Simultaneous Swelling Tests and Mechanical Monitoring of Bone Graft Substitutes

Introduction

Bone graft substitutes are materials that are used for structural support of fractures, as void fillers to prevent fractures, and to improve healing. They are typically composed of demineralized bone matrix (DBM) combined with a hydrogel carrier and/or cancellous bone chips, or various calcium compounds and their composites. Commercially available forms include gels, putties, pastes, strips, and sheets.

Non-destructive and contactless monitoring of the mechanical properties and swelling of bone graft substitutes using ElastoSens™ Bio² helps tailoring of the formulations and testing potential quality issues, such as variability in raw material quality or storage stability. Testing the formulations in fluid environment (buffer, plasma, blood, etc.) without sample loss gives an indication of handling time under wet conditions, fluid absorption during handling, and physical properties of the implant in the graft site. The impact of material degradation on its mechanical properties can also be tested.

Experimental Conditions, Results

1.0 g of DBM-based putty was moulded into a disk in a sample cup at 37 °C. The mechanical properties and sample volume were determined using ElastoSens™ Bio² before and after adding HBSS buffer solution. The tests were repeated at regular intervals while keeping the sample in the cup at 37 °C. As overall elasticity is measured, excess liquid was removed before each test and put back after. The results (Figs. 1 and 2) demonstrate the advantages of simultaneous non-destructive swelling and mechanical tests.

Fig. 2. Young’s modulus E of DBM-based putties upon swelling at 37 °C (n = 3). Inset: the first 5 h of the experiment.

On ElastoSens™ Bio²

ElastoSens™ Bio² is a benchtop instrument that measures without contact, non-destructively and in real time the viscoelastic properties of gels, putties and pastes as function of time or temperature. The patented technology behind the instrument is based on gentle mechanical vibration of sample confined in a sample cup and laser detection of the response. The response is converted into viscoelastic parameters (shear storage and loss moduli).

Advantages of ElastoSens™ Bio²:

• non-destructive and contactless simultaneous mechanical and swelling measurements
• removable sample cups: clean, retesting of the same sample possible at any time
• fast and easy to use
• affordable

Fig. 1. Swelling kinetics of DBM-based putties in HBSS at 37 °C.