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SUPEROXIDE DISMUTASE ACTIVITY AND SERUM LIPID PROFILE IN HEMODIALYSIS PATIENTS

AMELA BEĆIRAGIĆ, HALIMA RESIĆ, AMELA DERVIŠEVIĆ[1], ALMIR FAJKIĆ[2], NEJRA PROHIĆ, NESINA AVDAGIĆ[1], NERMINA BABIĆ[1], SELMA AJANOVIĆ and AIDA ĆORIĆ

University Clinical Center Sarajevo, Department of Hemodialysis, [1]University of Sarajevo, Faculty of Medicine, [2]Department of Human Physiology, and [2]University of Sarajevo, Faculty of Medicine, Department of Pathophysiology, Sarajevo, Bosnia and Herzegovina

Objectives/Aim: Hemodialysis (HD) is associated with a number of biochemical abnormalities including dyslipidemia and oxidative stress. The aim of this study was to evaluate the relationship between serum superoxide dismutase (SOD) activity and lipid profile in HD patients with different duration of HD treatment. ***Material and Methods:*** This cross-sectional study included 100 HD patients that were divided into two subgroups based on the duration of HD therapy: patients on HD for more than three months but less than five years (HD <5 years; n=48) and patients on HD for five years or more (HD ≥5 years; n=52). Control group (n=50) consisted of age- and gender-matched, apparently healthy individuals without subjective and objective indicators of any renal disease. Blood samples were obtained for determination of SOD, total cholesterol (TC), triglycerides (TG), low-density lipoprotein (LDL) and high-density lipoprotein (HDL). Serum SOD concentration was determined by ELISA method using a commercial kit. ***Results:*** Serum concentration of SOD was increased in HD patients when compared to healthy controls. SOD concentration was significantly higher in HD <5 year group compared with control group [12.29 (10.85-14.15) *vs.*11.04 (9.42 -12.99) U/mL; p<0.05]; however, there was no significant difference in SOD concentration between HD ≥5 year group [12.97 (10.27-14.56) U/mL] and healthy control subjects. In addition, there was no significant difference in serum SOD concentration between HD patients with different duration of dialysis therapy. The levels of TC, LDL and HDL were significantly decreased in both groups of HD patients as compared with control subjects (p<0.0005); however, serum TG levels did not differ significantly between the study groups. According to the ROC analysis, serum levels of TC, LDL and HDL had higher sensitivity than serum SOD concentration in differentiating HD patients from healthy subjects. ***Conclusions:*** According to our results, it is concluded that increased serum SOD concentration together with alterations in the lipid profile enhances the risk of atherosclerosis and favors higher incidence of cardiovascular complications in HD patients.

Key words: hemodialysis, superoxide dismutase, dyslipidemia

Address for correspondence: Amela Bećiragić, MD, PhD
Department of Hemodialysis
Sarajevo University Clinical Centre
Bolnička 25
71 000 Sarajevo, Bosnia and Herzegovina
Phone: 00387 33 29 80 89
E-mail: aibisbegovic@hotmail.com

INTRODUCTION

Hemodialysis (HD) is the most frequently used form of renal replacement therapy for many patients with end-stage renal disease (ESRD). One of the leading causes of morbidity and mortality in HD patients is cardiovascular disease (CVD). In 1998, the National Kidney Foundation reported that, after stratifying for age, race, and gender, mortality from CVD in HD patients was 10-30 times greater than in the general population (1).

Despite the neutral effect, HD is associated with a number of biochemical abnormalities including dyslipidemia and oxidative stress. Renal dyslipidemia is caused by certain dialysis-related parameters, which may significantly affect lipoprotein metabolism and modify the composition of plasma lipoproteins. It appears that a reduced catabolism and clearance of Apo B-containing lipoproteins of hepatic and intestinal origin constitutes the main abnormality.

Dyslipidemia in HD patients is distinct from that in the general population. Common lipid abnormality in HD patients is hypertriglyceridemia because patients with chronic renal failure mainly manifest insulin resistance activating hormone sensitive lipase; consequently, it leads to raised free fatty acids and the production of very low-density lipoprotein (VLDL) (2).

