

CHARACTERIZATION OF HYDRATION EFFECT ON HAEMOSTATIC SPONGE STRUCTURE USING MULTIMODAL IMAGING

Adrien Baldit (1), Chrystelle Po (2), Cédric Laurent (1), Halima Kerdjoudj (3), Olivier Perroud (1), Jesse Schiffler (2), Nadia Bahlouli (2) and Cédric Mauprivez (3)

1. LEM3-UMR-7239, CNRS – Univ. de Lorraine - Arts et Métiers ParisTech, France; 2. Laboratoire ICube, CNRS UMR 7357, Strasbourg, France; 3. BIOS, Univ. de Reims Champagne Ardenne, EA 4691 Reims, France.

Introduction

Haemostatic sponges are collagen or gelatin based elements used in surgeries such as the sinus lift [1]. Playing the role of a bone filler, the characterization of its mechanical and structural properties evolution during hydration are crucial to build predictive surgery simulations. For this reason, we addressed this study to determine the structural properties of collagen sponge during hydration using new non-invasive imaging protocol.

Methods

$\frac{1}{4}$ of haemostatic sponges (Hemocollagene, Septodont) was immersed in physiological serum (NaCl 0.9%, B. Braun) at room temperature until it reached the hydrated state. We observed the haemostatic sponge microscopic structure before hydration using x-ray computational tomography (CT, EasyTom nano, RX Solutions) (Fig 1a) and during the hydration using magnetic resonance imaging (MRI) equipped with cryoprobe (Bruker Biospin) (Fig 1b). The same operator performed manual segmentation using 3D slicer software (www.slicer.org) to avoid discrepancies due to contour interpretation. The volume operations as well as mesh generation have been done with Pyvista and Tetgen python libraries.

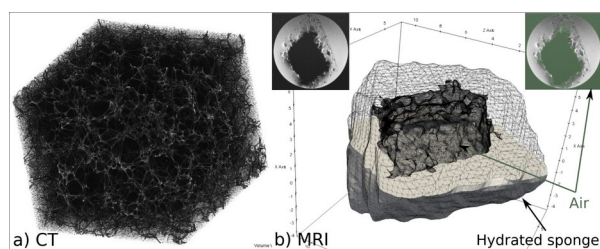


Figure 1: $\frac{1}{4}$ Hemocollagene haemostatic sponge segmentation based on a) CT and b) MRI images

Results

The dry microstructure obtained was consistent with previous optical pictures and scanning electron microscopy [2].

Regarding the hydration evolution, we discriminated 3 sponge parts from MRI images: the global or effective volume (Vol_{eff}), the hydrated volume (Vol_{hyd}) and the air volume (Vol_{air}) (Fig 2). The decrease of Vol_{eff} was correlated with decrease of the Vol_{air} . The hydrated

structure was consistent with subsequent biphotons microscopy imaging.

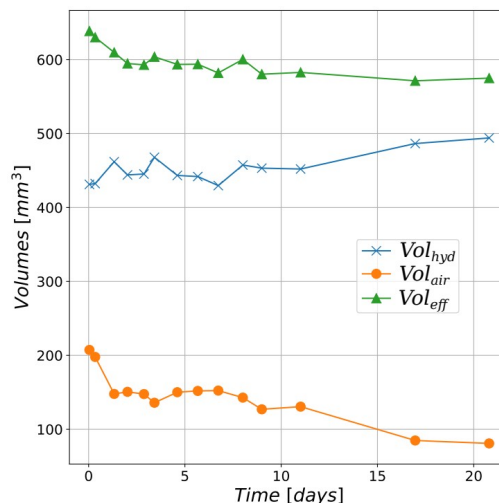


Figure 2: Evolution of $\frac{1}{4}$ Hemocollagene haemostatic sponge volume: effective sponge (Vol_{eff} , green), air content (Vol_{air} , orange) and hydrated collagen (Vol_{hyd} , blue).

Discussion

Based on a new non-invasive protocol to explore collagen materials during hydration, we showed the decrease of the sponge volume is induced by the air removal. The collagen is preserved excluding the hypothesis of sponge dissolution in the fluid. The evolution of the Vol_{eff} was consistent with previous study [2] but delayed. Within the MRI the temperature was not imposed to 37°C neither during sample resting in between acquisitions. The impact of the experimental factor (e.g. solution, temperature environment) need to be investigated as well as the evolution the microscopic structure during the hydration. This new non-invasive tool could be adapted to explore the structure under mechanical essay.

References

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