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ARTYKUŁ ORYGINALNY / *ORIGINAL ARTICLE*

The relation of serum thiol levels and thiol/disulphide homeostasis with the severity of coronary artery disease

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Abstract

Background: The balance of oxidant and antioxidant status plays a key role in the coronary artery diseases (CAD). Thiol is one of the most important antioxidant barriers in humans, and thiol/disulphide homeostasis is a novel oxidative stress marker.

Aim: We aimed to investigate the relation of serum thiol levels and thiol/disulphide homeostasis with the presence and severity of CAD.

Methods: A total of 161 patients who underwent coronary angiography owing to stable angina pectoris were consecutively enrolled. They were divided into three groups. Group I — 47 age- and gender-matched subjects with normal coronary angiography (control); group II — 71 newly diagnosed CAD patients with noncritical stenosis; and group III — 43 newly diagnosed CAD patients with critical stenosis. Serum native thiol, total thiol, and disulphide levels were measured, and disulphide/thiol ratios were calculated. Gensini scores were calculated in CAD patients.

Results: While the highest thiol levels were found in group I, the lowest one was observed in group III ($p < 0.001$). Total and native thiol levels were significantly lower in group II than in group I ($p < 0.001$ for each), but they increased considerably in group II compared with group III ($p = 0.031$ and $p = 0.028$, respectively). Disulphide levels decreased in group II and III compared with group I ($p < 0.001$ for each). No statistically significant changes were observed in disulphide/thiol ratios ($p > 0.05$). Gensini scores were negatively correlated with total and native thiols, and positively with age and dyslipidaemia. Stepwise linear regression analyses showed that native thiol was an independent predictor in the final model for Gensini score. Receiver operating characteristic curve analysis demonstrated that thiol values of 310.7 or below could predict CAD with 89% sensitivity and 85% specificity (AUC = 0.918; 95% CI 0.870–0.965).

Conclusions: While the disulphide/thiol ratio did not change significantly, decreased native thiol levels were associated with the presence and severity of CAD. This result indicates that the reduction of thiols may be an important factor in the development of CAD.

Key words: coronary artery disease, severity, Gensini scores, thiol, thiol-disulphide homeostasis, oxidative stress

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INTRODUCTION

Coronary artery disease (CAD) is the most common cause of mortality and morbidity all over the word, and these disorders encompass a diverse range of pathophysiological mechanisms [1]. Among them, oxidative stress has been reported as one of the underlying mechanisms by the vast majority of studies that comprehensively investigate atherosclerosis and related disorders [2, 3]. Coronary endothelial cells are vulnerable to oxidative damage, just like other cells. In a healthy body, once these cells are exposed to reactive oxygen species, antioxidant mechanisms are activated to overcome oxidative damage. Thus, cell viability is kept up by the balance between oxidants

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and antioxidant mechanisms. Briefly, if the oxidant/antioxidant balance shifts in favour of the oxidant, irreversible cell damage or death occurs [4, 5].

Thiols are important antioxidant agents in human beings. Thiols containing sulphur analogue of alcohol are available in free or oxidised form in plasma. The thiol pool of plasma is mainly composed of protein thiols including albumin and low molecular mass thiols to a lesser extent. The latter ones are mainly glutathione, homocysteine, cysteine, and gamma glutamine [6]. In case of high oxidative stress, thiol levels decrease in order to neutralise the reactive oxygen species. And, in this case, sulfhydryl groups of thiols play a critical role [7]. Upon oxidative stress, disulphide bonds undergo reversible formation between protein thiols and low molecular weight ones. These bonds may be reduced back to thiols, and thus thiol/disulphide homeostasis is sustained [8]. Recently it has been reported that the thiol/disulphide ratio is a novel oxidative stress marker, the level of which may alter in acute coronary syndromes [9, 10]. Although there is a confirmed association of oxidative stress with atherosclerotic coronary heart disease, to our knowledge, there is no study that address thiol levels and thiol/disulphide homeostasis in stable CAD. Therefore, we aimed to investigate the serum native thiol, total thiol, disulphide levels, and disulphide/thiol homeostasis in patients with and without coronary artery stenosis, and investigate whether any relation was present between thiol levels and the severity of CAD.

