



# THE CORONARY ARTERIES

Arteriography, Microanatomy, and Pathogenesis

of

Obliterative Coronary Artery Disease

By

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## INTRODUCTION

**T**HE MAGNITUDE of the problem of coronary artery disease needs no introduction in the present day. It is fitting however to pay tribute to the vast research endeavour which has already been expended in the investigation of this disease. For a time it appeared as if the morbid anatomical and histological studies of the first part of the century had been swept from the main current by a flood of contributions on plasma lipid chemistry and experimental atherogenesis. To many it must have seemed that this was the proper and logical sequence of investigation: first the definition of the lesion and then the search for its causation and its prevention. However, although substantial ground has been gained, a satisfactory solution to the aetiology of atherosclerosis has so far eluded its vigorous and sustained pursuit in the field of biochemistry.

Recrudescence of interest in the structural changes in the coronary arteries has been manifest in recent years. This is perhaps not unrelated to the frustrations of the biochemical approach, and to the new problems encountered in the direct surgery of the coronary arteries. At any rate it is evident that experimental and biochemical discoveries have outstripped knowledge of their morphological significance. There is still need for precise data on the anatomy and pathology of the coronary arteries of man. It is also important to preserve and reaffirm knowledge which has been established.

In this book some observations are presented which have been derived from an individual effort to study the pathology of coronary artery disease. Naturally much that is written in its pages has been said before, and is confirmed by word or illustration. It is also inevitable that much will be superseded by the application of advances in histochemistry and electron microscopy. Nevertheless the description is securely based on original observations and is supported by a sample of the visible evidence from which it was derived. Although their interpretation will doubtless be modified in the course of time, and concepts will be moulded or cast aside, the photographic illustrations should stand firm as faithful and permanent records of objective evidence.

Survey of the literature on the pathology of coronary artery disease reveals that previous investigators have severally concentrated on one, or a selected few, aspects of this subject. As an alternative it seemed worthwhile to attempt a correlation of all concurrently available data in a relatively

small number of cases. While pursuing this objective the author has had cause to reflect on the wisdom of those who have restricted the field of their observations within more manageable limits! Nevertheless the comprehensive nature of this survey has been most instructive. It has permitted opinions to be reached from original information on a wide range of topics and has thereby laid the foundations of a critical appreciation of the contribution of other workers. A part of this opportunity is made available to the reader who chooses to examine closely the illustrations assembled in this book and to read the interpretation which has been offered.

In order to obtain the maximum information on each case it was necessary to develop a method of examination which would meet the exacting requirements of the project. Firstly an arteriographic technique was required which would provide a three-dimensional picture of the intact coronary circulation. At the same time it must reveal the smallest communications between arterial branches and demonstrate the small vessels in occlusive lesions and in the diseased artery wall. The injected tissues must present no technical difficulty in the preparation of microsections. The histological structure and tinctorial characters of the myocardium and coronary arteries must not be materially altered. Means of demonstrating the findings stage by stage had to be planned in such a way that interference with subsequent observations was avoided. Lastly, it was desired that the findings at each stage should be permanently preserved, so that the original material could be studied repeatedly.

No record has been found of investigations which have sought to reveal at once and in the same specimen, in gross and in minute detail, so many aspects of coronary artery disease; and which have thereby allowed correlation of the assembled information in the manner which has been attempted in this book.

The arteriographic illustrations are of primary importance in this presentation. Indeed, a comparable demonstration of certain features has not been found elsewhere. In particular may be mentioned the radiographic demonstration of intimal vessels, of the processes of recanalization of occluded coronary arteries, and of arterial anastomoses of fine calibre. Other arteriographic findings are described for the first time. The main appeal of this book may well lie in the pictorial quality of its illustrations; but it is hoped that the reader will also find interest in the comprehensive nature of the survey, which presents a dynamic and three-dimensional concept of coronary heart disease.

## PREFACE

**T**HIS BOOK is primarily a record of individual research. No apology is made for the personal character of the text. The emphasis lies in the demonstration of findings, their interpretation and the development of concepts of pathogenesis in coronary artery disease. Although the contributions and opinions of other workers receive acknowledgement and critical appraisal, from the standpoint of original observations, there is no pretence of undertaking a comprehensive review of the enormous literature on this subject.

