

Enhancing PEEK Implants for Orthopedic Applications through Surface Modification with BMP-2 and Az-Gel Coating

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Abstract

Polyetheretherketone (PEEK) is a promising biomedical material for orthopedic and dental applications due to its excellent mechanical properties, low immunogenicity, and X-ray transparency. However, it exhibits bio-inertness and limited osteoconduction. Surface modification of PEEK can effectively address this issue while preserving its favorable properties. The primary objective of this study is to create a bioactive surface on PEEK implants through surface modification. Subsequently, BMP-2 was immobilized onto the porous structure through an intermediate layer of photoreactive gelatin (Az-Gel) to produce a bioactive PEEK implant. Surface characteristics and in vitro cellular behavior are systematically assessed using scanning electron microscopy (SEM), static contact angle measurements, cell proliferation assays, alkaline phosphatase activities, and cellular morphology. Our study results indicated the following: (1) A surface porous structure with pores mostly distributed between 0.24 μm and 0.74 μm in size and 3.5 μm in thickness was created on PEEK implants by immersing them in concentrated sulfuric acid, as determined by SEM and Image J software analysis. (2) The hydrophobicity of the PEEK implants could be reduced by the surface porous structure, while Az-Gel coating

substantially enhanced the hydrophobicity of the samples. (3) In vitro cytological studies demonstrated that PEEK implants decorated with BMP-2 through Az-Gel coating promoted adhesion, spreading, proliferation, extracellular matrix secretion, and osteogenic differentiation of MC3T3-E1 cells. Surface modification of PEEK implants with BMP-2 through Az-Gel coating can enhance osseointegration and osteogenic differentiation, making it a promising material for orthopedic implants and medical devices.

Key words: Polyetheretherketone (PEEK), Surface modification, BMP-2, photoreactive gelatin (Az-Gel), Biocompatibility, Osteointegration.