METHODS

Study population

A total of 161 patients who underwent coronary angiography owing to stable angina pectoris were consecutively enrolled in this study. They were divided into three groups. Group I, the control group, consisted of 47 age- and sex-matched subjects with normal coronary angiogram; group II included 71 patients with newly diagnosed noncritical coronary stenosis (≤ 50%) in at least one coronary artery; and group III included 43 patients with newly diagnosed critical coronary stenosis (> 50%) in at least one coronary vessel. Exclusion criteria were as follows: previous percutaneous coronary intervention or bypass grafting operation, isolated coronary ectasia and coronary slow flow without severe coronary stenosis, peripheral artery disease including carotids, atrial fibrillation, left ventricular dysfunction (ejection fraction < 50%), moderate or severe valvular heart disease, congenital heart disease, systemic inflammatory disorders, organ failures, and use of supplemental vitamins.

Medical history including cardiovascular risk factors and medications was taken from all subjects. After the measurement of weight and height according to the standard protocol, body mass index was calculated as weight/height squared (kg/m^2). Systolic and diastolic blood pressures were invasively recorded during angiography, but hypertension was not diagnosed according to these values (it was determined on assessments prior to angiography). Fasting blood samples were collected from all subjects, and echocardiography was performed before coronary angiography.

This study was performed with respect to the recommendations put forward via the Declaration of Helsinki. The study protocol was approved by the Ethical Committee and each participant gave written, informed consent.

Coronary angiography

Coronary angiographies were performed according to Standard Judkins technique. The coronary angiograms of the subjects were assessed for coronary stenosis by two experienced interventional cardiologists who were blind to the study. While critical coronary artery stenosis was defined as luminal diameter stenosis above 70% (n = 37) or 50–70% stenosis with documented ischaemia by myocardial scintigraphy (n = 6) in at least one major coronary artery, noncritical coronary artery stenosis was defined as luminal stenosis below 50%. If no luminal stenosis was present in any coronary artery, the coronary angiogram was described as normal. The severity of coronary atherosclerosis was then determined according to the Gensini score based on the degree of luminal narrowing and its geographical distribution [11].

Echocardiography

Echocardiographic assessments were performed based on the suggestions of the American Society of Echocardiography guidelines [12]. Echocardiography was made in the left lateral decubitus position by an ultrasound machine GE-Vingmed Vivid S6 system (GE-Vingmed Ultrasound AS, Horten, Norway) and M4S-RS (1.5–3.6 MHz) cardiac transducer. All measurements were performed by two experienced cardiologists who were unaware of the patients' data. The left ventricle systolic and end-diastolic diameters and interventricular septum and posterior wall thickness were measured on M-mode tracking at the papillary muscles level in the parasternal long axis view based on established standards. Left ventricular ejection fraction was calculated by modified Simpson's rule [12].

Biochemical analyses

Fasting venous blood samples were collected from all patients before angiography. Serum glucose, urea, creatinine, alanine amino transferase, triglyceride (TG), total cholesterol, and high-density lipoprotein cholesterol (HDL-C) levels were measured using a commercial kit (Abbott, USA), and low-density lipoprotein-cholesterol was calculated using the following formula: total cholesterol – (HDL-C) – TG/5. After the blood centrifuging, serum samples were stored at –80°C. Haematocrit and white blood cell counts were measured from K_2EDTA samples using an autoanalyser (Sysmex K-1000, Block Scientific, USA) within five minutes of sampling.

