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Evaluation of antioxidant status and Serum lipoprotein (a) in coronary heart diseases

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Abstract: Coronary heart disease (CHD) has become the most important cause of premature morbidity and mortality. The chief risk factors for CHD includes Smoking, Hypertension, Diabetes mellitus, Hypercholesterolemia, Low high density lipoprotein, Obesity, Mental stress, Type A personality and Genetic factors. Lipoprotein (a) has been established as a strong independent risk factor for premature CHD, which is highly thrombogenic and antifibrinolytic which begins to block the arteries much earlier than other risk factors. This study is planned to determine the antioxidant status and to estimate Serum lipoprotein (a) levels in patients of CHD and in patients with risk factors for CHD. Among all the patients, majority of patients belongs to upper and middle class. In routine investigations an increase in serum cholesterol, serum LDL, TC/HDL and LDL/HDL ratio were seen in all five groups including MI, HT, DM, Smokers and obesity cases, which were statistically significant. Serum Triglycerides were increased in MI, DM, Smokers and obesity cases, which were statistically significant, where as significant increase was not seen in HT cases. Serum VLDL showed a statistically significant increase in MI, Smokers and obesity cases, where as significant increases was not seen in HT and DM cases. Blood glucose showed a significant increase in DM cases, where as no significant increase were seen in MI, HT, smokers and obesity cases. A statistically significant decrease in serum HDL were seen in all five groups including MI, HT, DM, Smokers and obesity cases. In special investigations, there is significant increase in MDA, Lipoprotein (a) levels and significant decrease of antioxidants such as blood glutathione, Serum vitamin E, vitamin C and vitamin A in cases of coronary heart diseases and also in cases with risk factors for Coronary heart diseases including hypertension, diabetes mellitus, smoking and obesity. Hence, it is therefore concluded that MDA, Lipoprotein (a) and antioxidants like glutathione, vitamin E, Vitamin C and Vitamin A, be evaluated as biochemical parameters for preclinical assessment of "at risk group" for Coronary heart diseases and for assessing and monitoring cases of Coronary heart diseases.

Keywords: Coronary Heart Diseases, Lipoprotein (A), MDA, Antioxidants

1. Introduction

Coronary heart disease (CHD) has become the most important cause of premature morbidity and mortality. With the advancement of medical science in the 20th century, there has been a remarkable increase in the life expectancy throughout the world by controlling infections and consequently more number of deaths are recorded due to degenerative causes like coronary atherosclerosis. CHD is very important medical problem and in spite of a large number of researches for diagnosis and treatment, it takes a huge toll of human lives all over the globe. CHD produces localized ischaemia of the myocardium and when the occlusion is complete , myocardial infarction takes place. There are various risk factors, presence of which makes person more prone to develop CHD, the risk factors for CHD includes smoking, hypertension, diabetes mellitus, obesity and others. Lipid peroxidation is a free radical mediated reaction, it is not possible to measure free radicals, so lipid peroxidation is measured in terms of Malondialdehyde (MDA), which is end product of lipid peroxidation. There are natural protective molecule which scavenge free radicals called antioxidants e.g., Glutathione, Vitamin E, Vitamin C and vitamin A. The level of these antioxidants will determine the antioxidant status. Lipoprotein (a) [Lp(a)] is a specific class of lipoprotein particles consists of apo (a) which is linked with apo B_{100} by a disulfide bond. Lp(a) now been established as a strong

independent risk factor for premature CHD, which is highly thrombogenic and antifibrinolytic, which begins to block the arteries much earlier than other risk factors.

To know the co-relation of total antioxidant status by the parameters mentioned above and concentration of Lp(a) and to evaluate of whether they can be used as monitoring indices in Coronary heart diseases, The present study is planned with following objectives.

