The Evolution of Therapeutic Strategies for Osteoarthritis: From Pharmacotherapy to Cellular Technologies

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ABSTRACT INTRODUCTION:

Osteoarthritis (OA) is one of the most common musculoskeletal diseases, significantly reducing patients' quality of life and imposing a considerable socioeconomic burden. The evolution of OA treatment strategies reflects a shift from symptomatic management to pathogenetically based and regenerative interventions.

METHODS:

A literature review of clinical and preclinical studies from the past decade was conducted. Special attention was paid to randomized clinical trials (RCTs), systematic reviews, and meta-analyses that evaluated the efficacy of various therapeutic strategies, including NSAIDs, SYSADOAs, biological agents, and cellular therapies.

RESULTS SECTION:

Traditional pharmacological treatments such as NSAIDs and analgesics provide effective symptom relief but do not halt disease progression and have notable side effects with long-term use. SYSADOAs (glucosamine, chondroitin, hyaluronic acid) have shown modest benefits with controversial structural impact. Biological therapies targeting cytokines (TNF-α, IL-1) show limited efficacy in OA compared to RA. Surgical options like lavage and debridement offer short-term relief, while joint replacement remains the most effective but invasive method. Promising results have been demonstrated with intra-articular injections of MSCs and MSC-derived exosomes, which improve function, reduce pain, and modulate inflammation. Gene therapy and PRP are emerging modalities with supportive data, especially in early OA. Scaffold-based regenerative approaches are in the preclinical or early clinical phase [1].
Among traditional surgical options, procedures such as arthroscopic lavage and debridement are commonly used, but they provide only symptomatic relief and lack long-term effectiveness. In advanced OA, joint replacement remains the most effective method for pain relief and functional restoration, albeit with inherent risks and the limited lifespan of implants. Currently, regenerative technologies such as cell therapy are gaining increasing attention. A promising approach involves the use of mesenchymal stromal cells (MSCs), which possess immunomodulatory properties, stimulate cartilage regeneration, and reduce pro-inflammatory mediators. Clinical studies have demonstrated reductions in pain, slowed structural deterioration, and improved joint function following intra-articular injections of autologous or allogeneic MSCs [2].
Genetic engineering technologies also show significant promise, particularly for long-term OA control. Ongoing clinical trials are investigating viral vector-mediated delivery of genes encoding IL-1 antagonists or cartilage growth factors directly to the joint. Another innovative approach, platelet-rich plasma (PRP) therapy, enriched with growth factors, stimulates tissue regeneration and exhibits anti-inflammatory effects. Clinical trials report positive outcomes, especially in early-stage OA. The development of 3D cartilage tissue scaffolds derived from patient cells represents a cutting-edge technique that could radically transform future OA treatment paradigms [3].
A number of recent studies have focused on evaluating the efficacy of various sources of mesenchymal stem cells (bone marrow, adipose tissue, umbilical cord blood) and the methods of their administration. In the near future, large-scale randomized clinical trials with extended follow-up periods are planned, which will enable a more accurate assessment of the long-term safety and effectiveness of cellular and gene-based therapies for osteoarthritis treatment.

DISCUSSION:

The paradigm of OA treatment is transitioning from symptom relief to structural and biological repair. Cellular technologies, gene delivery systems, and bioengineered constructs are redefining therapeutic goals. While challenges such as regulatory hurdles, standardization, and cost remain, the trend toward personalized regenerative medicine in OA is gaining momentum.

SIGNIFICANCE / CLINICAL RELEVANCE:

Regenerative and cell-based strategies may address the root causes of OA, offering long-term symptom relief and functional recovery beyond what traditional treatments can provide.

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