Effect of diameter and length on stress distribution of the alveolar crest around immediate loading implants.

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Abstract

BACKGROUND:

Many clinical observations have shown that immediate loading is indicated when the stabilization of the bone/implant is optimal and when the estimated loads are not excessively high. Nonetheless, more experimental studies are needed to consider the immediate loading protocol as a safe procedure. Mechanical analysis using the finite element (FE) method analysis has been employed by many authors to understand the biomechanical behavior around dental implants.

PURPOSE:

This study was to evaluate the effect of the diameter and length on the stress and strain distribution of the crestal bone around implants under immediate loading.

MATERIALS AND METHODS:

By an ad hoc automatic mesh generator, high-quality FE models of complete range mandible was constructed from computer tomography, with three Straumann (Straumann Institute, Waldenburg, Switzerland) implants of various sizes embedded in the anterior zone. The implant diameter ranged from 3.3 to 4.8 mm, and length ranged from 6 to 14 mm, resulting in seven designs. The implant-bone interface was simulated by nonlinear frictional contact algorithm. For each design, vertical and oblique loadings of 150 N were applied, respectively, to each implant, and stresses and strains in the surrounding cortical bone were evaluated.

RESULTS:

The biomechanics analysis provided results that the oblique loading would induce significantly higher interfacial stresses and strains than the vertical loading, while the intergroup stress difference significant levels was evaluated using t-tests method and the level of significance (.05) that was accepted for significance. Under both loadings, the maximal values were recorded in the 3.3 (diameter) x 10 (length) mm implant configuration, whose mean and peak values were both higher than that of others with significant statistical differences. The second maximal one is 4.1 x 6 mm configuration, and the minimal stresses were recorded in 4.8 x 10 mm configuration, whose strains were also near to lowest.

CONCLUSIONS:

Increasing the diameter and length of the implant decreased the stress and strain on the alveolar crest, and the stress and strain values notably increased under buccolingual loading as compared with vertical loading, but diameter had a more significant effect than length to relieve the crestal stress and strain concentration.