Clinical Oral Investigations, vol.29, no.4, pp.214-1-214-12, April, 2025.

Structural response of mandibular first molars in the presence of proximal contacts: finite element analysis with antagonist teeth and alternative loading applications

A. Arias Paniagua; J.R. Jiménez Octavio; O.A. Peters; P. Riaza Solís; S. Dorado Nuño

Abstract-

Objectives

To compare the mechanical responses of a mandibular molar under functional loads using antagonist teeth and different loading applications and configurations.

Methods

A cone-beam computed tomography of a human mandible and maxilla was used to build 16 different three-dimensional models, including four mandibular configurations [single-tooth model (first mandibular molar-M), and inclusion of mesial (mM), distal (Md) or both proximal contacts (mMd)] and occlusal load applications either with antagonist teeth or alternative Finite Element (FE) models [point load (PL), distributed surface load (SL) and rigid metal sphere (MS)]. FE analysis was performed. Equivalent von Mises (VM) stress was calculated along the entire dentin and periodontal ligament of the first mandibular molar. Maximum VM stresses were compared among the different mandibular configurations and loading applications.

Results

The highest and lowest VM stress at 50 and 100 N corresponded respectively to the single-tooth SL model (5.78 and 11.5 MPa) and to occlusal load application with antagonist teeth and proximal contacts (2.08 and 3.58 MPa). Maximum VM stresses were consistently located at the cervical area of the mesial root and decreased when adjacent teeth were present.

Conclusions

Highest stresses are located in the cervical area of the mesial root of mandibular molars, but the biomechanical behavior depends on the presence of proximal contacts and the loading methodologies used. Single-tooth models represent the worst structural scenario.

Clinical relevance

Incorporating antagonist teeth and proximal contacts into FE models enhances the biofidelity of dental biomechanics simulations, enabling more accurate extrapolation to clinical conditions.

Index Terms- Biomechanics · Dental tissue · Finite element analysis · Functional load · Stress distribution

Citation:
Arias, A.; Dorado, S.; Jiménez-Octavio, J.R.; Peters, O.A.; Riaza, P. "Structural response of mandibular first molars in the presence of proximal contacts: finite element analysis with antagonist teeth and alternative loading applications", Clinical Oral Investigations, vol.29, no.4, pp.214-1-214-12, April, 2025.