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Pontifícia Universidade Católica do Rio Grande do Sul
Faculdade de Odontologia

Stresses in implant-supported overdentures with bone resorption

R.S. SHINKAI[1], L.O.H. MARIANO[1], E.A. SARTORI[1], J.R. BROILO[1], L. CORSO[2], and R.J. MARCZUK[3]

[1]Pontifical Catholic University of Rio Grande do Sul, Porto Alegre, RS, Brazil, [2]University of Caxias do Sul, Caxias do Sul, RS, Brazil, [3]Federal University of Rio Grande do Sul, Porto Alegre, RS, Brazil. E-mail: rshinkai@pucrs.br

The biomechanical behavior of implant-supported overdentures under masticatory load may change with periimplant marginal bone loss or ridge resorption. A periimplant bone loss of about 1 mm in the first year and 0.1 mm annually has been reported as normal (Jung et al., 1996; Kitamura et al., 2005).

Objective

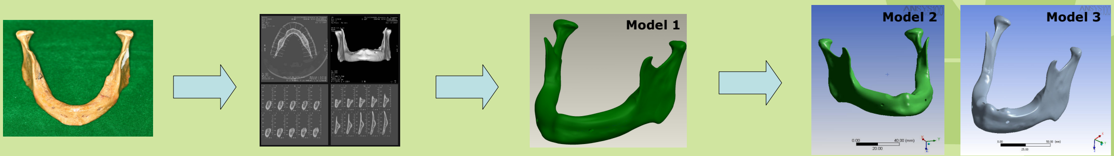
This 3D-finite elements method study evaluated the effect of bone levels on the stress distribution in overdentures with periimplant marginal bone loss and resorption of the distal ridge.

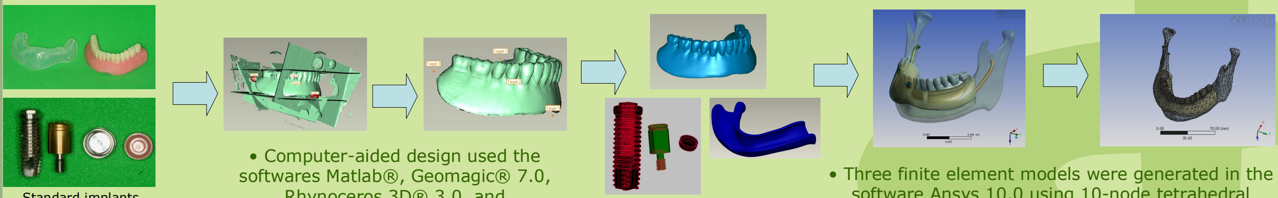
Materials and Methods

Tridimensional models were built from the digitized images of a computerized tomography of a mandible (70 1mm-thick slices) and 3D laser digitalization of implants, abutments, mucosa, and complete denture.

The geometric models of implants and abutments were mounted at the canine region to build the reference **model 1** with absence of bone resorption or bone loss.

To build the test models the mandible geometric solid was modified to simulate 2-mm vertical bone loss surrounding the implants (**model 2**) and model 2 + resorption of the distal ridge (**model 3**).

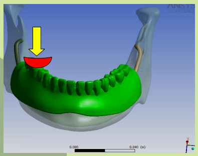




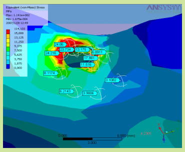
Standard implants (4.1 X 11.5 mm, external hex) and Locator attachment (3i Implant Innovations)

• Computer-aided design used the softwares Matlab®, Geomagic® 7.0, Rhynoceros 3D® 3.0, and SolidWorks®

• Three finite element models were generated in the software Ansys 10.0 using 10-node tetrahedral structural solid p-elements. The materials were considered homogeneous, isotropic, and linearly elastic. A perfect contact between bone and implants (100% osseointegration) was assumed. Boundary conditions included constraining 3 degrees of freedom at each of the nodes located at the mandibular condyles.



The models were loaded with a 100 N-axial vertical load applied on the right first molar, using a masticatory bolus simulation modeled as a rigid semi-sphere placed over the denture tooth (Daas et al., 2007).



The von Mises stresses were qualitatively analyzed in selected areas:

•Periimplant bone (internal /external views)

•Implants & prosthetic components

Table 1. Mechanical elastic properties of bone and materials used in the anisotropic models (Daas et al., 2007).

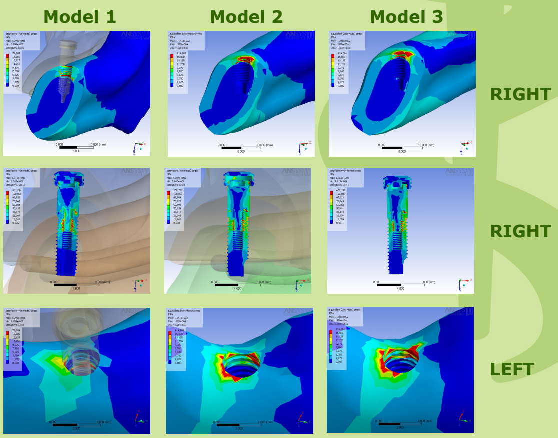
	Young's modulus (MPa)	Poisson's ratio
Cortical bone	13,700	0.3
Cancellous bone	1,370	0.3
Mucosa	1	0.37
Mandibular nerve	0.1	0.3
Overdenture (acrylic resin)	4,500	0.35
Implant (titanium)	135,000	0.3
Screw (titanium)	114,000	0.3
Attachment (titanium)	114,000	0.3
PTPE attachment component	19,000	0.3

Results

The highest stress concentration at marginal bone and implants occurred on the same side of the vertical load application for all models (right side).

The Von Mises stresses increased on the periimplant marginal bone and in the prosthetic components in the model with 2-mm vertical bone loss (model 2).

The combination of 2-mm vertical bone loss and resorption of the distal ridge (model 3) did not increase the stresses compared with the model with only periimplant marginal bone loss (model 2).



Model 1 – no bone loss

Model 2 – 2-mm periimplant bone loss

Model 3 – periimplant bone loss + distal ridge resorption

Conclusion

The results suggest that the periimplant marginal bone loss increases stress concentration in dental implants, abutments, and marginal bone independently from the bone resorption of the distal ridge.

Acknowledgments

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