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Editorial

Orthopaedic therapeutic advancement driven by innovations in biomaterial research and stem cell biology

For the injury and disease in the musculoskeletal system, the major treatment strategy currently used in clinics is surgical intervention with orthopaedic implants if to be indicated, including the prothesis for the joint replacement, fixators for fracture stabilization, biomaterial substitutes for bone and soft tissue reconstruction. In recent decades, with the deep understanding of the molecular and cellular mechanism underlying the bone and joint diseases, innovations are now shifting from replacement to minimal invasive surgery and musculoskeletal regeneration.

Several publications in this issue reported the intriguing results of new technologies and instruments developed and tested in clinical trials. Wang et al. analysed the clinical and radiological outcomes of tibial plateau fractures treated by minimally invasive surgery using a double reverse traction repositor. Their results indicated that the new instrument achieved better reduction rate, good functional recovery and less complications compared with those in the traditional open surgery [1]. In a prospective randomized controlled trial, Yang et al. found that the high-energy focused extracorporeal shock wave could prevent the occurrence of glucocorticoid-induced osteonecrosis of the femoral head [2]. Chen et al. verified the effectiveness of the tibial cortex transverse transport in the treatment of patients with recalcitrant diabetic foot ulcers in a multi-center cohort study. They found that the underlying mechanism was associated with the neovascularization and improved perfusion at the foot [3].

The development of new medical implants is largely driven by the innovations in the biomaterial research. Magnesium (Mg) and its alloy have attracted much attention due to its potential to be developed as degradable metal implants in orthopaedic surgery. In a review by Shan et al. various modification strategies and molecular mechanisms by which Mg ions regulate bone metabolism, as well as the challenges for the application of Mg-based implants were comprehensively summarized [4]. In a preclinical study, Yuan et al. developed a porous tantalum (pTa) filled cage composed of the polyetheretherketone and calcium silicate (PEEK/CS). In a goat model of cervical interbody fusion, it was demonstrated that the PEEK/CS/pTa cage showed comparable bony fusion to the PEEK/CS cages with autogenous bone grafts. The ion distribution of calcium and silicon released from cage in vivo has been determined and evaluated also. The results demonstrated the safety and translational potential of this graft-free bioactive cage [5]. Zhang et al. developed an injectable pH neutral bioactive bone cement, by mixing the phosphosilicate bioactive glass and α-calcium sulfate hemihydrate. Among different compositions (PSC/CSC: 10P/90C, 30P/70C, 50P/50C), 30P/70C was identified as the best formula, with suitable operability, appropriate physical compressive strength and good bone regeneration ability in vivo [6].

One major topic in this issue is the enhancement of fracture healing. Yang et al. reviewed the recent studies in the biomimicking design and application of artificial periosteum, especially focus on the material selection, biochemical and biophysical mimicry, providing a prospective view to promote bone healing [7]. Cao et al. introduced a new application of the 'old drug' puerarin. The local delivery of puerarin facilitates the repairing of critical-size defect in rats by promoting angiogenesis and osteogenesis [8]. Huang et al. compared the differential dynamics of bone autograft transplantation and stem cell therapy during bone defect healing in a murine model [9]. They found that both treatments induced recruitment of mesenchymal stem cells to the bone defect, but the macrophages and T cell populations are more diverse in the defect treated with the stem cells. These findings echoed with the conclusions of one systemic review in this issue. Chow et al. summarizes the studies to modulate the innate immune response to enhance fracture healing. They think that it is worth investigating to maintain a good population of M1 macrophages during the very early inflammatory stage for subsequent polarization to the M2 macrophages during the endochondral stage to achieve the desired outcome [10].

Although stem cell therapies have showed great promise in regenerative medicine, the cell dedifferentiation, immune rejection, and the cell fate in vivo are still the major concerns need to be improved. In this issue, Wu et al. summarized the exosome-based strategies for the treatment of osteoarthritis and intervertebral disc degeneration. They concluded that exosome-based therapy is superior to stem cell–based therapy in antisenescence and anti-inflammatory effects and possesses lower risks of tumorigenicity and immune rejection [11]. In another report led by Zhang et al. they found that the exosomes from hypoxia-stimulated bone marrow mesenchymal stem cells can promote tendon-bone healing in a rat model of anterior cruciate ligament reconstruction [12], which demonstrated that this cell-free approach is emerged as a new orthopaedic therapy.

In summary, the authors of this issue report innovations in biomaterials research and surgical inventions that advance our conventional surgical interventions for achieving better therapeutic effects through revolutions in the regenerative medicine, emerging with new findings in the stem cells biology.

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