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Effects of Mechanics for Uprighting Partially-Impacted Mandibular Second Molars using Miniscrew Anchorage: A Finite Element Analysis

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Abstract

Objectives: The purposes of this study were: (1) to evaluate the optimal force magnitude that can be applied to the initial uprighting of partially-impacted mandibular second molar (tooth 37) without exceeding the hydrostatic pressure of the periodontal ligament (PDL) capillary vessels' blood pressure, which is 0.0047 megapascal (MPa) and distribution pattern of hydrostatic pressure on PDL 37; and (2) to describe initial tooth displacement of the impacted tooth 37, mandibular first molar (tooth 36) and mandibular second premolar (tooth 35) using the finite element method.

Materials and methods: A three-dimensional (3D) finite element model was developed from CBCT images. Various pushing forces, 35 to 150 g were applied to evaluate the optimal force magnitude. A force direction was laid from an interradicular miniscrew head, which was placed in the cortical bone between the root 35 and root 36, to a buccal minitube on the impacted tooth 37. The optimal force magnitude was used to simulate the initial tooth displacement of impacted tooth 37, tooth 36, and tooth 35.

Results: The optimal force magnitude, when a single-pushing-uprighting force applied, was 80 g. The compressive hydrostatic pressure on PDL 37 appeared on the disto-lingual region close to the cemento-enamel junction (CEJ); and the tension on PDL 37 appeared on the mesio-buccal side of the mesial root and on the mesio-buccal side of the distal root close to the furcation. The initial displacement pattern of the impacted tooth 37 was lingual crown tipping, distal crown tipping, distal root tipping, and disto-lingual rotation of the crown. It was found that the teeth 36 and 35 were also displaced, though force was not directly applied to them. Teeth 36 and 35 showed lingual crown tipping, extrusion, and distal crown tipping.

Conclusions: This finite element analysis was revealed that the force magnitude that can be applied to initial uprighting the mandibular second molar for this study was 80 g. The initial displacement pattern of the mandibular second molar, as descending order, was lingual crown tipping, distal crown tipping, distal root tipping and disto-lingual rotation of the crown. It was also revealed that the adjacent teeth were displaced, even though uprighting force was not directly applied to them.

Keywords: finite element method, impacted mandibular second molar, miniscrew anchorage, uprighting