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Salivary Oxidative Status in Relation to Periodontal Status among Workers in Diagnostic Radiation Field

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ABSTRACT

Background: *Workers in diagnostic radiation field are at higher risk for systemic diseases as well as oral diseases like periodontal diseases. The aim of this study was to estimate the salivary oxidative stress marker and salivary antioxidants and their relation to periodontal status among a group of diagnostic radiation workers.* ***Material and methods:*** *The sample for this study included a study group which consisted of 40 men working in the diagnostic radiation field and a control group which consisted of 40 men-working as nurses or at a laboratory in Baghdad hospitals all of them aged 30-40 years. Collection of unstimulated salivary samples was carried out under standardized conditions. The salivary flow rate was measured, and then salivary analysis was done to determine the level of salivary antioxidants (zinc, copper, and manganese) and oxidative stress marker (protein carbonyl). Gingival, periodontal pocket depth and clinical attachment loss indices were used for recording the periodontal status.* ***Results:*** *Data analysis of the present study reported that salivary protein carbonyl, copper, and manganese were higher among radiographers than the control group with a statistically highly significant difference ($p<0.01$), while salivary zinc and salivary flow rate were lower among radiographers than the control group with a statistically highly significant difference ($p<0.01$). The gingival index was higher among radiographers although it was not significant statistically ($p>0.01$), periodontal pocket depth and clinical attachment loss were higher among radiographers than the control group with a statistically highly significant difference ($p<0.01$).* ***Conclusions:*** *Ionizing radiation affects salivary antioxidant, oxidative stress marker (protein carbonyl) and salivary flow rate and these in turn will affect periodontal status.*

Keywords: Diagnostic radiation, salivary oxidative status, periodontal status

INTRODUCTION

During the last decade, there is an increase in the number of persons who work in nuclear medicine and diagnostic radiation departments [1]. Since the major source of human-made radiation is from medical applications so the increase in the medical use of radiation will cause the largest part of the overall increase in the radiation exposure. People with health issues receive the majority of the dose, especially older individuals, who receive more diagnostic and therapeutic radiation doses and are not evenly distributed across the population [2]. Radiation exposure of radiological technologists is about two times higher than that of other occupation groups in the fields of diagnostic radiation workers, such as physicians, dentists, dental hygienists, and nurses [3].

Periodontal disease are chronic infectious diseases resulting in the inflammation of gingival and/or periodontal tissues with progressive loss of alveolar bone and include two basic forms, gingivitis and periodontitis. They are most common diseases initiated by a dental plaque with the inflammatory character [4,5].

Saliva is the clear viscous fluid circulating in the mouth as a mixture of secretions from major and minor salivary glands and traces from the saliva definitely promotes oral health [6].

Oxidative stress is characterized by an imbalance between oxidants and antioxidants, due to the excessive production of Reactive Oxygen Species (ROS) and the reduction in the rate of its removal by the antioxidant defense system. This metabolic disturbance favors the oxidation of biomolecules, contributing to the oxidative damage in the cells and tissues and consequently to the development of several chronic diseases [7-9]. However, reactive oxygen species have detrimental effects on tissue cells when produced in excess and may cause periodontal tissue breakdown [10].

Protein carbonyl (PC) groups are relatively stable end-products of protein oxidation generated by multiple forms of reactive oxygen species. It is the most widely used biomarker for oxidative protein damage with earlier production and greater stability compared with lipid peroxidation products [11].

An antioxidant is any substance that delays prevents or removes oxidative damage to a target molecule. Antioxidants are an inhibitor of the process of oxidation, even at relatively small concentration and thus have a diverse physiological role in the body [12].

