

CT Evaluation of Coronary Artery Disease

Paolo Pavone • Massimo Fioranelli • David A. Dowe

CT Evaluation of Coronary Artery Disease

PAOLO PAVONE
Director, Department of Radiology
"Mater Dei" Hospital
Rome, Italy
Former Chairman
Department of Radiology
University of Parma
Parma, Italy
paolo.pavone@materdei.it

DAVID A. DOWE
Coronary CTA Program Director
Atlantic Medical Imaging
Galloway, NJ, USA

MASSIMO FIORANELLI
Department of Cardiology
"Mater Dei" Hospital
Guglielmo Marconi University
Rome, Italy
massimo.fioranelli@fastwebnet.it

Originally published as:

Malattia coronarica

Fisiopatologia e diagnostica non invasiva con TC

Paolo Pavone, Massimo Fioranelli

© Springer-Verlag Italia 2008

All rights reserved

Library of Congress Control Number: 2008938918

ISBN 978-88-470-1125-0 Springer Milan Berlin Heidelberg New York
e-ISBN 978-88-470-1126-7

Springer is a part of Springer Science+Business Media
springer.com
© Springer-Verlag Italia 2009

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilm or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the Italian Copyright Law in its current version, and permission for use must always be obtained from Springer. Violations are liable to prosecution under the Italian Copyright Law.

The use of general descriptive names, registered names, trademarks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use. Product liability: The publishers cannot guarantee the accuracy of any information about dosage and application contained in this book. In every individual case the user must check such information by consulting the relevant literature.

Typesetting: C & G di Cerri e Galassi, Cremona, Italy
Printing and binding: Arti Grafiche Nidasio, Assago (MI), Italy

Printed in Italy

Springer-Verlag Italia S.r.l., Via Decembrio 28, I-20137 Milan, Italy

Preface

Coronary CT angiography (CTA) is rapidly changing the patient-care algorithms used to detect coronary artery disease, as well as the approach we take in risk-factor assessment and in the triage of patients. The rapid adoption of coronary CTA into clinical practice has been fueled by significant yearly advances in CT technology, which have improved the spatial and temporal resolution of this technique while simultaneously decreasing radiation exposure.

The growing utilization of coronary CTA has created a need for comprehensive didactic texts that explain the numerous applications of this new technology with respect to the pathophysiology of coronary artery disease, while also providing information on the approach to patients who have undergone previous bypass surgery or percutaneous coronary intervention. I believe this book accomplishes both of these goals, and does so in a reader-friendly format. The image quality of the many figures that accompany each chapter is excellent and reflects the use of state of the art technology. The techniques described for plaque detection and characterization represent the current thinking pervasive in the coronary CTA community. The comprehensive reference list at the end of the book offers the reader a wealth of resources for further study.

There is no doubt that this book will be popular with radiologists, cardiologists, CT technologists and anyone else seeking to acquire a comprehensive understanding of coronary artery disease and its depiction using coronary CTA.

Galloway, October 2008

David A. Dowe, MD

Contents

1	Clinical Anatomy of the Coronary Circulation	1
	MASSIMO FIORANELLI, CARLO GONNELLA, STEFANO TONIONI	
	Angiographic Anatomy of the Coronary Circulation	2
	Intramyocardial Vascularization and the Venous Circulation	6
	Variability of the Coronary Artery Circulation	7
	Anomalous Coronary Arteries	9
	Factors Determining Coronary Artery Size	10
2	Basic Techniques in the Acquisition of Cardiac Images with CT	15
	PAOLO PAVONE	
	Technical Principles in the Acquisition of Cardiac Images by CT	15
	From Conventional to Spiral CT	17
	From Spiral to Multislice CT	18
	Detector Number and Cardiac Imaging	20
	Temporal Resolution in Cardiac Imaging	20
	Types of Equipment and Their Clinical Uses in Cardiac Imaging	22
	Other Factors That Improve the Image Quality of CT Technology	23
3	CT Examination of the Coronary Arteries	25
	PAOLO PAVONE	
	Achieving Excellent Image Quality in CT of the Coronary Arteries	25
	Patient Preparation	26
	Informed Consent	26
	Bradycardia	27
	CT Angiography of the Coronary Arteries	28
	Contrast-Agent Injection	28
	Contrast-Agent Injection: Role of Resistance and Venous Anatomy	29
	Contrast-Agent Injection: Flow Rate and Amount	31
	Contrast Agents for CT Angiography of the Coronary Arteries:	
	Characteristics and Concentrations	32
	Optimizing the Imaging-Acquisition Window in CT Angiography of the	
	Coronary Arteries	33
	Cardiosynchronized Acquisition	33

