HEMODINÂMICA E CARDIOLOGIA INVASIVA

Coronariografias

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Indicações Atuais

- Angina pectoris refratária a terapia clínica otimizada
- Avaliação mais aprofundada para cirurgia de revascularização
- Isquemia silenciosa com teste não inavsivo positivo
- Síndromes Coronarianas Agudas
- Complicações mecânicas pós IAM (ruptura de núsculo papilar, defeito do septo intraventricular ou aneurisma de VE)

Indicações Atuais

- Coronariografia em pacientes em que DAC é incerta
- Dor torácica com teste provocativo incerto
- Insuficiência cardíaca e arritmias ventriculares
- Correção de doença congênita ou valvar

Técnica

- Injeções não seletivas na raiz da aorta
- Avaliação de lesões ostiais, anomalia de óstio de coronária e enxertos de coronárias
- Abordagem braquial ou femoral
- Vantagem braquial: doença vascular periférica, aneurisma aorta abdominal, casos de ambulatório
- Medicações habituais, jejum 6-8h, diazepam 5-10 mg, Dramin 50 mg

Técnica Femoral

- Punção, fioguia, dilatador, bainha, heparina 5000u e cateter de coronária, com torque e forma adequada para canulação
- Cateter levado até local desejado e depois conecta-se ao Manifold para monitorização das pressões e injeção de contraste
- Qualquer alteração na forma de onda durante a angiografia coronária (amortecimento e ventriculazição) significam um estenose ostial coronária uma posição desfavorável do cateter dentro da artéria coronária

