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FABRICATION AND EVALUATION OF POLYDOPAMINE (PDA) COATED HEXAGONAL BORON NITRIDE (hBN) MODIFIED POLYDIMETHYLSILOXANE (PDMS) 3D POROUS SCAFFOLD FOR IMPROVE OSSEOINTEGRATION

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ABSTRACT:

Purpose: Our goal is to enhance poor performance in supporting cell growth and proliferation in osseointegration. Herein, we fabricated a new scaffold material which was Polydimethylsiloxane (PDMS) based 3D structure, biocompatibility, cytocompatibility, and porous.

Materials and Methods: In this study, the scaffold was fabricated as polydopamine (PDA) coated hexagonal boron nitride (hBN) embedded in PDMS. First, 3D porous structure PDMS was prepared using two agents of PDMS with the salt scaffold method. In the second step, the scaffold was prepared with PDA coated hBN was embedded in PDMS. Nowadays, the application of PDA as a superior surface modifier in multifunctional biomaterials is drawing tremendous interests in bone tissue scaffolds to promote the osseointegration for bone regeneration. The hBN was used to increase the durability of PDMS. Because, it possesses preeminent physical and chemical properties such as high chemical stability, temperature-resistant, high thermal conductivity, low density, good mechanical strength, anti-oxidation ability, and biocompatibility. To perfectly the cells adhere to the surface, the hBN was coated with PDA. In the third step, the prepared scaffold was mineralized for the proliferation of cells.

Results: The prepared PDMS-based 3D scaffolds were characterized by Raman and Fourier transform infrared (FT-IR) spectroscopies. The structure of morphology was studied using the scanning electron microscope (SEM). The compression and tensile stress as mechanical properties of the scaffolds were evaluated for the PDMS, PDMS- hBN-PDA, and its mineralized form PDMS- hBN-PDA-Min. The results of the tensile strength scaffolds of PDMS-hBN-PDA-Dry and PDMS-hBN-PDA-Wet were calculated 588.4 kPa and 614.7 kPa, respectively. However, the tensile strength of 3D PDMS-Dry and PDMS-Wet were calculated 285.3 kPa and 423.2 kPa, respectively. The tensile strength value of PDMS-hBN-PDA-Dry was 53.6 % higher than that of 3D PDMS-Dry scaffold and also, elongation at break value of PDMS-hBN-PDA-Dry was 16.7 % higher than that of pristine PDMS-Dry scaffold. The contact angles were measured for the PDMS, PDMS- hBN-PDA, and PDMS- hBN-PDA-Min. scaffolds with deionized water droplets. The average contact angles (CAs) other mean surface wettability is a very important parameter for cell adhesion performance. The CAs were measured for the PDMS, PDMS-hBN-PDA, and its mineralized form PDMS- hBN-PDA-Min scaffolds with deionized water droplets. The CAs of the PDMS was measured $87.6^\circ \pm 1.15$ and after hBN-PDA was dispersed in PDMS its decreased around $72.1^\circ \pm 1.69$. This lower CA was related to PDA containing the hydrophilic groups such as catechol, amide, and imide groups. Furthermore, after the mineralization process, the CA was decrease than before and it was found around $71.3^\circ \pm 1.20$. This is because the catechol group of PDA was capturing some cations such as Ca^{2+} and K^+ . The literature shows that the CA of scaffolds is at around

65°–70° the appropriate values for the cell adhesion and proliferation. The thermal stability and degradation mechanism of scaffolds were investigated using Thermogravimetric analysis (TGA). According to the results, while embedding hBN in PDMS showed higher resistance to temperature than pristine PDMS, the mineralization process showed the same curve as PDMS.

Conclusion: In conclusion, PDMS is routinely used as a biomedical implant material and for fundamental cellular studies and has been confirmed as a biocompatible material. Moreover, the hBN used in the fabrication of scaffold is a novel nanostructure it has excellent properties such as high mechanical strengths, large surface area, and outstanding biocompatibilities. The application of PDA as a superior surface modifier in multifunctional biomaterials will be drawing tremendous interests in bone tissue scaffolds to promote the osteointegration for bone regeneration. Considering all these features and the results of characterization studies, we foresee that the prepared PDMS-hBN-PDA can be used as a perfect scaffold material in the future for cell adhesion and proliferation in osseointegration. Besides, a new 3D scaffold model based on PDMS was designed for bone tissue.

Key Words: Bone repairing materials, Polydimethylsiloxane, Hexagonal boron nitride nanoparticles, dopamine, Scaffold.