The role of biomechanics and biology on regenerative medicine

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Lesions of knee cartilage have poor self-healing capacity and can lead to persistent symptoms and impaired joint function. Moreover, if left untreated, they can further degenerate and lead to osteoarthritis. Several surgical techniques have been developed to address these lesions, although there is no agreement about the best option. In this context, there is an increased awareness of the role of subchondral bone in the pathogenetic process of articular surface lesions and, therefore, on the possibility of restoring any damaged osteochondral tissue as a single anatomic and functional unit. Several studies showed poorer results and higher failure rates when chondral restoration was performed in the presence of subchondral bone changes, supporting the need for osteochondral solutions. Nowadays, osteochondral tissue represents a significant challenge in regenerative medicine, due to its complex architecture and biomechanical properties. Therefore, the development of osteochondral scaffold faced uphill challenges due to poor tissue formation and scarce integration at the cartilage-bone interface. Different options are available to address osteochondral defects, including osteochondral autograft transplantation, fresh osteochondral allograft, and autologous chondrocyte implantation (ACI) techniques with bone augmentation. However, all these approaches present some drawbacks: those involving the transfer of autologous tissue can have a certain degree of donor-site morbidity, which mainly limits their use to small defects. Osteochondral allograft is an effective option for larger size defects, but they have limited availability in most countries. ACI/matrix-associated autologous chondrocyte transplantation (MACT) techniques require a 2-step surgery, with related higher costs and morbidity. For these reasons, cell-free off-the-shelf devices have been introduced to restore osteochondral defects through a single surgical procedure. This treatment approach led to the development of a few different devices, with variable results. Among these, an osteochondral scaffold made of type I collagen and hydroxyapatite (Maioregen; Finceramica) has been extensively investigated at short- to medium-term follow-up. Several studies showed promising clinical results in different groups of patients, although abnormal findings were reported with imaging evaluation. 10-years follow-up shows that regenerative potential of cell-free osteochondral scaffold is limited, as demonstrated by the signal alterations persisting over time on MRI scans. On the other hand, the clinical improvement was significant and stable over time both in terms of subjective and objective outcomes, including activity level, with overall good results.