Other lipid abnormalities seen in HD patients are reduced concentrations of high-density lipoprotein (HDL) cholesterol level and increased levels of intact or partially metabolized triglyceride-rich Apo B-containing lipoproteins in VLDL, intermediate-density lipoprotein (IDL), and small low-density lipoprotein (LDL) particles (3).

Among the reasons of lipid abnormalities are malnutrition and hypoalbuminemia present in many of these patients. Hypoalbuminemia is associated with pathophysiological changes in lipid metabolism by decreasing oncotic pressure, which stimulates hepatic synthesis of albumin and other proteins, including apolipoproteins, thus also leading to increase in total cholesterol, triglycerides and LDL, and decrease in HDL (4).

Excessive oxidative stress has long been demonstrated in hemodialysis patients due to reduced antioxidant capacity and increased pro-oxidant activity with negative effects on carbohydrates, lipids and body proteins.

During HD treatment, uremic toxicity, malnutrition and *progressive* decline in kidney function can lead to hyperproduction of agents from oxidative metabolism with pro-oxidant function, including reactive oxygen species (ROS) and uremic toxins. Losses of antioxidants *via* dialysis, the use of low biocompatible membranes and purity of dialysis water are the factors that may be responsible for reduced antioxidant defense mechanisms in HD patients.

Superoxide dismutase (SOD) is the first-line defense against the deleterious effects of ROS (5). It specifically scavenges superoxide by catalyzing its dismutation to H_2O_2 and O_2.

Dyslipidemia accompanied by excessive oxidative stress in HD patients accelerates the process of atherosclerosis, resulting in cardiovascular complications.

The present study evaluated the relationship between dyslipidemia and oxidative stress by evaluating lipid profile and serum SOD activity in patients on regular HD treatment.

SUBJECTS AND METHODS

Study population

The study was designed as a cross-sectional, clinical, comparative study, which was conducted at the Department of Hemodialysis, Sarajevo University Clinical Centre (SUCC). Based on the duration of hemodialysis therapy, study groups were divided into two subgroups of patients on HD for more than three months but less than five years (HD <5 years; n=48) and patients on HD for five years or more than five years (HD ≥5 years; n=52). Control group (n=50) consisted of age- and gender-matched, apparently healthy individuals without subjective and objective indicators of chronic renal disease.

Patients were on chronic HD program for a period longer than three months, for four hours three times a week (bicarbonate dialysis), with low-flux dialysate and Fresenius Medical Care dialysis monitors, 4008S with UF. The majority of patients (63%) were dialyzed through hemodiafiltration, while 37% patients were dialyzed through hemodialysis. The most common type of access for performing dialysis in HD patients was arteriovenous fistula (AVF, 79%), then tunnelled central venous catheter (12%) and temporary central venous catheter (9%).

Patients were regarded non-eligible for the study if any of the following criteria was met: age younger than 18 or more than 70 years, presence of malignancy, febrile disorders, acute or chronic inflammatory disease or coronary heart diseases during the study period.

Subjects of the control group had no history of inflammatory, autoimmune or rheumatic diseases, hyperlipidemia, hypertension or coronary heart diseases. None of the control subjects had received any medication, was current smoker or alcohol consumer.

Upon careful explanation of the study procedure, an informed consent in writing was obtained from all patients and healthy controls. The study was approved by the SUCC Ethics Committee. Investigations were carried out in accordance with the Declaration of Helsinki as revised in 2000.

Methods

Blood collection was performed under aseptic precautions at the SUCC Department of Hemodialysis immediately before each HD session, according to days of the week and in the morning, afternoon and evening shifts. Blood was collected from antecubital vein using 10-mL vacutainer tubes (BD Vacutainer Systems, Plymouth, UK). Each specimen was centrifuged at 2000 g for 10 min to separate serum, which was stored at -80 °C until SOD analysis.

