Development of Bioceramic Materials for Hip Joint Replacement

By

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One of the major causes of a total hip replacement revision is loosening of the acetabular component due to wearing out of particles from implant materials. The wear debris from the contact surfaces between the femoral head and the polyethylene liner migrates to the bone interface, causing infection and loosening. Various problems in the hip joint portion and prostheses developments have discussed in this study.

Several experimental studies have been conducted for evaluating mechanical, thermal, spectroscopic, and compositional characterizations of hip joint prosthesis materials.

In the present study, Hydroxyapatite, which is an important bioceramic material for hard tissue implantation is developed. In this thesis, synthesis of HAp and evaluation of its various characterizations have been reported. The HAp is obtained by usual solid state processing, which exhibits hexagonal crystal structure ($a_o \cong 9.3852 \pm 0.05$ Å and $c_o \cong 6.8211 \pm 0.05$ Å) having tendency to phase transition. The maximum compressive, tensile, bending strength has been found to be 271 MPa, 130 MPa, and 54 MPa respectively. The Vickers hardness value of this material is 5.37 GPa or 547.6 kgf/mm^2. Phase transformations were characterized by X-Ray Diffraction technique, Thermo-Gravitometric Analysis and Differential Thermal Analysis. Surface morphology, pore volume, and particle size were determined by Scanning Electron Microscopy, Brunauer-Emmett-Teller technique, and Particle Size Analysis. Chemical bonding present in the newly produced hydroxyapatite [$Ca_5(OH)(PO_4)_3$] material was confirmed by Fourier Transform Infrared Spectrometry.

The purpose of this study is to investigate the design of the current hip joint prostheses for discouraging the migration of the wear particles between the acetabular cup and femoral head and minimize the loosening of prosthesis. The main objective of this study is to develop a high strength porous bioceramic material to implant the hard tissue for artificial prosthesis.