4	Image Reconstruction	37
	PAOLO PAVONE	
	Planimetric Techniques	38
	Axial Images	38
	Multi-Planar Reformatting	38
	Reconstruction of the Curved Plane: Curved MPR	39
	Clinical Use of Planimetric Techniques	42
	Volumetric Techniques (Volume Rendering)	43
	Orthogonal and Perspective Imaging	43
	Volume Rendering of Human Anatomy	45
	Color and Virtual Lighting	46
	Clinical Use of Volume-Rendering Images	48
	Virtual Endoscopy	50
5	Coronary Pathophysiology	53
	MASSIMO FIORANELLI, CHIARA LANZILLO, FRANCESCO PEVERINI	
	Coronary Flow Reserve	54
	Coronary Stenosis: Definition and Evaluation in Coronary	
	Artery Disease	54
	The Limits of Coronary Angiography	56
6	The Atherosclerotic Plaque	59
	MADDALENA PIRO, SARA DI MICHELE, MASSIMO FIORANELLI	
	The Vulnerable Plaque: Biology and Histology	60
	The Vulnerable Plaque: Local and Systemic Factors Contributing to	
	Plaque Rupture	62
	Conclusion	64
7	Intravascular Ultrasound: From Gray-Scale to Virtual Histology	67
	FABRIZIO CLEMENTI, GIUSEPPE M. SANGIORGI	
	Introduction	67
	From Gray-Scale to Color-Coded IVUS: The Virtual-Histology Revolution	68
	Lesion Classification Using IVUS-VH	71
	IVUS-VH Console and Image Interpretation: Tips and Tricks	73
	Conclusion	74
8	Identification and Characterization of the Atherosclerotic Plaque Using Coronary CT Angiography	75
	PAOLO PAVONE, DAVID A. DOWE	
	Normal Vascular Wall	75
	Identification of Atherosclerotic Plaques in Coronary CT Angiography	76
	CT Density Values and Plaque Characterization: Fibrolipidic and Calcific Plaques	76
	Atherosclerotic Plaque and Disease Evolution	78
	Diagnostic Evaluation of Coronary Disease During Medical Therapy	83

9	Coronary CT Angiography: Evaluation of Stenosis and Occlusion	85
	PAOLO PAVONE, ROBERTO LEO	
	Non-Significant Moderate Stenosis	86
	Calcified Plaques: Problems in Defining Vascular Stenosis	87
	Significant Stenosis	89
	Remodeling	93
	Occlusion of the Coronary Arteries and the Development of Collateral Circulation	94
	Evaluation of Coronary-Artery Stenosis: A Review of the Literature	97
	Saving Lives	97
10	Current Strategies in Cardiac Surgery	103
	PAOLO SORDINI	
	Standard Grafting Techniques	103
	Results	106
11	Coronary CT Angiography: Evaluation of Coronary Artery Bypass Grafts	107
	MARCELLO DE SANTIS, PAOLO PAVONE	
	Pre-Operative CT Evaluation	107
	Post-Operative Evaluation of CABG	108
	CT Evaluation of CABG: Technique	109
	CT Evaluation of CABG: Results	109
12	Coronary Stents	113
	ENRICA MARIANO, GIUSEPPE M. SANGIORGI	
	Types of Stents	114
	Mechanism of Stent Expansion	115
	Materials	116
	Raw Material	116
	Fabrication Methods	116
	Geometry	118
	Closed Cell	118
	Open Cell	118
	Coatings	119
	Additions	119
	Radio-Opacity Enhancements	119
	Drugs	119
	Impact of Stent Design on Clinical Outcome	121
	Acute Outcome	121
	Long-Term Outcome	122
	Stent Coating	122
	Drug Elution	123
	Bioabsorbable and Biocompatible Stents	124
	Polymer-Free Solutions	126
	Biodegradable Platforms	126