Serum SOD concentration was determined by the commercially available quantitative sandwich enzyme-linked immunosorbent assay (ELISA) (CSB-EL-022399HU, Cusabio Company, China) according to the manufacturer's instructions at the Department of Biochemistry, Faculty of Medicine, University of Sarajevo.

These assays employ the quantitative sandwich enzyme immunoassay technique. Antibody specific for each enzyme is pre-coated onto a microplate. Standards and samples are pipetted into the wells and any enzyme present is bound by the immobilized antibody. After adding biotin-conjugated antibody specific for each enzyme and avidin-conjugated horseradish peroxidase, the substrate solution is added to the wells and colors develop in proportion to the amount of enzymes bound in the initial step. In the final step, color intensities were measured in appropriate wavelengths, on the STAT FAX-2100 microplate reader (Awareness Technology Inc., USA). The enzyme levels were reported as U/mL.

Lipid parameters were determined on an automated apparatus (Dimension RxL Max, Dade Behring, Germany) at the Institute of Clinical Chemistry and Biochemistry, SUCC, using standard methods. Serum total cholesterol (TC) was measured by the cholesterol oxidase method, while HDL cholesterol levels were determined by direct homogeneous enzymatic method. Serum triglyceride (TG) levels were assayed after enzymatic hydrolysis by simultaneous enzymatic determination of glycerol. LDL cholesterol was calculated using the formula of Friedewald *et al*. (6). The reference values of TG, TC, LDL cholesterol, HDL cholesterol (according to the reagent manufacturer's instructions) are as follows: TG 0.11-1.7 mmol/L, TC 3.1-5.2 mmol/L, HDL cholesterol 1.06-1.94 mmol/L, and LDL cholesterol 2-4.3 mmol/L.

Kolmogorov-Smirnov test of normality was used to test the normality and variance homogeneity of data. Data were expressed as mean ± SEM for normally distributed variables and as median and interquartile ranges for skewed variables. Categorical variables were shown as frequencies. Difference in normally distributed data was tested by independent *t*-test. Difference in the values of parameters that showed skewed distribution was assessed by Kruskal-Wallis test, followed by Mann-Whitney U test. Correlations between the variables were assessed by Pearson's test. To determine the accuracy and respective best cut-off values of serum SOD level and lipid profile for differentiating hemodialysis patients from healthy controls, the Receiver Operating Characteristic (ROC) curves and their corresponding areas under the curve (AUC) were used. Accuracy rate of diagnosing measures was calculated by use of 95% confidence interval (95% CI). The values of $p<0.05$ were considered statistically significant in all comparisons. Data were analyzed using the Statistical Package for the Social Sciences (SPSS) software version 13 (IBM, Chicago, Illinois, USA), and the results are presented in tables or figures.

RESULTS

As shown in Table 1, HD patients were significantly older than healthy subjects ($p<0.05$). The percentage of males was higher than that of females in both HD groups, yielding a significant difference as compared with the control group ($p<0.05$).

Table 1.
Age and gender of HD patients with different duration of dialysis therapy and the control group.

Variables		HD group < 5 years (n=48)	HD group ≥ 5 years (n=52)	Control group (n=50)
Age (years)		53.4 ± 1.68*¯	54.8 ± 1.67*	41.72 ± 1.39
Gender	male	30 (62.5%)*¯	30 (57.7%)*	18 (36%)
	female	18 (40%)*¯	22 (42.3%)*	32 (64%)

Data are presented as mean ± SEM; n (%); HD-hemodialysis; NS-not significant; p-probability * $p<0.05$ - compared with control group ¯ NS - compared with HD group ≥ 5 years

Fig. 1 shows the median and interquartile range of serum SOD concentration in control and HD groups. Median serum SOD concentration in HD <5 year group was statistically significantly higher compared with the control group [12.29 (10.85-14.15) *vs.*11.04 (9.42-12.99) U/mL; $p<0.05$]. There was no significant difference in serum SOD concentration between HD patients who were on hemodialysis therapy for five and more than five years [12.97 (10.27-14.56) U/mL] and healthy control subjects. There was no significant difference in serum SOD concentration between the two HD groups.

