Clinical,
Angiographic,
& Pathologic
Profiles

Coronary Heart Disease

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CORONARY HEART DISEASE

CLINICAL, ANGIOGRAPHIC, & PATHOLOGIC PROFILES

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with 1252 figures including 271 LogEtronic scanned radiographs

SPRINGER-VERLAG
New York Heidelberg Berlin
1976

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Library of Congress Cataloging in Publication Data

Main entry under title:

Coronary heart disease.
Bibliography: p. 587
Includes index.
1. Coronary heart disease. I. Vlodaver, Zeev. DNLM: 1. Coronary disease. 2. Angiocardiography. WG300 C8213
RC685. C6C674 616.1'23 75-35842

Printed in the United States of America

ISBN 0-387-90165-5 Springer-Verlag New York
ISBN 3-540-90165-5 Springer-Verlag Berlin Heidelberg

Abbreviations

ACV Anterior cardiac vein
Aneu Aneurysm
Ant Anterior
AP Anteroposterior
Ao Aorta
AoSt Aortic stenosis
AoV Aortic valve
ApB Apical branch
AV Atrioventricular
BP Blood pressure
BUN Blood urea nitrogen
C Catheter
CA Conus artery
Cal Calcification
CB Conus branch
Cir Left circumflex coronary artery
Cl Clip
Coll Collateral
CPK Serum creatinine phosphokinase
CS Coronary sinus
DiagB Diagonal branch
Dissect Dissecting aneurysm
ECG Electrocardiogram
FIP Fibrous intimal proliferation
GCV Great cardiac vein
HBD Serum α-hydroxybutyrate dehydrogenase
IMA Internal mammary artery
Inf Infarct
IntRC Intermediate segment of right coronary artery
IVC Inferior vena cava
LA Left atrium
LAB Left atrial branch
LAD Anterior descending coronary artery
LAO Left anterior oblique
Lat Lateral
LC Left coronary artery (main)
LCB Left coronary branch
LC arteriogram Arteriogram of left coronary arterial system
LDH Serum lactic dehydrogenase
LLB Left lateral branch of right coronary artery
LV Left ventricle
LPA Left pulmonary artery
LPV Left pulmonary vein
LVEDP Left ventricular end-diastolic pressure
LVH Left ventricular hypertrophy
MB Marginal branch
MCV Middle cardiac vein
MRAB Midright atrial branch
MuB Muscular branch
Myo Myocardium
NA Nodal artery
Oc Occlusion
PD Posterior descending coronary artery
Post Posterior
PT Pulmonary trunk
PV Posterior vein
PVLV Posterior vein, left ventricle
RA Right atrium
RAO Right anterior oblique
RAB Right atrial branch
RBB Right bundle branch
RC Right coronary artery
RC arteriogram Arteriogram of right coronary arterial system
RPA Right pulmonary artery
RPV Right pulmonary vein
RV Right ventricle
RVH Right ventricular hypertrophy
SA Sinus node artery
SB Septal branch
SCV Small cardiac vein
SGOT Serum glutamic oxaloacetic transaminase
St Stenosis
SVC Superior vena cava
VCG Vectorcardiogram
VG Vein graft
VSD Ventricular septal defect
WBC Total leukocyte count

Standard Units for Values

Various values are given in this book without reference to the units these represent. The following is a list of the parameters and the units of measurement used.

Blood urea nitrogen	milligrams per 100 milliliters of blood
Heart weight	grams
Hemoglobin	grams per 100 milliliters of blood
pCO_2(arterial blood)	millimeters Hg
pO_2(arterial blood)	millimeters Hg
Sedimentation rate (Wintrobe)	millimeters per hour
Serum cholesterol	milligrams per 100 milliliters of serum
Serum creatinine phosphokinase	international units
Serum α-hydroxybutyrate dehydrogenase	international units
Serum glucose	milligrams per 100 milliliters of serum
Serum glutamic oxaloacetic transaminase	international units
Serum lactic dehydrogenase	international units
Serum phospholipids	milligrams per 100 milliliters of serum
Serum total lipids	milligrams per 100 milliliters of serum
Serum triglycerides	milligrams per 100 milliliters of serum
Serum uric acid	milligrams per 100 milliliters of serum
Total leukocyte count	cells per cubic millimeter of blood

Preface

This book presents a comprehensive picture of ischemic heart disease to those who, either as practitioners or students, deal with the varied facets of this complex subject. It has meaning to the fields of clinical cardiology, radiology, thoracic surgery, and pathology.