1 To study the antioxidant status (mainly antioxidants- vitamin E, vitamin C and vitamin A) in patients of Coronary heart diseases and in patients with risk factors including smoking, Hypertension, Diabetes mellitus and Obesity, against normal healthy controls to evaluate a critical level if possible.
2 Estimation of Lipoprotein (a), a independent risk factor for Coronary heart diseases.
3 Estimation of malondialdehyde (MDA), which indicates the extent of Lipid peroxidation in Coronary heart disease.
4 Estimation of Glutathione (GSH), a protection against peroxidation.
5 To evaluate whether there can be used as monitoring indices in Coronary heart diseases.

2. Materials and Methods

2.1. Selection of Group

The present study comprises of 80 patients, 20 patients of myocardial infarction, 60 patients with risk factor of Coronary heart disease (CHD), including Hypertension, Diabetes mellitus, Smoking and Obesity, seeking medical care in Goa Medical college Hospital, Bambolim during the period of November 2004 to October 2005. 20 healthy age and sex matched subjects served as controls. All the patients in the study group and control group were aged between 30-60 years. In both the groups a detail history was obtained and a thorough clinical examination was carried out.

2.2. Collection of Blood Samples

About 5 ml of blood samples were collected in plain bulb and were allowed to clot. After one hour the serum was separated by centrifuging at 2500 rpm for 5 minutes at room temperature. Serum was used for measurement of MDA, Vitamin E and Lp(a). About 5 ml of blood samples were collected in flouride bulb, plasma was separated and used for measurement of Vitamin C, Vitamin A and whole blood for measurement of blood glutathione.

All estimation were done within 24-48 hours after sample collection.

2.3. Special Investigation

Special investigation like serum Lp(a) estimated using Turbilatex quantitative turbidimetric test, serum MDA estimated with principle of precipation of lipoprotein by adding 20% TCA and treating with TBA (Thiobarbituric acid) in sodium sulphate to form Chromogen, which forms complex in boiling water and extracted in butanol, measured at 530 nm (SATOH, 1978). Blood glutathione estimated by photometric method adopted by Beutler (1963) using 5-5' Di-thiobis 2-Nitro benzoic acid (D.T.N.B). Serum vitamin E determined as a serum tocopherol by their reduction of ferric to ferrous ion which then form a red complex with alpha dipyridyl (Baker and Frank, 1968). Vitamin C determined as plasma ascorbate by using 2,6-dichlorophenolindophenol titration method. Vitamin-A determined as a retinol and carotenes in serum using the carr price reaction (Kimble 1938-39, Kaser and Stekol 1943).

2.4. Routine Investigation

Blood glucose determined by Folin-wu's method, total serum cholesterol estimated using Liebermann Burchard reaction (Kim and Goldberg's method), Serum triglycerides estimated by GPO-PAP method (Enzymatic colorimetric method), serum HDL cholesterol by phospo tungstate magnesium method, LDL (Low density lipoprotein cholesterol) and VLDL (very low density lipoprotein cholesterol) is calculated by Frieldwald formula.

3. Results and Discussion

The present study comprises of 100 subjects, which includes 80 cases of Coronary heart diseases of which 20 cases of Myocardial Infarction (MI), 60 cases with risk factors for CHD including Hypertension (HT), Diabetes mellitus (MI), Smoking and Obesity (Table 1) and 20 age matched controls.

Table 1. *Distribution of total study subjects*

Group	Number of cases
Myocardial Infarction	20
Hypertension	15
Diabetes Mellitus	15
Smokers	15
Obesity	15
Control	20
Total	**100**

Table 2. *Age incidence of the patients in study group and control*

Age in years	Myocardial Infarction (20)	Percentage %	Hypertension (15)	Percentage %
30 to 40	2	10	1	6.6
41 to 50	7	35	1	6.6
51 to 60	11	55	13	86.6

continue

Age in years	Diabetes Mellitus (15)	Percentage %	Smokers (15)	Percentage %
30 to 40	1	6.6	1	6.6
41 to 50	2	13.3	3	20
51 to 60	12	80	11	73.3

continue

Age in years	Obesity (15)	Percentage %	Control (15)	Percentage %
30 to 40	2	13.3	5	25
41 to 50	2	13.3	6	30
51 to 60	11	73.3	9	45

