Abstract

The titanium dental implants has been long established as a standard treatment alternative for the replacement of missing tooth. Surface modification of the dental implant is an active research area, since it has led to the improvement in the survival of dental implants over the last four decades. The role of micro-rough surfaces is well established clinically in the literature.

The main aim of the present research work was to generate an implant surface with superimposed nano-surface topography on micro-topography. Additionally, the surface should have the capacity to hold any drugs or bioactive molecules that can accelerate the healing process. Therefore, this thesis work mainly focused on the evolution of a biocompatible and mechanically stable nanotubular surfaces on the micron topography of dental implants and their drug loading method. The benchmark SLA surface equivalent to the marketed implants was fabricated on an indigenous dental implant system and a non-inferiority randomized, double-blinded clinical trial was conducted jointly at Maulana Azad Institute of Dental Sciences, Delhi (as this part of the research has originated from a CSIR NMITLI project RP2756 for the development of indigenous dental implants).

Mechanically stable and biocompatible nanotubes were fabricated using a novel two step anodization under ultrasonication methodology. Simvastatin drug loading was performed on the nanotubular dental implant surface using an ultrasonically assisted dip-coating method. The osseointegration evaluation of the developed nanotubular dental implants and drug-loaded nanotubular dental implants was done by histomorphometry, micro CT and reverse torque measurement in a New Zealand white rabbit model.

The in vitro study result showed early differentiation and mineralization activity of the cells
on drug loaded nanotubular surfaces compared to other surfaces. The \textit{in vivo} study result shows a significant increase in the BIC\% (Bone Implant Contact), BV\% (Bone Volume) and reverse torque removal values around the drug-loaded dental implants at 4 weeks of healing, suggesting faster and stronger osseointegration.

The outcome of this thesis brings out a next-generation dental implant with nanotubular morphology for enhanced and predictable osseointegration in a normal bone situation, whereas, the drug holding capacity can increase the horizon of any medical implant application in any complex bone situations for the medically compromised patients.