After an introductory chapter on the anatomy of the coronary blood vessels, there follows a chapter on coronary arteriography. The latter considers techniques, indications, examples of normal and abnormal patterns, and complications of this procedure.

Specific chapters deal with variations in the sites of origin and distribution of coronary arteries, both as seen angiographically and anatomically. Congenital anomalies of the coronary arteries which may engender states of ischemic heart disease are presented.

The principal thrust of the work concerns the main arena of ischemic heart disease, namely, coronary atherosclerosis. The pathology of coronary atherosclerosis is presented in conjunction with the results of anatomic and angiographic studies.

Major chapters discuss the subjects of angina pectoris, acute myocardial infarction, healed myocardial infarction, surgical "revascularization" with indications and the postoperative states, and the surgical treatment of myocardial infarction and its sequelae.

In these chapters there is also case material from which profiles of the various manifestations are obtained through correlations of clinical, electrocardiographic, vectorcardiographic, angiocardiographic, and pathologic studies. Through these studies, some insight may be obtained into the various manifestations of ischemic heart disease, including the shortcomings of techniques used to diagnose and/or treat various forms of coronary disease.

For those relatively unfamiliar with electrocardiograms, legends are so devised as to give a succinct interpretation and to indicate the essentials from which the interpretation was derived.

In most instances, angiocardiograms are paired with labeled line drawings which help the uninitiated in the reading of films.

The pathologic aspects presented serve not only to establish the anatomic state of affairs in cases presented but will give those outside of the field of pathology insight into the varied pathologic processes observed in the broad field of ischemic heart disease.

It is the hope of the authors that this book presents a comprehensive and real picture of the complexities of ischemic heart disease, both to the person who deals in day to day practice with its problems, as well as to the student and resident who tries to develop firm concepts regarding the varied states observed in this common condition.

Acknowledgments

Many have contributed to the background of this work. Some have donated specimens and related clinical material and many have had an influence in the development of the thoughts that are expressed herein. While it is not possible to name all who in one way or another have contributed, the authors wish to express appreciation to all who have had an influence upon the production of the final product.

Certain specific individuals who are our colleagues either at the University of Minnesota or at the Miller Division of United Hospitals deserve special mention.

At the University of Minnesota Heart Hospital, Cardiovascular Radiology has grown jointly with the Divisions of Cardiovascular Surgery, and Pediatric and Adult Cardiology. Early cooperative effort with the latter three strong divisions prepared the way for continued growth of Cardiovascular Radiology. It was our privilege to be able to have worked with Drs. C. Walton Lillehei and Richard L. Varco, both of whom demanded angiographic demonstration of the coronary arteries at an early date. Later, many cases for coronary angiography were referred by Drs. Aldo R. Castaneda, Richard C. Lillehei, Demetre M. Nicoloff, and William G. Lindsay.

The earliest impetus for coronary angiography came from young, aggressive radiologists and cardiologists. The clinicians, Drs. Naip Tuna and M. John Murray, requested angiographic visualization of the coronary arteries for diagnostic purposes. Dr. Alan Thal, a young surgeon, and Dr. Richard G. Lester, the teacher of one of us (KA), performed the first coronary arteriography in this institution.

Thanks are expressed to the cardiologists, Drs. Yang Wang and Charles Jorgenson, who referred patients for angiography after thorough cardiologic evaluations and to Dr. Arthur H. L. From for clinical data. We are grateful for having had the opportunity to use cases provided by the Division of Pediatric Cardiology under Drs. Ray C. Anderson, Russell V. Lucas, and James H. Moller. We are privileged to be part of a research project by Dr. Henry Buchwald concerning the surgical treatment of patients with hyperlipidemia. Routine coronary angiography carried out on these asymptomatic patients has taught us a great deal about the diagnostic values and limitations of various clinical tests as well as the importance of coronary angiography.

This work could not have been possible without the guidance of an associate and personal friend of one of us (KA), Dr. Augustin Formanek, who expertly performed many thousands of coronary arteriographic procedures. Without the support of Dr. Eugene Gedgaudas, Head, Department of Diagnostic Radiology of the University of Minnesota, the program could not have been brought to fruition.