Table 1. Clinical characteristics in all groups

	Group I (n = 47)	Group II (n = 71)	Group III (n = 43)
Age [years]	56 (53–60)	54 (51–57)	59 (55–63)
Male sex	29 (62%)	40 (56%)	27 (63%)
Body mass index [kg/m^2]	27.0 (25.4–28.5)	28.1 (26.6–29.6)	28.3 (26.8–29.8)
Resting heart rate [bpm]	78 (75–81)	80 (77–82)	82 (79–84)
Systolic BP [mm Hg]	120 (115–125)	123 (119–126)	124 (120–128)
Diastolic BP [mm Hg]	76 (73–79)	77 (74–79)	78 (74–81)
Diabetes	6 (13%)	11 (15%)	6 (14)
Hypertension	9 (19%)	12 (17%)	8 (19)
Dyslipidaemia	5 (11%)	8 (11%)	7 (16)
Smoking	7 (15%)	10 (14%)	7 (16)
Family history	7 (15%)	10 (14%)	8 (19)
ACEI/ARBs	6 (13%)	7 (10%)	6 (14)
Beta-blockers	3 (6%)	4 (6%)	2 (5)
Diuretics	5 (11%)	7 (10%)	4 (9)
Calcium channel blockers	3 (6%)	6 (8%)	4 (9)
Statins	3 (6%)	6 (8%)	3 (7)
Fibrates	1 (2%)	2 (3%)	1 (2)

P > 0.05 for all variables; ACEI — angiotensin converting enzyme inhibitor; ARB — angiotensin receptor blocker; BP — blood pressure; continuous variables are presented as mean and 95% confidence interval

Thiol/disulphide homeostasis was measured as defined by Erel et al. [13]. Subsequently, reducible disulphide bonds were reduced to compose free functional thiol groups. Unused reductant sodium borohydride was used up and extracted with formaldehyde, and all thiol groups containing native and reduced ones were determined after reaction with 5, 5′-dithiobis-(2-nitrobenzoic) acid. Half of the difference between native and total thiols ensured the dynamic disulphide quantity (−S-S). After detection of the native thiol (−SH) and disulphide (−S-S) amount, the ratio of disulphide to native thiol (−S-S−/−SH) was calculated [13].

Statistical analyses

Data were expressed as mean (95% confidence interval [CI]) and number (percentage). One-sample Kolmogorov-Smirnov test was used to test the normality of variable distributions. ANOVA test was used for the comparison of continuous variables with normal distribution between the groups, and Kruskal-Wallis test was used for the comparison of continuous variables with skewed distribution. The χ^2 test or Fisher's exact test, where appropriate, was used to compare categorical variables between the groups. For correlation analyses, Pearson's correlation analysis was preferred for data with normal distribution; however, Spearman's correlation was preferred for data with skewed distribution. Independent predictors of Gensini score were determined using stepwise linear regression analysis. A two-sided p value of less than 0.05 was considered to be statistically significant. Receiver operating characteristic (ROC) curve analysis was used to determine the cut-off values for sensitivity and specificity of native thiol in predicting CAD. All analyses were implemented by SPSS 20.0 (Chicago, IL, USA).

RESULTS

All groups were similar in terms of demographic, clinical, and basal laboratory parameters and echocardiographic characteristics (Tables 1, 2). Also, the presence of hypertension, diabetes mellitus, dyslipidaemia, family history, and smoking were similar in all groups. Usage of antihypertensive drugs was also similar in all groups (Table 1).

In terms of angiographic characteristics, stenotic involvements of epicardial coronary arteries were significantly higher in group III than in group II in all coronary arteries including the left main coronary artery, left anterior descending artery, left circumflex artery, and right coronary artery. While the Gensini score was zero in group I, as expected, group III had the highest Gensini score (Table 2). Additionally, while the highest native thiol, total thiol, and disulphide levels were found in group I, the lowest levels were observed in group III. Furthermore, although group II had significantly lower native thiol, total thiol, and disulphide levels compared with group I ($p < 0.001$ for each), native thiol and total thiol levels in group II increased considerably compared with group III ($p = 0.028$ and $p = 0.031$, respectively) (Table 2, Fig. 1A–C). On the other hand, although the disulphide/native thiol and disulphide/total thiol ratios increased in group II and group III compared with group I, these increases did not reach statistically significant levels (Table 2).