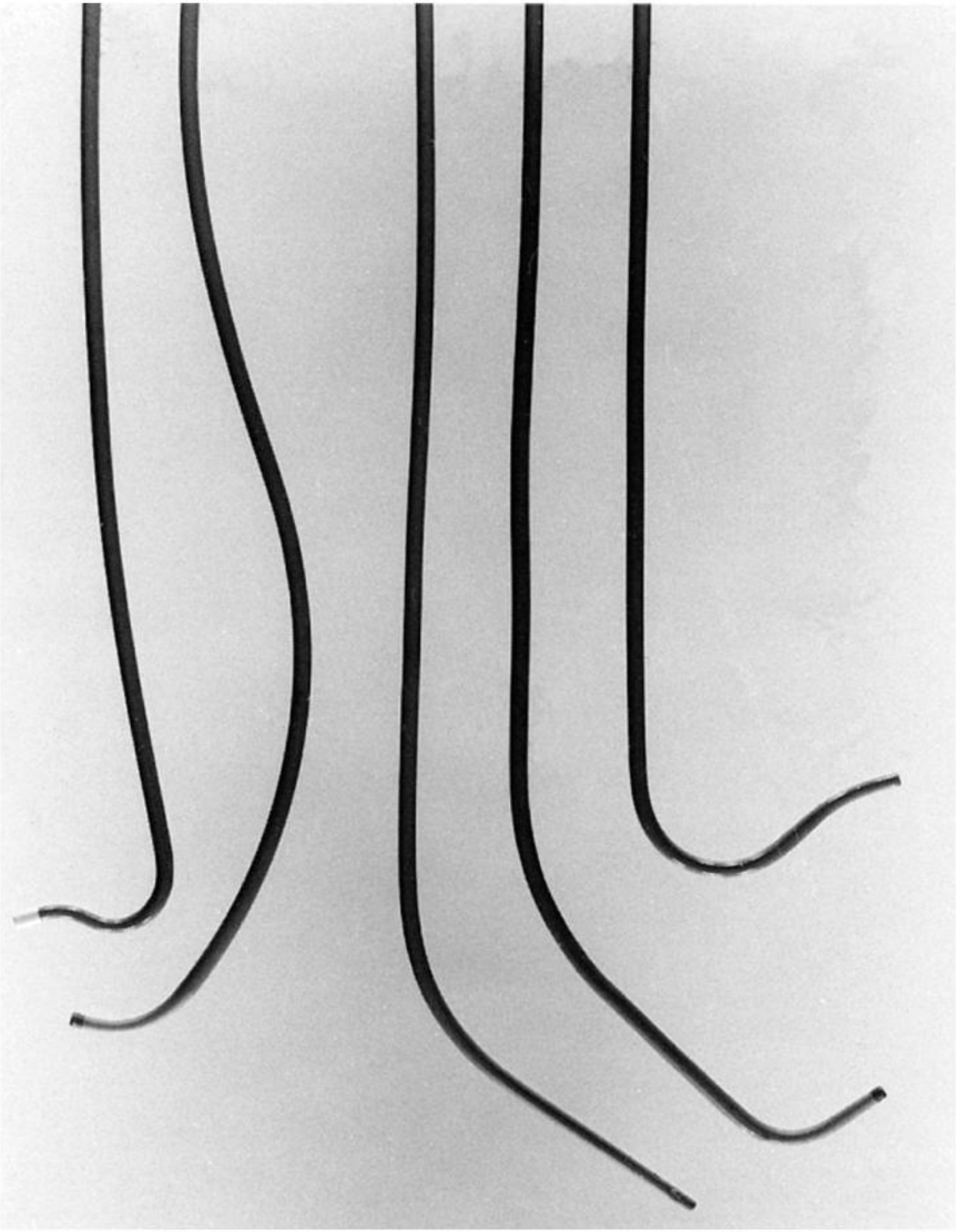


Figure 11.1 Types of catheters currently in wide use for selective native coronary angiography. **Left to right.** Amplatz right, Judkins right, Sones, Judkins left, and Amplatz left.

Técnica Femoral

- Monitorização da pressão e fluoroscopia em OAE até Ao ascendente
- Judkins é mais fácil (JL 4), raiz da aorta alargada (JL 5 ou 6)
- Coronária direita 2-3 cm acima da esquerda com rotação horária

