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Impact of Iron Deficiency Anemia on Serum Lipid Profile in Indian Adults

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Abstract

Background: Iron deficiency and lipid metabolism disorders are common health problems but the number of published studies investigating lipid alterations in Iron Deficiency Anemia (IDA) is relatively low and the results of these studies are inconsistent. Some of these studies show that lipid parameters in iron deficient patients are higher in value than those of healthy control patients, whereas others indicate that lipid parameters fall to lower levels in iron deficiency, but improve to normal range following the rise of hemoglobin (Hb) after iron replacement or transfusion. Therefore, in the present study, we investigated the changes in serum lipid concentrations that occur in patients of IDA. *Materials and Methods:* This is a cross-sectional study carried out in SRM Medical College Hospital and Research Centre, Chennai. Totally 200 subjects, both men and women aged >18yrs [100 patients with IDA(cases) and 100 patients without IDA (controls)] were included in our study and tested for lipid profile. *Statistical Analysis:* The data were analyzed by SPSS version 21 using Independent samples unpaired 't' test. 'p' value <0.05 was considered as statistically significant. *Results:* The baseline hematological parameters of the IDA patients were found to be significantly different from controls (Table 1). The levels of serum TG and serum VLDL were significantly (P <0.05) higher in the IDA group, whereas the levels TC, LDL and HDL were significantly (P = 0.01) lower in IDA. In our study mean serum TC and LDL levels was statistically significant (P < 0.05) between mild, moderate and severe anemia whereas mean serum TG, HDL, VLDL was not statistically significant. Except LDL in mild and severe anemia there was no significant difference between male and female in other lipid parameters among varying degrees of anemia. *Conclusion:* We conclude that, serum lipid profile is altered in the presence of IDA. But the role of iron in blood lipid metabolism has received little attention, especially in India, and must be explored to establish if IDA is a contributing factor in the etiology of cardiovascular disease in humans which must be considered seriously and hence all attempts should be made to treat this micronutrient deficiency promptly.

Keywords: Iron Deficiency; Anemia; Serum Lipid Profile.

Introduction

Iron deficiency and lipid metabolism disorders are common health problems but the number of published studies investigating lipid alterations in Iron Deficiency Anemia (IDA) is relatively low and the results of these studies are inconsistent.Also populations of these studies are generally limited to children or young adult patients[1,2]. Some of these studies show that lipid parameters in iron deficient patients are higher in value than those of healthy control patients, whereas others indicate that lipid parameters fall to lower levels in iron deficiency,but improve to normal range following the rise of hemoglobin (Hb) after iron replacement or transfusion [3].

Various studies, both in animals and in humans have linked IDA with altered blood lipid profile[4-7]. Although associations have been found between dietery iron intake and serum lipid and lipoprotein

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concentrations in animal models, such relationships have not been investigated extensively in humans and the available data are inconsistent [8,9]. Knowledge about the effect of iron deficiency on serum lipid profile is limited. Despite such a high prevalence of IDA and dyslipidemia, no relevant study could be found linking the two with reference to Indian population [4].

Therfore, in the present study, we investigated the changes in serum lipid concentrations that occur in patients of IDA.

Materials and Methods

This is a cross-sectional study carried out in SRM Medical College Hospital and Research Centre, Chennai (november 2016 to june 2017) after obtaining approval from our institutional ethical committee. The subjects randomly selected from both outpatient and inpatient departments of our SRM hospital were included in the study evaluation.

Totally 200 subjects, both men and women aged >18yrs [100 patients with IDA (cases) and 100 patients without IDA(controls)] were included in our study and tested for lipid profile. All the laboratory parameters analyzed for study group were analyzed for the control group as well. A formal informed consent was obtained in writing, permitting their participation in this study. Detailed medical history was recorded. Smokers, chronic alcoholics, chronic infection/disease, those with diabetes mellitus, heart, liver, renal, thyroid and hematological disease, history of drug therapy both long term and those affecting serum lipid level, steroids, hematinic therapy especially during the past 1 year were excluded from the study.