Minerals are required in the body cells for the proper functioning of the enzymes. Their absence is known to affect the metabolism of many macromolecules. They include selenium, copper, iron, zinc, and manganese. They act as cofactors for the enzymatic antioxidants. Each one of Copper superoxide dismutase (Cu)SOD, Zinc superoxide dismutase (Zn) SOD, and Manganese superoxide dismutase (Mn)SOD is a class of enzyme that consists of different types of SODs, depending upon their metal cofactors such as Cu-Zn and Mn. Cu-Zn SOD is found in the cytosol having Cu and Zn at their active sites which helps in proton conduction, whereas Mn-SOD is found in mitochondria and has Mn at its active site. These metals are responsible for SOD's antioxidant activities [13].

PATIENTS AND METHODS

The sample for this study included men aged 30-40 years old and they are work in Baghdad hospitals. The study group consisted of 40 men working in diagnostic radiation field for at least 5 years and a control group consisted of 40 men working as nurses or in the laboratory, they had no systemic diseases and were not taking any dietary supplements.

For each participant, the saliva collection was carried out in the morning (9-11 A.M). Unstimulated salivary samples were performed under standardized condition [14]. The salivary flow rate is calculated by dividing the volume of collected saliva in milliliter (ml) by the time required for collection in a minute (min) [15].

Biochemical analysis for zinc and copper in saliva was done using Buck scientific atomic absorption (flame) spectrophotometer, while analysis of manganese in saliva was done using atomic absorption (flameless) spectrophotometer.

Oxidative stress marker (protein carbonyl) in saliva was analyzed using carbonyl protein assay kit (SazaKits, India) and spectrophotometry was used to measure the colored complex as manufacturer instructions [16].

Clinically, gingival index (GI) was assessed [17]. The probing pocket depth (PPD) and Clinical Attachment Loss (CAL) were measured with the calibrated periodontal probe (Williams probe) [4].

Data analysis was conducted by application of SPSS program (SPSS version 24) using means, independent sample t-test and Pearson's correlation coefficient test.

RESULTS

The finding of this study showed that salivary flow rate for the study group was lower than that of the control group with a statistically highly significant difference ($p<0.01$), Table 1.

Table 1 Salivary flow rate among study and control group

Variable	Group				Statistical difference	
	Study		Control			
	Mean	±SE	Mean	±SE	t-test	p-value
Flow rate	0.192	0.010	0.358	0.014	9.545	0.000**
**Highly Significant at ($p<0.01$)						

As revealed in Table 2, the mean value of salivary zinc in the study group was lower than that of the control group with the statistically highly significant difference between them, while copper and manganese were higher for the study group than for the control group with the statistically significant difference between them ($p<0.01$).

Table 2 Salivary zinc, copper and manganese among study and control group

Variable	Group				Statistical difference	
	Study		Control			
	Mean	±SE	Mean	±SE	t-test	p-value
Zn	3.963	0.077	5.098	0.088	9.740	0.000**
Cu	3.928	0.083	3.020	0.047	-9.471	0.000**
Mn	0.016	0.001	0.014	0.001	-2.188	0.032*
*Significant at (p<0.05); **Highly Significant at (p<0.01)						

Table 3 showed that protein carbonyl for the study group was higher than that for the control group with a statistically highly significant difference (p<0.01).

Table 3 Salivary oxidative stress marker (protein carbonyl) among study and control group

Variable	Group				Statistical difference	
	Study		Control			
	Mean	±SE	Mean	±SE	t-test	p-value
PCO	1.304	0.002	1.158	0.006	-24.231	0.000**
**Highly Significant at (p<0.01)						

Table 4 illustrated that gingival index was higher among the study group than among the control group but statistically not significant (p>0.05). Furthermore, periodontal pocket depth and clinical attachment loss were higher among study group than among the control group with the statistically highly significant difference between them (p<0.01).

