A MORPHOLOGY STUDY ON SCLEROFOAMS

Francesca Cosmi [1], Salvatore Scozzese [1], Giovanna Biasi [2]

[1] University of Trieste, via A. Valerio 10, 34127 Trieste, Italy

[2] SOC Chirurgia Vascolare, Az. Ospedaliera Universitaria, Udine, Italy

Corresponding author: cosmi@units.it

1. Introduction

Sclerotherapy is an established and attractive alternative to surgery in the treatment of varicose veins and sclerosants, like polidocanol, are often used as foams injected under ultrasound control. Different methods of sclerofoam preparation exist [1, 2].

The aim of this work is to investigate the possibility and the significance of a morphology characterization of sclerofoams obtained under different preparation conditions.

In this study, six sclerofoams samples were prepared in our laboratory. According to the Tessari's method [3], we obtained the foam by mixing 20 or 50 times air and polidocanol drug (3% and 0.5% concentration) using two syringes and a three-way connector (Fig.1). Each foam was then injected in a Eppendorf tube using pipes of different dimensions (C1: 1.3x45 mm and C2: 0.3x13 mm) and immediately quick-frozen in liquid N_2 to avoid macro-crystals formation while preserving the foam structure during the measurements.

Fig. 1 The device for foam preparation

The internal microstructure of the frozen foams was obtained by X-ray micro-Computed Tomography. The set-up used at the Tomolab facility of Elettra (Trieste, Italy) achieves a spatial resolution of 10 micron (Fig.2). The 3D reconstructions of the foams structures were analyzed and several morphological parameters such as number, dimensions and degree of isotropy of the bubble structures were computed [4, 5, 6].

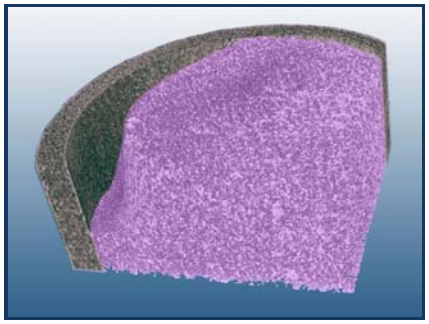

Fig. 2 A portion of the 3D reconstruction of a polidocanol foam (the external part of the tube is also visible)

2. Experimental Results

Differences can be easily observed in the structures obtained with different foam preparation methods, for example by examining the samples sections shown in Fig.3.

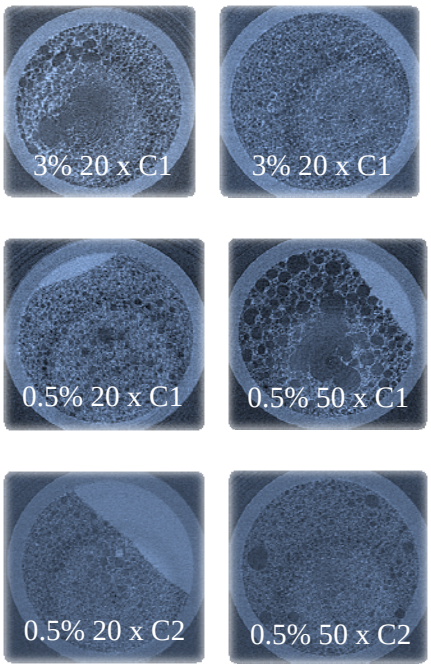

Fig. 3 Different foam structures obtained by varying the preparation parameters

The morphological analyses were conducted on a 200^3 voxel volume extracted from the central portion of the samples. A quantitative characterization of the different foam microstructures can be attained by computing the histograms of the bubbles volume and of the bubbles wall thickness (obtained by Pore3D [4] and by Quant3D [5] software respectively), shown in Fig. 4 and Fig. 5. Anisotropy analyses by Mean Intercept Length and Star Volume Distribution methods were also performed on the same cubic volumes but could not be presented in this abstract for brevity.

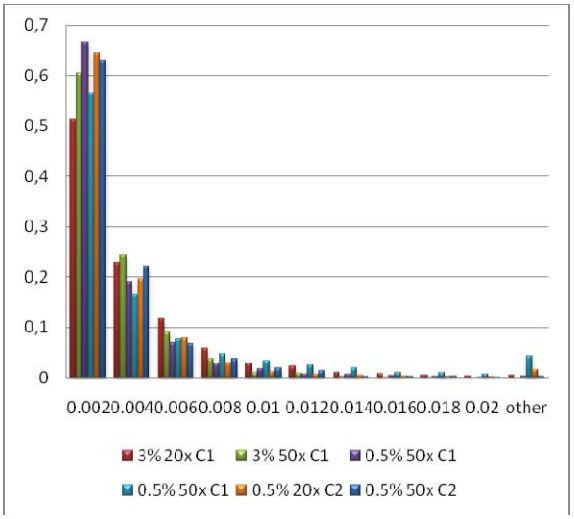

Fig. 4 Histograms of the bubbles volume.

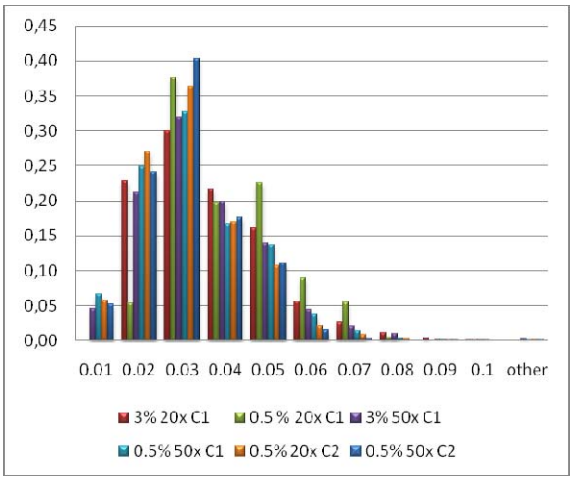

Fig. 5 Histograms of the bubbles wall thickness.

3. Conclusions

An original experimental approach has been proposed, in which micro-tomography and morphological techniques have been successfully used to characterized the sclerofoams. To our knowledge, this is also the first attempt to monitor sclerofoams for applied research purposes. In order to obtain quantitative results of clinical significance, a larger number of experimental observations is required and further work has already been planned.

4. Acknowledgements

Samples quick-freeze and images acquisition were possible thanks to the support of the Tomolab staff, in particular D. Dreossi and N. Sodini, while images reconstruction and Pore3D computations were conducted with the help of F. Brun and R. Cely Barroso.

5. References

[1] Coleridge Smith P, "Saphenous ablation: sclerosant or sclerofoam?" Semin Vasc Surg. 18 (2005) 19-24. Review

[2] Bergan JJ, Pascarella L, "Severe chronic venous insufficiency: primary treatment with sclerofoam." Semin Vasc Surg.18 (2005) 49-56. Review

[3] Tessari L. "Nouvelle technique d'obtention de la sclero-mousse." Phlébologie. 53 (2000) 129

[4] Brun F, Mancini L, Kasae P, Favretto S, Dreossi D, Tromba G, "Pore3D: A software library for quantitative analysis of porous media". Nuclear Instr. Meth. in Physics Research A 615 (2010) 326–332

[5] Ketcham RA, "Three-dimensional grain fabric measurements using high-resolution X-ray computed tomography" J. Structural Geology 27 (2005) 1217-1228

[6] Smit TH, Schneider E, Odgaard A. "Star length distribution: a volume-based concept for the characterization of structural anisotropy." J Microsc. 191 (1998) 249-57