Those having hemoglobin (Hb) <13gm/dl in males and <12gm/dl in females, mean corpuscular volume (MCV) <80fl, mean corpuscular hemoglobin (MCH) <26pg/cell, mean corpuscular hemoglobin concentration (MCHC) <32gm/dl and peripheral smear showing microcytic hypochromic picture were considered to have IDA and confirmed by their serum iron and ferritin levels.

Measurements

For serum lipid reference level, National Cholesterol Education Programme [NCEP], Adult Treatment Panel III [ATP III] [NCEP – ATP III] guideline was referred. Hypercholesterolemia defined as Total Cholesterol [TC] > 200 mg/dl, LDL-C > 100 mg/dl, Hypertriglyceridemia > 150 mg/dl and HDL-C < 40 mg/dl, VLDL-C >30mg/dl. Dyslipidemia defined by presence of one or more than one abnormal serum lipid concentration.

Hb, MCV, MCH, MCHC were measured by SYSMEX XT-1800i analyzer. Serum iron (TPTZ) and serum ferritin (Bio-Rad QuanimuneFerrin IRMA, Biorad lab).

Venous blood samples were collected from all the subjects after atleast 8 hours fasting. TC, TG, HDL-C was measured by enzymatic method by using OLYMPUS AU400 autoanalyzer on the same day of collection.

Statistical Analysis

The data were analyzed using SPSS version 20 and presented as mean ± S.D for continuous variables.

Unpaired t- test was applied for comparison of group means. Pearson's co-efficient of correlation was calculated to determine correlation between two variables. p value <0.05 was considered statistically significant.

Results

The baseline hematological parameters of the IDA patients were found to be significantly different from controls (Table 1). The IDA subjects had significantly lower Mean Corpuscular Volume (MCV), Mean Corpuscular Hemoglobin (MCH) and Mean Corpuscular Hemoglobin Concentration (MCHC) values as compared to the control group. Mean serum iron and serum ferritin was significantly low in IDA than the control group.

Table 1: Baseline hematological parameters of Ida patients and controls

Parameters	IDA (n=200)	Control (n=200)	Unpaired T test	P value
Hb (g/dl)	10.52 ± 0.12	14.13 ± 0.09	-23.186	0.0001
Hematocrit (%)	31.35 ± 0.71	41.61 ± 0.45	-12.221	0.0001
MCV (fl)	66.79 ± 1.53	87.40 ± 0.51	-12.791	0.0001
MCH (pg/cell)	23.88 ± 0.50	29.04 ± 0.14	-9.910	0.0001
MCHC (g/dl)	31.11 ± 0.24	33.51 ± 0.14	-8.767	0.0001
Serum iron (mcg/dl)	42 ± 0.61	74 ± 0.32	-24.56	0.0001
Serum ferritin (mcg/dl)	12.09 ± 1.21	41.06 ± 0.43	-26.74	0.0001

Table 2: Baseline lipid parameters of IDA patients and controls

Parameters	IDA (n=200)	Control (n=200)	Unpaired T test	P value
TC (mg/dl)	119.28 ± 1.11	167.32 ± 2.80	-15.957	0.0001
LDL	80.94 ± 0.84	117.62 ± 2.71	-12.938	0.0001
TG	203.50 ± 2.65	137.73 ± 7.60	8.175	0.0001
HDL	23.43 ± 0.20	38.59 ± 0.83	-17.818	0.0001
VLDL	42.15 ± 0.48	25.00 ± 0.96	16.032	0.0001

Table 3: Comparison of lipid parameters among subjects with grades of anaemia

Parameters	Mild (n=83)	Moderate (n=89)	Severe (n=28)	ANOVA	P value
TC	120.40 ± 1.65	120.76 ± 1.51	111.25 ± 3.82	4.388	0.014
LDL	82.48 ± 1.08	80.88 ± 1.35	76.61 ± 2.63	2.603	0.051
TG	199.53 ± 4.33	204.36 ± 3.79	212.54 ± 6.91	1.305	0.274
HDL	23.47 ± 0.26	23.30 ± 0.34	23.68 ± 0.57	0.201	0.818
VLDL	41.78 ± 0.92	41.84 ± 0.53	44.18 ± 1.22	1.460	0.235

Table 4: Comparison of lipid parameters between males and females among mild anaemia subjects

