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Methodology and Clinical Applications

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1986 **MARTINUS NIJHOFF PUBLISHERS**
a member of the KLUWER ACADEMIC PUBLISHERS GROUP
BOSTON / DORDRECHT / LANCASTER

Distributors

for the United States and Canada: Kluwer Academic Publishers, 190 Old Derby Street, Hingham, MA 02043, USA
for the UK and Ireland: Kluwer Academic Publishers, MTP Press Limited, Falcon House, Queen Square, Lancaster LA1 1RN, UK
for all other countries: Kluwer Academic Publishers Group, Distribution Center, P.O. Box 322, 3300 AH Dordrecht, The Netherlands

Library of Congress Cataloging in Publication Data

Reiber, J. H. C. (Johan H. C.)
Quantitative coronary and left ventricular cineangiography.

(Developments in cardiovascular medicine)
Includes bibliographies and index.
1. Cineangiography. 2. Coronary heart disease--Diagnosis. 3. Heart--Diseases--Diagnosis. I. Serruys, P. W. II. Slager, C. J. III. Title. IV. Series.
[DNLM: 1. Angiocardiography. 2. Cineangiography. 3. Heart Ventricle--radiography. W1 DE997VME / WG 141 R347g]
RC683.5.C54R45 1985 616.1'207572 85-21450
ISBN 0-89838-760-4 (U.S.)

ISBN 0-89838-760-4 (this volume)

PRINTED IN THE NETHERLANDS

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.

Many colleagues and friends have contributed in one way or the other to one or more chapters. We would like to mention (per group in alphabetical order): from the laboratory for clinical and experimental image processing: Frederik Booman, M.Sc., Ingrid P.M. Broeders, Pauli M. van Eldik-Helleman, Robert J.N. Kalberg, M.Sc., Cornelis J. Kooijman, M.Sc., Jan van Ommeren, M.Sc., Edwin J.B. van Ree, B.Sc., and Johan H.C. Schuurbiers, B.Sc.; from the catheterization laboratory: Ad den Boer, B.Sc., Marcel van den Brand, M.D., Pim J. de Feyter, M.D., Ton E.H. Hooghoudt, M.D., Juan Planellas, M.D., Vasco Ribeiro, M.D., Harry Suryapranata, M.D., and William Wijns, M.D.; from the information theory group of the Delft University of Technology: Jan J. Gerbrands, M.Sc., and the following colleagues, at that time students, who wrote their master of science theses on a particular part of the entire project: Bob H.D. van den Elskamp, M.Sc., Mark M. ter Kuile, M.Sc., M.BA; Gabe Langhout, M.Sc., Robert-Jan van Meenen, M.Sc., Ruud T. Rademaker, M.Sc., Bas Scholts, M.Sc., Cees Slump, Ph.D., Hong Sie Tan, M.Sc., and Gert-Jan Troost, M.Sc.; from the coronary care unit and nuclear cardiology laboratory: Maarten L. Simoons, M.D., Ph.D.; from the laboratory for clinical and experimental information processing: Ron van Domburg, M.Sc., Simon H. Meij, M.Sc., and Cees Zeelenberg, M.Sc.; from the laboratory of biomechanics: Ronald W. Brower, Ph.D. and Harold J. ten Katen, B.Sc.; from the Eye Hospital in Rotterdam: Guus V.M. Schulte, M.D. (Ch. IX); and our foreign friends Joerg Grimm, Ph.D., Otto M. Hess, M.D., and Hans P. Krayenbuehl, M.D., F.A.C.C. (Ch. XV) from the Cardiology Division, University Hospital in Zürich, Switzerland, and Michel E. Bertrand, M.D., and Jean Marc Lablanche (Ch. XIX) from the Cardiology Division, University of Lille, France.

We wish to thank Jaap Deckers, M.D., of the Thoraxcenter for his redaction of the special topic on the cold pressor test (Ch. XX), Jacques D. Barth, M.D., the Thoraxcenter, Hans Jansen, Ph.D., the Departments of Internal Medicine III and Biochemistry, Jan C. Birkenhäger, M.D., the Department of Internal Medicine III, all from the Erasmus University and University Hospital Dijkzigt, Rotterdam, and Alexander C. Arntzenius, M.D., the Department of Cardiology, University Hospital Leiden, the Netherlands, for their redaction and contributions to Chapter XXII: Quantitative coronary angiography in a lipid intervention study, and Federico Piscione, M.D. from the Clinica Medica I, 2nd Medical School, Napoli, Italy, who studied and described regional left ventricular filling dynamics during PTCA (Ch. XXIII) during his one year stay at the Thoraxcenter.

We also wish to acknowledge our photographer Jan Tuin, who has spent so many hours over the years in providing us with diapositives, films and prints. We are particularly grateful to our secretaries Ria Kanters-Stam and Saskia Spierdijk, who have typed and edited so many versions of the various chapters.

This work would not have been possible without the continuing support from Paul G. Hugenholtz, M.D., F.A.C.C., Chief of the Department of Cardiology, Geert T. Meester, M.D., Ph.D., Professor of Clinical Pathophysiology of the

Cardiovascular System and Nicolaas Bom, Ph. D., Head of the Bio-Engineering Group, Thoraxcenter. Finally, we are indebted to the Dutch Heart Foundation, which has supported the developments and clinical applications of the quantitative analysis of the coronary arteries from July 1978 until September 1984 under grants 77.084, 79.109 and 80.129.

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