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Biocompatibility of implantable materials: an oxidative stress viewpoint

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Abstract:

Oxidative stress occurs when the production of oxidants surpasses the antioxidant capacity in living cells. Oxidative stress is implicated in a number of pathological conditions such as cardiovascular and neurodegenerative diseases but it also has crucial roles in the regulation of cellular activities. Over the last few decades, many studies have identified significant connections between oxidative stress, inflammation and healing. In particular, increasing evidence indicates that the production of oxidants and the cellular response to oxidative stress are intricately connected to the fate of implanted biomaterials. This review article provides an overview of the major mechanisms underlying the link between oxidative stress and the biocompatibility of biomaterials. ROS, RNS and lipid peroxidation products act as chemo-attractants, signalling molecules and agents of degradation during the inflammation and healing phases. As chemo-attractants and signalling molecules, they contribute to the recruitment and activation of inflammatory and healing cells, which in turn produce more oxidants. As agents of degradation, they contribute to the maturation of the extracellular matrix at the healing site and to the degradation of the implanted material. Oxidative stress is itself influenced by the material properties, such as by their composition, their surface properties and their degradation products. Because both cells and materials produce and react with oxidants, oxidative stress may be the most direct route mediating the communication between cells and materials. Improved understanding of the oxidative stress mechanisms following biomaterial implantation may therefore help the development of new biomaterials with enhanced biocompatibility.

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