CHARACTERISATION AND THREE-DIMENSIONAL RECONSTRUCTION OF SYNTHETIC BONE MODEL FOAMS

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INTRODUCTION

Synthetic open-cell foams (Sawbones®) are being used to model vertebra cement injection experiments. However, these foams lack a reliable microstructure characterisation.

OBJECTIVES

- To characterize the Sawbones® foams histomorphometrically.
- To obtain the 3D virtual models of Sawbones® foams.

MATERIALS AND METHODS

Sawbones® foams
- Polyurethane open cell rigid foams (white and blue foams, WF and BF; \( \rho_{\text{WF}} = 0.09 \text{ g/cm}^3 \) and \( \rho_{\text{BF}} = 0.12 \text{ g/cm}^3 \)).
- Cell structure 95% open; cell sizes 1.5 to 2.5 mm; compressive strength \( C_{\text{WF}} = 6.2 \text{ MPa} \) and \( C_{\text{BF}} = 18.6 \text{ MPa} \).

Scanning electron microscopy (SEM)
- SEM was used to reveal both the micro architectural features and the composite nature of the foams.
- SEM images were treated with ImageJ (version 1.44p) to estimate the trabecular thickness (Th), the trabecular separation (Sp) and the cell size of the foams.

Micro-computed tomography (µ-CT)
- Maximum resolution of 46 µm (i.e. physical distance between successive images).
- DICOM image files were treated with ImageJ, converted to 8 bit grayscale, binarised and thresholded with smooth software commands.
- The 3D virtual models were built, after proper set work, with ImageJ.

Parametric characterization
- BoneJ, a plugin for ImageJ, was used to analyze the bone-like geometry of the foams. The selected indices were the bone-volume to total-volume ratio (BV/TV), the trabecular thickness (Th), the trabecular plate thickness (Th.Pt), the connectivity density (Conn.D), the degree of anisotropy (DA) and the fractal dimension (Frac.D).
- The statistic data control was performed on 10 subsets of 50 consecutive images to minimize the computation time (data: mean ± standard deviation).

RESULTS

- Sawbones® foams (WF and BF), while having different porosity, had similar histomorphometric indices.
- The microstructure of Sawbones® foams was similar to trabecular bone.
- Sawbones® foams had similar histomorphometric indices than human vertebra (see Table1).

CONCLUSIONS

The microstructure of Sawbones® foams is similar to that of trabecular bone. These foams are a good option to study in vitro the infiltration behaviour of bone cements and the like.

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