Table 3. *Distribution of cases according to their Socio-economic status*

Group	Socio-economic status	Number of pts	Percentage
Myocardial Infarction (20)	Lower	4	20
	Middle	6	30
	Upper	10	50
Hypertension (15)	Lower	3	20
	Middle	5	33.3
	Upper	7	46.6
Diabetes Mellitus (15)	Lower	2	13.3
	Middle	5	33.3
	Upper	8	53.3
Smokers (15)	Lower	5	33.3
	Middle	4	26.6
	Upper	6	40
Obesity (15)	Lower	2	13.3
	Middle	4	26.6
	Upper	9	60
Control (20)	Lower	5	25
	Middle	7	35
	Upper	8	40

Table 4. *Showing the chief symptoms in 20 patients of myocardial infarction*

Symptoms	No. of patients	Percentage %
Chest pain	18	90
Sweating	16	80
Vomiting	9	45
Breathlessness	6	30
Palpitation	8	40
Giddiness	4	20

Table 5. *Table Showing the levels of serum Lipoprotein (a) in cases and controls.*

Group	Range of serum Lipoprotein (a) (mg/dl)	Mean± S.D. (mg/dl)	P value
Myocardial Infarction (20)	28-79	43.59±10.22	<0.001
Hypertension (15)	25-44	33.83±6.29	<0.001
Diabetes Mellitus (15)	28-45	36.57±5.29	<0.001
Smokers (15)	29-42	33.93±3.57	<0.001
Obesity (15)	22-38	29.07±3.42	<0.001
Control (20) (Reference group)	13-18	15.27±1.31	

ANOVA F: 50.155 F : (5, 94) P<0.001
As the P value is P<0.001, the result is highly significant.

Table 6. *Table Showing the levels of MDA in cases and controls.*

Group	Range of serum MDA (µmol/l)	Mean± S.D. (µmol/l)	P value
Myocardial Infarction (20)	12.2-20	15.98±2.06	<0.001
Hypertension (15)	9-17.3	12.64±2.64	<0.001
Diabetes Mellitus (15)	10-17.7	13.77±2.17	<0.001
Smokers (15)	11.5-15.5	13.3±1.12	<0.001
Obesity (15)	10-13.5	11.68±1.09	<0.001
Control (20) (Reference group)	4.3-8.8	16.76±1.20	

ANOVA F: 557.648 df : (5, 94) P<0.001
As the P value is P<0.001, the result is highly significant.

Table 7. *Table Showing the levels of GSH in cases and controls.*

Group	Range of blood GSH (mg%)	Mean± S.D. (mg%)	P value
Myocardial Infarction (20)	35.4-57.2	48.94±5.57	<0.001
Hypertension (15)	42.5-60	55.46±4.65	<0.001
Diabetes Mellitus (15)	34.5-60	52±6.61	<0.001
Smokers (15)	49-57.2	54.08±2.16	<0.001
Obesity (15)	52.9-62	59.17±2.21	>0.05
Control (20) (Reference group)	60.1-64.3	62.28±1.42	

ANOVA F: 24.5338 df : (5, 94) P<0.001

Table 8. *Table Showing the levels of alpha tocopherol in cases and controls.*

Vitamin	Group	Range of (mg/l)	Mean± S.D. (mg/l)	P value
Alpha Tocopherol	Myocardial Infarction (20)	3.8-8.2	5.33 ± 1.12	<0.001
	Hypertension (15)	4.1-8.3	5.98 ± 1.33	<0.001
	Diabetes Mellitus (15)	4.1-10.7	6.28 ± 1.88	<0.001
	Smokers (15)	4-5.4	4.90 ± 0.32	<0.001
	Obesity (15)	4.5-6.6	5.88 ± 0.48	<0.001
	Control (20) (Reference group)	10.7-14.4	12.74 ± 1.34	

ANOVA F: 111.959 df : (5, 94) P<0.001
As the P value is <0.001, the result is highly significant.

