Short Communication

Stem Cell Research and Regenerative Medicine

Preventing Complications is a Crucial First Step in the use of Embryonic Cells in Regenerative Medicine

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Abstract

When the body's antioxidant defence mechanism cannot keep up with the generation of reactive oxygen species (ROS), oxidative stress (OS) results. OS has a significant impact on cellular health and performance. On cells that go through a predetermined and time-regulated phase of proliferation or differentiation, such as perinatal stem cells, ROS can have a profoundly detrimental effect. Because these immunotolerant stem cells are used so extensively in regenerative medicine, it's critical to lower OS to keep them from losing function and expand the field's use of them. The use of antioxidants and other substances that can indirectly influence the antioxidant defence system by boosting cellular stress response pathways is one method for achieving this goal. Lowering ROS levels via enhancing autophagy and mitochondrial activity. The purpose of this review is to compile information on OS processes in perinatal stem cells and potential mitigation tactics.

Keywords: Cell senescence • Antioxidants • Mesenchymal stem cells • Perinatal cells • Regenerative medicine

Introduction

Reactive oxygen species (ROS) buildup in tissues above normal levels is a phenomenon known as oxidative stress (OS) [1]. Under certain physiological circumstances, this imbalance might be advantageous, but it could also be dangerous. ROS are vital for the immune system's defence against viruses and pathogens at the physiological level. A strong immunological response can result from the generation of ROS, which can also activate other immune cells and signalling pathways. Additionally, ROS play a crucial part as redox messengers [2]. Particularly, ROS control a variety of biological activities, such as cell signalling, protein modification, and gene expression. The oxidation and reduction of particular amino acid residues, the modulation of enzyme activity, and the effect on the cellular redox status can all be a part of ROS-mediated signalling [3]. As a result of excessive ROS generation brought on by outside factors such exposure to harmful substances, illness, radiation, pollution, and psychological stress, on the other hand, OS might develop. It is true that OS can harm a variety of cellular elements, such as cellular membranes, proteins, lipids, and nucleic acids. During typical cellular metabolic activity, ROS are created [4]. The critical role that OS plays in a number of clinical illnesses, including autoimmune and neurodegenerative diseases, viral and bacterial infections, as well as being largely responsible for cellular ageing, has attracted attention in recent years [5].

Regenerative medicine and perinatal cells

A vast range of potential treatments for many illnesses and conditions, including cancer, diabetes, neurological disorders, orthopaedic injuries, and cardiovascular disease, are available in the promising subject of regenerative medicine [6]. Stem cell replacement for damaged tissues is one of the fundamental tenets of regenerative medicine. This is because stem cells have the capacity to multiply and differentiate. However, there are drawbacks to using stem cells, including as the potential for tumour development, immunogenicity, and ethical dilemmas [7].

Amniotic epithelial cells (AEC) are understood to be particularly vulnerable to the effects of ROS exposure on perinatal cells; Menon and colleagues' investigations successfully characterised the effects of ROS-producing substances, such as water-soluble cigarette smoke extract (wsCSE), on AECs both during in vitro culture and in vivo [8,9]. In individuals with pPROM, they demonstrated histologic evidence of cellular senescence and described changes to the nucleus, mitochondria, and rough endoplasmic reticulum. In addition, Menon and colleagues found that amniotic epithelial cells cultured in the presence of wsCSE displayed activation of senescence-associated molecules like SK1, P-p38 mitogen-activated protein kinase (MAPK), and p19, which promoted an increase in DNA damage and the onset of typical senescent features, such as the release of SASP and Damage-Associated Molecular Pattern (DAMP) molecules and increased expression of Senescence [10].

Conclusion

Numerous physiological processes, including pregnancy, ageing, and the immunological response, depend on the OS balance and ROS regulation. Controlling ROS generation is crucial in cell therapy methods because stem cells, which make up the majority of this therapeutic application, are particularly susceptible to ROS imbalance, impairing their ability to function. The placental architecture and different perinatal cell populations are impacted by the imbalance in redox state brought on by malfunctioning regulatory mechanisms. Additionally, both in vivo and in vitro exposure of perinatal cells to ROS activates molecules linked to senescence, causes DNA damage, and kick-starts the senescence phenotype. To fully comprehend how OS affects perinatal cells at the molecular level, more research is required. However, perinatal cells could be protected from the start of the senescence-associated phenotype by taking antioxidant supplements, such as the popular NAC molecule. Research on how various culture media and certain additives affect prenatal cells may potentially result in the creation of novel culture conditions that more accurately replicate the in vivo environment when in vitro cultivating.

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