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7.5. Biomechanical Problems in the Dental Area

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The duration of the viscoelastic PDL response due to orthodontic tipping

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The periodontal ligament (PDL) is a soft connective tissue that secures the tooth cementum to the alveolar bone. The PDL demonstrates viscoelastic characteristics typical to soft biological tissues. However, there is lack of information regarding the duration of the viscous behavior. Physiologically, teeth are heavily loaded for short durations as opposed to orthodontic treatment where long-term low forces are applied. In both cases, initial tooth movement occurs due to deformation of the PDL. Over time, like in orthodontic treatment, the applied force system constitutes biological responses that govern remodeling processes that eventually allow tooth displacement. Thus, it is expected that during orthodontic tipping, short-term tooth movement will be characterized by PDL creep response; however, the duration of this response was not investigated. We hypothesized that during orthodontic tipping in humans, creep response of the PDL stabilizes during a time-course of minutes. The objective was to develop a computational model to determine the short-term tooth movement during orthodontic tipping. Viscoelastic mechanical behavior of human PDL previously measured *in vivo* [1] was utilized to develop a mathematical model describing tooth movement due to PDL relaxation response. Fitted model parameters were used to derive a computational model which simulates short-term tooth movement caused by tipping. The time-dependent-PDL response as affected by force (0.5-3 N) and tooth-crown length (6-10 mm), i.e. magnitude and location of the applied tipping force, was studied. The results showed that initial tooth movement, governed by PDL creep response, is stabilized in a short time, ~2.25-7.5 minutes, and consequently the hypothesis was verified. This finding should be taken under consideration in numerical models such as finite element models.

Reference: *1. Brosh, T., Machol, I.H., Vardimon, A.D. Deformation/recovery cycle of the PDL in human teeth with single or dual CP. Archives of Oral Biology 2002; 47: 25-92.*