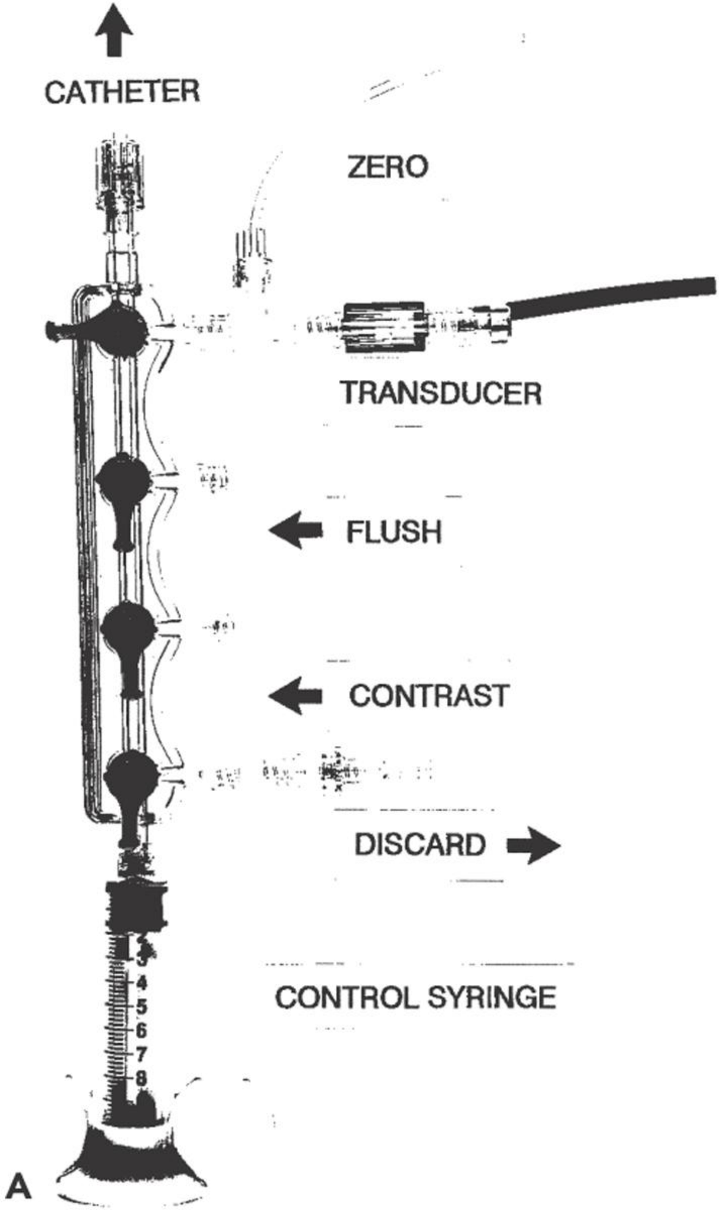
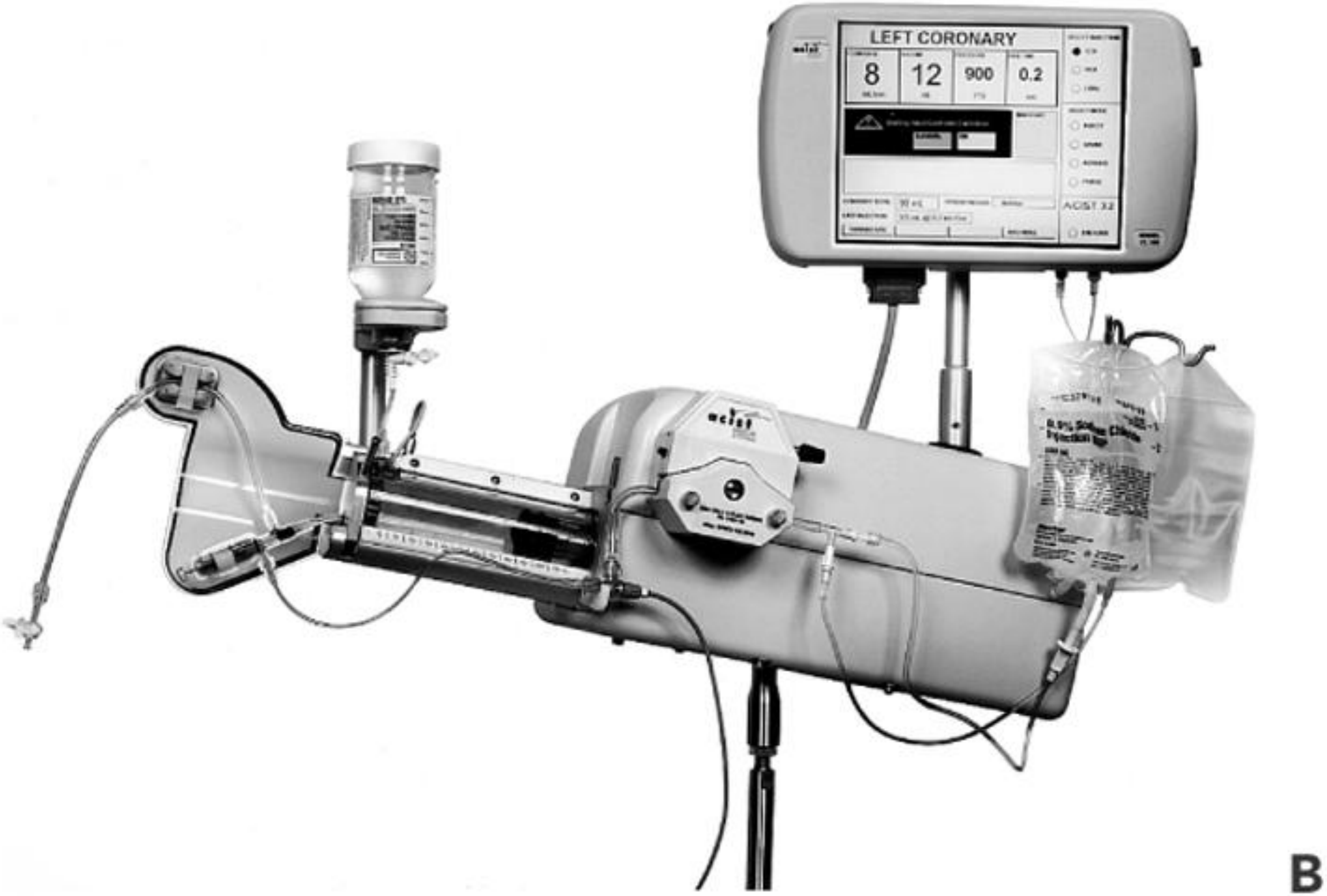


