IN-VIVO MEASUREMENTS AND NUMERICAL ANALYSIS OF THE BIOMECHANICAL CHARACTERISTICS OF THE HUMAN PERIODONTAL LIGAMENT

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Introduction

Gingivitis and periodontal diseases have damaging effects on the periodontium and commonly affect the mechanical properties of the periodontal ligament (PDL). This might lead to loss of teeth. The aim of this study was to measure and calculate the biomechanical properties of the PDL using an intraoral loading device that is able to measure tooth displacement intraorally. Time-dependent activations with varying displacements were realised in-vivo on human teeth.

Methods

In-vivo investigations were performed on five volunteers with clinically and radiographically appearing healthy periodontal tissue. The average age of the volunteers was 26 years. Upper left first incisors were selected to undergo the intraoral measurements. The mentioned tooth was loaded with the maximum displacement of 0.15 mm and loading times between 0.1 s and 5.0 s.

Based on the in-vivo measurements, patient-specific numerical models were developed to simulate the relationship between the applied force and tooth displacement. The numerical force/displacement curves were fitted to the in-vivo data to obtain the material properties of the human PDL.

Results

The numerical results regarding material parameters of PDL indicated its bilinear material behaviour (Figure 1). The numerically calculated Young's modulus varied between 0.04 MPa and 0.40 MPa for E_1 (decreasing with increasing the loading time), between 0.60 MPa and 1.65 MPa for E_2 (increasing with increasing the loading time).

Figure 1 shows the experimentally und numerically obtained force/displacement curve

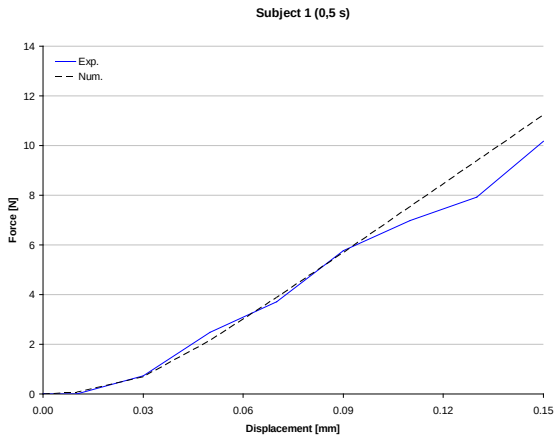

Figure 1: Experimentally und numerically obtained force/displacement curve

Discussion

The obtained results of this study indicated an improvement in the understanding of the biomechanical properties of PDL and can support clinical the prognosis of periodontal diseases.

References

Drolshagen et al, J Biomech, 44:2136-2143, 2011.