Table 2. Laboratory, echocardiographic, and angiographic characteristics in all groups

	Group I (n = 47)	Group II (n = 71)	Group III (n = 43)	P
Fasting glucose [mg/dL]	92.4 (88.7–96.1)	93.7 (90.4–97.0)	94.3 (90.5–98.2)	0.493**
Urea [mg/dL]	24.1 (23.2–25.1)	23.9 (23.1–24.7)	24.5 (23.6–25.5)	0.615*
Creatinine [mg/dL]	0.79 (0.78–0.81)	0.80 (0.79–0.82)	0.81 (0.80–0.83)	0.136*
Alanine amino transferase [U/L]	23.3 (22.7–23.9)	23.8 (23.2–24.4)	24.3 (23.7–24.9)	0.133*
Total cholesterol [mg/dL]	191.0 (185.7–196.3)	194.4 (190.2–198.6)	195.9 (191.2–200.6)	0.178**
Low density cholesterol [mg/dL]	118.8 (113.8–123.7)	122.3 (118.4–126.1)	124.0 (119.3–128.7)	0.105**
High density cholesterol [mg/dL]	39.6 (38.5–40.7)	39.2 (38.5–40.0)	38.9 (38.1–39.8)	0.103**
Triglycerides [mg/dL]	161.0 (151.3–170.8)	159.7 (152.3–167.1)	160.3 (151.3–169.2)	0.973*
White blood cell [$10^3/\mu L$]	8.8 (8.6–9.0)	8.9 (8.8–9.0)	9.0 (8.9–9.2)	0.082*
Haematocrit [%]	42.6 (41.8–43.3)	43.4 (42.8–44.1)	42.8 (41.9–43.7)	0.209*
Native thiol [μmol/L]	352.4 (337.5–367.3)	260.4 (248.3–272.6)[c]	234.5 (217.9–251.1)[a, b]	< 0.001*
Total thiol [μmol/L]	389.5 (374.3–404.7)	286.5 (274.2–298.9)[c]	260.2 (242.7–277.7)[a, b]	< 0.001*
Disulphide [μmol/L]	18.6 (17.0–20.2)	13.0 (11.4–14.7)[c]	12.9 (11.1–14.6)[a]	< 0.001*
Disulphide/native thiol [%]	5.4 (4.8–6.0)	5.4 (4.3–6.5)	5.7 (4.8–6.6)	0.273**
Disulphide/total thiol [%]	4.8 (4.4–5.3)	4.6 (3.9–5.3)	5.0 (4.3–5.7)	0.273**
Echocardiography				
LV end-diastolic diameter [mm]	48.1 (47.3–48.8)	48.1 (47.4–48.7)	48.5 (47.8–49.2)	0.598*
LV end-systolic diameter [mm]	33.0 (32.5–33.6)	32.8 (32.4–33.2)	33.2 (32.6–33.8)	0.523**
LV septal thickness [mm]	8.8 (8.4–9.1)	8.9 (8.6–9.2)	9.0 (8.7–9.4)	0.585**
LV posterior wall thickness [mm]	8.2 (7.9–8.5)	8.4 (8.1–8.6)	8.6 (8.3–8.9)	0.182**
LV ejection fraction [%]	61.7 (61.0–62.3)	61.8 (61.3–62.3)	62.7 (62.0–63.4)	0.055*
Angiography				
Left main coronary artery	0	3 (4%)	9 (21%)[a, b]	< 0.001***
Left anterior descending coronary artery	0	59 (83%)[c]	42 (98%)[a, b]	< 0.001***
Left circumflex coronary artery	0	38 (54%)[c]	37 (86%)[a, b]	< 0.001***
Right coronary artery	0	23 (32%)[c]	29 (67%)[a, b]	< 0.001***
Gensini score	0	4.5 (3.9–5.2)[c]	50.1 (38.9–61.3)[a, b]	< 0.001**

*p value for ANOVA test; **p value for Kruskal-Wallis test; ***p value for Chi-squared test; [a]$p < 0.05$ between group I and III; [b]$p < 0.05$ between group II and III; [c]$p < 0.05$ between group I and II; LV — left ventricle; continue variables are presented as mean and 95% confidence interval

