Evaluation of the structural behavior of three and four implant-supported fixed prosthetic restorations by finite element analysis

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Abstract

Purpose
There is much controversy about the minimum number of implants and maximum cantilever length in mandible prosthetic restoration. Finite elements analysis of three and four implant-supported prostheses was performed to determine the stresses in the superstructure, implants and cortical bone and, therefore, the failure prediction for each restoration.

Methods
An edentulous mandible was modeled from CT scan images. Two finite element models of three and four implant-supported prostheses with cantilever lengths of 10 and 15 mm were created. Occlusal loads in different parts of the superstructure were applied and shear and normal stresses were calculated.

Results
Two failure criteria were analyzed: the von Mises criterion for isotropic materials (superstructure and implants) and the Tsai-Wu criterion for transversely isotropic material (cortical bone). Both criteria predict failure in the three implant-supported prosthesis for all cases analyzed. The same applies for the four-implant prosthesis of 15 mm cantilever length. However, four implants and a cantilever length of 10 mm passed the failure criteria and were considered safe.

Conclusions
The results from the patient analyzed showed that fixed support prostheses on three implants are not recommended from a structural point of view because they do not adequately support occlusal loads. Excessive stress in the superstructure and the cortical bone can be expected, which would anticipate the failure of the restoration. Fixed support prostheses on four implants with a cantilever length of 10 mm properly resist occlusal loading.

Keywords
Finite element analysis; Dental implant; Implant-supported fixed prosthetic restoration; Stress distribution; Failure criteria

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