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SUBJECT: Composite of nanocellulose-based hydrogels in the regeneration of cartilage tissue

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DESCRIPTION:

Cartilage loss due to age-related degeneration and mechanical trauma is significant and challenging. It has been reported that 60% of patients examined by knee arthroscopy exhibit cartilage damage, and ~ 15% of people over 60 years old have some clinical symptoms of such damage. The damaged cartilage lacks adequate self-healing capability due to its lack of vascularization, innervation, lymphatic networks, and progenitor cells [1]. Cartilage damage is still a threat to human beings, yet no treatment is currently available to fully restore the function of cartilage [2]. Crosslinked HA hydrogel and HA/Gelatin/Chondroitin sulfate biomimetic hydrogel were fabricated for cartilage repair [3,4]. Additionally, research reported injectable hydrogels with HA and chitosan for cartilage tissue engineering [2]. Moreover, numerous preclinical studies have evaluated the effects of injectable and non-injectable hydrogels on cell repair after complexation with cells [2,5]. Based on thorough investigations, the low mechanical properties caused by the instability and possible reversibility of physical and some chemical crosslinking systems negatively affect their application [6]. Furthermore, some strategies, such as those employing a pH-sensitive chitosan hydrogel, are hardly compatible with cell encapsulation [6]. Besides, most recent research in cartilage tissue engineering focused either on the slow time of in situ gelation [3-7] or on unsuitable mechanical properties [1,3-5]. However, what is essential is adding a natural biopolymer needed for a positive effect. One of the essential purposes of tissue engineering is to improve the chemical interactions of the components to supply suitable mechanical properties to support intense physiological loading conditions and manipulation during transplantation [8].

This project aims to develop and analyze the influence of the addition of cellulose nanofibers with a 3D structure design for cartilage regeneration.
The research has started by forming the chemical structure of hydrogel and developing a combination of another electrospun layer modified with the gas bubble expansion method to provide a suitable scaffold with good long-term mechanical properties. The source material will be natural and synthesis polymers, for instance, hyaluronic acid, one of the cartilage's main components. We plan to load hydrogels with various nano/microparticles to enhance mechanical and biological properties. During the research, all needed structure, properties, biocompatibility, degradability, and in-vitro biological investigations will be performed.

According to the investigation, first, we ordered the polymers, solvents, stuff, and materials. Secondly, we should optimize the viscosity of the main materials. So, the viscosity of HA solutions was conducted by viscosity meter and the better solution was recognized based on the curves of zero viscosity. Then, the specific amount of EDC/NHS as crosslinking agents was added to the HA solution and analyzed. Apart from it, the hydrogel was synthesized and characterized before and after adding cellulose nanofibers.

The gelation degree and chemical and morphological properties of Gelma and HA electrospun nanofibers were analyzed for experimental characterization. Notably, crosslinking of HA / Gelma / cellulose nanofibers samples was studied. Until now, we have prepared and characterized the first step.

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