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Perspective

Innovative Biomaterials and Medications Treating Musculoskeletal Diseases

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DESCRIPTION

Musculoskeletal diseases are challenging medical conditions that are becoming more common around the world, placing a heavy burden on patients, families, and our society's healthcare system. Given that many musculoskeletal disorders lack effective diagnostic or treatment methods, it is critical to investigate novel approaches to these diseases. In this issue, we have included documents on the most recent advances in innovative biomaterials, pharmaceutical molecules, and technologies for some of the most difficult musculoskeletal diseases, as well as animal models developed to investigate the underlying mechanisms of those approaches.

Although bone tissue has the ability to self-repair, effective bone repair is required because spontaneous bone repair can take months. Furthermore, in many cases, such as critical-sized bone defects, delayed bone union, tumours, and so on, additional efforts are often required, and biomaterials have been shown to effectively facilitate bone repair. Tissue-engineered periosteum has recently demonstrated significant osteogenic potential summarized the importance of periosteum for osteogenesis and chondrogenesis from the perspectives of periosteum tissue structure, osteogenesis performance, clinical application, development of periosteum tissue engineering, and the pros and cons of various tissue engineering methods. Titanium (Ti) and CoCrMo alloys have been widely used as prostheses in patients with massive bone defects or amputation.

These materials, however, can only provide mechanical support and cannot promote bone regeneration improved the prostheses by combining carbon fiber-reinforced polyetheretherketone (PEEK) with TiCu/TiCuN and discovered that it promoted bone repair *via* angiogenesis. Similarly, angiogenesis and bone apposition in the defect site were promoted by Silicon-substituted Calcium Phosphate (Si-CaP) ceramic combined Si-Cap with autogenous fine particulate bone powder in a rabbit model to alleviate spinal fusion with bone marrow-derived stem cells. Because magnesium (Mg) has good biodegradability, biocompatibility, and osteogenic stimulation ability, Mg implants improved angiogenesis to prevent the development of medication-related osteonecrosis of the jaw.

Mature articular cartilage cannot regenerate itself, unlike bone. Consequently, biomaterials are significantly more crucial in enhancing cartilage regeneration. However, mesenchymal stem cells or chondrocytes have just a little amount of cell affinity for collagen and hyaluronic acid, the primary elements of cartilage's Extra Cellular Matrix (ECM). A native cartilage ECM-imimicking scaffold containing polydopamine was created in response to mussel inspiration in order to promote cell adhesion and differentiation while also enhancing the immunological microenvironment. Instead of using gelatin to aid in cell adhesion and proliferation, directly embedding adipose-derived stem cells into alginate microspheres was one method used to solve this issue. Sulfonation treatment improved the biofunctionality and immunomodulatory capacity of PEEK scaffolds. Because mechanical strength is important for weight-bearing tissues and poor mechanical properties can lead to cartilage degeneration, the investigators adjusted the compressive modulus of sulfonated PEEK by fabricating a porous scaffold with 3D printing technology. Based on a similar rationale, 3D printing was used to create a stiff subchondral bony compartment that provides constant mechanical support for long-term cartilage regeneration. Similar approaches have been used to treat Inter Vertebral Discs (IVD) developed a hydrogel with injectability, high bio-safety, and nucleus pulposus-matched viscoelastic properties to prevent IVD degeneration. The meniscus is another load-bearing cartilaginous tissue in the knee synovial joint.

A mixed natural material composed of particulated juvenile allograft cartilage and synovium was transplanted to facilitate meniscus regeneration, resulting in superior structural integrity, superficial smoothness, and marginal integration. As synovium and synoviocytes play an important role in the knee joint, including nutrition supplementation and inflammatory response, the microenvironment of the repair site can be regulated locally in this manner. According to this, an osteoarthritis subtype was defined by synovial lipid metabolism disorder and fibroblast-like synoviocyte dysfunction. Advanced computational and robotic technologies, such as 3D printing, can help build customized devices for scientific research in addition to scaffolds. 3D printing was used to create a movable unloading device to aid in

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in the establishment of the disuse osteoporosis mouse model.

The robotic-assisted Total Knee Arthroplasty (TKA) system has been introduced into clinical practice, providing more accurate operations with less bone resection and soft tissue damage. The accuracy of a newly designed "Skywalker" robot for TKA in 31 patients in Shanghai, China was evaluated in a prospective randomized and multicenter study, both resulting in safe, effective, and better mechanical axis alignment compared to conventional TKA. Computational technology can also help clinicians diagnose diseases developed an automatic phantom-free quantitative computed tomography system that improved the accuracy and precision of measuring spinal bone mineral density and diagnosing osteoporosis.

Aside from biomaterials and high-tech devices, Chinese medicine is a vast field that is still under-explored, in part because the components of herbs usually have minor side effects. As a result, the effect and mechanistic study of Chinese medicine is one of the emerging directions in basic and translational research, with the Nobel Prize drug artemisinin as an example.

It was discovered that puerarin, a component isolated from the root of the Puerariae lobate Ohwi, was able to disrupt osteoclast activation *via* blocking the integrin-3 Pyk2/Src/Cbl signalling pathway, and that baicalein flavonoid.

The development of drugs and biomaterials has a number of bright prospects thanks to these chemical explorations. We anticipate that the information in this issue will be invaluable to researchers and clinicians in gaining insight into the difficulties that musculoskeletal diseases present as well as cutting-edge approach to study and manage these conditions.