Figure 11.2A A. Four-port coronary manifold. This manifold provides a closed system with which blood can be withdrawn from the catheter and discarded. The catheter can be filled with either flush solution or contrast medium, and the catheter pressure can be observed, all under the control of a series of stopcocks. The fourth port is connected to an empty plastic bag and is used as a discard port (for blood from the double flush, air bubbles) so that the syringe need not be disconnected from the manifold at any time during the procedure. Attachment of the transducer directly to the manifold allows optimum pressure waveform fidelity (see Chap. 9), and the fluid-filled reference line allows zeroing of the transducer to midchest level. **B.** The Bracco-Squibb Acist device consists of a contrast filled power injector, controlled by a sterile pneumatic actuator to deliver contrast in amounts and rates up to the limits preprogrammed on the digital panel. A power flushing system and a pressure transducer are also included, duplicating many of the functions of the traditional four-port manifold.



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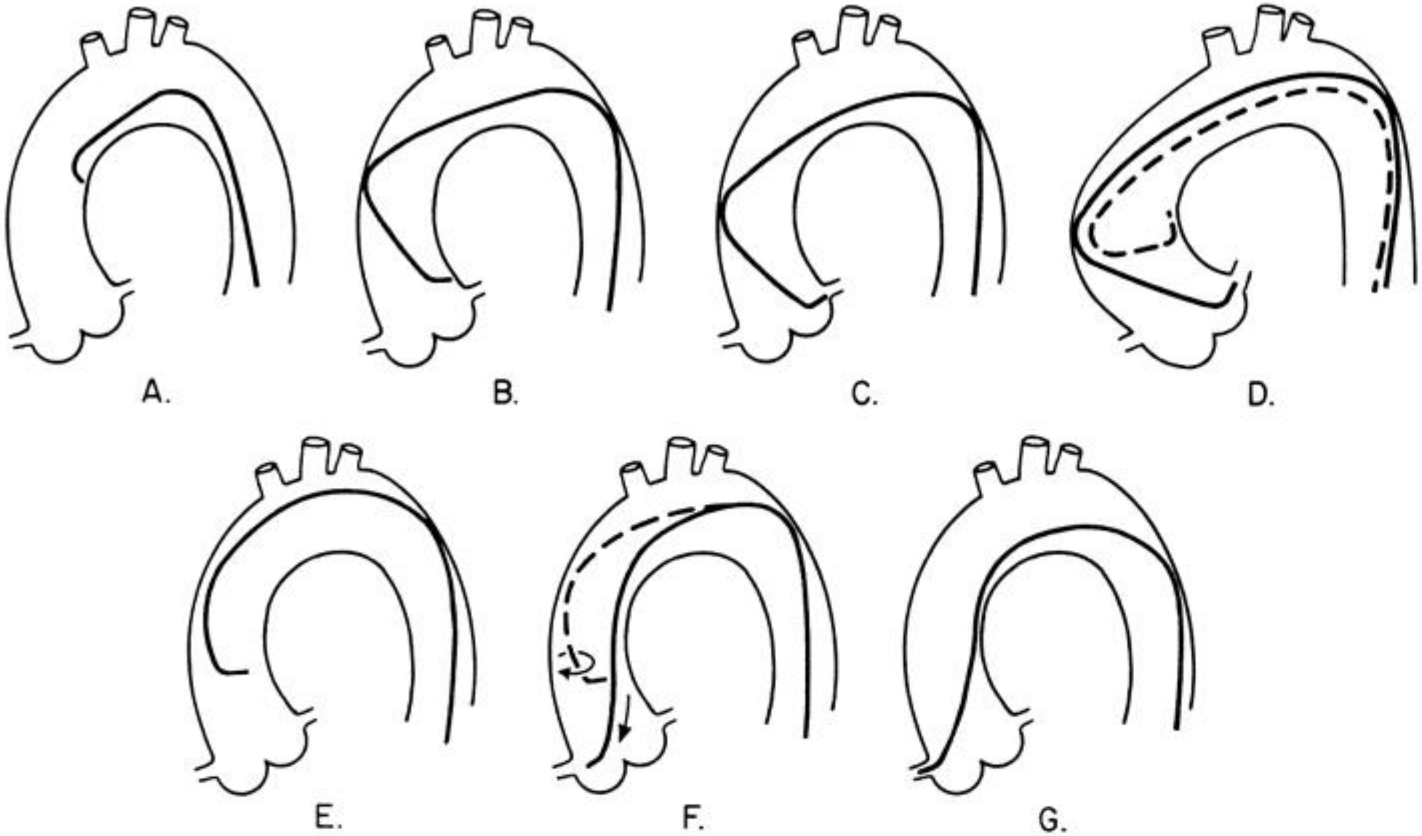