	Tyrosine-Derived Polycarbonate	127
	Magnesium Alloy	127
	Conclusion	127
13	CT Angiography of Coronary Stents	129
	MARCELLO DE SANTIS, PAOLO PAVONE	
14	X-ray Exposure in Coronary CT Angiography	133
	PAOLO PAVONE	
	Damage from Ionizing Radiation	133
	X-ray Dose During CT	134
	Techniques for Limiting X-ray Exposure in Coronary CT Angiography	134
	X-ray Exposure and Patient Age	136
	Conclusion	137
15	Use of MSCT Scanning in the Emergency-Room Evaluation of Patients with Chest Pain	139
	GIULIO SPECIALE, VINCENZO PASCERI	
	Causes of Acute Chest Pain	140
	Multislice CT Scanning in Acute Chest Pain	142
	The “Triple Rule Out” Protocol	144
	Conclusion	144
16	Current Recommendations for Coronary CT Angiography	147
	MASSIMO FIORANELLI, FRANCESCA SBANDI	
	Technical Considerations	148
	Evaluation of Coronary Stenoses in Patients at Low or Intermediate Risk of Cardiovascular Disease	148
	Evaluation of Coronary-Artery Bypass Patency	149
	Other Frequent Uses of Coronary CT Angiography	150
	Contraindications to Coronary CT Angiography	150
	Future Directions in Non-invasive Coronary Artery Imaging with Coronary CT Angiography	150
17	Prognostic Value of Coronary CT	153
	MASSIMO FIORANELLI, ANTONIO LUCIFERO	
	Suggested Readings	157

Contributors

FABRIZIO CLEMENTI
Interventional Cardiology Unit
“Tor Vergata” University
Rome, Italy

MARCELLO DE SANTIS
Department of Radiology
“Mater Dei” Hospital
Rome, Italy

SARA DI MICHELE
Department of Cardiology
“Mater Dei” Hospital
Rome, Italy

MASSIMO FIORANELLI
Department of Cardiology
“Mater Dei” Hospital
Guglielmo Marconi University
Rome, Italy

CARLO GONNELLA
Department of Cardiology
“Mater Dei” Hospital
Rome, Italy

CHIARA LANZILLO
Department of Cardiology
“Mater Dei” Hospital
Rome, Italy

ROBERTO LEO
Department of Internal Medicine
“Tor Vergata” University
Rome, Italy

ANTONIO LUCIFERO
Department of Cardiology
“Mater Dei” Hospital
Rome, Italy

ENRICA MARIANO
Interventional Cardiology Unit
“Tor Vergata” University
Rome, Italy

VINCENZO PASCERI
Interventional Cardiology Unit
San Filippo Neri Hospital
Rome, Italy

PAOLO PAVONE
Department of Radiology
“Mater Dei” Hospital
Rome, Italy

FRANCESCO PEVERINI
Department of Internal Medicine
“Mater Dei” Hospital
Rome, Italy

MADDALENA PIRO
Department of Cardiology
“Mater Dei” Hospital
Molecular and Cellular Cardiology
Sacred Heart University
Rome, Italy

XII Contributors

GIUSEPPE M. SANGIORGI
Interventional Cardiology Unit
Emo Centro Cuore Columbus
San Raffaele Hospital
Milan, Italy

FRANCESCA SBANDI
Department of Cardiology
“Mater Dei” Hospital
Rome, Italy

PAOLO SORDINI
Heart Surgery Unit
San Filippo Neri Hospital
Rome, Italy

GIULIO SPECIALE
Interventional Cardiology Unit
San Filippo Neri Hospital
Rome, Italy

STEFANO TONIONI
Interventional Cardiology Unit
Fatebenefratelli, San Pietro Hospital
Rome, Italy

Clinical Anatomy of the Coronary Circulation

Massimo Fioranelli, Carlo Gonnella, Stefano Tonioni

In the anatomic evaluation of the coronary arteries by multi-slice computed tomography (MSCT), the classification of the American Heart Association, which divides these vessels into 15–16 segments, including those segments with diameters > 1.5 mm, is often used (Fig. 1.1). In this chapter, a more complex classification will be applied as it provides a more detailed anatomic picture.

