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Review Article

Improving orthopedic use of stem cell engineering: A mini-review

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Abstract

Cell-based therapies for cartilage regeneration have gained popularity as a potential solution to the ongoing problem of articular cartilage repair in orthopedic surgery. There have been some successes with autologous chondrocyte implantation, but there are also some drawbacks. These include limited donor sites, donor site morbidity, dedifferentiation of isolated chondrocytes during monolayer expansion, and poor integration of repair tissue into the native cartilage. The potential of mesenchymal stem cells (MSCs) as a replacement cell source has so gained popularity. Self-renewing, highly expandable, and capable of developing into chondrocytes and osteoblasts, MSCs are very simple to separate. In this review, we focus on current developments in tissue engineering that use the so-called tissue engineering trio of mesenchymal stem cells, biomaterial scaffolds, and chondrogenic signals to generate effective cartilage tissue substitutes.

Keywords: stem cell, orthopedic, cartilage

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Introduction

MSCs have been discovered in several human tissues, including adipose tissue, synovium, and bone marrow. The stem cells of bone marrow (BMSCs) have been the subject of the greatest research. BMSCs have been found to exhibit markers for hypertrophic chondrogenesis, which mineralize in response to osteogenic stimuli, such as collagen type X and matrix metalloproteinase-13. The relative number of cells compared to BMSCs and the simplicity of the isolation process have made adipose-derived stem cells (ADSCs) an appealing option. (1)

The role of the environment

The identification of the ideal environmental conditions required for the development of effective cartilaginous grafts is one of the major problems in tissue engineering employing MSCs. It is possible to integrate biochemical and biomechanical stimuli in ways that work in concert to promote chondrogenesis, attain phenotypic stability, and produce grafts that closely resemble the intricate structure of native cartilage (2).

Scaffolds

Another essential component of the regeneration of cartilage tissue is the design and production of scaffolds. Recent research has concentrated on the construction of biomimetic scaffolds that reproduce the spatially variable mechanical characteristics and intricate three-dimensional zonal architecture of native cartilage, as opposed to classic tissue engineering, which has focused on employing natural and synthetic biomaterials. The work of Nguyen and colleagues who layered particular mixtures of synthetic and natural biopolymers to generate distinct niches in a polyethylene glycol-based hydrogel is one recent example of such a technique (3,4).

Using internal stem cells to improve cartilage repair

The idea of utilizing acellular constructions that give biological cues to regulate endogenous stem cells is a new strategy that is gaining a lot of attention in the area. In order to regenerate the whole surface of a rabbit's proximal humeral head, Lee et al. (5) employed an acellular bioscaffold made of composite polycaprolactone and hydroxyapatite that was fed with TGF-3. Other research has targeted the chondrogenic and osteogenic differentiation of endogenous stem cells in a spatially distinct manner using bio instructive scaffolds that contain TGF-1 in the top layer and BMP-4 in the bottom layer (6).

Conclusion

Orthopedic surgery still faces substantial challenges with articular cartilage repair, which has raised interest in cell-based therapies for cartilage regeneration. Even though autologous chondrocyte implantation has been used with some degree of success, there are several drawbacks to this method, including donor site availability and morbidity, dedifferentiation of the isolated chondrocytes during monolayer expansion, and inadequate integration of repair tissue into the native cartilage. As a result, mesenchymal stem cells (MSCs) have become a more popular alternative cell source. Stem cell therapy may become more significant as these techniques advance in treating orthopedic illnesses.

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