READER'S FORUM

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Finite element analysis of peri-implant bone stresses induced by root contact of orthodontic microimplant.

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Q. I think that it is quite complicated and difficult to study the mechanism of micro-implant failures due to root proximity and to design a correct experimental modeling. I want to express my respect for your achievement. I have a few questions regarding your article.

Q1. You mentioned that there was 0.1 mm displacement at apex of MI in the root proximity model. Could you describe how you specifically displaced MI with precision?

Q2. With 0.1 mm displacement on the apex, you applied 5 N orthodontic force on the head. What is the relationship between direction of head and apex location when you applied orthodontic force? According to Figure 1, it seems that the force directions were identical. If the direction of two forces are different (for example, opposite direction), how could this fact affect the result?

Questioned by

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A. Thank you for the interest. Our responses to your questions are as follows:

A1. Most problems of the finite element study in orthodontics concern with boundary value issues. In this study, we reproduced a model into the FE mesh model and set the boundary conditions with the specific force magnitude and displacement. Displacement boundary conditions are usually used when the model is fixed, but it also can be used when force is applied. Usually, force conditions are set first, and then stress distribution are calculated following displacement. However, it may be convenient or sometimes even mandatory to use displacement boundary conditions instead of force boundary conditions. When wire springs are used, force level would vary according to the amount of activation, so the amount of activation should be set for displacement boundary condition to be calculated. Displacement boundary condition is used when it is difficult to measure force conditions (for example, root proximity). Excitation or traumatic stimulation from root proximity may be converted into a specific magnitude of force, but it is still difficult to find related experimental data. It is possible to assume the amount of root displacement as thickness of root surface is already known. In this study, displacement boundary condition was applied according to the references, which described that the root displaces the distance of a half thickness of the root surface. The same method was applied by setting the amount of displacement in the module of boundary condition in finite element software.

A2. In root proximity model, there was no force applied at the head part of MI (Figure 2). As you mentioned, if orthodontic force and displacement due to root proximity were the same (like Figure 1) in the x-axis, it may counterbalance stress on the bone since orthodontic force generates compressive stress at the upper part of the cortical bone (Figure 3) while root proximity generates compressive stress at the lower part of the cortical bone

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(Figure 5). It would be clear if you consider the stress distribution on the root surface in case of uncontrolled tipping. In this regard, stress would be superposed each other if the forces were in the opposite direction. As stress from orthodontic force is much lower than that from root proximity, the role of orthodontic force in stress of the bone may not be substantial. Therefore, if root proximity

persisted, detrimental effects would present regardless of direction of orthodontic force.

Replied by

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