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ORIGINAL ARTICLE

A Comparison of Thiol/Disulphide Levels of Workers in Operating Rooms and Emergency Healthcare Centers

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ABSTRACT

Objective: Thiol/disulphide homeostasis has a crucial role for life. The aim of this study was to compare thiol/disulphide homeostasis in healthcare professionals working in the operating room (Group 1) and healthcare professionals working in the emergency department (Group 2).

Materials-Methods: This was a descriptive study. Fortynine operating room volunteers (Group 1) and 49 emergency department volunteers (Group 2) were included in this study. Thiol and disulphide concentrations were measured using the novel automated measurement method developed by Erel & Neşelioğlu in 2014.

Result: The thiol/disulphide levels were compared in both groups; Native thiol in group 1 was 353,57 ± 49,86 μmol.L^{-1}, and it was 333,73 ± 37,38 μmol.L^{-1} (p = 0.028) in group 2. total thiol values were 384,71 ± 52,36 μmol.L ^{1} and 370,94 15,56 ± 5,36 μmol.L^{-1}(P =0,133), respectively in group 1 and 2. In group 1,disulphide levels were 15,56±5,36 μmol.L^{-1}, in group 2 it was 18,61 ± 7,71 μmol.L^{-1} (p = 0,025), disulphide/native thiol in group 1 was 4,47 ± 1 %, and in group 2 it was measured %, 5,73 ± 2,95% (p = 0.009). Disulphide/total thiol in the group 1 was 4,06 ± 1,32% and 5,03 ± 2,13% (p = 0,008) in group 2. Native thiol / total thiol levels were 90,23 ± 12,16% in group 1 and 89,93 ± 4,26% in group 2 (p = 0,871). Native thiol level in group 1 and high level of disulphide in group 2 indicate that the exposure to oxidative stress in the emergency department is higher than in the operating room.

Conclusion: Our results show that participants of emergency room group have statistically higher levels of disulphide than participants working in operating room which may suggest presence of oxidative stress related with workplace exposures.

Key Words: Health personnel, oxidative stress, thiol/disulphide homeostasis.

INTRODUCTION

The oxidative stress is caused by the domination of the oxidants due to the destruction of the balance between the antioxidant defense system of the body and free radicals. Free oxygen radicals are synthesized in small quantities in the body during normal metabolism process and do not harm the body, but they are synthesized in extreme quantities leading to oxidative stress in some conditions such as viral diseases, exposure to ionizing radiation and environmental pollution. Also, it is suggested that free oxygen radicals (ROS) are responsible for the pathogenesis of some viral and chronic diseases [1, 2, 3]. Antioxidant defense systems have duties to prevent ROS damage on the body. Working in the

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night shift instead of the normal daytime work can lead to medical problems caused by created oxidative stress [4, 5]. It is found that there is a correlation between the exposure to night-lights and glutathione peroxidase activity in women working at nights [5, 6]. On the other hand, waste and leaking anesthetic gases have a significant effect on the exposure of the operating room workers, causing reproductive, neurological, hematologic, immunologic, hepatic and renal system diseases [7].

Thiols are effective in antioxidant defense procedure and thiol/disulphide homeostasis has an important role for life. Dynamic thiol/disulphide homeostasis plays a critical role in antioxidant protection, detoxification, signal transduction, apoptosis, regulation of enzymatic activity and transcription factors and cellular signaling mechanisms [8, 9]. It is known that a number of cellular functions such as DNA and protein synthesis, protein release, cytoskeleton architecture, differentiation, apoptosis and antioxidant defense are modulated by thiol/disulphide change mechanisms of redox active thiol groups at certain stages [9,10].

Thiol groups of proteins, thiol groups of low molecular weight compounds, cysteine residues and other thiol groups are oxidized by the oxidant molecules presented in the environment and turned into reversible disulphide structures. The formed disulfide structures can be reduced against to thiol groups, thereby thiol/disulphide balance can be maintained [10].

While Oxidative products give excess electrons to compounds containing thiols to be reduced, Thiol groups are oxidized and then cause the formation of the dipeptide bonds; this is a reversible reaction and dynamic thiol/disulphide balance is achieved [10]. A lot of information about the biochemical process can be obtained by measuring the dynamic thiol/disulphide homeostasis [9].

In our descriptive study, we aimed to compare the oxidative stress by measuring thiol/disulphide homeostasis levels between the emergency and the operating room staff who both have intense working hours.

