Comparative evaluation of implant designs influence of diameter, length and taper on stress and strain in the mandibular segment - A three dimensional Finite Element Analysis

Abstract

Introduction:

Success or failure of dental implants depends on the amount of stress transferred to the surrounding bone. Increased amount of loading to bone through implant cause failure, whereas decrease in amount of loading to bone causes improved success rate of implants. Biomechanical interaction between implant and bone decides the long term function or prognosis of dental implant system.

Aim and objectives:

To evaluate the influence of implant length and diameter on stress distribution. To understand the stress distribution around bone implant interface. To understand the response of bone, under axial and non-axial loading conditions.

Materials and methods:

Finite element 3D mandibular model was made using CBCT of patient with completely edentulous mandible and in that model five posterior bone segments were selected. Nobel Replace Select Tapered implant with diameter and length 3.5x10mm, 4.3x10mm, 3.5x11.5mm and 4.3x11.5mm respectively were selected and three dimensionally modelled using Creo 2.0 parametric Pro/E software. Bone and implant models were assembled as 20 models and finite element analysis was done using ANSYS workbench v17.0 under axial and non-axial loads.

Result: Under axial load and non-axial loads 3.5x10mm implant showed maximum von mises stress and strain in both cortical and cancellous bone whereas implant with diameter and length 4.3x11.5mm showed minimum von mises stress and strain in both cortical and cancellous bone.

Conclusion: In axial and non-axial loads amount of stress distribution around implant and bone interface is influenced by diameter and length of implant in cortical and cancellous bone respectively. Increased diameter of the implant produces the minimum stress in cortical bone. Increased length of the implant produces the minimum stress in cancellous bone.

Keywords: axial load, cancellous bone, cortical bone, finite element analysis, non-axial load and tapered implant.