Figure 11.4 Judkins technique for catheterization of the left and right coronary arteries as viewed in the left anterior oblique (LAO) projection. In a patient with a normal-size aortic arch, simple advancement of the JL4 catheter leads to intubation of the left coronary ostium **(A–C).** In a patient with an enlarged aortic root **(D),** the arm of the JL4 may be too short, causing the catheter tip to point upward or even flip back into its packaged shape (dotted catheter). A catheter with an appropriately longer arm (a JL5 or JL6) is required. To catheterize the right coronary ostium, the right Judkins catheter is advanced around the aortic arch with its tip directed leftward, as viewed in the LAO projection, until it reaches a position 2 to 3 cm above the level of the left coronary ostium **(E).** Clockwise rotation causes the catheter tip to drop into the aortic root and point anteriorly **(F).** Slight further rotation causes the catheter tip to enter the right coronary ostium **(G).**

Técnica Femoral

- Amortecimento e Ventriculização indicam restrição do fluxo na coronária ou estenose
- Respiração profunda verticaliza coração auxiliando cateterizar óstio esquerdo
- As vezes Amplatz é necessário
- Canulação da CD (JR 4) é mais delicada
- Ponta voltado para dentro e, assim, vir a deitar contra o lado direito

Técnica Femoral

- Damping e ventriculização é mais comum:
- 1) Menor calibre do vaso
- 2) Espasmo ostial
- 3) Canular ramo do cone
- 4) Estenose ostial real
- **Enxerto coronário** (MIE ou Safena)
- - Judkins ou Amplatz direita dirigido parede da Aorta para pegar óstio
- Cateter **Schoonmaker**

