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Hydrogel Membrane Injected to the Regeneration of Bone Growth

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DESCRIPTION

Injectable hydrogels that can form *in situ* have been investigated, with the aim of developing minimally invasive surgical procedures. These 3D networks, composed of biocompatible polymers and reagents, are usually formed under mild conditions. In recent years, multicomponent hydrogels such as interpenetrating polymer networks, which are systems composed of two or more networks, have emerged as innovative biomaterials. The success of the IPN strategy is due to the synergistic combination of favorable properties of each of the polymer networks. Polysaccharides represent a particularly interesting class of macromolecules for IPN design as they are abundant and available from renewable sources. In addition, they exhibit a large variety of compositions and properties, and they are amenable to tailored chemical modifications to customize the biological/mechanical properties of the resulting hydrogels. Guided bone regeneration is an established clinical procedure in which a bone graft biomaterial is implanted into the wound cavity to trigger bone regeneration, and a membrane is then placed over the bone graft to prevent soft tissue invasion and to enhance the stability of the bone graft material. The membrane plays a key role in preventing unwanted soft tissue migration into the defect area, and it, therefore, provides sufficient time and space for invasion and proliferation of osteogenic cells. There is currently a wide range of commercially available membranes. Among these, high-density polytetrafluoroethylene membranes are widely used and are considered the "gold standard." Natural membranes are mostly represented by porcine or bovine collagen with products such as Bio-Gide EZ Cure or BioMend. These materials do not cause any inflammatory responses but exhibit strong load bearing capacities against the compressive force of the soft tissue overlying them and provide adequate space for tissue regeneration. The animals were carefully examined for inflammation, allergic reactions, or other complications around the surgical site throughout the entire healing period. Additionally, the clinical handling performed by doctors while applying membranes is crucial. Due to their simplicity of use, quick formation of a solid membrane after injection, and ability to fill complex defects, injectable formulations are particularly appealing in this regard. We previously reported silanization of hydroxypropyl methylcellulose by the addition of alkoxysilane groups, allowing formation of Si-HPMC hydrogels by silanol condensation. Numerous applications of this self-hardening hydrogel, including drug delivery for intervertebral discs, bone regeneration, and cartilage repair, have been thoroughly investigated. Additionally, in a canine periodontal defect, we have shown that this cross-linked polymer can function as a physical barrier against cell invasion. The synergistic effect obtained by the interpenetration of the two polymer networks improved the physicochemical properties, with the dense network ensuring a barrier effect against soft tissue invasion and delaying the hydrogel resorption. Most resorbable membranes used to date, made of polylactic acid or animal-derived collagen, are characterized by rapid resorption kinetics after implantation. Thus, once the membranes are degraded, they no longer support the underlying regenerating process. In order to improve their properties, commercially available membranes can also be made of cross-linked polymers. Indeed, the presence of physical or chemical crosslinking nodes delays the loss of their barrier properties. Commercially available cross-linked membranes can thus delay resorption. However, in the context of GBR, the main drawback of this self-curing hydrogel is its slow crosslinking process that hinders the rapid *in situ* formation of a membrane

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CONFLICT OF INTERESTS

The authors declare that they have no conflict of interest.

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