Wien Klin Wochenschr (2016) 128 [Suppl 8]:S572–S575
DOI 10.1007/s00508-015-0752-4

Wiener klinische Wochenschrift
The Central European Journal of Medicine

The effect of upper gastrointestinal system endoscopy process on serum oxidative stress levels

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Received: 4 March 2014 / Accepted: 20 January 2015 / Published online: 10 April 2015

Summary Some authors have investigated the effects of oxidative stress in some process such as undergoing laparoscopic. However, the effect of upper gastrointestinal system endoscopy process on oxidative stress is unclear. We evaluated the short-term effect of upper gastrointestinal system endoscopy process on oxidative stress. Thirty patients who underwent endoscopy process and 20 healthy controls were enrolled in the prospective study. Serum total antioxidant capacity and total oxidant status measurements were measured before and after endoscopy process. The ratio percentage of total oxidant status to total antioxidant capacity was regarded as oxidative stress index. Before endoscopy process, serum total antioxidant capacity levels were higher, while serum total oxidant status levels and oxidative stress index values were lower in patients than controls, but this difference was not statistically significant (all, $p > 0.05$). After endoscopy process, serum total antioxidant capacity and total oxidant status levels were significantly higher in patients than before endoscopy process (both, $p < 0.05$). However, oxidative stress index values were slight higher in patients but this difference was not statistically significant ($p > 0.05$). We observed that serum TAC and TOS levels were increased in patients who underwent endoscopy process after endoscopy process. However, short-time upper gastrointestinal system endoscopy process did not cause an important change in the oxidative stress index. Further studies enrolling a larger number of patients are required to clarify the results obtained here.

Keywords Upper gastrointestinal system endoscopy · Oxidative stress

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Introduction

Upper gastrointestinal system endoscopy is a valuable imaging modality for evaluating the esophagus, stomach and duodenum. Benign and malignant lesions of the upper gastrointestinal tract can be diagnosed with the procedure, and it can be performed for therapeutic purposes as well as diagnosis [1].

Oxidative stress is defined as an increase in reactive oxygen species (ROS) production, which results from a deterioration of the balance between oxidants and antioxidants in the body [2]. Oxidative stress can occur when the production of ROS exceeds the cellular antioxidant capacity, which can damage cellular macromolecules like DNA, proteins and lipids [3].

Measurements of individual antioxidants may not accurately reflect the true antioxidant status of the organism. Thus, measurements of total antioxidant capacity (TAC) are essential in evaluating antioxidant status [4–6]. Measurements of TAC and total oxidant status (TOS) have been accurate at predicting oxidative status [6].

Some authors have previously investigated the effects of various processes such as laparoscopic surgery on oxidative stress levels [7–14]. However, the effect of upper gastrointestinal system endoscopy process on serum oxidative stress levels is unclear. We evaluated the short-term effect of upper gastrointestinal system endoscopy process on oxidative stress.

Materials and methods

Subjects

The study was conducted by medical faculty in the Endoscopy Unit in the Department of Gastroenterology at Harran University. Thirty patients who underwent endoscopy process were enrolled in the prospective study. The patients had been scheduled for upper gastrointestinal endoscopy because of symptoms that suggested gastrointestinal disease.

The control group consisted of 20 age- and sex-matched healthy volunteers from the hospital staff. The subjects were asymptomatic and had unremarkable medical histories and normal physical examinations. No control subjects were receiving supplements with antioxidant vitamins, such as vitamins E or C. The control subjects were not taking drugs, smoking or consuming alcohol.

The study protocol was conducted in accordance with the 2000 revision of the Helsinki Declaration and approved by the local ethics committee. All subjects were informed about the study, and written consent was obtained from each subject.

Exclusion criteria

Patients were excluded if they had a history of alcohol abuse, smoking, taking antioxidant or fish-oil supplements in the previous month, receiving Helicobacter pylori eradication therapy, active infection, hypertension, diabetes mellitus, hyperlipidemia, chronic respiratory insufficiency, rheumatoid arthritis, cirrhosis, renal disease, coronary heart disease, cerebrovascular disease, or malignant tumor.

Measurement of total antioxidant capacity

Serum TAC levels were determined using an automated measurement method that was developed by Erel [15]. In the assay, a ferrous ion solution that is present in Reagent 1 is mixed with hydrogen peroxide, which is present in Reagent 2. The sequentially produced radicals that are produced by the hydroxyl radical, such as brown colored dianisidinyl radical cation, are also potent radicals. Using this method, the antioxidative effect of the sample against the potent free radical reactions, which is initiated by the produced hydroxyl radical, is measured. The assay has achieved excellent precision values of lower than 3%. The results are expressed as mmol Trolox equiv./L.

