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Oxidative stress in patients with differentiated thyroid cancer: Early effects of radioiodine therapy

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Ionizing radiation in differentiated thyroid cancer (DTC) patients treated with radioiodine (131-I) produces reactive oxygen species (ROS), which could induce oxidative stress with disturbance of redox balance. The aim of this study was to evaluate oxidative stress in DTC patients treated with 3.7 or 5.5 GBq of 131-I using values for serum malondialdehyde (MDA, a marker of oxidative stress), uric acid (to determine antioxidant status) and total antioxidative status (TAS). The study population included 20 DTC patients and 20 healthy controls. Significant differences in MDA concentrations were found between DTC patients before 131-I therapy and control subjects ($p = 0.001$), while TAS values were similar in both populations ($p>0.05$). There was a negative correlation between MDA concentrations and TAS in the DTC group before therapy ($R^2 = 0.2973$, $p = 0.013$). Three days after 131-I therapy, MDA concentrations were higher than the pretreatment values (3.36 ± 1.69 nmol/mL vs. 2.93 ± 1.31 nmol/mL; $p = 0.006$), while serum uric acid concentrations declined progressively from 341.0 ± 80.39 µmol/L to 304.25 ± 77.25 µmol/L ($p = 0.026$) in 3 days and 291.2 ± 88.86 µmol/L ($p = 0.009$) in 7 days after 131-I therapy. There was no dose-dependent effect on MDA, or uric acid concentrations and TAS. Thus, 131-I therapy in DTC patients induced oxidative stress, which was accompanied by a simultaneous and extended reduction in uric acid concentration, but without significant disturbances in TAS. This is the first study that evaluated TAS capacity in DTC patients before and 7 days after 131-I therapy. The relatively stabile TAS values in these patients indicated a good protection from oxidative stress induced by high doses of ionizing radiation.

Keywords: Differentiated thyroid cancer, Radioiodine therapy, Oxidative stress, Malondialdehyde, Uric acid, Total antioxidant status

Reactive oxygen species (ROS) are produced during normal cellular metabolism, in the process of cellular respiration and during phagocytosis. A low level of ROS is necessary in many biochemical processes[1]. In addition, ROS are formed as a consequence of various external factors, including ionizing radiation[2]. Living cells have very strong antioxidant protection mechanisms that eliminate any excess of ROS[3]. Oxidative stress is a state of imbalance between production and elimination of ROS where ROS generation dominates[4], which can lead to cell damage and death.

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Abbreviations: ABTS, 2.2′-azino-di-(3-ethylbenz-thiazoline sulfonate); DTC, differentiated thyroid carcinoma; MDA, malondialdehyde; ROS, reactive oxygen species; TAS, total antioxidative status; TSH, thyroid-stimulating hormone.

Lipid peroxidation is one of the most studied consequences of ROS action. It can be defined as oxidative deterioration of unsaturated lipids in cell membranes with the formation of many cytotoxic end-products, such as malondialdehyde (MDA)[5]. As a highly reactive organic compound, MDA is often used as a biological marker of oxidative stress[6]. MDA production can be reduced by uric acid, a powerful antioxidant that contributes as much as two-third of all free radical scavenging capacity in plasma[7].

Thyroid cancer is the most common malignancy of the endocrine system, the incidence of which has been increasing over the past 20 years[8]. Differentiated thyroid carcinomas (DTCs) account for more than 90% of all thyroid cancers and include papillary and follicular histological types[9]. As DTCs originate from the follicular cells of the thyroid, with the ability to accumulate iodine, the treatment of DTC patients with radioactive iodine (131-I) is a standard procedure for ablation of remnant thyroid tissue and for treatment of