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BIOMECHANICAL SIMULATION OF HAEMOSTATIC SPONGES USED FOR SINUS LIFT PROCEDURE

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1. Introduction

The objective of this study is to provide a geometrical model that describes the morphological behavior of haemostatic gelatin-based sponges under the effect of hydration following the sinus lift surgery [1]. For this purpose, a finite element model was developed to simulate conditions close to clinical ones and experimentally reproduced by Okley et al. [2].

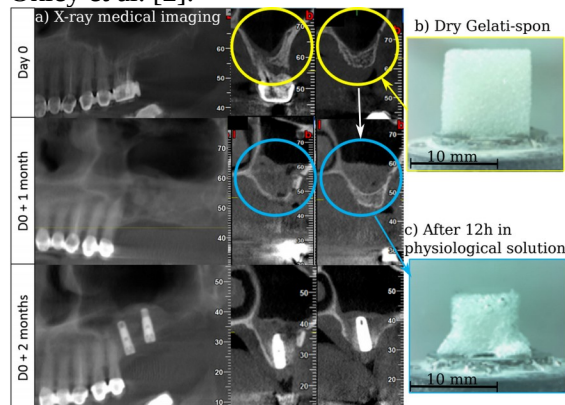


Figure 1: Sinus lift X-ray monitoring with in yellow the defect to fill and in blue the newly formed bone after one-month implantation. b) side view of a dry haemostatic sponge (Gelita-spon) and c) its state after 12 hours within physiological fluid. The final objective is to build a patient specific tool to predict how much initial sponge volume is required to promote the bone formation and support the dental implants once mineralized.

2. Materials and Methods

Modelling such a shrinking within physiological conditions rises many issues involving hydro-chemo-mechanical couplings. Aiming a fast answer to the clinical demand, the morphological effects of hydration on haemostatic sponges has been modelled through a thermo-stress problem [3] with Abaqus where the temperature variation represented the sponge hydration. Gelita-spon

sponge being cubic ($10 \times 10 \times 10 \text{ mm}^3$), only one fourth has been used with a mesh size of 1mm leading to 250 linear hexahedral temperature-displacement coupled elements (C3D8H).

3. Results

An optimisation loop has been set with Python to reach the set of parameters fitting the experiments presented in Fig 2.

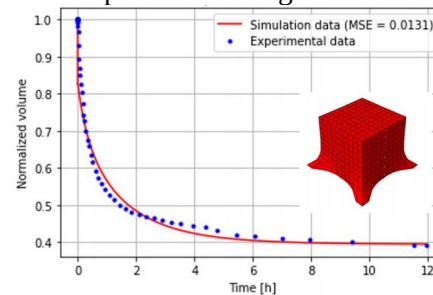


Figure 2: Simulation results (red line) fitting experimental data (blue dots) in terms of normalized volume as function of time.

The associated final geometries (one example in Fig 2) are close to experiments Fig 1c.

4. Discussion and Conclusions

The results are satisfactory for an extend to the patient specific geometry, i.e. sinus cavity. Although, mesh refinement led to convergence issues due to excessive deformations. Besides, the analogy with thermomechanics is far from reality and microstructural analyses are under progress to be coupled with poromechanical simulation.

5. References

1. Sohn D.-S. et al., J Oral Maxillofac Surg, 68:1327–33, 2010.
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3. Banks D., Acque Sotterranea - Italian Journal of Groundwater, 2012, 1

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