Table 9. *Table Showing the levels of Ascorbic acid in cases and controls.*

Vitamin	Group	Range of (mg/l)	Mean± S.D. (mg/l)	P value
Ascorbic acid	Myocardial Infarction (20)	4.4-8.0	5.75 ± 0.91	<0.001
	Hypertension (15)	5-8	6.76 ± 1.05	<0.001
	Diabetes Mellitus (15)	4.4-10	6.72 ± 1.69	<0.001
	Smokers (15)	5-7.2	6.02 ± 0.54	<0.001
	Obesity (15)	6.1-8.3	7.48 ± 0.65	<0.001
	Control (20) (Reference group)	9.2-13.1	11.26 ± 1.37	

ANOVA F: 62.718 df : (5, 94) P<0.001
As the P value is <0.001, the result is highly significant.

Table 10. *Table Showing the levels of Vitamin A in cases and controls.*

Vitamin	Group	Range of (mg/l)	Mean± S.D. (mg/l)	P value
Vitamin A	Myocardial Infarction (20)	0.26-0.4	0.31 ± 0.04	<0.001
	Hypertension (15)	0.28-0.43	0.33 ± 0.04	<0.001
	Diabetes Mellitus (15)	0.28-0.41	0.33 ± 0.03	<0.001
	Smokers (15)	0.3-0.43	0.37 ± 0.04	<0.001
	Obesity (15)	0.31-0.62	0.48 ± 0.08	>0.05
	Control (20) (Reference group)	0.34-0.6	0.47 ± 0.08	

ANOVA F: 25.541 df : (5, 94) P<0.001

Table 11. *Table Showing the levels of serum cholesterol in cases and controls.*

Vitamin	Group	Range of (mg%)	Mean± S.D. (mg%)	P value
Serum Cholesterol	Myocardial Infarction (20)	173-276	234.0 ± 29.12	<0.001
	Hypertension (15)	180-272	234.4 ± 25.30	<0.001
	Diabetes Mellitus (15)	165-276	226.9 ± 38.03	<0.001
	Smokers (15)	165-290	229.4 ± 34.11	<0.001
	Obesity (15)	189-289	26.01 ± 29.42	<0.001
	Control (20) (Reference group)	167-192	178.2 ± 7.81	

ANOVA F: 16.448 df : (5, 94) P<0.001
As the P value is <0.001, the result is highly significant.

Table 12. *Table Showing the levels of serum Triglycerides in cases and controls.*

Vitamin	Group	Range of (mg%)	Mean± S.D. (mg%)	P value
Serum Triglycerides	Myocardial Infarction (20)	145-251	180.4 ± 24.89	<0.001
	Hypertension (15)	110-198	153 ± 23.28	>0.05
	Diabetes Mellitus (15)	124-260	177.6 ± 29.88	<0.001
	Smokers (15)	139-194	166.6 ± 18.85	<0.001
	Obesity (15)	163-245	198.0 ± 21.61	<0.001
	Control (20) (Reference group)	124-143	133.1 ± 5.65	

ANOVA F: 25.541 df : (5, 94) P<0.001

Table 13. *Table Showing the levels of serum HDL in cases and controls.*

Vitamin	Group	Range of (mg%)	Mean± S.D. (mg%)	P value
Serum HDL	Myocardial Infarction (20)	30-42	35.75 ± 3.25	<0.001
	Hypertension (15)	36-49	40.07 ± 3.55	<0.001
	Diabetes Mellitus (15)	35-50	40.6 ± 3.92	<0.001
	Smokers (15)	28-43	35.89 ± 4.59	<0.001
	Obesity (15)	34-46	40.2 ± 3.61	<0.001
	Control (20) (Reference group)	46-64	55.8 ± 5.55	

ANOVA F: 59.917 df : (5, 94) P<0.001
As the P value is <0.001, the result is highly significant.