The right coronary artery (RCA) takes origin from the right aortic sinus of Valsalva and then divides to form two terminal branches, the posterior descending artery (PDA) and the posterolateral (PLV) branches. Along its

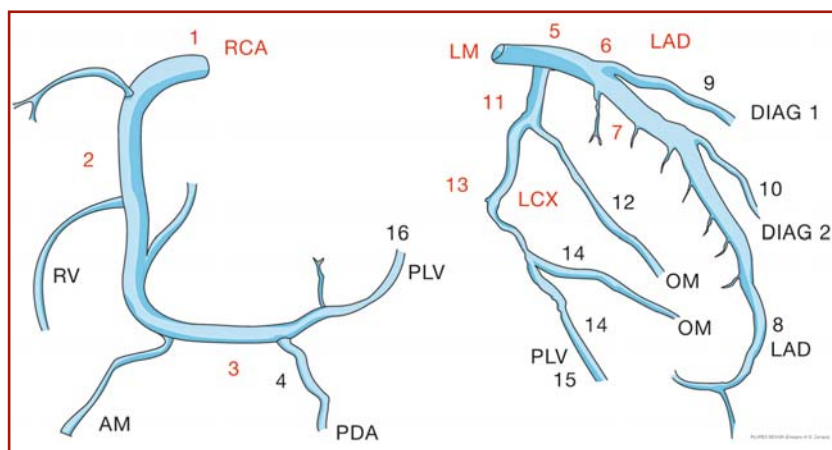


Fig. 1.1. The American Heart Association divides the coronary tree into 15–16 segments. *RCA* Right coronary artery, *RV* right ventricular branch, *AM* acute marginal branch, *PLV* posterolateral ventricular branch, *PDA* posterior descending artery, *LCA* left coronary artery, *LM* left main artery, *LAD* left anterior descending artery, *DIAG 1* 1st diagonal branch, *DIAG 2* 2nd diagonal branch, *LCx* left circumflex artery, *OM* obtuse marginal branches

course, the RCA gives off several branches: the sinus node artery, right ventricular (RV) branches, acute marginal (AM) branch, and the atrioventricular node artery.

The left coronary artery (LCA) arises from the left aortic sinus; the left main (LM) branch of the LCA ends in a bifurcation, giving rise to the left anterior descending artery (LAD) and the left circumflex artery (LCx); sometimes, a third ramus intermedius is present between these two branches. The LAD gives off septal (SP) and diagonal (DIAG) branches and ends at the apex of the heart, sometimes reaching the posterior interventricular groove. The LCx has two or three marginal branches (OM), before either terminating or, in the case of left-dominant or balanced circulation, giving off a posterolateral branch or ending in the posterior atrioventricular groove. Figure 1.1 shows the myocardial areas perfused by the RCA, LAD, and LCx.

Angiographic Anatomy of the Coronary Circulation

In the following, the coronary anatomy is described using the classification proposed in the *Bypass Angioplasty Revascularization Investigation* (BARI) trial reported by Alderman and Stadius (1992), in which the coronary arteries are separated into 29 segments (Fig. 1.2).

The coronary trees have two principal components: (1) the arteries and the veins, which course and ramify on the surface of the heart (subepicardial system), and (2) their perforating branches (intramyocardial system).

The subepicardial system is formed by the right and left coronary arteries, arising from the right and left aortic sinus of Valsalva, respectively. The RCA is divided into three segments. The first segment (BARI 1) extends from the coronary ostium to the first RV branch; if the latter is not present, the segment is usually identified between the ostium and the acute margin of the heart. The second segment (BARI 2) extends from the first RV branch to the acute margin of the heart, which usually coincides with the origin of the AM branch (BARI 10). This vessel is the most constant branch of the RCA and it runs on the surface of the free wall of the right ventricle in the direction of the apex, at an angle proportional to the proximity of its origin. The third segment (BARI 3) begins at the acute margin of the heart and courses to the origin of the PDA (BARI 4), at the level of the crux cordis. At this level, in right-dominant circulation (85% of cases), the RCA divides into two terminal branches, the PDA and PLV branches (BARI 5), perfusing the diaphragmatic wall of the left ventricle. In the remaining 15% of cases, the circulation may be left-dominant or balanced: in left-dominant circulation, the PLV and PDA originate from the LCx; in balanced circulation, the PDA originates from the RCA, and the PLV from the LCx.

The concept of dominance is defined by the relationship between the RCA and LCx, according to the origin of the PDA and in relation to the arterial supply of the inferior wall of the left ventricle, but not in relationship to the extent of the circulatory system.