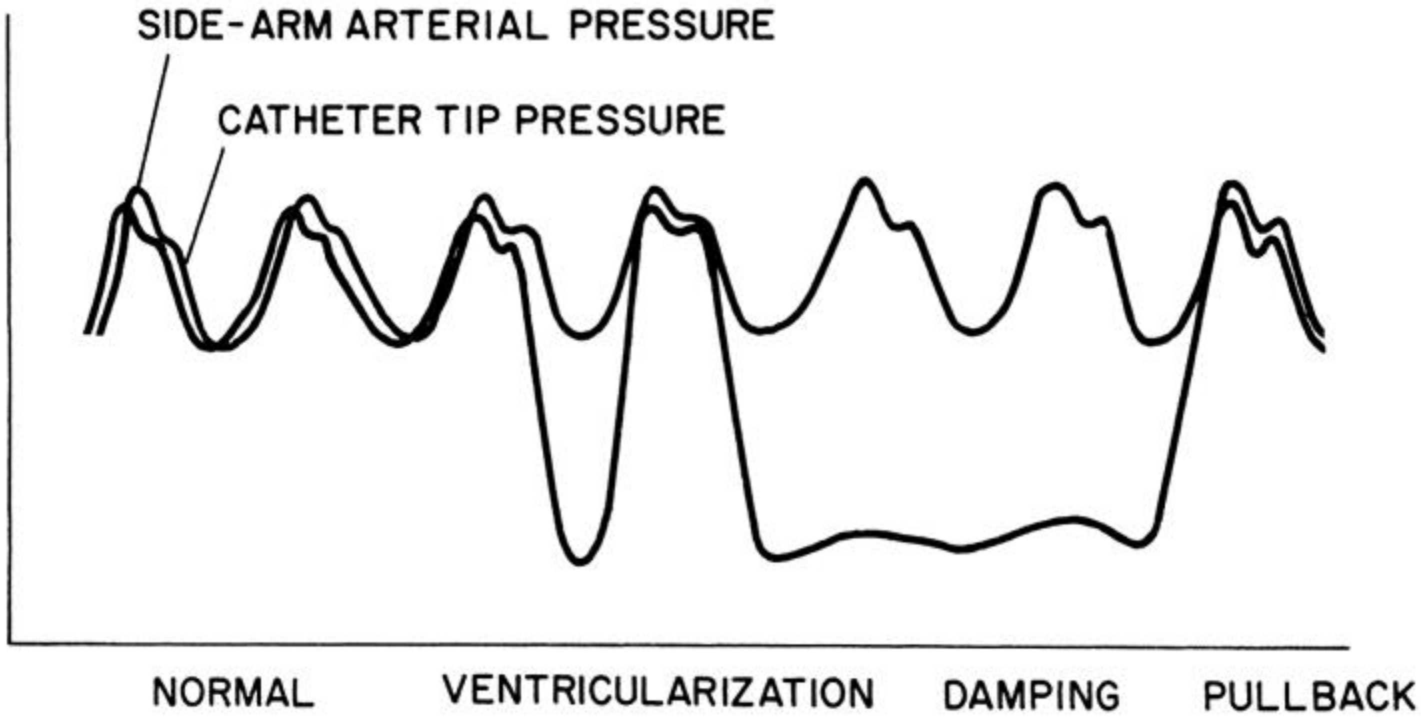


Figure 11.3 Pressure tracings as recorded during coronary angiography. Except for its earlier phase and slightly lower systolic pressure, catheter tip pressure should resemble the pressure waveform simultaneously monitored by way of the femoral side-arm sheath or other arterial monitor (e.g., radial artery). In the presence of an ostial stenosis or an unfavorable catheter position against the vessel wall, the waveform shows either ventricularization (in which systolic pressure is preserved but diastolic pressure is reduced) or frank damping (in which both systolic and diastolic pressures are reduced). In either case, the best approach is to withdraw the catheter immediately until the waveform returns to normal and to attempt to define the cause of the problem by nonselective injections in the sinus of Valsalva. Alternatively, a catheter equipped with side holes near the tip may be used to provide ongoing coronary perfusion.

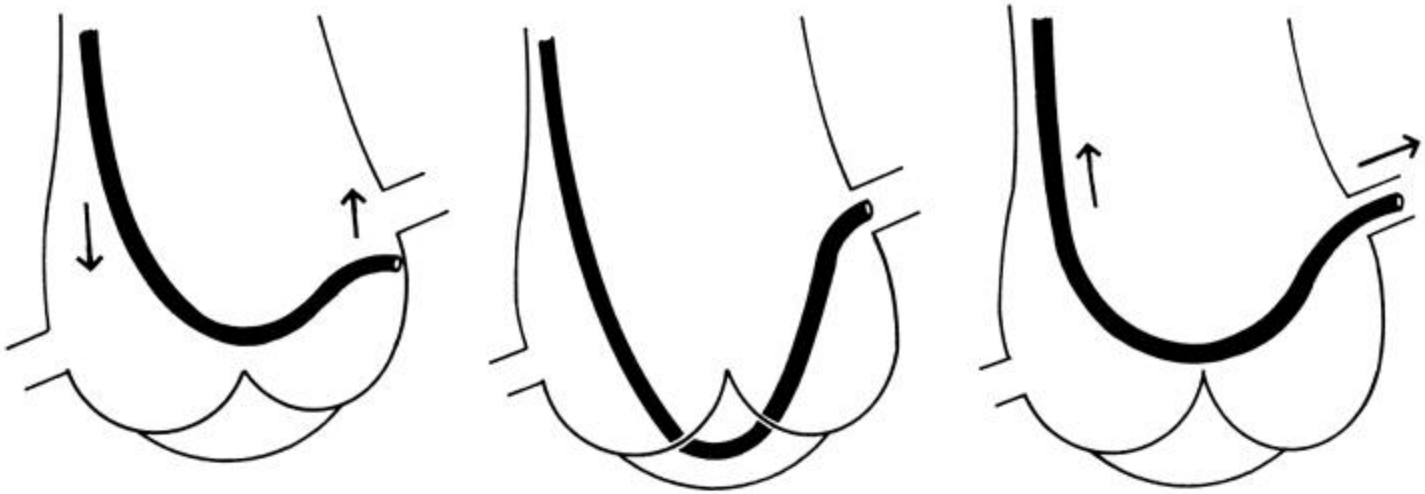


Figure 11.5 Catheterization of the left coronary with an Amplatz catheter. The catheter should be advanced into the ascending aorta with its tip pointing downward so that the terminal catheter configuration resembles a diving duck. As the Amplatz catheter is advanced into the left sinus of Valsalva, its tip initially lies below the left coronary ostium **(left)**. Further advancement causes the tip to ride up the aortic wall and enter the ostium **(center)**. Slight withdrawal of the catheter causes the tip to seat more deeply in the ostium **(right)**.