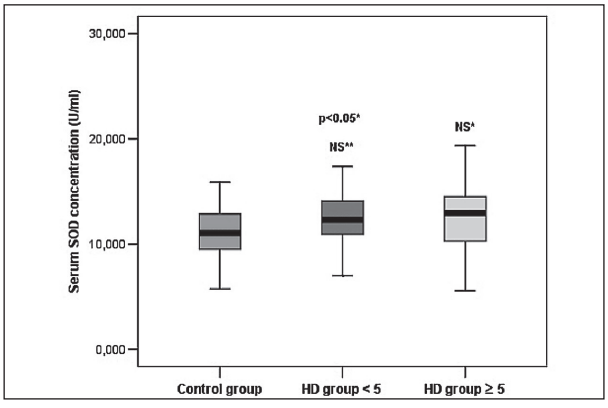

Fig. 1. *Box-and-whisker plots of serum SOD concentration (U/ml) in HD patients with different duration of dialysis therapy and healthy controls.*

Data are presented as median (25th and 75th percentiles); SOD - superoxide dismutase; HD - hemodialysis * compared with control group ** compared with HD group ≥ 5 years

As shown in Table 2, serum concentrations of TC, LDL cholesterol and HDL cholesterol were significantly lower in both groups of HD patients in comparison with control subjects (p<0.0005). The values of these lipid parameters were higher in patients of HD <5 year group than in patients of HD ≥5 year group, but the differences were not significant. There were no significant differences in serum TG concentrations between the study groups.

Table 2.
Comparison of serum concentrations of total cholesterol, triglycerides, low-density lipoprotein and high-density lipoprotein between hemodialysis patients with different duration of hemodialysis therapy and healthy controls.

Parameters	HD group < 5 years (n=48)	HD group ≥ 5 years (n=52)	Control group (n=50)	HD group < 5 years *vs* HD group ≥ 5 years p=	HD group < 5 years *vs* Control group p=	HD group ≥ 5 years *vs* Control group p=
TC (mmol/L)	4.4 ± 0.13	4.2 ± 0.11	5.7 ± 0.16	NS	**0.0005**	**0.0005**
TG (mmol/L)	1.85 (1.27-2.38)	1.59 (1.27-2.25)	1.46 (0.96-2.3)	NS	NS	NS
LDL (mmol/L)	2.6 (2.10-2.86)	2.37 (1.91 -2.62)	3.35 (2.86-3.81)	NS	**0.0005**	**0.0005**
HDL (mmol/L)	0.89 (0.76-1.08)	0.85 (0.73-1.12)	1.28 (1.15-1.63)	NS	**0.0005**	**0.0005**

Data are presented as mean ± SEM; median (25th and 75th percentiles); **TC**-total cholesterol**; TG -** triglycerides**; LDL**-Low-density lipoprotein; **HDL** - High-density lipoprotein; **NS** - not significant; **p** - probability

The ROC curve for serum SOD level in total study sample of HD patients *vs.* healthy control subjects with significant AUC is shown in Figure 2A. The optimal cut-off value for serum SOD level in differentiating HD patients from healthy subjects selected by ROC curve was 12.05 U/mL, with sensitivity of 57%, specificity of 72%, positive predictive value of 80% and negative predictive value of 45% (Table 3). The overall accuracy of serum SOD concentration in discriminating HD patients was 62%. Serum SOD level had fair diagnostic accuracy for differentiation between HD patients and healthy control (AUC 0.716; p=0.03).

The ROC curve of TC, LDL and HDL for differentiation between HD patients and healthy controls is shown in Figure 2B. As shown in Table 3, the optimal cut-off value for LDL in differentiating HD patients from healthy subjects, selected by ROC curve (AUC 0.869; p=0.0005) was 2.705 mmol/L (sensitivity 88%, specificity 72%, positive predictive value 63% and negative predictive value 92%). Moreover, ROC analysis also suggested 1.025 mmol/L as optimal cut-off point for HDL in differentiating HD patients from healthy controls (AUC 0.864; p=0.0005, sensitivity 92%, specificity 74%, positive predictive value 61% and negative predictive value 94%).

