An important aspect of orthopedic implant integration is the enhancement of functional activity of osteoblasts at the tissue-implant interface without any fibrous tissue intervention. Nanostructured implant surfaces are known to enhance osteoblast activity. Objective of this thesis work is to develop simple and cost effective method for the fabrication of nanostructures on titanium implants showing good biocompatibility and compare the influence of different nanostructures on osteoblast response in vitro as well as in vivo. A set of nonperiodic structures ranging from mesoporous, nanoscaffolds, nanoflowers, nanoneedles, nanorods and octahedral bipyramids were fabricated by systematically tuning the hydrothermal conditions such as reaction medium composition, concentration, temperature and time duration. All nanomodified titanium surfaces were characterized by Scanning Electron Microscopy, Energy Dispersive Analysis, X-ray Diffraction, Transmission Electron Microscopy, High Resolution TEM and Electron Diffraction. Surface area analysis by dye adsorption test showed that all the nanosurface modified samples have an increased surface area in comparison to polished Ti surface. Adhesion strength analysis using microscratch test revealed good adhesion strength of nanoscaffold and nanoneedular structures. Further a detailed in vitro cellular response as well as in vivo osteointegration studies was carried out on selected nanostructures such as nanoscaffold (NS), nanoleaf (NL), Nanoneedles (NN) in comparison to electrochemically modified nanotube (NT) as well as control polished Ti (NP). Our studies showed that, a specific surface nanomorphology, viz., nanoleaves, which is a network of vertically aligned, non-periodic, leaf-like structures with thickness in the nanoscale, provided a distinct increase in osteoblast cell proliferation, alkaline phosphatase (ALP) activity and collagen synthesis, compared to several other types of nanomorphologies such as nanotubes, nanoscaffold and nanoneedles. Gene expression analysis of ALP, osteocalcin, collagen, decorin and Runx2 showed ~20-40 fold up-regulation on the leaf-like topography. Cytoskeletal arrangement studies on this substrate again revealed a unique response with favorable intracellular protein expressions of vinculin, FAK and src. In vivo osteointegration...
study over 12 weeks on rat model (Sprague Dawley) showed an early-stage bone formation (60% bone contact by 2nd week and ~ 85% by 8th week, p<0.01) in the leaf-like nanopattern, without any inflammation around the implant material.