Table 14. *Table Showing the levels of serum LDL in cases and controls.*

Vitamin	Group	Range of (mg%)	Mean± S.D. (mg%)	P value
Serum LDL	Myocardial Infarction (20)	163-215	193.5 ± 14.56	<0.001
	Hypertension (15)	130-190	165.8 ± 19.71	<0.001
	Diabetes Mellitus (15)	155-184	171.7 ± 8.21	<0.001
	Smokers (15)	126-187	160.7 ± 18.68	<0.001
	Obesity (15)	184-226	207.2 ± 14.09	<0.001
	Control (20) (Reference group)	119-139	128.9 ± 6.36	

ANOVA F: 66.931 df : (5, 94) P<0.001
As the P value is <0.001, the result is highly significant.

Table 15. *Table Showing the levels of serum VLDL in cases and controls.*

Vitamin	Group	Range of (mg%)	Mean± S.D. (mg%)	P value
Serum VLDL	Myocardial Infarction (20)	30-50	39.8 ± 5.21	<0.001
	Hypertension (15)	21-46	32.7 ± 7.81	>0.05
	Diabetes Mellitus (15)	21-52	35.0 ± 10.36	>0.05
	Smokers (15)	35-49	41.6 ± 4.33	<0.001
	Obesity (15)	34-67	53.6 ± 11.74	<0.001
	Control (20) (Reference group)	25-34	28.6 ± 2.43	

ANOVA F: 22.535 df : (5, 94) P<0.001

Table 16. (A). *Table Showing Total Cholesterol / HDL ratio in cases and controls.*

Vitamin	Group	Range	Mean± S.D.	P value
Total Cholesterol / HDL	Myocardial Infarction (20)	4.9-7.6	6.51 ± 0.68	<0.001
	Hypertension (15)	4-6.9	5.84 ± 0.70	<0.001
	Diabetes Mellitus (15)	3.9-6.7	5.50 ± 0.95	<0.001
	Smokers (15)	5.1-7.9	6.27 ± 0.92	<0.001
	Obesity (15)	4.3-7.6	6.45 ± 0.83	<0.001
	Control (20) (Reference group)	2.6-3.9	3.17 ± 0.37	

ANOVA F: 54.312 df : (5, 94) P<0.001
As the P value is <0.001, the result is highly significant.

Table 16. (B). *Table Showing LDL / HDL ratio in cases and controls.*

Vitamin	Group	Range	Mean± S.D.	P value
LDL / HDL ratio	Myocardial Infarction (20)	4.9-6.3	5.38 ± 0.38	<0.001
	Hypertension (15)	3.3-4.9	4.10 ± 0.48	<0.001
	Diabetes Mellitus (15)	3.1-4.8	4.24 ± 0.39	<0.001
	Smokers (15)	3.6-6.2	4.60 ± 0.74	<0.001
	Obesity (15)	4.1-5.9	5.14 ± 0.51	<0.001
	Control (20) (Reference group)	1.9-2.7	2.28 ± 0.19	

ANOVA F: 106.342 df : (5, 94) P<0.001

Table 17. *Table Showing the levels of Blood Glucose in cases and controls.*

Vitamin	Group	Range of (mg%)	Mean± S.D. (mg%)	P value
Blood Glucose	Myocardial Infarction (20)	75-122	104.1 ± 10.76	>0.05
	Hypertension (15)	85-120	105.6 ± 9.98	>0.05
	Diabetes Mellitus (15)	134-286	204.2 ± 42.37	<0.001
	Smokers (15)	84-123	108.2 ± 10.00	>0.05
	Obesity (15)	99-121	110.2 ± 6.10	>0.05
	Control (20) (Reference group)	88-110	99.3 ± 6.36	

ANOVA F: 75.687 df : (5, 94) P<0.001

Table 18. A). *Table Showing correlation coefficient between serum Liproprotein (a) and MDA*

