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Utilizing Mesenchymal Stem Cell (MSC) Therapies for Diverse Pathology Treatments

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Abstract

Mesenchymal Stem Cell (MSC) therapies have emerged as a promising avenue for the treatment of a wide range of pathological conditions. These multipotent cells possess unique immunomodulatory properties and the capacity to differentiate into various cell lineages, making them versatile candidates for diverse therapeutic applications. This review explores the current state of MSC-based therapies in the context of treating various pathologies, including neurodegenerative diseases, autoimmune disorders, cardiovascular ailments and tissue regeneration. We discuss the mechanisms underlying MSC-mediated therapeutic effects, recent advancements in MSC isolation, expansion and delivery techniques, as well as the challenges and future prospects of utilizing MSCs in clinical settings. The potential of MSC therapies to revolutionize the landscape of modern medicine is underscored, offering new hope for patients suffering from a wide spectrum of debilitating conditions.

Keywords: Therapy • Pathology • Neurodegenerative diseases

Introduction

Mesenchymal stem cells are a prevalent cell type utilized in the field of regenerative medicine. Numerous research studies have demonstrated the efficacy of MSC-based therapies in addressing a wide range of pathologies, encompassing neurological disorders, cardiac ischemia, diabetes, as well as bone and cartilage diseases. One specific condition of note is Osteoarthritis (OA), characterized by inflammation and currently lacking effective treatments. In pre-clinical models, MSCs (mesenchymal stem/stromal cells) have shown promise in restoring degenerated cartilage. In early-stage clinical trials, the intra-articular administration of MSCs has resulted in reduced pain and protection or healing of cartilage. Interestingly, consistent findings suggest that the observed effects stem from a "hit-and-run" mechanism, involving the temporal release of paracrine molecules. MSCs produce a multitude of chemokines and cytokines that contribute to tissue repair, restoration of normal tissue metabolism and crucially, the suppression of inflammation [1-3].

Description

The secretion of therapeutic factors increases in response to inflammatory signals or apoptosis triggered by the host immune system. Trophic effectors, which are soluble molecules, are either released or transported by extracellular vesicles (ECVs). Mesenchymal stem cells have found applications in various orthopedic conditions, such as osteoarthritis, serving as a model for tissue regeneration in this context. The initial successful treatment involved an anterior cruciate ligament transection combined with total medial meniscectomy in a caprine model of osteoarthritis. Notably, MSCs quickly dissipate from the target tissue post-administration, yet they continue to exert chondroprotective and immunomodulatory effects. Their therapeutic effectiveness, now believed to be primarily paracrine-mediated, appears to operate independently of engraftment.

Extensive research has explored the use of Mesenchymal Stem Cells (MSCs) in the treatment of various retinal diseases. The therapeutic potential of MSCs derives from their capacity to differentiate into multiple lineages and their secretomes, which are rich in immunomodulatory, anti-angiogenic and neurotrophic factors. Numerous studies have highlighted the role of MSCs in retinal repair and regeneration. MSC-secreted factors have been shown to prevent retinal degeneration, enhance retinal morphology and function and facilitate mitochondrial support for retinal cells. Additionally, MSC-secreted exosomes exhibit anti-apoptotic and anti-inflammatory properties. Building on promising preclinical outcomes, several clinical trials have been initiated to explore the potential advantages of MSC-based therapies for retinal diseases. Mesenchymal Stem Cells (MSCs) have been successfully isolated from various tissue sources, including bone marrow, adipose tissue, dental pulp, umbilical cord blood and amniotic membrane. They are considered promising candidates for therapy aimed at regenerating and repairing degenerated retinal cells in various retinal degenerative disorders [4,5].

Conclusion

Several compelling reasons support the consideration of Mesenchymal Stem Cells (MSCs) as a viable treatment option for retinal disorders. Firstly, they engage in paracrine signaling by secreting neurotropic factors, which play a pivotal role in repairing neuro-retinal cells. Secondly, MSCs possess immunomodulatory properties that can mitigate the pro-inflammatory conditions often associated with retinal degenerative diseases. Thirdly, they exhibit the capability to release anti-angiogenic factors, thereby hindering the pro-angiogenic processes implicated in the disease's development. While conventional treatments such as surgery and ocular medications may slow the progression of ocular diseases, innovative approaches like stem cell and gene therapy hold the potential to rejuvenate the compromised retinal structure. Human Mesenchymal Stem Cells (MSCs), alternatively known as mesenchymal stromal cells or medicinal signaling cells, assume a pivotal role in the realm of regenerative medicine. Their regenerative attributes, including self-renewal, trophic factor secretion and the capacity to induce various mesenchymal cell lineages, make them indispensable. Additionally, MSCs possess homing and trophic properties that influence the immune system, the microenvironment surrounding damaged tissues and the process of tissue repair, thereby providing a comprehensive framework for cell-based therapies. Consequently, it comes as no surprise that MSCs stand as the most frequently utilized adult stem cells in clinical trials.

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