is also statistically significant compared to the IDA group with P value < 0.05.

In a study done by Balasubrahmanian et al. mean HbA1c levels among iron deficiency anaemia group was 7.6+/- 0.5 and among control group it was 5.5+/-0.8 with P value being < 0.05.

In a study done by Coban et al[9]. mean serum HbA1c levels were high among iron deficiency anaemia group was 7.4 +/- 0.8; which is significantly high compared to the control group, their mean HbA1c being 5.9 +/- 0.5 with P value being <0.05 which is statistically significant.

The mean HbA1c of the iron deficiency group after treatment was 6.2 +/- 0.6 which is also statistically significant compared to the IDA group with P value < 0.05.

Table: Comparison of the present study with other studies with regard to cases and controls

	Cases			Controls		
	Present study	**Bala subrahmanian et al**	**Coban et al.**	**Present study**	**Bala subrahmanian et al**	**Coban et al.**
Number of population	100	50	50	100	50	50
Mean HbA1c levels	5.39+/- 0.32	7.6+/- 0.5	7.4 +/-0.8	4.53+/- 0.27	5.5+/-0.8	5.9+/- 0.5

The mean HbA1c levels were high among IDA group compared to healthy controls which correlate with these studies.

Table: Comparison of the present study with other studies with regard to IDA group and IDA after treatment group

	Cases (IDA group)			IDA after treatment group		
	Present study	Nitin Sinha et al.	oban et al.	Present study	Nitin Sinha et al.	oban et al.
Number of population	100	50	50	85	50	50
Mean HbA1c levels	5.39+/- 0.32	4.6+/-0.6	7.4 +/-0.8	4.48+/-0.30	5.9+/-0.6	6.2+/-0.6

In the present study in patients with IDA, HbA1c decreased significantly after iron treatment from a mean 5.39+/-0.32 to 4.48+/-0.30 which correlates with the study conducted by Coban etal[9].

But in the study conducted by Nitin Sinha et al[11]. demonstrated a significant increase in the HbA1c levels in IDA group from 4.6+/-0.6 to 5.9 +/- 0.6 after treating iron deficiency anaemia which does not correlate with the present study

Table: Comparison of the present study with other study with regard to mean serum ferritin with HbA1c levels

Groups	Present study (mean ferritin levels) (mcg/l)	Study by Nitin Sinha et al. (mean ferritin levels) (mcg/l)	Study by Balasubrahmanian et al. (mean ferritin levels) (mcg/l)
IDA group	8.25+/-1.66	7.0+/-3.1	3.68+/-1.8
Control group	130.01+/-55.65	232.8+/-76.7	22.3+/-6.1
IDA after treatment group	44.94+/-15.64	279.1+/-83.8	_

The serum ferritin levels were low among the IDA group and are normal in the control group. The serum ferritin levels improved to normal levels following iron replacement therapy in the IDA group which correlates with the study conducted by Nitin Sinha et al. The serum ferritin levels were low among the IDA group and are normal in the control group in the study conducted by Balasubrahmanian et al.

CONCLUSION

The results showed that iron deficiency is associated with higher levels of HbA1c, which could evoke problems in the diagnosis of uncontrolled diabetes mellitus in iron deficient patients. The iron status of the patients must be considered during the interpretation of HbA1c levels in diabetes mellitus. The iron replacement therapy is thus very important in diabetic patients with iron deficiency, as it would also increase the reliability of the HbA1c determinations.

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