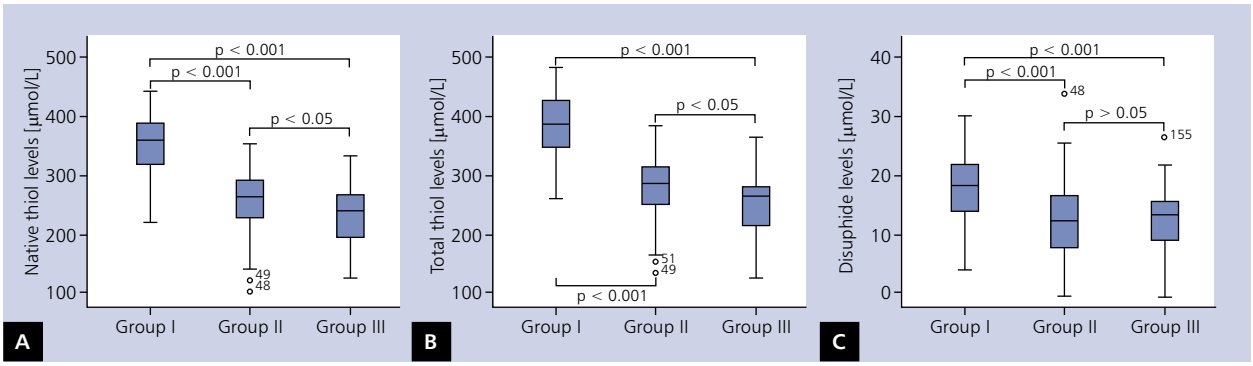

Figure 1. The comparison of thiols and disulphide levels between groups; **A.** Native thiol levels; **B.** Total thiol levels; **C.** Disulphide levels

Table 3. The correlation analyses between Gensini score and other parameters in all groups

Gensini score	Bivariate correlation	
	R	P
Native thiol	–0.399	< 0.001
Total thiol	–0.398	< 0.001
Disulphide	–0.131	0.098
Age	0.245	0.002
Hypertension	0.073	0.361
Diabetes	0.115	0.147
Dyslipidaemia	0.171	0.030
Family history	–0.072	0.363
Smoking	0.111	0.161

Bivariate correlation analyses revealed significant negative correlations between Gensini scores and native thiol and total thiol. Gensini scores had a significantly positive correlation with age and the presence of dyslipidaemia (Table 3). On the other hand, native thiol and total thiol were negatively correlated with age (r = –0.218 and r = –0.217, respectively, p = 0.006 for each). Moreover, stepwise linear regression analyses revealed that native thiol level was an independent predictor in the final model for estimation of the Gensini score (Table 4). Additionally, ROC curve analysis demonstrated that native thiol values of 310.700 or below could predict the CAD with 89% sensitivity and 85% specificity (area under curve = 0.918; 95% CI 0.870–0.965) (Fig. 2).

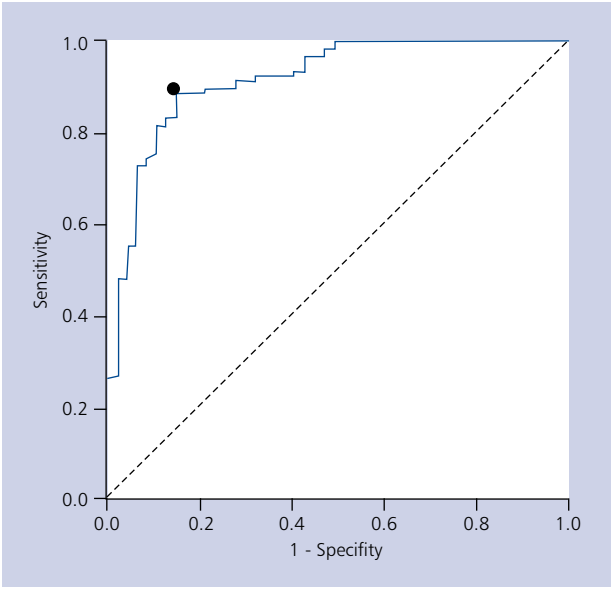

Figure 2. Receiver operating characteristic (ROC) analyses for the presence of coronary artery disease. ROC curve demonstrated that thiol values of 310.7 or below could predict coronary artery disease with 89% sensitivity and 85% specificity (area under curve = 0.918; 95% confidence interval 0.870–0.965)

DISCUSSION

To our knowledge, this study is the first study that investigates thiols and thiol/disulphide homeostasis in patients with stable CAD. In this study, we found that native and total thiol levels were significantly decreased in patients with critical CAD, and these reductions were significantly correlated with severity of the CAD. However, there was no significant change in disulphide/thiol ratios. The results of our study revealed that reduced native thiol levels independently predicted CAD. The sensitivity and specificity of native thiol for this prediction was very strong.