Great thanks are also expressed to all of our Cardiovascular Fellows and Residents who conscientiously participated in the vast majority of the examinations, some of which are recorded herein.

At the Miller Division of United Hospitals, a community hospital, an atmosphere was established wherein the studies necessary for this work could be done in an unhampered manner. For this, we are grateful to Mr. William N. Wallace, President of United Hospitals, and to its administration. From this hospital, we are appreciative of the efforts and cooperation of Drs. Thomas E. Johnson and John B. Marta, who provided us with some of the coronary arteriograms used in the book, and to Drs. James N. Karnegis, Milton M. Hurwitz, and Allan P. Rusterholz, among others, who supplied clinical and electrocardiographic data. We are conscious of insights provided us into the surgical aspects of coronary heart disease by our surgical colleagues at the Miller Division of United Hospitals, namely, Drs. Bernard G. Goott, John B. Lunseth, Ronald H. Dietzman, Samuel W. Hunter, and Raymond C. Bonnabeau.

Acknowledgment with warmth is made to Drs. Brian C. Campion and Fredarick L. Gobel, Cardiologists at the Saint Paul-Ramsey Hospital and the Minneapolis Veterans Hospital, respectively, for their contributions.

For assistance in the pathologic workup of cases we recognize with appreciation the efforts of many residents in pathology at both the University of Minnesota and the Miller Division of United Hospitals.

For assistance in compilation of material, thanks go to Mary Scherman, and for expert work in the many aspects of developing the manuscript we are deeply indebted to Jane Jungbauer. For art work, the level of our gratitude to Mr. Robert C. Benassi may be judged by the care and quality in the many units which he prepared for us. For quality of our angiograms, thanks go to our technicians, Kathleen, Mary, Sue, and Anette.

冠心病 《临床、血管造影和病理学》

本书是以冠心病为专题的图谱性书籍，除X线照像外，并附有简图说明，它从临床、血管造影、胸外科和病理学等不同的侧面，讨论了冠心病和其他冠状动脉异常和疾患，反映了自冠状动脉造影广泛应用以来，对冠心病的一些新认识。书中用较大篇幅讨论了心绞痛、急性心肌梗塞、愈合性心肌梗塞、血运再建外科、心肌梗塞及其后遗症的外科治疗等。在叙述中还采用例症解说。内容充实。可供心血管病专科、内科、外科、儿科、放射科医师和病理学工作者参阅。

目次：①冠状血管的解剖，②冠状动脉造影，③冠状动脉开口水平的变异，④冠状动脉开口部位的变异，⑤冠状动脉发育不全，⑥左冠状动脉长度的变异，⑦单独冠状动脉开口，⑧冠状动脉异常连通，⑨阻塞性冠心病的病理，⑩血管造影—病理对照分析，⑪心绞痛，⑫中间综合症，⑬急性心肌梗塞，⑭愈合性心肌梗塞，⑮血运再建外科，⑯心肌梗塞及其后遗症的外科治疗。

Contents

1 ANATOMY OF THE CORONARY VESSELS

The two main coronary arteries, the right and the left, originate from the aorta (Ao); in about half the population, a third artery, the so-called conus artery (CA), also originates from the Ao.

There are two types of cardiac veins: (1) the large veins, which run in the epicardium and terminate in the coronary sinus (CS), and (2) the Thebesian veins, which terminate directly in either the right (RA) or left atrium (LA).

The Right Arterial System

The Right Coronary Artery

The right coronary artery (RC) arises from the upper part of the right aortic sinus; as it leaves the Ao, it points somewhat anteriorly and proceeds toward the right between the pulmonary artery, to its left, and the RA, to its right, to enter the right atrioventricular (AV) sulcus. It then passes along the right AV sulcus past the acute margin of the heart to the base of the posterior (Post) interventricular sulcus (the "crux").

The RC terminates at the crux about 10 percent of the time (James, 1961), but it is far more common for the artery to form a sharp, U-shaped turn and continue in the crux toward the cardiac apex as the posterior descending artery (PD). Several branches of the RC have been given names.

When the CA does not begin at the Ao, it appears as the first branch of the RC and supplies the right ventricular infundibulum. Usually, (about 55 percent of the time) the next major branch arising from the RC is the sinus node artery (SA) (James, 1974), which runs posterior to the RA appendage and proceeds upward toward the junction of the superior vena cava (SVC) and the RA. In its course, it supplies branches to the RA.

