Preface

The aim of the work presented here is to develop quantitative techniques for ultrasound and photoacoustic imaging for the assessment of architectural and vascular parameters.

The works in this book can be divided into two macro areas: (1) morphological vascular studies based on the development of quantitative imaging techniques for the use with clinical B-mode ultrasound images, and (2) preclinical architectural vascular studies based on quantitative imaging techniques for ultrasound and photoacoustics.

The first section, which makes up the second and third chapters, focuses on the development and validation of quantitative techniques for the assessment of vascular morphological parameters that can be extracted from B-mode ultrasound longitudinal images of the common carotid artery. In Chap. 2, results from numerous past studies are presented, including the validation of techniques for correctly locating the CCA in B-mode ultrasound images, the development and implementation of novel completely automated techniques for the IMT measurement and plaque segmentation, and the validation and association of the automatically measured IMT value with clinical parameters. Chapter 3 focuses instead on the validation of the intima-media thickness variability parameter. Recent studies have shown that the IMT variation along the carotid artery wall has a stronger correlation with atherosclerosis than the nominal intima-media thickness value itself; hence this chapter presents an in-depth study and validation of the IMT variability (IMTV) parameter, confronting the question if manual segmentations of the lumen–intima and media–adventitia borders can be trusted as ground truth in the calculation of this parameter.

The second section, the fourth and fifth chapters, instead emphasizes quantitative imaging techniques for the assessment of architectural parameters of vasculature that can be extracted from 3D volumes, first using contrast-enhanced ultrasound (CEUS) imaging and, second, photoacoustic imaging without the administration of any contrast agent. More specifically, Chap. 4 demonstrates how the characterization and description of the vascular network of a cancer lesion in mouse models can be effectively determined using both traditional microbubbles and liposomes. Eight mice were administered both microbubbles and liposomes and 3D CEUS volumes were acquired. Vascular architectural descriptors were calculated after a skeletonization technique was applied. Chapter 5 focuses on the development and validation of a skeletonization technique for the quantitative assessment of vascular architecture in burn wounds using completely non-invasive photoacoustic imaging, thus not requiring any contrast agent administration. It was shown how this technique could provide quantitative information about the vascular network from photoacoustic images that can distinguish healthy from diseased tissue.

A summarizing discussion (Conclusions and Final Remarks) concludes this work.

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Springer
http://www.springer.com/978-3-319-48997-1

Quantitative Ultrasound and Photoacoustic Imaging for
the Assessment of Vascular Parameters
Meiburger, K.M.
2017, IX, 108 p. 37 illus., 18 illus. in color., Hardcover
ISBN: 978-3-319-48997-1