Table 4 Periodontal parameters among study and control group

Variable	Group				Statistical difference	
	Study		Control			
	Mean	±SE	Mean	±SE	t-test	P-value
GI	0.876	0.088	0.829	0.112	-0.328	0.744
PPD	3.340	0.295	0.613	0.234	-7.251	0.000**
CAL	1.614	0.190	0.293	0.119	-5.903	0.000**
**Highly Significant at (p<0.01)						

The correlations between periodontal parameters and salivary antioxidants and oxidative stress marker for both study and control groups were revealed in Table 5. The negative correlations among study group were found between GI with Zn, Cu, and Mn and between CAL with PCO; on the other hand negative correlations among the control group between PPD with Mn and between CAL with Cu. The remaining correlations were in a positive direction and all of them were statistically not significant (p>0.05).

Table 5 Correlation between periodontal parameters and antioxidants (zinc, copper, and manganese) and protein carbonyl

Group			Zn	Cu	Mn	PCO
Study	GI	r	-0.053	-0.196	-0.016	0.271
		p	0.747	0.224	0.922	0.091
	PPD	r	0.267	0.022	0.211	0.244
		p	0.096	0.895	0.191	0.129
	CAL	r	0.234	0.070	0.099	-0.018
		p	0.147	0.670	0.543	0.910
Control	GI	r	0.103	0.206	0.160	-0.058
		p	0.528	0.202	0.324	0.724
	PPD	r	0.102	0.164	-0.207	0.188
		p	0.530	0.312	0.201	0.245
	CAL	r	0.144	-0.177	0.067	0.049
		p	0.376	0.275	0.683	0.763

DISCUSSION

In the current study, data analysis showed that the study group has a lower salivary flow rate than the control group, this agrees with the previous study who stated that head and neck radiotherapy commonly damages the salivary glands, decreasing the salivary flow rate and changing salivary composition [18].

In the present study, data analysis showed that the salivary copper and manganese among the study group were higher than that among the control group which may be consider as a protective mechanism against the increase in Reactive Oxygen Species (ROS) in the previous study in which the circulating redox status in radiologic technologists was examined by measuring $O2^-$ levels in blood and found an increase in O^{2-} among them. On the other hand, the salivary zinc in the present study was lower among the study group than that of the control group this could be due to exhausted antioxidants (zinc) to neutralize the elevated level of ROS [19]. There was no previous study concerning the relation between radiation and these minerals (Zinc, copper, and manganese) to compare with.

Finding of the present study showed that the salivary oxidative stress marker (protein carbonyl) among the study group was higher than that among the control group, yet again this may be due to the significant increase in ROS among radiographers and this result agree with the previous study who reported an increase in plasma malondialdehyde MDA levels in specific subgroups of radiologic technologists [20], in addition it was in agreement with other findings of higher red blood cell MDA levels in radiographers when compared to the controls [21].

Data of this study showed that the periodontal pocket depth, clinical attachment loss and gingival indices among the study group were higher than that among the control group. This agrees with another study in which the level of deep periodontal pockets was found to be higher among the irradiated subjects as compared to the non-irradiated subjects and also came in accordance with who found a higher periodontal index among radiation workers. This may be due to the reduced salivary flow rate among those workers which was a risk factor for increasing periodontal diseases infection by dropping bacterial clearance as well it has an effect on microbial homeostasis [22,23]. Increases in ROS among radiographers as reported by another study could be another reason for increasing periodontal diseases [20]. Furthermore, zinc was lower among study group than that of the control group found by this study and since zinc acts as a cofactor in many enzyme-controlled processes during wound repair in addition to neutralizing bacterial toxins so it could be reduced during periodontal tissue repairing [13,24]. On the other hand, the results of present study disagree with another study in which there was no relation between Zn, Cu with periodontal status [25]. Besides the increases in ROS, it may lead to worse periodontal status due to tissue destruction and protein carbonyl formation this agree with other studies in which higher levels of protein carbonyl were associated with worse periodontal status with significant correlation [26-28]. Another explanation could be due to the reduced immunity among study group this agrees with who found a decrease in secretory immunoglobulin A among radiation workers [22].

CONCLUSION

Ionizing radiation affects salivary antioxidant, oxidative stress marker (protein carbonyl) and salivary flow rate and these, in turn, will affect periodontal status.

DECLARATIONS

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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