MATERIALS AND METHODS

This study was conducted in Yenimahalle Education and Research Hospital between 01.01.2016 - 01.07.2016 after taking approval of Clinical investigations Ethical Committee (14/12/2015 - 2015/46).

This is a descriptive study. 49 operating room personnel aged 18 or older, and 49 emergency department personnel working at least six months in their units were involved in this study, as volunteers. A voluntary consent form was obtained from all participants. The personnel who had a history of smoking and immunosuppressive disease, use of immunosuppressive drugs and vitamin or mineral supplements or any antioxidant agents, any attempt or procedure under general anesthesia within the last 6 months, and any previous exposure to oxidative damage (radiology unit etc.) were not included in the study. A questionnaire consisting of 6 questions was given to all participants and the effect of the recorded variable on thiol/disulphide homeostasis was evaluated for each participant. 5 ml of blood samples were taken from all participants in the morning and samples were stored at -80 ° C after centrifuging in 10 minutes at 3600 rpm in the biochemistry laboratory.

After all the samples were collected, they were all dissolved at the same time and the blood thiol / disulfide parameters were examined by Roche Hitachi Cobas 501 automatic analyzer at Ankara Atatürk Training and Research Hospital Biochemistry Laboratory by using Erel & Neselioglu's newly developed automated measurement method [9].

Changes in the thiol level of each parameter were evaluated.

The obtained data were recorded with SPSS 11.5 and the Student t-test was used to determine the differences between the groups with normal distribution; In the case of categorical variable, Chi-Square test was used to compare two groups. The statistical boundary was given $p < 0.05$.

RESULTS

In our study, according to our findings, gender, age group, marital status, having children, working time, weighted diet did not affect thiol/disulphide levels statistically. Female ratio (69,4%), greater than 40 age group ratio(42,9%) and greater than study for 15 years time radio (55,1%) were statistically significantly higher in group 1 than group 2 (Table 1). According to the biochemical analysis; native thiol (353,57±49,86 µmol/L) in group 1; disulphide (18,61±7,71µmol/L), disulphide/native thiol (5,73±2,95%)ratio and disulphide/total thiol (5,03±2,13%)ratio levels in the group 2 were statistically significantly higher , but total thiol (group1: 384,71±52,36, group 2: 370,94±36,15) and native thiol/total thiol ratio (group 1: 90,23±12,16%, group 2: 89,93±4,26%) were not statistically significance (Table 2).

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Table 1. Demographic characteristics of the study groups

Variable	Group		P
	Operating Room (n=49) n(%)	Emergency Room (n=49) n(%)	
Gender K/E	34/15(69,4)	22/27(44,9)	0,014
Age			
<30	9(18,4)	15(30,6)	0,015
30-39	19(38,8)	26(53,1)	
=>40	21(42,9)	8(16,3)	
Marital status			0,170
Married	39(79,6)	33(67,3)	
Single	10(20,4)	16(32,7)	
Child owner	36(73,5)	27(55,1)	0,059
Working hours			0,001
<5	5(10,2)	37(75,5)	
5-14	17(34,7)	12(24,5)	
=>15	27(55,1)	0(0,0)	
Type of Diet			0,310
Fruits and vegetables	7(14,3)	9(18,4)	
Balanced	28(57,1)	20(40,8)	
Meat	6(12,2)	12(24,5)	
Other	8(16,3)	8(16,3)	

Table 1. Laboratory findings of the study groups

Variable	Group		P
	Operating Room (n=49) Mean±SD	Emergency Room (n=49) Mean±SD	
Native thiol (µmol/L)	353,57±49,86	333,73±37,38	0,028
Total thiol (µmol/L)	384,71±52,36	370,94±36,15	0,133
Disulphide (µmol/L)	15,56±5,36	18,61±7,71	0,025
Disulphide/native thiol (%)	4,47±1,56	5,73±2,95	0,009
Disulphide/total thiol (%)	4,06±1,32	5,03±2,13	0,008
Native thiol/total thiol (%)	90,23±12,16	89,93±4,26	0,871

DISCUSSION

Our results show that participants of emergency room group have statistically higher levels of disulphide (or lower levels of thiol/disulphide ratio) than participants working in operating room which may suggest presence of oxidative stress related with workplace exposures. This was the first study for comparing these two groups on thiol/disulphide homeostasis.

