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BIOMECHANICAL ANALYSIS OF TOOTH MOVEMENTS IN CASE OF BONE LOSS AND ANTERIOR CROWDING IN THE LOWER JAW USING FINITE ELEMENT METHODS

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Summary: Objective: In order to eliminate plaque niches remaining after periodontal treatment of affected teeth and prevent a recurrence of the periodontal infection, pronounced anterior crowding is treated orthodontically. The treatment indication results from functional and aesthetic aspects. The aim of this study was to examine the biomechanical behaviour of the mandibular incisors in the presence of bone loss and crowding using numerical models.

Methods: The developed finite element (FE) model is based on an idealised geometry, in which an anterior crowding of about 4 mm and a bone loss of 4 to 5 mm were generated and discretised with degenerated tetrahedral elements. Also, treatment elements adapted to the situation were modelled with forces of 0.2 N per incisor to level the crowding. The material parameters for bone and teeth (homogeneous, isotropic, E = 2 GPa and E = 20 GPa) and healthy periodontal ligament (PDL) were integrated into the FE models from previous investigations. Pure couples of forces were applied to determine the location of the centres of resistance (CR). The results were compared with those of a model with reduced attachment but unchanged PDL and, on the other hand, with a morphologically healthy patient.

Results and Discussion: The initial tooth mobility is significantly increased by the reduced attachment. The anterior teeth with periodontal defects show higher strains (up to 50%) of the PDL, especially in the apical region. Although the teeth from first premolar to second molar were combined to form an anchorage unit, mesialising, rotating and tipping movements occurred. It is of particular importance to control the force levels to prevent further damage of the PDL and root resorption.

Conclusion: Clinically this treatment is easy to accomplish. The numerical simulation however has to be decomposed into several subsequent individual load cases, thus complicating the calculations. In case of periodontitis, significant reductions in orthodontic forces per tooth are recommended. Presumably due to the initial high deflections in such a reduced PDL, pain, further attachment loss and root resorption occur.