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Low-Cost GelMA/Graphene Hydrogel-Based Microneedles For Monitoring Osteochondral Diseases

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Osteonecrosis, which can arise from various etiologies, has sparked discussions regarding the complexity of its treatment, given its progressive nature and its impact on young individuals in their productive years [1]. Consequently, in response to the demands of modern medicine, the adoption of new technologies offers versatility in the possibility of developing novel devices that, when integrated with the human body, record essential information for medical treatment [2]. Consequently, Microneedles (MNs) emerge as a response to these pressing demands, offering their minimally invasive characteristic through the skin, rendering them suitable for disease treatment, monitoring, and drug administration [3]. In the presenty study, microneedles will be developed using cost-effective techniques based on GelMA/Graphene hydrogel at varying concentrations. The mold was obtained via conventional 3D printing using poly (lactic acid) (PLA), aiming for innovative and reproducible compendiums for further studies. Subsequently, the molds underwent plasma treatment via Dielectric Barrier Discharge (DBD) for surface modification, with the purpose of altering the hydrophobic nature of PLA, facilitating the demolding of the microneedles. Afterwards, the obtained MNs will be morphologically characterized using Scanning Electron Microscopy (SEM) and Optical Microscopy (OM), chemically analyzed using Fourier Transform Infrared Spectroscopy (FTIR), thermally evaluated through Exploratory Differential Scanning Calorimetry, mechanically tested via compression assays, and electrochemically assessed. It is expected that, in a promising and revolutionary manner, the MNs will exhibit significant potential to support and streamline treatments for osteonecrosis. [1] MIGLIORINI, Filippo et al. Prognostic factors in the management of osteonecrosis of the femoral head: a systematic review. The Surgeon, v. 21, n. 2, p. 85-98, 2023. [2] HUANG, Xinshuo et al. 3D-assembled microneedle ion sensor-based wearable system for the transdermal monitoring of physiological ion fluctuations. Microsystems & Nanoengineering, v. 9, n. 1, p. 25, 2023. [3] ZHANG, Lijing et al. Fabrication, evaluation and applications of dissolving microneedles. International Journal of Pharmaceutics, v. 604, p. 120749, 2021.