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Original Article

Factors and mechanisms of oxidative stress In human pathology

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ABSTRACT

The active forms of oxygen and nitrogen are well recognized as having both harmful and beneficial forms. Excessive production of reactive forms of oxygen and nitrogen leads to oxidative/ nitrosative stress; a deleterious process that can be an important mediator of damage to cellular structures, including lipids and membranes (by loss of compartmentalization and selective transport), proteins (by oxidation of cysteine residues and changes in structure and loss of function), deoxyribonucleic acid (by mutations and altered gene expression). In contrast, the beneficial effects of active forms of oxygen and nitrogen occur at low concentrations and play a physiological role in cellular responses; for example, by modulating multiple cellular signaling pathways. A controlled balance between prooxidant and antioxidant substances (the so-called "redox balance") is important for the maintenance of proper cellular functions, as any disturbance of such balance can cause pathological conditions. A number of human diseases include the phenomenon of oxidative stress in their pathogenesis. During inflammation, pro-oxidants are secreted into tissues mainly by macrophages and granulocytes and play a central role in what is commonly defined as 'innate immunity'. However, at the same time, prooxidant forms in the inflamed tissue can reveal various harmful effects, the intensity of which coincides with the emergence of pathological effects of inflammation. In chronic renal failure, elevated levels of reactive oxygen species occur as a result of neutrophil activation, which occurs during dialysis operations as a result of contact with poorly biocompatible substances and is associated with pathological processes such as amyloidosis and accelerated atherosclerosis. In the case of diabetes, oxidative processes can play a role both in the origin and progression of the disease, as well as in the emergence of complications, among which atherosclerosis takes the first place. Glucose, in fact, can directly interact with amino acids, peptides and proteins, contributing to the formation of carbonyls in these structures ("protein glycation", Maillard reactions). Such modified molecules (called "highly glycated end-products") can readily form aggregates, and this phenomenon is believed to be involved (in addition to diabetic complications) in the universal aging process in both diabetics and healthy individuals. Moreover. oxidative stress is the important mechanism responsible for the so-called ischemia-reperfusion injury, that is, the changes that occur in organs and tissues when oxygen supply is restored after a period of ischemia. Oxidative stress is an important factor in many severe and common human pathologies. In these diseases, the active forms of oxygen and nitrogen are responsible for the formation of structural and functional changes in biological macromolecules, which ultimately leads to damage to cells, tissues and organs. Above all, from a diagnostic perspective, such changes can be used as useful biomarkers to identify disease processes in patients

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