The optimal cut-off value for TC selected by ROC curve (AUC 0.855; p=0.0005) was 4.85 mmol/L, yielding a sensitivity of 86%, specificity of 76%, positive predictive value of 64% and negative predictive value of 91%.

The overall accuracy of TC in identifying HD patients was highest (79%), followed by LDL (77%) and HDL (76%). According to ROC analysis, serum TC, LDL and HDL concentrations had good diagnostic accuracy in differentiating HD patients from healthy subjects.

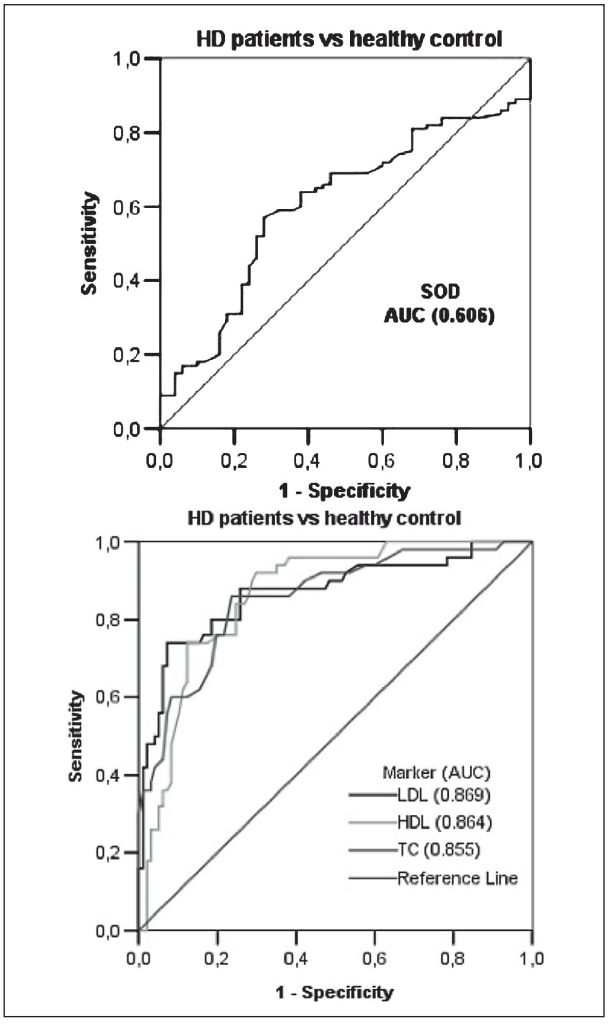

Fig. 2. (A) Receiver operating characteristic (ROC) curve of serum SOD level for differentiation between HD patients and healthy controls. (B) ROC curve of low-density lipoprotein (LDL), High-density lipoprotein (HDL) and total cholesterol (TC) for differentiation between HD patients and healthy controls.

Table 3.
Optimal cut-off, area under the curve with 95% confidence interval (AUC, 95% CI), sensitivity, specificity, positive and negative predictive value, overall accuracy of serum SOD level, low-density lipoprotein, high-density lipoprotein and total cholesterol in differentiating between HD patients and healthy controls.

Variable and cut-off values	Diagnosing measures						p
	AUC (95%CI)	SEN	SPE	PPV	NPV	Overall accurate	
Hemodialysis patients *vs* healthy controls							
SOD (≥ 12.05 U/mL)	0.606 (0.51 -0.70)	57%	72%	80%	45%	62%	**0.03**
LDL (≤ 2.705 mmol/L)	0.855 (0.79-0.92)	88%	74%	63%	92%	77%	**0.0005**
HDL (≤ 1.025 mmol/L)	0.864 (0.80-0.92)	92%	70%	61%	94%	76%	**0.0005**
TC (≤ 4.85 mmol/L)	0.869 (0.80-0.93)	86%	76%	64%	91%	79%	**0.0005**