Measurement of total oxidant status

The serum TOS levels were determined using a novel automated measurement method that was developed by Erel [16]. Oxidants that are present in the sample oxidize the ferrous ion-o dianisidine complex to ferric ion. The oxidation reaction is enhanced by glycerol molecules that are abundantly present in the reaction medium. The ferric ion makes a colored complex with xylenol orange in an acidic medium. The color intensity, which can be measured spectrophotometrically, is related to the total amount of oxidant molecules that are present in the sample. The assay is calibrated with hydrogen peroxide, and the results are expressed in terms of micromolar hydrogen peroxide equivalent per liter (μmol H_2O_2 equiv./L).

Oxidative stress index

The oxidative stress index (OSI) value was calculated according to the following formula [17]: OSI (arbitrary unit) = TOS (μmol H_2O_2 equiv./L)/TAC (mmol Trolox equiv./L).

Blood samples

On the morning after overnight fasting, blood samples were obtained immediately before and after the endoscopy process. The samples were drawn from a cubital vein into blood tubes and were immediately stored on ice at 4 °C. The serum was separated from the cells by centrifugation at 3,000 rpm for 10 min and was then analyzed.

Statistical analysis

The results were expressed as the mean ± standard deviation. The comparison of parameters between the patient and control groups was performed using Student's *t* test. The paired sample t-test was used to compare TAC, TOS and OSI before and after the endoscopy process. Correlation analyses were performed using a Pearson's correlation test. The results were considered to be statistically significant when p was less than 0.05. Analyses were performed with the statistical software SPSS 11.0.

Results

The demographic data for the patients and control subjects are shown in Table 1. The mean age of the patients was 35.8 ± 7.5 years. The mean age of the control subjects was 33.4 ± 9.1 years. There were no significant differences between the patients and control subjects with respect to age, gender or body mass index ($p > 0.05$) (Table 1).

Before the endoscopy process, the serum TAC levels were higher and the serum TOS levels and OSI values were lower in patients compared to controls, but the differences were not statistically significant (all, $p > 0.05$) (Table 2).

Table 1 Demographic characteristics of the patients and the control group

	Controls ($n=20$)	Patients ($n=30$)	p
Sex (female/male)	10/10	15/15	0.613
Age (years)	33.4 ± 9.1	35.8 ± 7.5	0.315
BMI (kg/m²)	25.3 ± 4.6	25.5 ± 3.3	0.871

Values are the mean ± SD
BMI Body mass index

Table 2 Antioxidant and oxidant levels of patients and controls before the endoscopy process

Parameters	Controls ($n=20$)	Patients ($n=30$)	p
TOS (μmol H_2O_2 Eqv./L)	4.40 ± 1.43	4.34 ± 0.93	0.855
TAC (mmol Trolox Eqv./L)	1.30 ± 0.37	1.43 ± 0.58	0.400
OSI (arbitrary unit)	3.68 ± 1.68	3.57 ± 1.72	0.824

Values are the mean ± SD
TOS Total oxidant status, *TAC* Total antioxidant capacity, *OSI* Oxidative stress index

Table 3 Antioxidant and oxidant levels of patients before and after the endoscopy process

Parameters	Before ($n=30$)	After ($n=30$)	p
TOS (μmol H_2O_2 Eqv./L)	4.34 ± 0.93	5.58 ± 3.04	0.05
TAC (mmol Trolox Eqv./L)	1.43 ± 0.58	1.81 ± 0.84	0.05
OSI (arbitrary unit)	3.57 ± 1.72	3.69 ± 2.45	0.772

Values are the mean ± SD
TOS Total oxidant status, *TAC* Total antioxidant capacity, *OSI* Oxidative stress index

After the endoscopy process, the serum TAC and TOS levels were significantly higher in the patients who underwent the endoscopy process (both, $p < 0.05$). The OSI values were slightly higher in the patients, but this difference was not statistically significant ($p > 0.05$) (Table 3).

The mean duration of the endoscopic procedure was 284.56 ± 68.04 s. The duration of the endoscopic procedure was not correlated with the TAC, TOS levels and OSI values after the endoscopy process ($p > 0.05$).

Discussion

To the best of our knowledge, no previous literature has reported serum TAC, TOS levels and OSI values before and after upper gastrointestinal system endoscopy process.

We evaluated the short-term effect of upper gastrointestinal system endoscopy process on oxidative stress. Before the endoscopy process, there was no significant difference between patient and control groups according to demographic characteristics, serum TAC and TOS levels, and OSI values. After the endoscopy process, we observed that serum TAC and TOS levels were significantly higher in patients who underwent the endoscopy process. OSI values were slightly higher in the endoscopy patients, but this difference was not statistically significant.