The PDA, also called the posterior interventricular branch, with its septal branches (BARI 9), is the most important branch of the RCA; it courses in the

homonymous groove without reaching the apex of the heart, which is usually supplied by the recurrent branch of the LAD. The PLV immediately originates after the PDA, at the level of the crux cordis. It courses along the posterior atrioventricular sulcus, branching with its collateral vessels (BARI 6–8) at the diaphragmatic and inferioposterior wall of the left ventricle.

The RCA furnishes smaller branches such as the conus artery, sinus node artery, RV branches, and atrioventricular node artery (Fig. 1.3). The conus artery is the first vessel originating from the RCA. In 40% of the cases it directly originates from the right aortic sinus or from the aorta. The sinus node artery arises from the RCA (2/3 of the cases); in the 25% of cases, it may originate from the LCx, while in 10% the two vessels arise from both coronary arteries. The RV branches originate in the second segment of the RCA and run along the surface of the RV, anterior to the interventricular groove. The number

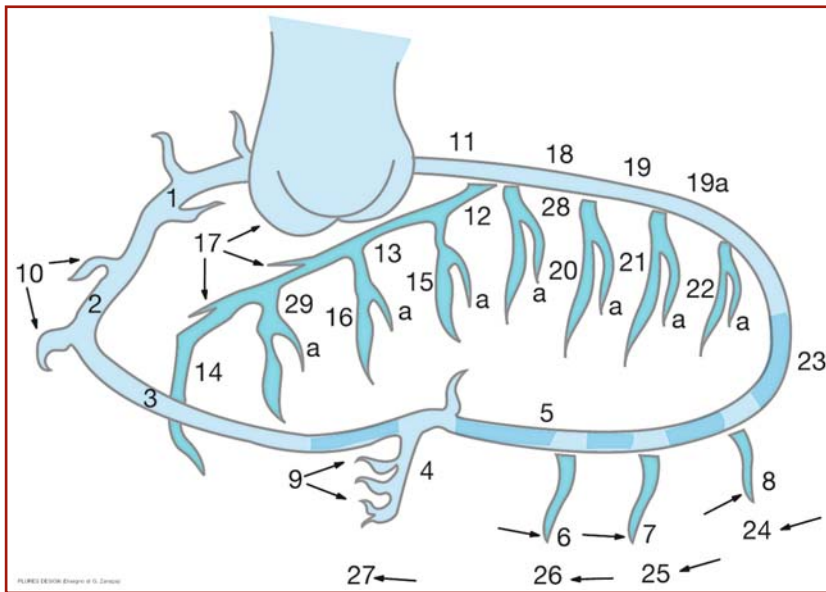


Fig. 1.2. Map of the coronary arterial tree according to the BARI Study Group. This map was used in CASS (Coronary Artery Surgery Study) and includes the diagonal, marginal, and Valsalva branches. The coronary arteries are divided into 29 segments: 1 Proximal segment of the right coronary artery (RCA), 2 middle segment of the RCA, 3 distal segment of the RCA, 4 posterior descending artery (PDA), 5 posterolateral branch of the RCA (PLV), 6 1st posterolateral branch of the RCA, 7 2nd posterolateral branch of the RCA, 8 3rd posterolateral branch of the RCA, 9 inferior septal branches, 10 acute marginal branches of the RCA, 11 left main of the left coronary artery (LM), 12 proximal segment of the left anterior descending artery (LAD), 13 middle segment of the LAD, 14 distal segment of the LAD, 15 1st diagonal branch (DIAG), 15a lateral 1st diagonal branch, 16 2nd diagonal branch, 16a lateral 2nd diagonal branch, 17 septal branches of the LAD (SP), 18 proximal segment of the left circumflex artery (LCx), 19 middle segment of the LCx, 19a distal segment of the LCx, 20 1st obtuse marginal branch (OM), 20a lateral 1st obtuse marginal branch, 21 2nd obtuse marginal branch, 21a lateral 2nd obtuse marginal branch, 22 3rd obtuse marginal branch, 22a lateral 3rd obtuse marginal branch, 23 LCx continuing as the left atrioventricular branch, 24 1st left posterolateral branch, 25 2nd left posterolateral branch, 26 3rd left posterolateral branch, 27 left posterior descending artery (PD) (in left-dominant circulation), 28 ramus intermedius, 28a lateral ramus intermedius, 29 3rd diagonal branch, 29a lateral 3rd diagonal branch