Past the origin of the SA another right atrial branch usually arises, often called the mid-right atrial branch (MRAB).

The RC also gives off two or more branches to the free wall of the right ventricle (RV), some passing over the anterior wall of the RV, the muscular branches (MuB). The largest branch of the RC runs along the acute margin of the RV and is called the marginal or acute marginal branch (MB). The MB supplies the anterior and diaphragmatic walls of the RV.

In many hearts, the RC terminates as the PD. However, the RC terminates frequently by dividing into two branches, namely, the PD and a left lateral branch (LLB). The latter courses in the left AV sulcus for varying distances and then proceeds over the lateral wall of the left ventricle (LV), where it terminates. In some such cases, an accessory PD originates from the LLB and courses over the diaphragmatic surface of the LV from its base toward the apex.

The artery of the AV node, the so-called nodal artery (NA), usually arises from the RC just proximal to the origin of the PD. It proceeds upward to penetrate the atrial septum for supply of the AV node.

For the purposes of this book the RC is divided into two segments, the Ant and the intermediate. The Ant segment lies between the vessel's origin and the level of origin of the MB. The intermediate segment of the RC lies between the origins of the MB and the PD.

Anatomy of the Coronary Vessels

The Right Arterial System

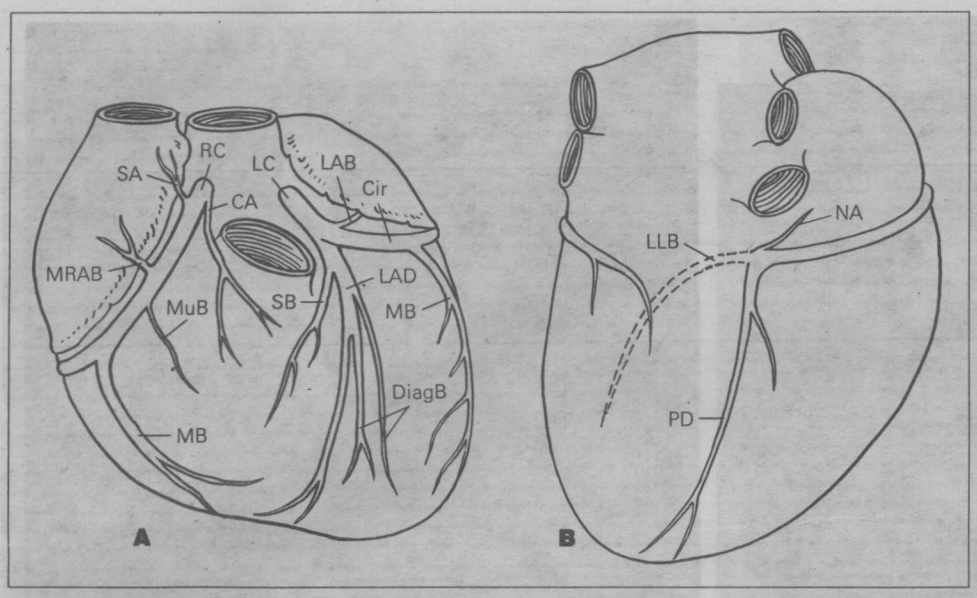


FIG. 1: Diagrams of the main coronary arteries and their branches seen from the anterior (**A**) and posterior (**B**) aspects of the heart. In this illustration is shown the common phenomenon in which the PD arises as the terminal branch of the RC. Variation from this pattern is shown in Figures 2 through 4.

