INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Study on Ossification Around Macro-textured Implant Topographies

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SHORT ABSTRACT

Surface topography on implant surface at different length-scales are known to provide either mechanical stability or promote bone growth. Macro-textured surfaces are primarily provided to enhance mechanical stability to the implant. However, there is a scarcity of studies investigating the influence of macro-textured implant surfaces on bone-growth. Combining finite element analysis (FEA) and a mechanoregulatory tissue differentiation algorithm, a study has been performed to investigate the influence of three distinct macro-textured implant surfaces on bone growth. Results indicate that higher levels of bone-implant tangential micromotion inhibits formation of bone and promotes formation of fibrous tissue and cartilage. Furthermore, it was observed that textures containing filleted and chamfered edges reduce the formation of fibrous tissue. Thereafter the combined influence of sliding and gap distances on bone growth considering two macro-textured implant surfaces has been studied. In addition, the influence of texture density on bone growth was also analysed. Results show that higher values of both gap and sliding distances promote fibrous tissue formation. Nevertheless, the directional component of micromotion with lower magnitude plays the deciding role in formation of tissue phenotypes. Additionally, the study indicates that there is no linear relationship between the texture density and amount of tissue formed at the bone-implant interface gap. Further, Neural Network (NN) schemes have been formulated to establish predictive models of bone growth with given surface topographical dimensions. In a follow-up study, an integrated approach combining the FEA, NN and genetic algorithm (GA) was attempted to find optimally designed macro-textures to enhance the formation of bone growth. Finally, a comparative study to investigate the influence of textured and non-textured implant surface on bone growth has been studied on femoral implants under routine activities and fibrous tissue is observed to have formed while climbing stairs compared to that in normal walking. This study suggests that climbing stairs just after a hip replacement surgery is detrimental to the patient compared to normal walking. Furthermore, non-textured implants produce more fibrous tissue compared to textured implants under similar musculoskeletal loading conditions which might promote aseptic loosening of implant.