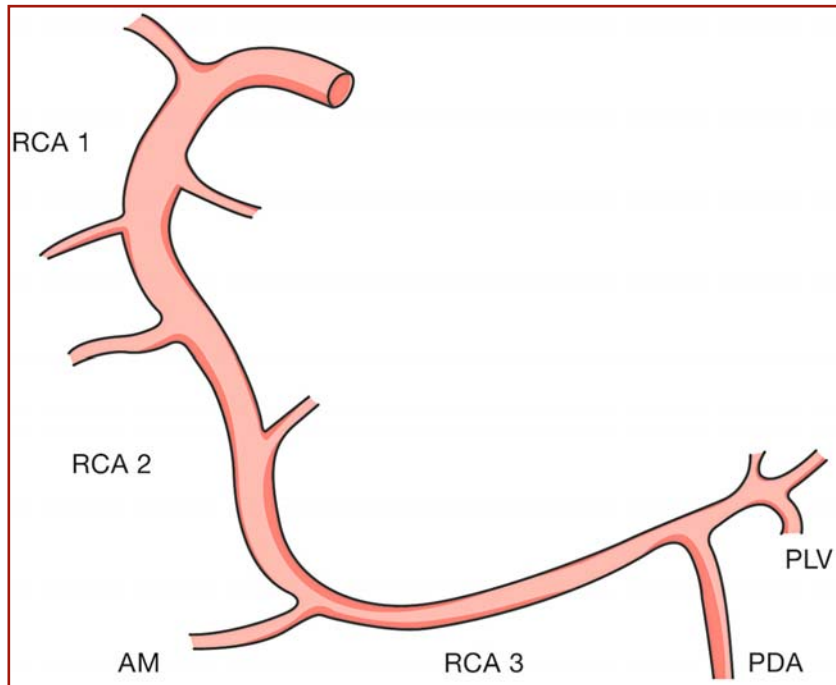


Fig. 1.3. Right coronary artery in left anterior oblique (LAO) view. *RCA* Right coronary artery (segments 1–3), *AM* acute marginal branch, *PLV* posterolateral branch, *PDA* posterior descending artery

of these branches varies greatly and is inversely proportional to the diameter of such vessels. In 99% of the cases of right-dominant circulation and in 75% of the cases of balanced circulation, the atrioventricular node artery arises at the end of the third segment of the RCA. It is important in the angiographic identification of the crux cordis. In individuals with left-dominant circulation, it originates from the distal segment of the LCx. At the level of Koch's triangle is the subendocardial artery, situated between the septal cuspid of the tricuspid valve and the coronary sinus; it furnishes branches to the posterior interventricular septum and the atrioventricular node.

The LCA arises from the left aortic sinus, at a higher level than the RCA, and is divided into three segments (Fig. 1.4). The LM branch of the LCA (BARI 11) extends for a varying length (generally 2 cm, diameter 3–6 mm) from the ostium to the bifurcation of the LAD and LCx. In 30–37% of the cases, the LM artery gives off three branches, one of which, the ramus intermedius (BARI 28), runs toward the apex and supplies the anterolateral wall of the left ventricle.

The LAD is the most constant, in origin and distribution, among all the coronary vessels. It originates from the LM artery and runs in the anterior interventricular groove to the apex of the heart. In 70% of the cases, the LAD extends up to the posterior interventricular groove such that it furnishes branches for perfusion of the inferior interventricular septum and the apex; otherwise, these arise along the length of the PDA. The first segment of the LAD (BARI 12) runs from the bifurcation of the LM artery to the origin of