Parameters	Male (N=29)	Female (N=54)	Unpaired T test	P value
TC	120.52 ± 2.50	120.33 ± 2.16	0.053	0.958
LDL	85.72 ± 1.53	80.74 ± 1.40	2.250	0.027
TG	196.55 ± 7.64	201.13 ± 5.28	-0.502	0.617
HDL	23.76 ± 0.45	23.31 ± 0.32	0.819	0.415
VLDL	42.86 ± 2.05	41.20 ± 0.90	0.858	0.393

Table 5: Comparison of lipid parameters between males and females among moderate anaemia subjects

Parameters	Male (N=40)	Female (N=49)	Unpaired T test	P value
TC	118.65 ± 2.48	122.49 ± 1.83	-1.272	0.207
LDL	79.43 ± 2.02	82.06 ± 1.80	-0.975	0.332
TG	200.85 ± 3.95	207.22 ± 6.09	-0.835	0.406
HDL	23.25 ± 0.57	23.35 ± 0.41	-0.141	0.889
VLDL	41.80 ± 0.76	41.88 ± 0.75	-0.072	0.943

Table 6: Comparison of lipid parameters between males and females among severe anaemia subjects

Parameters	Male (n=12)	Female (n=16)	Unpaired T test	P value
TC	108.83 ± 5.63	113.06 ± 5.30	-0.541	0.593
LDL	71.00 ± 3.90	80.81 ± 3.27	-1.936	0.054
TG	205.17 ± 8.20	218.06 ± 10.42	-0.921	0.365
HDL	23.83 ± 1.04	23.56 ± 0.66	0.231	0.819
VLDL	45.58 ± 1.23	43.13 ± 1.92	0.997	0.328