The investigation was commenced during a research assistantship in cardiology in the University of Edinburgh, created on the initiative of Dr. A. Rae Gilchrist and sponsored by the Department of Health for Scotland. The original work was carried out in the pathology departments of the Royal Infirmary and the University, Edinburgh. Review and analysis of the material collected continued during the tenure of the author's present appointment in the Department of Materia Medica and Therapeutics in the University of Glasgow. Gratitude is expressed to all who gave their support through encouragement, facilities and criticism. Their number includes Dr. A. Rae Gilchrist, Professor A. Murray Drennan, Dr. R. F. Ogilvie, the late Professor J. C. Brash, Dr. M. F. Oliver and Professor Stanley Alstead. The decision to present this work in book form was fostered by Professor Alstead and catalysed by Professor G. L. Montgomery.

The entire investigation was conducted personally in all its aspects, with the exception of routine histology. The preparation of paraffin sections of the coronary arteries was undertaken by Mr. Stewart Rankeillor, Department of Pathology, University of Edinburgh, and some special stains were later applied to spare sections by Mr. Ian Mackie, Stobhill General Hospital, Glasgow. The methods were largely the product of personal experimentation. Departures from conventional procedures were all original innovations provoked by dissatisfaction with the shortcomings of earlier results.

The original arteriograms, the monochrome photographs of 2 mm. sections of the coronary arteries and all the line drawings were prepared by the author. Assistance has been gratefully received from several quarters in the preparation of the illustrations for publication. The greatest burden of photographic reproduction of arteriograms and line drawings has fallen on Mr. P. S. Waldie and his assistants, Department of Clinical Photography, Stobhill Hospital, Glasgow. Most of the photomicrographs are the work of

Mr. D. MacAllister, Department of Physiology, University of Glasgow. Photographic support has also been supplied by Mr. T. Dodds and assistants, Department of Medical Photography, University of Edinburgh and by Mr. G. Marshall, Department of Anatomy, and Miss Sheila Grace, Department of Materia Medica and Therapeutics, University of Glasgow. Secretarial assistance in the preparation of the manuscript was given by Mrs. M. Strathearn, University of Glasgow.

Many of the illustrations have been previously published, and acknowledgment is made for kind permission to use the following illustrations:

*British Heart Journal*: Figures 2:17, 20, 22, 23, 26

4:31, 32,\* 34,\* 35

6:1, 2, 3,\* 4, 5, 7, 8, 9, 11, 12, 14, 15

*Scottish Medical Journal*: Figures 1:8

3:3

4:1,\* 2,\* 3, 5, 7, 12, 14, 17,\* 18, 19,\* 21,\* 24,

25, 27, 28

6:17

Appendix Figure 2

*British Journal of Radiology*: Figures 1:3, 4, 5

*Quarterly Journal of Medicine*: Figure 3:1

Lea and Febiger, Philadelphia, and Dr. Donald E. Gregg: Figure 4:36

W. F. M. F.

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\*New illustration, similar subject.

## NOTE ON STEREO-VIEWING

**I**N A NUMBER of instances the arteriograms have been presented as stereo-pairs. A simple stereoscope has been provided and the following instructions for its use should be followed. Unfortunately halftone reproductions will not permit the use of stereoscopy at higher magnifications, such as was the practice with the original arteriograms.

Lighting should be bright but shaded from the eyes and should cast no reflections or shadows.

The page should be flat and the stereoscope, eyes and stereo-pairs centred and aligned in the same horizontal plane.

Commence with the stereoscope close to the eyes and about 8 inches from the page. If two separate images are seen, suitable adjustment of the distances of instrument and eyes from the page may assist their fusion. It may be necessary voluntarily to relax accommodation and convergence and to make small movements of tilting and rotation of the stereoscope before fusion of images is achieved. The commonest source of failure is insufficient attention to correct alignment. Some individuals however do not customarily employ binocular vision but parallax for their judgement of three dimensions and may find it impossible to achieve convincing stereoscopy.

Stereovision can also be attained without the aid of lenses by holding the page at a sufficient distance, perhaps twenty inches, from the eyes and, with due attention again to centring and alignment, relaxing convergence until the images swim together and fuse. When this manoeuvre has been successfully carried out, and the stereoscopic view securely held, the page may be brought closer to the eyes, up to the limit of tolerance.



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