

QUANTITATIVE CORONARY AND LEFT VENTRICULAR CINEANGIOGRAPHY

Methodology and Clinical Applications

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Introduction

In recent years there has been an increasing interest in quantitative analysis of coronary cineangiograms and already for a longer time of left ventricular cineangiograms. The need for quantitation of coronary arterial dimensions has been stimulated by the introduction of new therapeutic procedures in the catheterization laboratory, such as the balloon dilatation technique (PTCA) and thrombolytic therapy, by the need to study the vasoactive responses of pharmaceutical agents, and also by the desire to study the progressive nature of coronary artery disease with the ultimate goal to find ways to bring a halt to the progression of coronary atherosclerosis or even achieve regression of the disease. Parallel with these clinical developments, rapid technical developments in computer architectures and semiconductor memories have made it possible to digitize and store cineframes or selected portions thereof in image processors and to analyze these pictorial data quantitatively at affordable prices.

More than 15 years of research have been directed by various groups towards the semi- or fully-automated delineation of the left ventricular boundaries on a frame-to-frame basis. Yet not a single system with fully-automated capability is commercially available. In the mean time many different left ventricular wall motion models have been developed, again with little consensus on which model is to be preferred as no golden standard exists.

Since the early nineteen seventies our department has been heavily involved in the development of image processing techniques for the semi- or fully-automated analysis of cineangiograms, to derive new, clinically relevant, parameters from these images; these techniques have been validated extensively and applied to clinical studies. This book describes our approaches and results in these areas. In addition, extensive overviews of the work of others have been included. Twelve chapters describe the various methodologies, followed by eleven chapters with clinical applications.

In the first chapter an extensive overview is presented of left ventricular and coronary angiographic procedures in terms of techniques, applications and their limitations. In the second chapter, the X-ray image forming process is described

and technical information about the different components of the X-ray system is provided. In Chapter III the computer-based Cardiovascular Angiography Analysis System (CAAS) is described in detail, followed by a description of the left ventricular angioprocessing system, the Contouromat, in Chapter IV. The validations of these techniques are described in Chapter V. In the following chapters VI through IX, technical applications and new developments on the CAAS are presented, such as the definitions of selection criteria for coronary contrast catheters (Ch. VI), the densitometric analysis of coronary obstructions (Ch. VII), the three-dimensional reconstruction of coronary arterial segments from two projections (Ch. VIII) and the structural analysis of the entire coronary arterial tree (Ch. IX).

An extensive methodological review of existing quantification systems for coronary and left ventricular cineangiograms is presented in Chapter X. The basic principles of a new endocardial landmark motion model for left ventricular function are described in Ch. XI. Finally, in Chapter XII the cardiovascular database and coronary reporting system are described; all the database parameters that may be stored and retrieved are defined in the Appendix.

All clinical applications are presented in the second part of this book. In Chapter XIII the influence of the intracoronary administration of a calcium-antagonist (nifedipine) on left ventricular function, coronary vasomotility and myocardial oxygen consumption is described. The preliminary results of the Thoraxcenter randomized trial on intracoronary thrombolytic therapy and its influence on left ventricular function are presented in Chapter XIV. Various aspects of the percutaneous transluminal coronary angioplasty (PTCA) procedure are investigated and discussed, such as left ventricular chamber stiffness (Ch. XV), the question whether PTCA is mandatory after successful thrombolysis (Ch. XVI), diameter versus densitometric area measurements of coronary obstructions pre- and post-PTCA (Ch. XVII), and finally, left ventricular performance, regional blood flow, wall motion and lactate metabolism during PTCA (Ch. XVIII). Various aspects of coronary vasomotor tone are presented in chapters XIX (the role of vascular wall thickening) and XX (the effect of the cold pressor test on coronary dimensions). The functional significance of coronary obstructions in terms of transstenotic pressure gradients and defect sizes in exercise/redistribution thallium-201 scintigraphy is presented in Chapter XXI, while the changes in coronary arterial dimensions as related to lipid metabolism obtained in the Leiden Diet Intervention Trial are presented in Chapter XXII. Finally, the asynchrony in regional filling dynamics as a consequence of uncoordinated segmental contraction during transluminal coronary occlusion is described in Chapter XXIII.

Thus, this book should be of interest to all researchers and clinicians who are involved in cardiac catheterization procedures and/or the interpretation of the resulting images, either methodologically or clinically. Many of the techniques developed presently, will be applied routinely in the near future.

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