A DEVICE FOR SIMULTANEOUS COMPRESSION MEASUREMENTS OF HUMAN CARTILAGE

Nikolaos V. Georgiou, Nikolaos D. Nikolaou, Panagiotis D. Alevras, Elisavet I. Chatzopoulou, Ioannis N. Melas, Christopher G. Provatidis, Leonidas G. Alexopoulos

Mechanical Engineering Department, National Technical University of Athens, Greece

Introduction

Biomechanical testing of soft tissue is of the utmost importance in the study of its mechanical response and material properties. Regarding articular cartilage, compression tests are typically applied to obtain the tissue's stress-strain curves and then evaluate its mechanical properties (e.g. Young's modulus) [Knecht, 2006]. Such tests are typically of very low throughput, performed on a single sample, using sophisticated equipment and taking long time to complete. Herein, we design a device for simultaneous indentation tests of multiple samples, allowing the efficient compound screening and its use in drug discovery.

Methods

Our device consists of a guide that positions 24 indenters to the centre of the wells of a standard 24-well plate (figure 1). The vertical displacement of the indenters, under their own weight, is monitored periodically, by a laser sensor (μ-ε ILD1402) with 2μm measurement accuracy. A motorized XY stage controlled via custom software positions the sensor above all indenters. In each well an independent creep test is performed, where, a 3mm cartilage disk (1-2mm in thickness) is centred by a conical cylinder and compressed under the constant weight of the 20gr indenter. Lately, a new design was evolved from the prototype with increased accuracy and manufacturability.

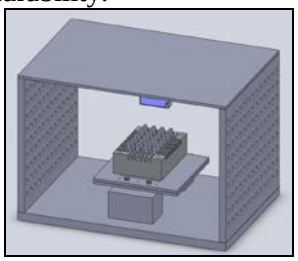

Figure 1: The prototype device.

Results

Indentation tests were performed on cartilage disks and compared with our reference equipment (Bose ElectroForce 3100) to verify the performance of our prototype (figure 2). The displacement curves measured by the prototype and the reference equipment are very similar, proving the measurement capacity of the prototype.

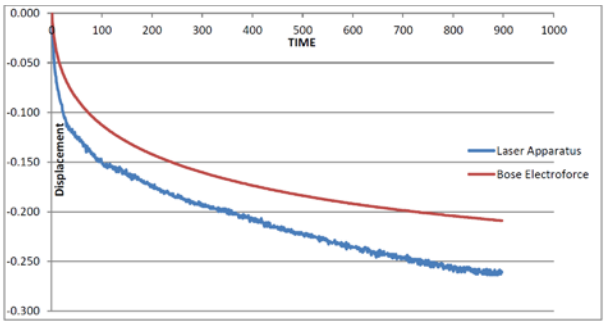

Figure 2: Displacement curves as measured by our prototype (blue line) and reference equipment (red line).

Discussion

Herein, we presented a device for simultaneous compression measurements of articular cartilage explants. Our prototype does not share the accuracy or sensitivity of state of the art biomechanical testing devices, but its high throughput ability allows for the first time to use biomechanical testing for compound screening purposes. Limitations in the prototype exist, mostly related to the original design concept, featuring almost entirely custom CNC parts.

Currently we have completed a new, redesigned version (figure 3), using off the shelf components with manufacturability as a priority. The calibration procedure is standardized, creating comparable results across all devices.

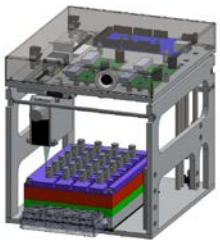

Figure 3: The redesigned device.

References

Knecht *et al*, Clinical Biomechanics 21(10): 999-1012, 2006.