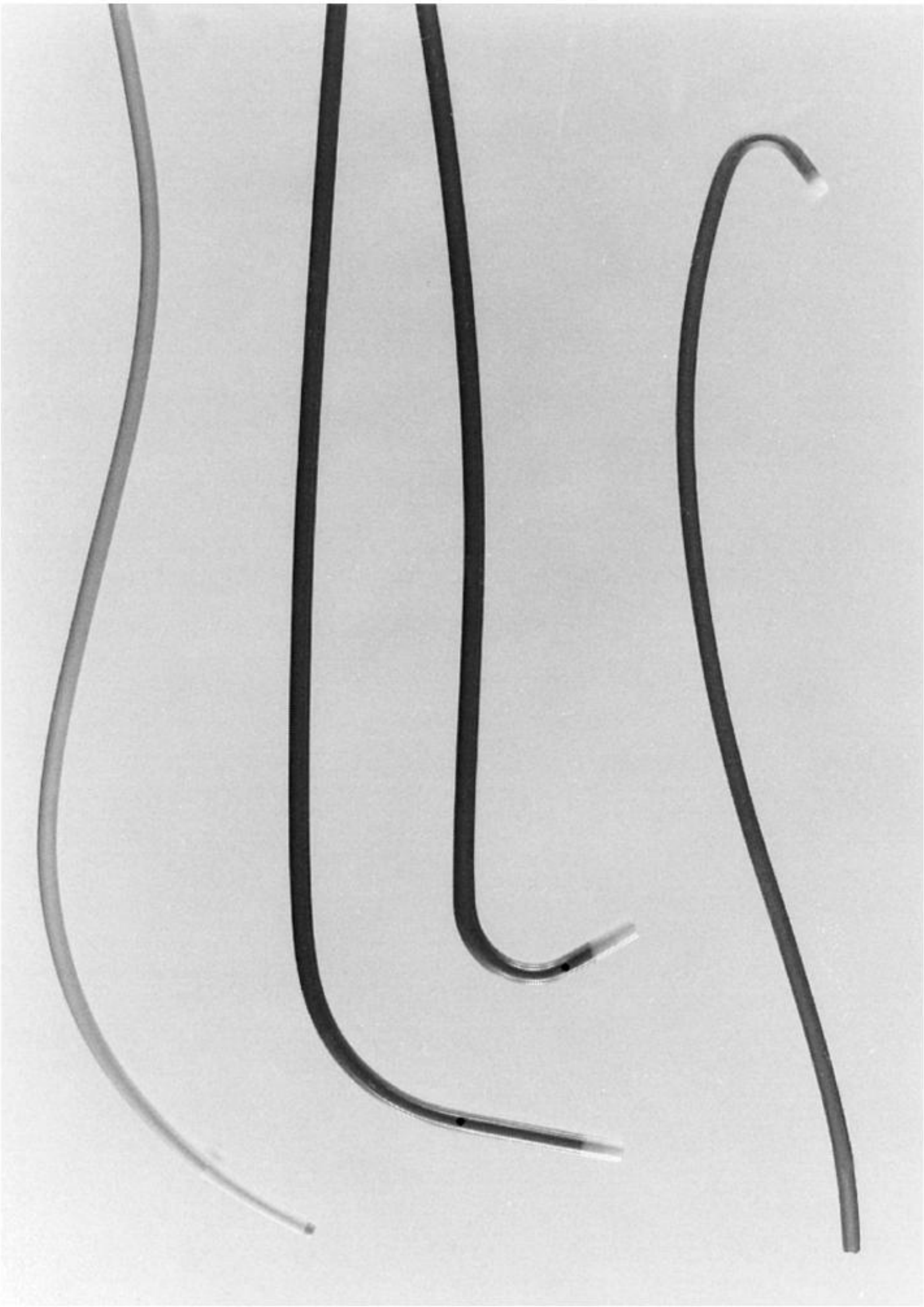