An association of CAD with inflammation and oxidative stress is well known [3]. A previous study revealed that paraoxonase and arylesterase activities, which are both antioxidant molecules, decreased in severe CAD, and this reduction predicted the severity of CAD [14]. Some studies also showed that raised oxidative stress or decreased antioxidant status was associated with atherosclerotic coronary artery disorders [15, 16]. Our results were compatible with these studies, as expected. We found that thiols and disulphide levels were significantly raised in noncritical CAD and critical CAD groups compared with control. Further, critical CAD patients had a statistically lower thiol levels compared with noncritical CAD patients. These results suggested a negative association between thiol levels and the severity of coronary artery stenosis. Also, oxidative stress was found to be increased even in subclinical atherosclerosis detected by carotid intima–media thickness [17]. Investigators of this study also determined oxidative stress by measuring thiol level like

Table 4. Stepwise linear regression analyses for Gensini score estimation

	Model I (R^2 = 0.155)		Model II (R^2 = 0.187)		Model III (R^2 = 0.214)	
	β	p	β	p	β	p
Native thiol	–0.394	< 0.001	–0.384	< 0.001	–0.347	< 0.001
Dyslipidaemia			0.178	0.016	0.179	0.014
Age					0.168	0.024

us, and their study was compatible with our results. A study conducted by Palazhy et al. [18] demonstrated that oxidative stress was increased in CAD patients under statin therapies, and independent predictors for CAD estimation compared with novel coronary risk factors including apolipoprotein B, lipoprotein (a), and homocysteine. And these results were also concordant with our results in terms of CAD estimation. However, we considered that the results of this study had some contradictions. They compared oxidative stress parameters between three groups (group 1: healthy control; group 2: diabetics with CAD; and group 3: diabetics without CAD). However, hypertensive patients were included in groups 2 and 3 but not included in group 1 [18]. Thus, hypertension might affect the changes of oxidative parameters in addition to diabetes or CAD. Previous studies supporting our idea also reported elevated oxidative stress in hypertension [19, 20]. However, our results clearly showed a strong relationship between thiol and severity of CAD without causing confusion. Additionally, the basic part of the non-enzymatic antioxidant system in the body is thiols, and they are the first defensive molecules in elimination of oxidant agents [13, 21]. Therefore, thiol levels may be an earlier indicator for CAD, especially in the early stage. Another important result of our study was a significantly inverse correlation between thiol levels and age. When considering that antioxidant defence mechanisms are reduced by ageing, this result seems to be logical. Also, it was previously reported that thiol levels decrease in old age [22]. Similarly, Gensini scores were positively correlated with age and the presence of dyslipidaemia in our study, and this result was not surprising. However, regression analyses showed native thiol levels as an independent predictor in the final model for estimation of Gensini score rather than others.

Recently, the importance of disulphide/thiol homeostasis has been indicated in some studies. Kundi et al. [9] reported that the disulphide/thiol ratio increased in acute myocardial infarction, and they asserted that this ratio might be an indicator to detect acute myocardial damage. Our results showed that although the disulphide/thiol ratio was minimally raised with the severity of CAD, this was not statistically significant. There may be two explanations for this condition. Firstly, this balance may be shifted to disulphide in only acute coronary events. And secondly, the small sample size may be responsible for the discrepancy between our results and those of the previous study conducted by Kundi et al. [9].

On the other hand, CADs are the leading causes of premature death throughout the world [23]. Therefore, early diagnosis and effective treatment of CAD is highly important. Our results showed that decreased thiol levels may be an underlying pathophysiologic cause for development of CAD, and thus we speculate that our study can inspire the future studies about development of new treatment strategies so as to treat CAD. We hope that some molecules such as gamma-glutamylcysteine-ethyl-ester or thioredoxins affecting thiol levels or activity might provide a useful alternative to conventional medications for the prevention and treatment of CADs in near future [24, 25].

