

عنوان مقاله:

A Nano-indentation Identification Technique for Viscoelastic Constitutive Characteristics of Periodontal Ligaments

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خلاصه مقاله:

Introduction: Nano-indentation has recently been employed as a powerful tool for determining the mechanical properties of biological tissues on nano and micro scales. A majority of soft biological tissues such as ligaments and tendons exhibit viscoelastic or time-dependent behaviors. The constitutive characterization of soft tissues is among very important subjects in clinical medicine and especially, biomechanics fields. Periodontal ligament plays an important role in initiating tooth movement when loads are applied to teeth with orthodontic appliances. It is also the most accessible ligament in human body as it can be directly manipulated without any surgical intervention. From a mechanical point of view, this ligament can be considered as a thin interface made by a solid phase, consisting mainly of collagen fibers, which is immersed into a so-called ground substance. However, the viscoelastic constitutive effects of biological tissues are seldom considered rigorous during Nano-indentation tests. Methods: In the present paper, a mathematical contact approach is developed to enable determining creep compliance and relaxation modulus of distinct periodontal ligaments, using constant rate indentation and loading time histories, respectively. An adequate curve-fitting method is presented to determine these characteristics based on the Nano-indentation of rigid Berkovich tips. Generalized Voigt-Kelvin and Wiechert models are used to model constitutive equations of periodontal ligaments, in which the relaxation and creep functions are represented by series of decaying exponential functions of time. Results: Time-dependent creep compliance and relaxation function have been obtained for tissue specimens of periodontal ligaments. Conclusion: To improve accuracy, relaxation and creep moduli are measured from two tests separately. Stress relaxation effects appear more rapidly than creep in the periodontal ligaments

کلمات کلیدی:

Nano-indentation, Creep and Relaxation, Periodontal Ligaments, Viscoelastic Biological Tissues, Contact Mechanics

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