ORIGINAL RESEARCH PAPER

Anatomy

REVIEW OF NEWER TECHNIQUES OF CARTILAGE REGENERATION AS AN ADJUNCT FOR NATURAL HEALING

KEY WORDS:

Dr Manisha Roy Tutor, Dept Of Anatomy Mahatma Gandhi Memorial Medical College And Hospital, Jamshedpur Jharkhand

Cartilage regenerative is an important issue. A set of diseases affect the cartilage and the repair and regeneration of cartilage is required to enable the tissue to heal. This enables the joint environment to be healthy without any/less symptoms. The cells of cartilage are proliferative as the age advances and this makes the condition challenging to identify the appropriate cells and stimulate them for regeneration of the cartilage. Articular cartilage has minimal endogenous ability to undergo repair. Multiple chondral restoration strategies[1]. This review consists of the different methods of cartilage regeneration available in the literature. There is use of cells, biomaterials in the cartilage regeneration.

Mesenchymal stem cells (MSCs) present an attractive treatment option for articular cartilage repair[2]. Human mesenchymal stromal cells are prone to form epiphyseal or hypertrophic cartilage and have an age-related limited proliferation. On the other hand, it is difficult to obtain functional chondrocytes from human embryonic stem cells[2]. The optimum MSC source, cell concentrations, implantation technique, growth factors need to evaluated and investigation for the optimum benefit[3].

Mobilization of the endogenous pool of stem cells will provide a less costly and less invasive method of cartilage regeneration especially when it is injured or damaged. Articular cartilage has a very limited capacity for repair after injury. The adult body has a pool of stem cells that are mobilized during injury or disease. These cells exist inside niches in bone marrow, muscle, adipose tissue, synovium, and other connective tissues. A method that mobilizes this endogenous pool of stem cells will provide a less costly and less invasive alternative if these cells successfully regenerate defective cartilage[4]. Growth factors induce recruitment, proliferation, and differentiation of endogenous progenitor cells, endogenous cell sources for regenerating cartilage. In this direction, an antichondrogenic regulator microRNA-221 (miR-221) was highly effective in promoting in vitro chondrogenesis of monolayered MSCs in the absence of the chondrogenic induction factor TGF-β[5].

Effect of fibronectin on cartilage regeneration through the activation of chondrogenic progenitor cells (CPCs) was studied. It was reported that fibronectin enhances CPC proliferation, migration, and chondrogenic differentiation through the integrin α5β1-dependent signalling pathway[6]. Cartilage repair was evaluated histologically, biochemically, and biomechanically which exhibited stem cell-relevant markers.

Animals commonly used in cartilage repair studies include murine, lapine, canine, caprine, porcine, and equine models. Small animal rodent and lapine models are cost effective, easy to house, and useful for pilot and proof-of-concept studies. Large animal models with thicker articular cartilage permit study of both partial thickness and full thickness chondral repair, as well as osteochondral repair. Joint size and cartilage thickness for canine, caprine, and mini-pig models remain significantly smaller than that of humans[7].

Cartilage defects are normally concomitant with posttraumatic inflammation and pose a major challenge in cartilage repair. Reducing the inflammation improves the regeneration.

Techniques for repairing focal articular cartilage defects are evolving from methods that induce a local stimulation of fibrocartilaginous repair to methods that will lead to a hyaline articular cartilage repair. Mosaicplasty and autologous chondrocyte implantation are used[8].

Hydrogels can exhibit similar mechanical, swelling, and lubricating behavior to articular cartilage, and promote the chondrogenic phenotype by encapsulated cells. Hydrogels have been prepared from naturally derived and synthetic polymers, as cell-free implants and as tissue engineering scaffolds, and with controlled degradation profiles and release of stimulatory growth factors. Using hydrogels, cartilage tissue has been engineered in vitro that has similar mechanical properties to native cartilage[9].

Autologous and allogeneic chondrocytes are the possible alternative as a source of stem cells in selected patients. Xenotransplantation is a possible solution due to it high cell availability, quality and genetic engineering capabilities[10].

Cartilage tissue engineering is an emerging technique for the regeneration of cartilage tissue damaged as a result of trauma or disease. As the propensity for healing and regenerative capabilities of articular cartilage are limited, its repair remains one of the most challenging issues of musculoskeletal medicine. tissue engineering research involving cells, stimulating factors and scaffolds, either alone or in combination. The role of stimulating factors, including growth factors, gene therapies, biophysical stimuli, and bioreactors, as well as scaffolds, including natural, synthetic, and nanostructured scaffolds, in cartilage tissue regeneration[11].

Sources of cells include including embryonic stem cells, mesenchymal stem cells, induced pluripotent stem cells, and cartilage progenitor cells, showed potential for applications in chondrogenic differentiation[12]. Stem cells can be developed as important cell sources for cartilage tissue engineering if appropriate microenvironments and bioactive factors are made available.

Approaches that employ combinations of ideal seed cells, biomaterials, and growth factors to repair defect areas because cartilage lacks spontaneous regenerative capabilities. Hydrogels are three-dimensional water-swollen networks that provide a unique microenvironment to promote the chondrogenic phenotype by encapsulating cells as a functional cartilage substitute in a defect area. hydrogels and their synergistic action with growth factors to co-regulate cell behaviors and cartilage regeneration[13].

Nanomaterials have special superiority in regulating stem cell behaviors due to their special mechanical and biological properties and biomimetic characteristics. Therefore, they have been given great attention in tissue regeneration. Nanomaterials are divided into organic and inorganic nanomaterials. They provide the microenvironment to support differentiation of stem cells. Nanomaterials inducing stem cells to differentiate into chondrocyte phenotypes would be a benefit for cartilage tissue regeneration, then promoting the development of cartilage tissue engineering[14].

Cell-laden hydrogels are the primary building blocks for bioprinting, and, also termed bioinks, are the foundations for creating structures that can potentially recapitulate the architecture of articular cartilage. To be functional, hydrogel constructs need to unlock the regenerative capacity of encapsulated cells. The recent identification of multipotent articular cartilage-resident chondroprogenitor cells (ACPCs), which share important traits with adult stem cells, represents a new opportunity for cartilage regeneration[15]. Harnessing the potential of these cells in 3D hydrogels can open new avenues for biomaterial-based regenerative therapies, especially with advanced biofabrication technologies (e.g. bioprinting).

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