Limitations of the study

This study has some limitations. Firstly, the sample size was small. Secondly, although participants using supplemental vitamins were excluded, we could not make any standardisation in antioxidant content of daily diet of the subjects. Thirdly, we did not measure other antioxidant parameters such as lipid hydroperoxide, paraoxonase, and arylesterase. Fourthly, optical coherence tomography and intravascular ultrasound could not be applied for detection of coronary plaque burden because they were not available in our clinic. And lastly, we studied only patients with stable CAD; however, we did not include patients with acute coronary syndromes.

CONCLUSIONS

Consequently, serum thiol (native and total) and disulphide levels decreased with the severity of CAD, and native thiol levels independently predicted CAD with strong sensitivity and specificity, while thiol/disulphide homeostasis did not change significantly with the severity of CAD. This result indicates that the reduction of thiols may be an important factor in the aetiology of CAD. Moreover, future treatment strategies on CAD might focus on new mechanisms including thiol mediated oxidation.

Conflict of interest: *None declared*

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Zależność między stężeniem tioli w surowicy i homeostazą tiole/disulfidy a stopniem ciężkości choroby wieńcowej

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Streszczenie

Wstęp: Równowaga między oksydantami a antyoksydantami ma podstawowe znaczenie w chorobie wieńcowej (CAD). Tiole to związki będące jednymi z najważniejszych antyoksydantów w organizmie człowieka, a homeostaza tiole/disulfidy jest nowym wskaźnikiem stresu oksydacyjnego.

Cel: Celem niniejszej pracy było zbadanie zależności między stężeniem tioli w surowicy oraz homeostazą tiole/disulfidy a występowaniem i stopniem ciężkości choroby wieńcowej.

Metody: Do badania włączono kolejnych 161 chorych poddanych koronarografii z powodu stabilnej dławicy piersiowej. Pacjentów podzielono na trzy grupy. Grupa I (kontrolna) stanowiła 47 osób z prawidłowym wynikiem koronarografii dobranych pod względem wieku i płci, grupa II — 71 chorych z nowo rozpoznaną CAD z niekrytycznym zwężeniem tętnicy wieńcowej, a grupa III — 43 chorych z nowo rozpoznaną CAD z krytycznym zwężeniem tętnicy wieńcowej. U pacjentów zmierzono surowicze stężenia tiolu natywnego, tiolu całkowitego i disulfidów oraz obliczono współczynniki tiole/disulfidy. U osób z CAD określono wskaźnik Gensiniego.

Wyniki: Najwyższe stężenie tioli stwierdzono w grupie I, natomiast najniższe — w grupie III ($p < 0,001$). Stężenia tiolu całkowitego i natywnego były istotnie niższe w grupie II niż w grupie I ($p < 0,001$ dla obu), natomiast w grupie II były znacznie wyższe niż w grupie III (odpowiednio $p = 0,031$ i $p = 0,028$). Stężenia disulfidów były obniżone w grupie II i III w porównaniu z grupą I ($p < 0,001$ dla obu). Nie stwierdzono statystycznie istotnych zmian wartości współczynnika tiole/disulfidy ($p > 0,05$). Wartości wskaźnika Gensiniego korelowały ujemnie ze stężeniami tiolu natywnego i całkowitego oraz dodatnio z wiekiem i dyslipidemią. W analizie krokowej regresji logistycznej wykazano, że stężenie tiolu natywnego było niezależnym czynnikiem predykcyjnym wskaźnika Gensiniego. Na podstawie analizy krzywych ROC stwierdzono, że wartości stężenia tiolu wynoszące 310,7 lub mniej pozwalają prognozować CAD z czułością wynoszącą 89% i swoistością równą 85% (AUC = 0,918; 95% CI 0,870–0,965).

Wnioski: Podczas gdy współczynnik tiole/disulfidy nie zmienił się istotnie, obniżone stężenia tiolu natywnego wiązały się z obecnością i stopniem ciężkości CAD. Te obserwacje wskazują, że zmniejszenie stężenia tioli może być ważnym czynnikiem w rozwoju CAD.

Słowa kluczowe: choroba wieńcowa, stopień ciężkości, skala Gensiniego, tiol, homeostaza tiole/disulfidy, stres oksydacyjny

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