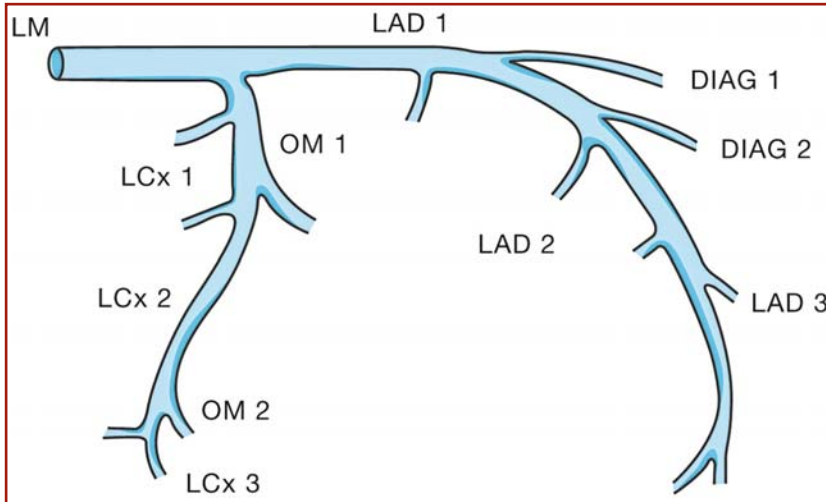


Fig. 1.4. Left coronary artery in caudal right anterior oblique (RAO) view. *LM* Left main artery, *LAD* left anterior descending artery (segments 1–3), *DIAG 1* 1st diagonal branch, *DIAG 2* 2nd diagonal branch, *LCx* left circumflex artery (segments 1–3), *OM 1* 1st obtuse marginal branch, *OM 2* 2nd obtuse marginal branch

the first septal branch (SP, BARI 17). The second segment (BARI 13) extends from the origin of the first septal branch to the origin of the third septal or second DIAG branch. The third segment (BARI 14) ends at the apex, surrounding and sometimes traveling up to the posterior wall. When the third SP or second DIAG branch is not identified, the end of the second segment of the LAD is conventionally defined as the half-length between the first SP and the apex. The LAD furnishes branches for the anterior interventricular septum and the anterolateral wall of the left ventricle. There are generally three SP branches and they originate at right angles from the LAD.

The first SP branch is constant in its origin and course; thus, it is important to identify its passage between the proximal and middle segments of the LAD. Some segments may run intramyocardially, but generally they develop caudally, along the interventricular septum, and supply the proximal two-thirds of the anterior septum. The second and third SP branches are more variable, with narrow diameters; they supply the distal third of the anterior septum. There are usually three DIAG branches (BARI 15, 16–29), each of which originates at an acute angle from the LAD; their pathway is to the anterolateral wall of the left ventricle. The diameter of these vessels is inversely proportional to the number of branches.

The LCx develops from the LM artery and runs in the posterior atrioventricular groove; after a short tract under the left atrium, it continues in the left posterior atrioventricular groove and contacts the mitral annulus. The LCx splits into three segments. The first (BARI 18) extends from the origin to the first marginal branch (OM, BARI 20). If the first OM is absent or not clearly identifiable, the zone of transition among the first and second segments is conventionally identified by a point corresponding to the half-length between the origin of the LCx and the origin of the second OM (BARI 21). The second

segment (BARI 19) runs from the origin of the first OM to the origin of the second OM. If the second marginal branch is absent, the zone of transition is defined by the half-length between the origin of the first OM and the point where the circumflex artery terminates. The third segment (BARI 19a), in right-dominant circulation, extends from the origin of the second OM to the termination point of the vessel; in left-dominant or balanced circulation, to the point of origin of the left ventricular branch or the posterolateral branch in the posterior atrioventricular groove (BARI 23). In left-dominant circulation, the LCx gives rise to the left ventricular branch or PLV, with its side branches (BARI 24–26) and to the PDA (BARI 27), with its septal branches (BARI 9).

The LCx gives rise to the sinus node artery, left atrial branch, and marginal branches. In 25% of the cases, the sinus node artery arises from the proximal segment of the LCx, near the ostium. The atrial branch originates at the end of the proximal segment and runs to the inferoposterior wall of the left atrium. Of the three OM branches, the first one is usually larger and constant; it terminates on the posterolateral wall of the left ventricle toward the apex. Its development is inversely proportional both to the extent of the RCA on the posterolateral surface of the left ventricle and to the number and development of the diagonal branches of the LAD.

Intramyocardial Vascularization and the Venous Circulation

After oxygen and nutritional substrates have been extracted by the myocardium, a portion of the desaturated blood is transported directly into the ventricles through the Thebesian veins. Nevertheless, most of the blood, through the venules and myocardial veins, goes to the epicardial veins, which drain in the coronary sinus, located in the inferoposterior region of the right atrium.

