Abstract

The aim of the thesis is genesis and fabrication of novel antimicrobial segmented polyurethane scaffold (SPU) for guided bone regeneration (GBR). The work describes the preparation, characterization, fabrication, application, and future prospective of antimicrobial SPU based nanofibrous scaffold for the potential GBR applications. The contribution and future prospects of the present thesis is also presented at the end. SPU scaffolds are fabricated from various biocompatible, biodegradable polyols composed of segments such as Poly carbonate diol (PCD), poly(ε-caprolactone) (PCL), poly(ethylene carbonate) (PEC), poly(dimethyl siloxane) (PDMS) and Chrysin (ChR). The two tailor-made polyols of random block copolymers such as PCL-*b*-PDMS and PCL-PEC-*b*-PDMS are synthesized by enzymatic ring opening polymerization. Subsequently, it was taken for the SPU synthesis via polycondensation reaction. The structure elucidation of the synthesized various polymers are confirmed by ^{1}H, ^{13}C NMR, analysis and GPC.

In order to import the antimicrobial characteristics of the scaffold along with the osteoconductivity, we have synthesized various structurally architecture hydroxyapatite (HA) nanorods and it were ornamented onto the various synthesized SPUs via *in-situ* polymerization technique. The scaffolds were fabricated using electrospinning technique from these synthesized SPU polymers and it's ornamented SPUs. The bulk morphology and crystal structure of the various HA nanorods are studied by HRTEM and WXRD, respectively. Surface morphology and wettability of the scaffolds are investigated by FESEM and contact angle meter, respectively. Sparingly, various HA nanorods ornamented SPU scaffolds exhibit tremendous improvement in the mechanical properties with excellent antimicrobial activity against various human pathogens. After confirmation of high osteoconductivity from biomineralization, improved biodegradation and excellent biocompatibility against osteoblast cells (*in-vitro*), the various SPU and its ornamented scaffolds were implanted in rabbits by subcutaneous and intraosseous (tibial) sites for the *in-vivo* studies. Various histological sections reveal the signatures of early cartilage formation, endochondral ossification, and rapid bone healing at around ~4 weeks of the critical defects filled with ornamented scaffold compared to SPU scaffold. It implies that osteogenic potential and ability to provide an adequate biomimetic microenvironment for mineralization for GBR of the scaffolds. Organ toxicity studies further confirm that no tissue architecture abnormalities observed in hepatic, cardiac and renal tissue sections. These significant finding manifests the feasibility of fabricating a mechanically adequate nanofibrous SPU scaffolds by a biomimetic strategy and the advantages of various HA nanorod ornamentation in promoting osteoblast phenotype progression with microbial protection for GBR applications.

Keywords: Nanohydroxyapatite; Segmented Polyurethane; Polyols; Polycarbonate Diol (PCD), Polycaprolactone (PCL); Polyethylene Carbonate (PEC); Polydimethyl Siloxane (PDMS); Electrospun Scaffold; Guided Bone Regeneration; Histology.