To measure TAC levels, we used an automated method that has several major advantages over other available methods. The simple and cheap assay provides accurate measurements of TAC that can be obtained in as little as 10 min, which makes the assay suitable for the clinical biochemistry laboratory [6].

We assayed the oxidative status of the study population using TOS, TAC and OSI as indicators of oxidative stress, which reflect the redox balance between oxidation and antioxidation [6]. Oxidative stress can be defined as an increase in oxidants or a decrease in antioxidant capacity, and various oxidants and antioxidants have additive effects on oxidative status [18]. While the serum level concentrations of oxidants and antioxidants can be individually measured, they may not accurately reflect the oxidative status [19].

Several authors have investigated the effects of various processes, such as laparoscopic surgery, on oxidative stress [7–14]. Seven et al. [7] investigated lipid peroxidation and erythrocyte antioxidants among patients who underwent laparoscopic surgery, patients who underwent open cholecystectomy and healthy controls. The authors observed that laparoscopic cholecystectomy caused significantly less oxidative stress than the open operation. Their results show that both types of cholecystectomy cause oxidative stress and lead to an adaptive antioxidant response in the body. However; both oxidative stress and the antioxidant response are more pronounced after traditional open cholecystectomy. In another study, Glantzounis et al. [8] investigated thiobarbituric-acid reactive substances (TBARS) and total antioxidant status (TAS) levels preoperatively, 5 min after the pneumoperitoneum was deflated or after the operation and 24 h postoperatively. In that study, a significant elevation in the concentration of thiobarbituric acid-reactive substances was observed in the early postoperative measurements compared to the preoperative measurements that were conducted in the laparoscopic cholecystectomy group. Compared to the preoperative levels, total antioxidant status (TAS) and uric acid levels were significantly lower on postoperative day 1; however, no alterations to the concentrations of TBARS were observed in the postoperative period in patients who underwent an open cholecystectomy. During open cholecystectomy and laparoscopic cholecystectomy, Bukan et al. [9] observed increasing levels of malondialdehyde, nitrite and nitrate. The oxidative stress increased significantly in both groups, but laparoscopic cholecystectomy caused significantly less oxidative stress during surgery. The oxidative stress level returned to preoperative levels more quickly after laparoscopic cholecystectomy than after open cholecystectomy. Other studies have also revealed that laparoscopic cholecystectomy causes minor changes in antioxidant enzyme activity and oxidative stress levels, which is not the case with open cholecystectomy [10, 11].

Polat et al. [12] investigated the effects of different intra-abdominal pressures on lipid peroxidation and protein oxidation during laparoscopic cholecystectomy. Thiobarbituric acid-reactive substance levels were used to assess lipid peroxidation and protein carbonyl contents. Protein sulfhydryl groups were also measured to assess protein oxidation. The authors concluded that carbon dioxide insufflation could lead to an elevated oxidative stress response during laparoscopic cholecystectomy; however, no difference was found between the two examined groups.

In a recent study, Koksal et al. [13] used a direct automated colorimetric method to compare the total oxidant status with the TAS during laparoscopic cholecystectomy. No significant differences in the serum TOS and TAS levels were observed among patients who underwent a laparoscopic cholecystectomy. Similarly, Baysal et al. [14] investigated the TOS and TAS levels in pediatric patients who underwent laparoscopic surgery. Compared to levels after the anesthesia was induced, the authors observed increases in plasma TOS and OSI levels and decreases in TAS levels at the end of the surgery.

Diagnostic, therapeutic, and follow-up upper gastrointestinal endoscopies are increasingly performed because of their high diagnostic value, therapeutic applicability, low complication rates, and ease of application [20, 21]. During endoscopy procedures, air is released into the stomach to further investigate. While the air is removed as quickly as possible, we hypothesized that this process could cause TOS levels to increase. We also observed an antioxidative defense against this oxidative effect. Thus, the OSI was not significantly different after the endoscopy.

Our study has several limitations. First, the study relied on a cross-sectional design. Second, the number of patients was small. Our observations should be confirmed in larger patient samples. Finally, the long-term effect of upper gastrointestinal system endoscopy process on the OSI cannot be established in our study.

In conclusion, we observed that serum TAC and TOS levels were increased in patients who underwent endoscopy process after endoscopy process. However, the upper gastrointestinal system endoscopy process did not cause a significant change in the oxidative stress index. Additional studies that enroll larger numbers of patients are required to clarify these results.

Conflict of interest statement

The authors state that there are no conflicts of interest regarding the publication of this article.

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