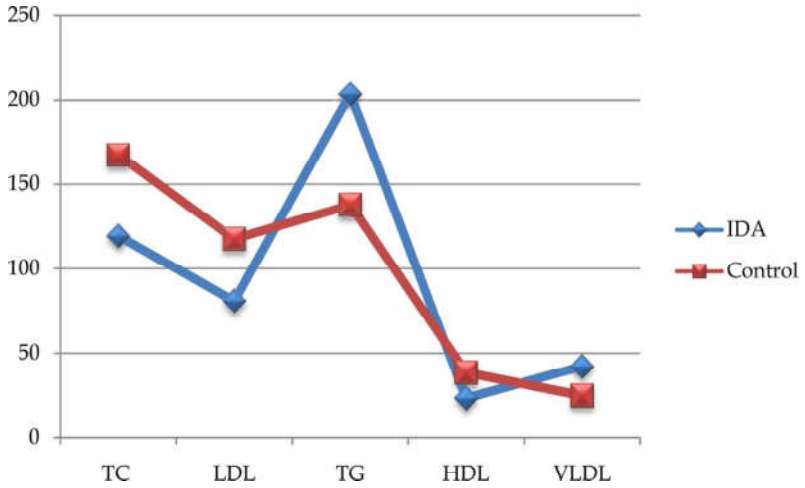

Fig. 1: Baseline lipid parameters of IDA patients and controls

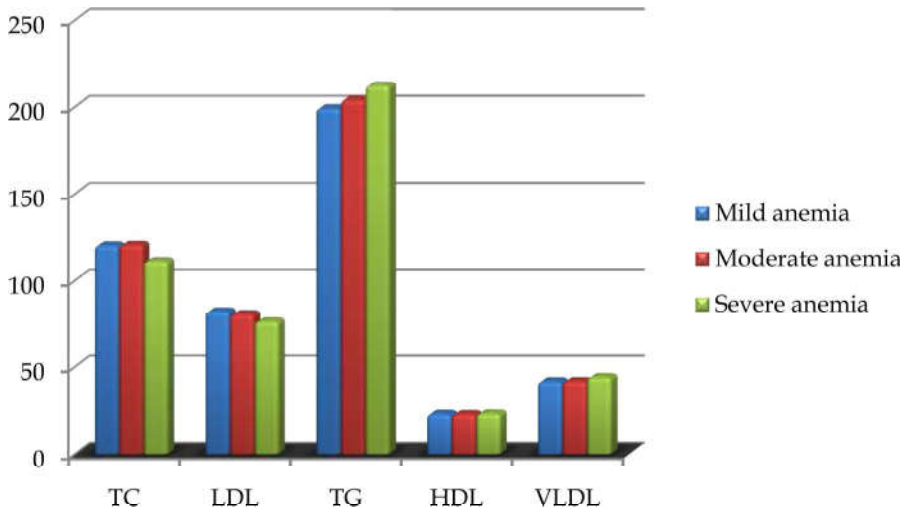

Fig. 2: Comparison of lipid parameters among subjects with grades of anaemia

The comparison of serum lipid profile between the IDA and the control group is summarized in Table 2 and Figure 1. The levels of serum TG and serum VLDL were significantly (P <0.00) higher in the IDA group, whereas the levels TC, LDL and HDL were significantly (P = 0.01) lower in IDA.

Comparison of lipid parameters among subjects with mild, moderate and severe degree of anaemia is summarized in Table 3 and Figure 2.

In our study mean serum TC and LDL levels was statistically significant (P < 0.05) between mild, moderate and severe anemia whereas mean serum TG, HDL, VLDL was not statistically significant Except LDL in mild and severe anemia there was no significant difference between male and female in other lipid parameters among varying degrees of anemia. (Table 4,5,6)

Discussion

IDA is the world's most wide spread nutritional disorder and also the commonest cause of anemia occurring regardless of age, gender and socio economic status affecting both industrialized and developing countries. It is the most common cause of anemia. On a world wide basis WHO has estimated that about a third of the population is suffering from anemia with IDA.

Altered lipid profile have been previously described in various anemia like IDA, thalassemia, sickle cell disease, G6PD deficiency, spherocytosis, aplastic anemia and myelodysplastic syndrome [10-14].

In our study we observed a significant decrease in serum levels of TC, LDL, HDL and significant increase in serum levels of TG and VLDL in IDA than those without IDA.

In a study conducted by Hanna Shalev et al, reports revealed that TC, HDL and LDL were lower in anemic patients when compared with control subjects [10]. Also hypocholesterolemia, decreased HDL and increased VLDL but increased LDL were observed by Anil Kumar Mani Tiwari et al [15]. Decreased HDL, increased TG and VLDL were observed by VenkateshwarluNandyala et al,but he observed increased TC and LDL in anemic patients which contradicts our results [8]. Similar to our results, Verma U et al also observed decreased TC, LDL in anemic patients [16]. Jong Weon Choi et al observed decreased TC but decreased TG in his study [2]. Similar to our results, AydinEce et al observed decreased TC and LDL levels and Vijaykumar B Antappanavar et al observed increased TG and VLDL [4,7] .

The pathophysiology of the hypocholesterolemia remains obscure, although several mechanisms have been proposed. Plasma dilution resulting from anemia, increased cholesterol requirement associated with erythroid hyperplasia, macrophage system activation with cytokine release, increased cholesterol uptake by the reticuloendothelial system and liver injury secondary to iron overload [10,11].

In order to elucidate the mechanism underlying the anemia, associated hypocholesterolemia, we sought to determine whether hypocholesterolemia is a specific manifestation of increased red blood cell proliferation or whether it also occurs in patients with decreased erythropoiesis.

Increased proliferation of erythroid cells in the bone marrow was previously shown to be associated with an increased cholesterol requirement [10,17]. Since mature erythrocytes can renew membrane cholesterol only through exchange with plasma cholesterol, one way to meet the higher requirement is to increase the expression of the LDL receptors and theraby, increase the receptor-mediated removal of plasma LDL leading to hypocholesterolemia [10].

Elevated triglyceride level in the circulation of patients with high erythroid activity has been previously described in association with diseases such as thalassemia and was explained by extrahepaticlipolytic activity [10].

Conclusion

We conclude that, serum lipid profile is altered in the presence of IDA. But the role of iron in blood lipid metabolism has received little attention, especially in India, and must be explored to establish if IDA is a contributing factor in the etiology of cardiovascular disease in humans which must be considered seriously and hence all attempts should be made to treat this micronutrient deficiency promptly.

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