AUC-Area under the curve**; CI-**Confidence Interval; **SOD-**superoxide dismutase; **LDL**-Low-density lipoprotein; **HDL**-High-density lipoprotein; **TC**-total cholesterol; **SEN-**sensitivity; **SPE**- specificity;**PPV**-positive predictive value; **NPV**-negative predictive value; **p**-probability

DISCUSSION

The clearly confirmed fact that patients on chronic HD are at an increased risk of cardiovascular morbidity and mortality has stimulated a whole range of research aiming at identifying appropriate biomarkers to optimize the diagnosis and treatment of this group of patients. In this regard, the role of oxidative stress and dyslipidemia as potentially important processes is primarily attributed to atherosclerotic changes in blood vessels of HD patients.

Oxidative stress, as a result of the imbalance between toxic compounds and defense mechanisms, is associated with numerous adverse complications in patients with chronic renal disease. Consequently, excessive production of ROS or toxic compounds is accompanied by the lack of antioxidants, which is particularly pronounced in hemodialysis patients.

Superoxide dismutase is a metalloenzyme present in all eukaryotic cells, included in the front line defense against ROS mediated injury. Recent studies of SOD activity in HD patients found conflicting results (7,8). Results of our study showed significantly increased values of serum SOD concentration in HD <5 year group of patients compared to control subjects. There was no significant difference in serum SOD concentration between HD patients who were on HD for five and more than five years and healthy control subjects. Our findings are in accordance with the study conducted by Hacisevki (9), which included 64 patients on HD and a control group of 22 healthy subjects. SOD concentration was increased in dialysis patients as compared with healthy subjects. Kose *et al.* (10) report an increased erythrocyte SOD activity in the post-dialysis group when compared with the pre-dialysis group. Contrary to our observation, Mooujerlo (11) showed a decreased activity of the SOD enzyme in HD patients, whereas Weinstein *et al.* (12) report no change in the SOD enzyme levels due to HD.

We presume that the increased activity of SOD in HD patients may be a defense mechanism of the cell due to the increased production of free radicals in renal failure. Decreased activity of antioxidants in maintenance HD patients may contribute to the increased oxidative damage and development of renal complications. Loss of antioxidants through dialysis membrane and the use of incompatible one are factors that may be responsible for the imbalance between oxidants and antioxidant mechanisms in patients on HD.

Progressive renal failure is associated with lipoprotein abnormalities and dyslipidemia. However, dyslipidemia may not appear as hyperlipidemia in the majority of HD patients. This gives rise to various differences, even though the pathogenesis and lipid profile phenotype in HD patients are similar to the pre-dialysis period.

Some of our findings are concordant with previous similar reports but vary from the others. Contrary to other results, we observed a statistically significantly lower TC level and no significant differences in serum TG concentrations in HD patients with different duration of HD therapy compared to control subjects. The possible explanation of our results is the impact of cytokinemia, which may be related to impaired removal of lipid substances (13).

In both HD patient groups, LDL and HDL cholesterol were significantly lower in comparison to controls. This hypo-HDL cholesterol level in ESRD patients on dialysis is agreed upon by several authors (14,15) and could be due to a decrease in the activity of le-

cithin-cholesterol acyltransferase (LCAT) responsible for the decrease in the esterification of free cholesterol in HDL cholesterol, decreased HDL components, and an increase in the activity of cholesterol ester transfer protein (CETP), implying an increase in HDL esterified cholesterol transfer to LDL (16).

Removal of excess lipids from the vascular wall by HDL cholesterol is a key anti-atherogenic mechanism of HDL-cholesterol. It has been shown that HDL cholesterol inhibits the expression of E-selectin or other adhesion molecules by vascular endothelial cells exposed to cytokines. This results in decreased binding of inflammatory cells, which is consistent with functional inhibition of atherosclerosis. Interruption of a signaling pathway involving sphingosine kinase activation and the synthesis of sphingosine-1-phosphate has been proposed as a mechanism for the anti-atherogenic effects of HDL cholesterol on the expression of adhesion molecules (17).

