Influence of Apical Root Resection on the Biomechanical Response of a Single-rooted Tooth—Part 2: Apical Root Resection Combined with Periodontal Bone Loss

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Abstract

Introduction: In a clinical situation, an apically resected tooth is often accompanied by a varying degree of periodontal bone loss. The purpose of this study was to assess the influence of apical root resection combined with periodontal bone loss on the biomechanical response of a single-rooted tooth. **Methods:** A basic intact model and a basic apically resected model of the upper central incisor were selected for the numerical analysis. From each basic model, 6 models were developed assuming different amounts of periodontal bone loss (0, 0.5, 1, 1.5, 2, and 3 mm). Maximum von Mises stress (σ max), maximum tooth displacement (ΔR max), and effective crown-to-root ratio (α) were calculated for each condition. **Results:** There were only marginal differences (a 2.1% difference in σ max and a 16.9% difference in ΔR max) between the biomechanical responses of the intact model and the apically resected model when the tooth was supported by a normal periodontium. However, when destruction of the periodontium was assumed, the intact model and the apically resected model responded differently. The difference increased as the periodontal bone loss progressed, resulting in a 68.7% difference in σ max and a 56.3% difference in ΔR max when the periodontal bone loss increased to 3 mm (α = 0.48). **Conclusions:** Although the biomechanical response of an apically resected tooth was relatively stable when the tooth was supported by a normal periodontium, the apically resected tooth showed a more deteriorated response compared with the intact tooth as the periodontal bone loss progressed. *(J Endod 2015;41:412–416)*

Key Words

Alveolar bone loss, apicoectomy, biomechanics, crown-to-root ratio, endodontic microsurgery, finite element analysis

Up until now, the success of endodontic microsurgery has been characterized by biologic recovery, mainly based on healing of the periapical lesion (1–12). However, it should be noted that an apically resected tooth would be exposed to continuous occlusal loading even after complete biologic recovery. Therefore, to ensure good long-term prognosis of an apically resected tooth, it is important to provide favorable biomechanical conditions (13). In this context, several attempts have been made to assess the influence of biomechanical factors associated with an apically resected tooth (14, 15), and recently, Jang et al (16) suggested that 3 mm of apical root resection does not induce a significant change in the biomechanical parameters when the tooth is supported by a normal periodontium.

However, in a clinical situation, teeth often undergo not only apical root resection but also experience varying extents of periodontal bone loss at the same time. For example, an apically resected tooth could be affected by periodontal disease that accompanies surrounding alveolar bone loss, or a tooth already affected by periodontal disease could undergo endodontic surgery including apical root resection (2, 4–6). Therefore, there is a need to simulate both apical root resection and periodontal bone destruction in the same model to provide a better prediction about the prognosis of an apically resected tooth from a biomechanical standpoint.

The purpose of this study was to evaluate the influence of apical root resection on the biomechanical response of a single-rooted tooth under varying degrees of periodontal bone loss, by comparing an intact tooth and an apically resected tooth using 3-dimensional finite element analysis (FEA). The null hypothesis for this study was that an apically resected tooth and an intact tooth show the same degree of biomechanical changes with the same amount of periodontal bone loss.

Materials and Methods

Development of Geometric Models

Two 3-dimensional geometric models of an upper incisor reconstructed in the preceding study (16) were selected as the basic models in this study for the continuity of data analysis. From these models, a total of 12 different models with varying degrees of periodontal bone loss were developed.

