Preface

Patient-specific modeling of biological tissue is of vital importance for an accurate determination of the biomechanical effects of surgeries of select different clinical treatments. Consideration of realistic mechanical properties in combination with the most advanced constitutive laws, computational analysis techniques and available medical imaging techniques (CT, MRI,) provides a powerful tool for modeling biological structures. Simulation-based medicine and the development of complex computer models of biological structures are ubiquitous in modern biomedical engineering and clinical research. Despite the many investigations developed in this field, the exact mechanical behavior of the different biological structures and the causes of many of their pathologies are not completely understood. This is partially due to inherent limitations of experimental studies such as their high cost, difficulties associated with the capture of accurate measures of strain and stress and, especially, the difficult and sometimes impossible reproduction of certain natural, pathological or degenerative situations.

This book contains a small collection of invited chapters on patient-specific modeling and can be a significant contribution to the state-of-the-art in the field of Computational Biomechanics focused in the context of Patient Specific computational modeling with a total of seven chapters has been included. An operator insensitive method to reconstruct vascular bodies from Computer Tomography-Angiography (CT-A) data is given by Gasser in Chap. 1. The approach is based on beam- and shell-like deformable (active) contour models and facilitates a hex-dominated Finite Element mesh generation for an efficient numerical computation of mechanical field variables. Fernandez et al. present in Chap. 2 a suite of subject-specific musculoskeletal models that were developed using the framework of The International Union of Physiological Sciences (IUPS) Physiome Project that has been developed as a framework for creation, sharing and dissemination of multiscale mathematical models of human physiology. In Chap. 3, Creane et al. review the current state of the art in the clinical risk assessment for atherosclerotic plaque disruption and details the barriers yet to be overcome if patient specific computational modeling is to be used as a clinical tool. Heidenreich et al. describe a methodology for the modeling and simulation of human ischemic heart in Chap. 4. Recent advances in lower-cost, non-invasive imaging and computing power (surface scanning, Cone Beam Computerised Tomography (CBCT) and Magnetic Resonance (MRI)) to capture and process surface and internal structures to a high resolution are presented by Richmond et al. in Chap. 5. Borghi et al. describe in Chap. 6 a computational mechanics model of TAA based on patient-specific anatomical and flow conditions, acquired from Magnetic Resonance Imaging (MRI) and Computed Tomography (CT). The model has been applied to eight patients with TAAs at different locations of the aorta as well as a normal subject as a control case for comparison. Finally, Lanchares et al. present in Chap. 7 a patient-specific model of the eye for helping in different ophthalmologic surgical techniques. They present the usefulness of this model to help in surgical planning of incisional surgery for the correction of astigmatism, the numerical analysis of the process of accommodation and the numerical simulation of the scleral buckling technique for retinal detachment.

Finally, the editors greatly appreciate the effort, dedication and work of the authors. Their expertise and worldwide reputation in Biomechanics field have undoubtedly enriched the scientific discussion contained in the book chapters.

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