Our results are consistent with those of several recent studies which have reported normal or low levels of LDL cholesterol in HD patients (18,19). Although the results of a large number of studies show that LDL level is not elevated in CKD patients, LDL particles are usually smaller, denser and more atherogenic in their form. Accumulation of small LDL particles is associated with a higher rate of cardiovascular events. Previous studies showed an increased level of LDL in dialysis-dependent CKD patients compared to healthy controls and low LDL as a risk factor for CVD development. As a consequence of the significantly modified lipid subfraction turnover, retention time of lipoproteins in the circulation is prolonged. Thus, lipoproteins are at risk of post-ribosomal modification, which includes glycation, oxidation, and carbamylation. These modified lipoproteins have reduced affinity for the classic LDL receptors and are taken up by the scavenger receptors, especially increased in uremia, on the macrophage surface. The final result is the accumulation of cholesterol and the formation of foam cells, resulting in the development of atherosclerotic plaques in the vascular walls. There are several mechanisms by which small dense LDL is likely to play a causal role in promoting atherosclerosis: increasing superoxide generation (O^{-2}) from the endothelium, decreasing basal nitric oxide (NO) production, increasing trans-endothelial filtration, reducing affinity for LDL receptors, and increasing binding to intimal proteoglycans (20).

In addition, results of the previous studies show that chronic renal failure patients treated with HD have an increased prevalence of IDL and lipoprotein(a) (Lp(a)) (21). Hirowatari *et al*. report lower levels of HDL cholesterol and LDL cholesterol, and higher level of IDL cholesterol in ESRD patients on HD (22). As a result of many studies, Shoji *et al*. propose that the IDL cholesterol level is the possible target in the management of dyslipidemia in renal disease (23).

Current literature suggests that the levels of Lp(a) increase as kidney disease progresses and decline after kidney transplantation. Some authors showed a decrease in the clearance of Lp(a) in HD patients, demonstrating the involvement of the kidney in its elimination. Lp(a) predicts the development of carotid atheromatous disease and vascular events in dialysis patients (24).

It should be noted that dialysis itself does not affect the serum lipid profile. However, certain parameters closely related to dialysis may have a significant influence on lipoprotein metabolism and lead to changes in the lipidogram of HD patients. Some of them are dialysis membrane, dialysis fluid, anticoagulant therapy, and treatment with phosphate binders such as sevelamer hydrochloride and sevelamer hydrocarbonate. The use of high-velocity polysulfonic or cellulose membranes instead of low-membrane membranes is associated with a significant reduction in TG levels and increased levels of apolipoprotein A and HDL cholesterol. The use of bicarbonate dialysis can increase the level of HDL cholesterol compared to acetic dialysis (25). Another possible factor that can potentially affect lipoprotein metabolism in HD patients is the repeated use of heparin as an anticoagulant. Heparin releases lipoprotein lipase from the endothelial surface and thus its chronic use may result in lipoprotein lipase depletion and defective catabolism of TG-rich lipoproteins (3).

According to the ROC analysis, our study revealed that, due to the poor diagnostic accuracy, serum SOD concentration could not be used as an independent marker in differentiating HD patients from healthy subjects, or in differentiating HD patients with different HD duration. In contrast, serum LDL, HDL and TC levels had good diagnostic accuracy in differentiating HD patients from healthy subjects. Since by searching the literature we found no similar study, we could not compare our results with results of other authors.

CONCLUSION

In our study, oxidative stress was characterized by a significant increase of serum SOD concentration in ESRD patients on HD compared to controls. In respect of lipid profile, it was observed that serum levels of TC, LDL and HDL were significantly lower in HD patients when compared to control subjects. However, serum

TG levels did not differ significantly between the study groups. The accompanying serum lipid alteration in HD patients increases the risk of atherosclerosis and favors a higher incidence of cardiovascular complications. Therefore, lipid regulation must be instituted to decrease the risk of complications in HD patients.