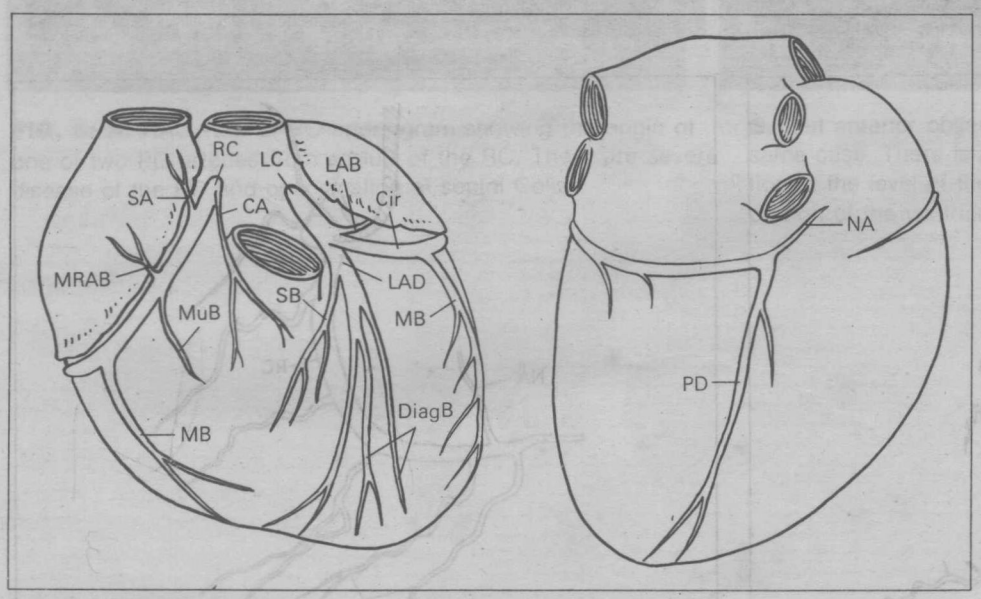
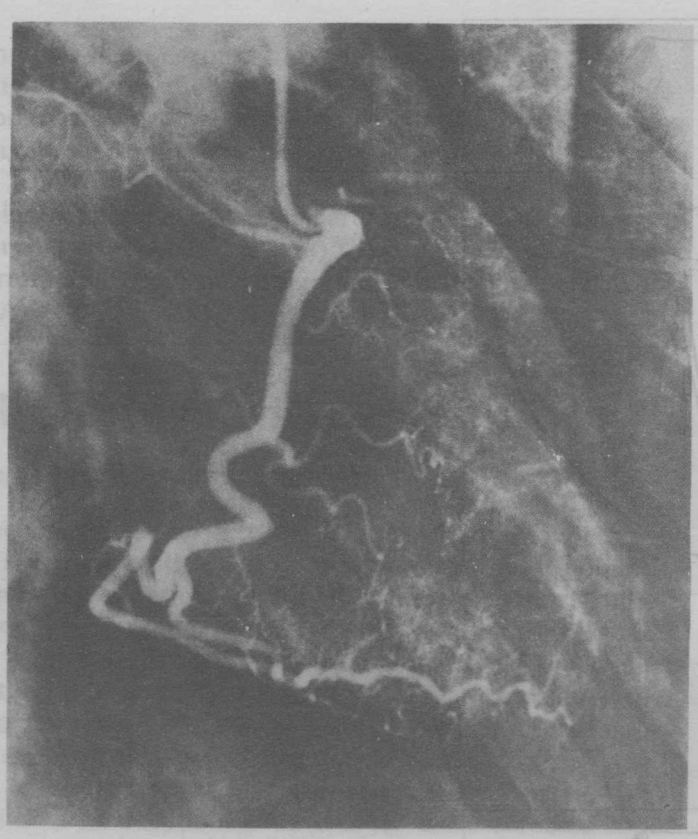
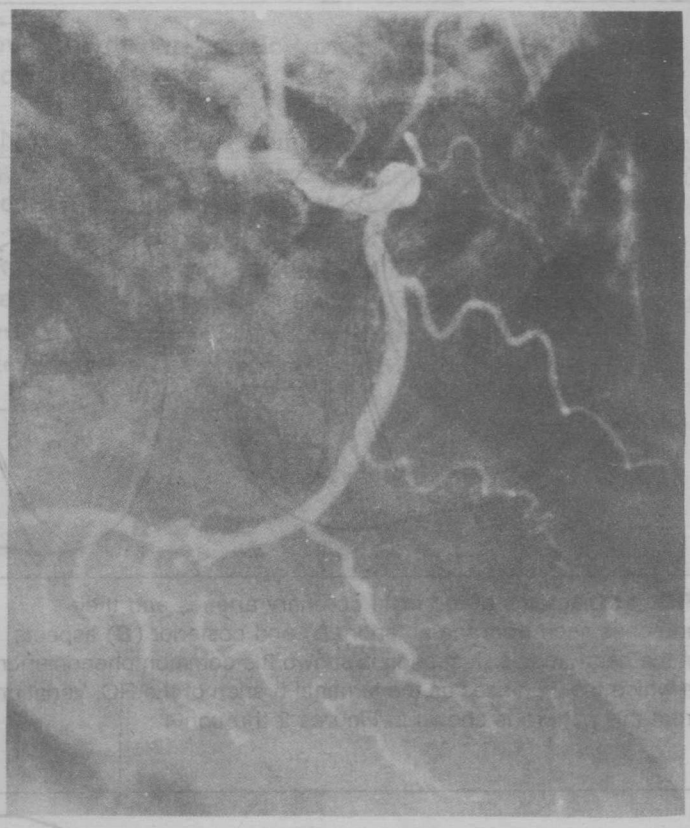