The epicardial arteries are muscular vessels with a wall thickness of about 100 μm ; they are made up of three overlapping layers: intima, media, and adventitia. These arteries, which transport oxygenated blood to the arteries, arterioles, and capillaries, traverse the surface of the heart covered by epicardium or sometimes by subepicardial adipose tissue. Muscular bridges of variable length, in which the epicardial vessels become intramyocardial, are present in 5–22% of the cases at the anterior LAD and in 86% in the other coronary arteries (Fig. 1.5).

Normal embryological development of the coronary circulation involves the formation of collateral vessels, that link the different sections of the arterial circulation. The collateral circulation consists of four types of vessels: intramyocardial vessels originating from the same vessel (intracoronary circulation), intramyocardial vessels originating from two or more coronary arteries (intercoronary circulation), atrial vessels connecting with the vasas vasorum of the aorta or other arteries (extracardiac circulation), and intramyocardial vessels that directly communicate with the ventricles (arteriolar luminal circulation). In the normal adult myocardium, the collateral circulation consists of small-caliber vessels ($< 50 \mu\text{m}$ in diameter) that contribute only marginally to coronary flow. In the presence of obstruction or myocardial ischemia, the diameter of the collateral vessels expands to 200–600 μm ; the growth of a medial layer allows a significant quantity of blood flow. The development of collaterals results in the formation of connections among proximal and distal segments of a vessel crossing a stenosis.

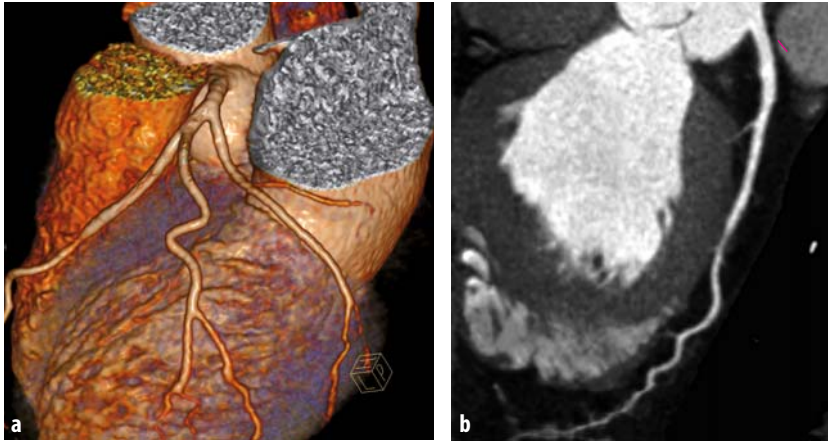


Fig. 1.5 a, b. Myocardial bridging of the left anterior descending artery reduces the arterial diameter

Variability of the Coronary Artery Circulation

The above-described anatomic scheme is highly variable. This is in contrast to other arterial vascular districts, which have a constant, readily identifiable anatomy, such as the carotid, or iliac-femoral arteries, where, except for differences of caliber, the morphology, origin, and anatomic course are the same between individuals. Variations in the coronary arteries include the type of dominance, differences in caliber, and alternative branch morphologies. This aspect of the coronary circulation must be kept in mind during diagnostic evaluation of the arteries, to avoid considering an artery that is small and poorly developed as a stenosis.

The variability of the coronary circulation is such that two patients rarely have the same coronary vascular anatomy. In this context, the use of terminology such as “strongly developed branch” or “hypoplastic vessel” identifies the development of the vessel but does not denote the presence or absence of atherosclerotic lesions. For example, in some patients, the course and caliber of the LCx are highly developed, while in others the artery may be small and perfuse only a small portion of the myocardium. These differences are compensated for by the development of other vessels, which balance the perfusion of a myocardial region by a hypoplastic artery perfusion. The morphology of an artery and the extent of the territory it perfuses are very important considerations in therapeutic planning. The larger the myocardial region perfused by an artery, the greater the justification for a myocardial revascularization procedure in the presence of a critical stenosis.

As shown in Figure 1.6, there are some cases in which the LAD is more developed than the LCx, but in other situations the LCx is more developed and perfuses the largest part of the left ventricle. The caliber of the branches originating from these two arteries depends on the size of the artery from which they derive; that is, the DIAG branches will be of larger caliber than the OM branches when the LAD is more developed than the LCx, while the OM branches will be more developed if the caliber of the LCx is larger.