The common pathogenesis of oxidative stress and dyslipidemia in HD patients has not yet been fully clarified and new studies regarding this pathogenesis are therefore needed. Thus, after HD, ESRD patients become more vulnerable to cardiac and cerebrovascular accidents due to increased oxidative stress and compromised lipid status. New approaches are to be adapted with reference to dialysis membrane and dialysis technique.

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S A Ž E T A K

AKTIVNOST SUPEROKSID DISMUTAZE I LIPIDNI PROFIL U SERUMU PACIJENATA S HEMODIJALIZOM

A. BEĆIRAGIĆ, H. RESIĆ, A. DERVIŠEVIĆ[1], A. FAJKIĆ[2], N. PROHIĆ, N. AVDAGIĆ[1], N. BABIĆ[1], S. AJANOVIĆ i A. ĆORIĆ

Univerzitetski klinički centar Sarajevo, Klinika za hemodijalizu, [1]Univerzitet u Sarajevu, Medicinski fakultet, Zavod za humanu fiziologiju i [2]Univerzitet u Sarajevu, Medicinski fakultet, Zavod za patofiziologiju, Sarajevo, Bosna i Hercegovina

Uvod/cilj: Hemodijaliza (HD) je povezana s brojnim biokemijskim abnormalnostima uključujući dislipidemiju i oksidativni stres. Cilj istraživanja bio je ispitati aktivnost i utvrditi povezanost enzima superoksid dismutaze (SOD) s parametrima lipidnog profila kod bolesnika na HD. ***Metode:*** Presječnom studijom obuhvaćeno je 100 HD bolesnika koji su podijeljeni u dvije skupine: bolesnici koji su bili liječeni pomoću HD više od tri mjeseca, ali manje od pet godina (HD <5 godina, n=48) i bolesnici koji su bili liječeni pomoću HD pet godina i više (HD ≥5 godina, n=52). Kontrolnu skupinu (n=50) činile su po dobi i spolu odgovarajuće zdrave osobe bez subjektivnih i objektivnih pokazatelja bubrežne bolesti. Uzorci krvi služili su za određivanje koncentracija SOD, ukupnog kolesterola, triglicerida (TG), lipoproteina male gustoće (LDL) i lipoproteina velike gustoće (HDL). Serumska koncentracija SOD određena je metodom ELISA upotrebom komercijalnog kita. ***Rezultati***: Serumska koncentracija SOD bila veća kod HD bolesnika u usporedbi sa zdravim kontrolnim osobama. Koncentracija SOD u skupini bolesnika na HD <5 godina bila je značajno veća u odnosu na kontrolnu skupinu ispitanika [12,29 (10,85-14,15 prema 11,04 (9,42-12,99) U/mL (p<0,05)], ali nije utvrđena značajna razlika u koncentraciji SOD između skupina bolesnika na HD ≥5 godina [12,97 (10,27-14,56) U/mL] i zdravih ispitanika kontrolne skupine. Uz to, nije bilo značajne razlike u serumskoj koncentraciji SOD između HD bolesnika koji su bili liječeni pomoću HD <5 godina i ≥5 godina. Utvrđeno je značajno smanjenje koncentracija TC, LDL i HDL u objema skupinama HD bolesnika u odnosu na kontrolnu skupinu (p<0,0005), ali razine serumskih TG nisu se značajno razlikovale između promatranih skupina. Rezultati dobiveni ROC analizom pokazali su da su serumske razine TC, LDL i HDL u odnosu na serumsku koncentraciju SOD osjetljivije u razlikovanju HD bolesnika i zdravih osoba. ***Zaključak:*** Na osnovi naših rezultata može se zaključiti da povišena serumska koncentracija SOD, zajedno s promjenama lipidnog profila, povećava rizik od ateroskleroze i kardiovaskularnih komplikacija kod HD bolesnika.

Ključne riječi: hemodijaliza, superoksid dismutaza, dislipidemija