FIG. 2: A variation in distribution of the coronary arteries, occurring in about 10 percent of the population, in which the PD is represented as the terminal branch of the circumflex artery (Cir).

Diagrams of the main coronary arteries and their important branches are shown in Figures 1 and 2.





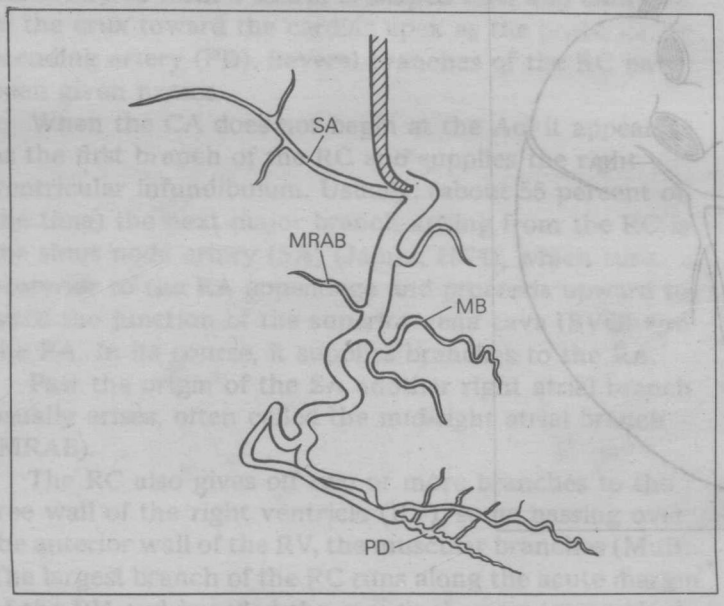


FIG. 3: Normal RC seen in an RC arteriogram in the right anterior oblique (RAO) position. The CA is not visualized; it is presumed to have arisen from the Ao. Two PD branches are present.

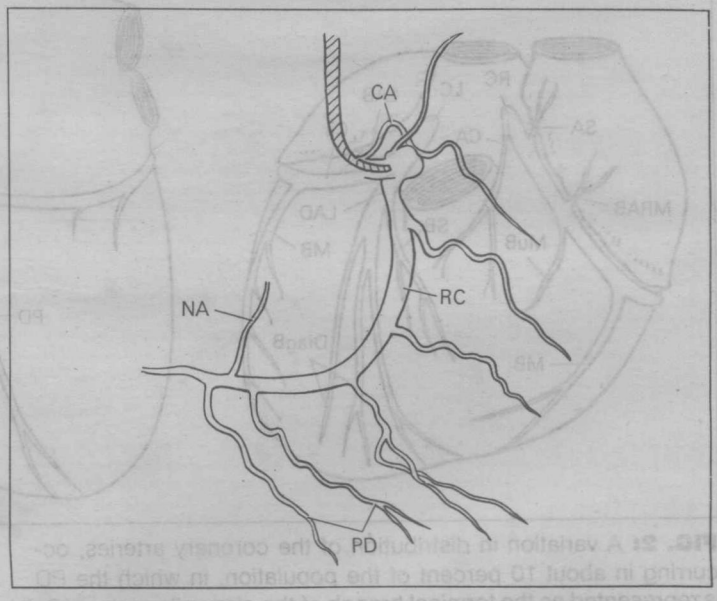


FIG. 4: Normal RC seen in an RC arteriogram in RAO view, in which the CA arises from the RC. The terminal portion of the RC continues beyond two PD branches, and, although not clearly visualized, an example of a LLB can be observed.