Group	'r' value	'P' value
Myocardial Infarction (20)	-0.500	<0.05 *
Hypertension (15)	0.576	<0.05 *
Diabetes Mellitus (15)	0.097	>0.05
Smokers (15)	0.574	<0.05 *
Obesity (15)	0.116	>0.05

* Statistically significant

Table 18. B). *Table Showing correlation coefficient between serum Liproprotein (a) and GSH*

Group	'r' value	'P' value
Myocardial Infarction (20)	-0.123	>0.05
Hypertension (15)	-0.243	>0.05
Diabetes Mellitus (15)	0.158	>0.05
Smokers (15)	-0.659	<0.01 **
Obesity (15)	-0.874	<0.001 **

* * Statistically highly significant

Table 18. C). *Table Showing correlation coefficient between serum Liproprotein (a) and Vitamin E*

Group	'r' value	'P' value
Myocardial Infarction (20)	-0.413	>0.05
Hypertension (15)	-0.465	>0.05
Diabetes Mellitus (15)	-0.694	<0.01 **
Smokers (15)	-0.660	<0.01 **
Obesity (15)	-0.813	<0.01 **

* * Statistically highly significant

Table 18. D). *Table Showing correlation coefficient between serum Liproprotein (a) and Vitamin C*

Group	'r' value	'P' value
Myocardial Infarction (20)	- 0.004	>0.05
Hypertension (15)	- 0.606	>0.05 *
Diabetes Mellitus (15)	-0.748	<0.01 **
Smokers (15)	-0.246	>0.05
Obesity (15)	-0.735	<0.01 **

* Statistically significant
* * Statistically highly significant

Table 18. E). *Table Showing correlation coefficient between serum Liproprotein (a) and Vitamin A*

Group	'r' value	'P' value
Myocardial Infarction (20)	-0.116	>0.05
Hypertension (15)	0.12	>0.05
Diabetes Mellitus (15)	0.512	>0.05
Smokers (15)	0.132	>0.05
Obesity (15)	-0.255	>0.05

As the P value is >0.05, the correlation is statistically not significant.

Table 18. F). *Table Showing correlation coefficient between serum Liproprotein (a) and TC/HDL ratio*

Group	'r' value	'P' value
Myocardial Infarction (20)	-0.342	>0.05
Hypertension (15)	0.009	>0.05
Diabetes Mellitus (15)	0.018	>0.05
Smokers (15)	-0.498	>0.05
Obesity (15)	0.021	>0.05

As the P value >0.05, the correlation is statistically not significant.

The analysis of study group revealed that the Coronary heart diseases cases were between 30 to 60 years (Table-2). In Myocardial infarction cases, 51 to 60 years group maximum with 55% followed by 41 to 50 years group with 35%. Age matched controls, 51 to 60 years group maximum with 45% followed by 41 to 50 years group with 30%. It has been long known that ageing has a steady and consistent with atherosclerotic lesion. It is universally accepted that men are more prone to coronary atherosclerosis than women of child bearing age .After menopause, however women have equal risk of developing CHD.

Majority of the cases were from upper class with 50% followed by middle class with 30% (Table-3). As observed by many workers, the incidence of CHD is higher in person with high Socio-Economic status, while it is lower in low socio-economic groups. Majority of patient of myocardial infarction, 90% presented with chest pain followed by, 80% with sweating (Table-4), 45% with vomiting, 30% with breathlessness, 40% with palpitation and 20% with giddiness.