Oxidative stress is defined as the shift of the balance between the antioxidant defense system of the body and free radicals (ROS) in favor of the oxidants [1]. Oxidative stress leads to oxidative destruction

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of lipids and other macromolecules, which results in the exchange of cell membranes and other cell components, leading to cellular necrosis and death, resulting in tissue damage and chronic diseases [1, 2, 3]. Smoking, viral infections, inflammation, ischemia reperfusion, excessive accumulation of transition metals, cancer medications and radiation may increase oxidative stress [1].

Defense systems preventing damage in the body due to ROS are called Antioxidant defense systems. Although the theory of free oxygen radicals has been known for many years, the protective effect of antioxidants against diseases has gained importance in recent years [2]. There are many different substances that can act as antioxidants. Antioxidant defense system consists of antioxidant enzymes such as superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx), glutathione reductase (GR), glutathione, vitamins (A, C, E), melatonin, non-enzymatic antioxidants, and some trace elements. Antioxidants prevent lipid peroxidation by inhibiting peroxidation chain reaction or by collecting reactive oxygen species. Antioxidants also have protective effects against cancer by reducing the oxidative damage to DNA and the abnormal increase in cell division [2, 3]. If employees work based on the shift system, changes in both cell level and whole organism level may be seen. It is known that oxidative stress causing cellular damage is responsible for several medical disorders. According to a study including nurses, oxidative stress parameters were shown to be increased. [4]. In addition to that, the total plasma antioxidant capacity of night workers was found to be decreased at the end of the shift compared to the values measured during the shift [5]. The circadian rhythm affects the antioxidant enzyme activity and the cellular mRNA levels of this enzyme [6].

Operating room personnel are exposed to infectious agents, intensive stresses, anesthetic gases, radioactive materials, chemical substances, equipment and agents that are used in the sterilization of operating room and surgical materials.

Waste and leaking anesthetic gases are the major oxidative stress agents exposed to operating room workers, these cause reproductive, neurological, hematologic, immunologic, hepatic and renal system diseases [7]. Oxidative stress causes lipid peroxidation, oxidative damage to DNA, and degradation of the antioxidant defense system in exposed professionals [8]. Thiol is an organic compound containing a sulfhydryl group that plays a critical role in preventing the formation of oxidative stress states in cells. Important thiols in the plasma are low molecular weight thiols including albumin, protein, cysteine, cysteinylglycine, glutathione, homocysteine, and γ--glutamyl cysteine [9].

While Oxidative products give excess electrons to compounds containing thiols to be reduced, Thiol groups are oxidized and then cause the formation of dipeptide bonds; this is a reversible reaction and dynamic thiol/disulphide balance is achieved [10]. This balance plays a critical role in antioxidant defense, detoxification, apoptosis, regulation of enzymatic activity and cellular signaling. A lot of information about the biochemical process can be obtained by measuring the dynamic thiol/disulphide homeostasis [9]. It is known that many cellular functions such as DNA and protein synthesis, protein release, cell differentiation, apoptosis and antioxidant defense are modulated by thiol-disulfide exchange mechanisms at certain stages [10, 11]. Abnormal thiol/disulphide equilibrium levels are seen in the pathogenesis of diabetes mellitus, cardiovascular diseases, cancer, rheumatoid arthritis, chronic renal failure, Parkinson's disease, Alzheimer's disease, multiple sclerosis and liver diseases.

Ates et al. showed that disulphide levels increased in patients with newly diagnosed hypertension and patients with type 1 diabetes mellitus Also, Cakici et al. demonstrated that disulfide levels were increased in adolescent patients with newly diagnosed hypertension [12, 13, 14]. Kundi et al. found that hospital mortality was increased in patients with a low rate of thiol/disulphide in non-ST elevated myocardial infarction [15]. Gumusyayla et al. found that the level of disulphide in Alzheimer patients was significantly higher [16].

According to the results, we determined that the exposure to oxidative stress was higher in the emergency service workers compared to the operating room workers. Our study is the first one to compare the thiol/disulphide levels of the operating room workers and emergency workers. We hope that such studies will open the way for objective evaluations to measure for stressful and intense working conditions in concrete terms. We believe that comprehensive and advanced researches are needed.

CONFLICT OF INTEREST STATEMENT

The authors declare they have no conflicts of interest

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