Model Group 1 (Intact Models)

For developing the models in this group, the "intact model" from the preceding study (16) was used as the basic intact model (Fig. 1). The total length of the model was 21 mm, which included 12 mm of the anatomic root and 9 mm of the anatomic

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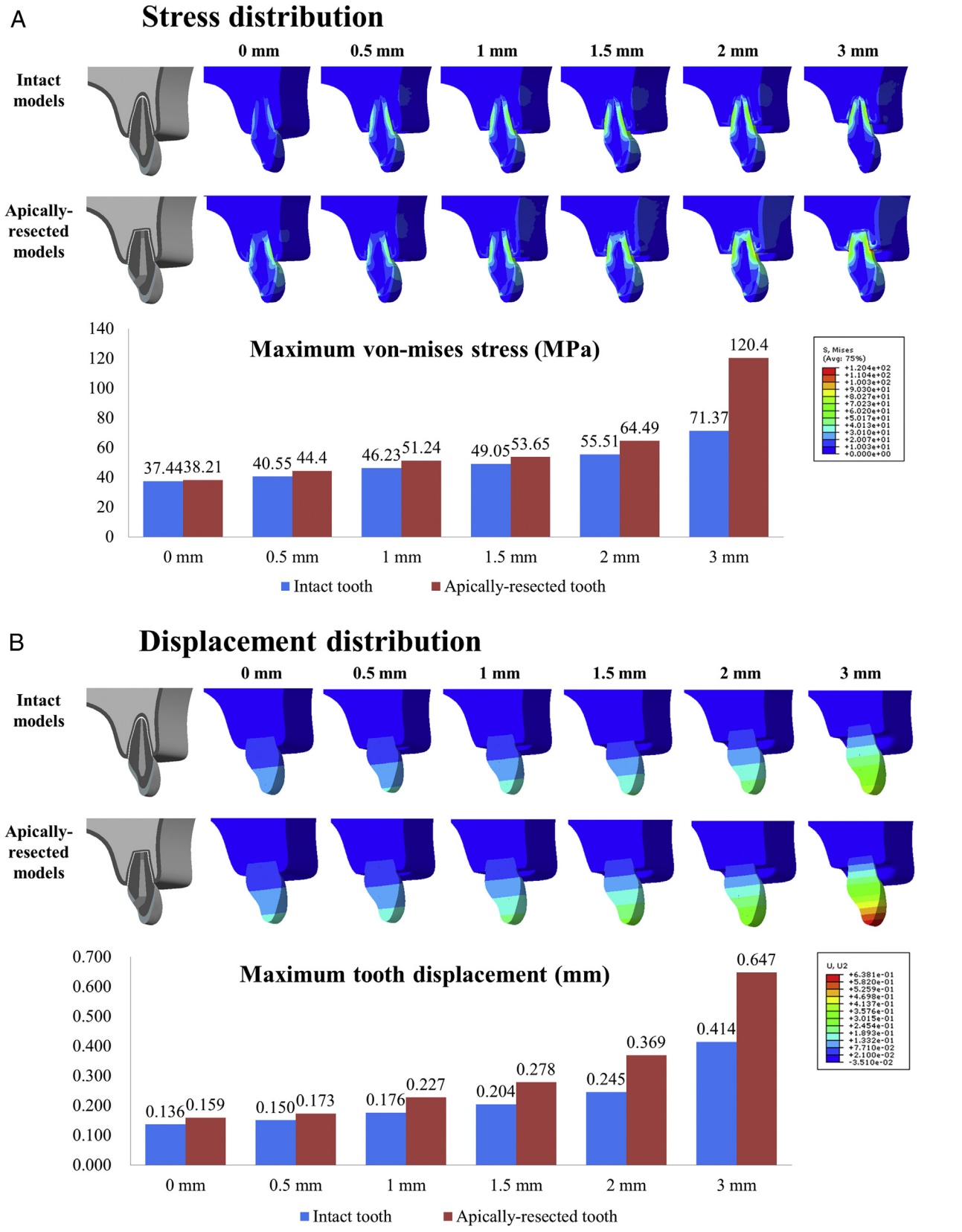

Figure 1. (*A*) Stress distribution in the intact model and the apically resected model with 0, 0.5, 1, 1.5, 2, and 3 mm of periodontal bone loss, and (*B*) displacement distribution in the intact model and the apically resected model with 0, 0.5, 1, 1.5, 2, and 3 mm of periodontal bone loss. (The FEA result of "model group 1" and the "basic apically resected model" was identical with the result of "model group 3" and the "completely healed model" of the preceding study [16] because the same geographic structure and material properties were assumed between these models.)