Results of routine investigation shows an increase in serum cholesterol, serum LDL, TC/HDL and LDL/HDL

ratio were seen in all five groups including MI, HT, DM, Smokers and Obesity cases, which were statistically significant. Serum Triglycerides were increased in MI, DM, Smokers and Obesity cases, which were statistically significant, where as significant increase was not seen in HT cases. Serum VLDL showed a statistically significant increase in MI, Smokers and Obesity cases, where as significant increase was not seen in HT and DM cases. Blood glucose showed a significant increase in DM cases, where as no significant increase were seen in MI, HT, Smokers and Obesity cases. A statistically significant decrease in serum HDL were seen in all five groups including MI, HT, DM, Smokers and Obesity cases. (Table 11, 12, 13, 14, 15, 16 (A) & (B), 17)

In special investigations MDA and Lipoprotien (a) levels are increased in all five group including MI, HT, DM, Smokers and Obesity in comparison with levels in normal healthy controls (Table- 5 & 6).The similar results were obtained by Boston.A.G.et al 1996, Sarah.H.W.et al 1996, Assman.G.et al 1998, Leo.J.S.et al 1999, Matthias.N. et al 2000, Rajeshekhar.D.et al 2004, who demonstrated a rise in serum Lipoprotein(a) levels in cases of CHD as compared to controls and who reported that elevated Lp(a) is an independent risk factor for the development of CHD.

Vitamin E and Vitamin C levels were decreased in all five groups including MI, HT, DM, Smokers and Obesity in comparison with levels in normal healthy controls.

Glutathione and Vitamin A levels were decreased in four groups including MI, HT, DM and Smokers in comparison with levels in normal healthy controls, where as in Obesity group the levels were not significant (Table-7).

Serum MDA levels were found to be higher in cases as compared to controls. This could be due to increased oxidative stress. We have also found a positive correlation between severity of disease and MDA levels.

Blood Glutathione, Serum Vitamin E, plasma Vitamin C and plasma Vitamin A levels were studied in patients of CHD and in patients with risk factor for CHD, as a measure of antioxidant status. Results showed a highly significant decrease in Glutathione, α- tocopherol, ascorbic acid and Vitamin A levels in cases as compared to controls. This could be indicative of increased need and a defective antioxidant mechanism in order to overcome the oxidative stress (Table- 8 & 9).

An increased tendency to peroxidation of polyunsaturated fatty acids resulting from a reduction in anti oxidant availability might favour thrombosis.

In Hypertension group, serum MDA and serum Lipoprotein (a) levels are elevated and Blood Glutathione, serum Vitamin E, plasma Vitamin C and plasma Vitamin A levels were diminished, as compared to controls.

In smokers group, serum MDA and Serum Lipoprotein (a) values were increased and Blood Glutathione, serum Vitamin E, plasma Vitamin C and plasma Vitamin A values were diminished, as compared to controls.

In obesity group, serum MDA and Serum Lipoprotein (a) levels were elevated and serum Vitamin E and plasma Vitamin C levels were diminished, where as Blood Glutathione and plasma Vitamin A levels were not significant as compared to controls.

Thus, there were alterations in MDA, Lipoprotein (a) and anti-oxidant levels in cases of Coronary heart diseases and also in cases with risk factor for Coronary heart disease including hypertension, diabetes mellitus, smokers and obesity (Table 18, A, B,C,D,E & F).

From the results, it can be conclude that serum MDA can be used to detect severity of Coronary heart diseases, as we have observed a significant decrease in blood glutathione, Vitamin E, Vitamin A with the increase in severity of oxidative stress.

A highly statistically significant increase in the serum Lipoprotein (a) was seen in cases as compared to controls. So we can conclude that Lipoprotein (a) is an independent risk factor for Coronary heart diseases.

It is therefore, concluded that MDA, Lipoprotein (a) and anti-oxidants like Glutathione, Vitamin E, Vitamin C and Vitamin A, be evaluated as bio-chemical parameters for preclinical assessment of “at risk group” for Coronary heart diseases and for assessing and monitoring cases of Coronary heart diseases.

Further studies with anti-oxidant Vitamin supplementation have to be performed to test the nature of association between high MDA, high Lipoprotein (a) and low anti-oxidants in Coronary heart diseases. And also further studies are required to evaluate the significance of serum Lipoprotein (a) estimation in the assessment of CHD risk of human subjects.

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