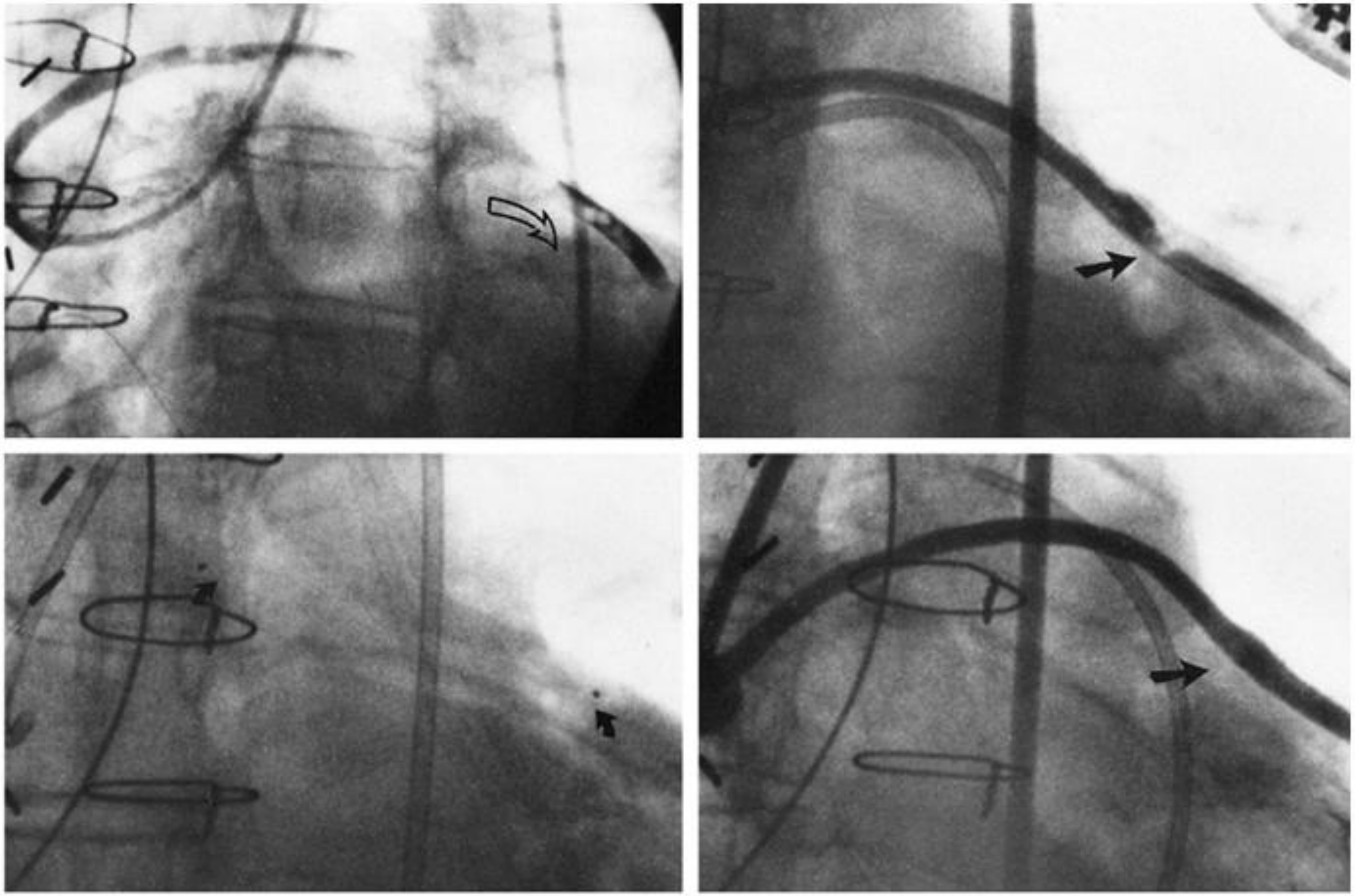
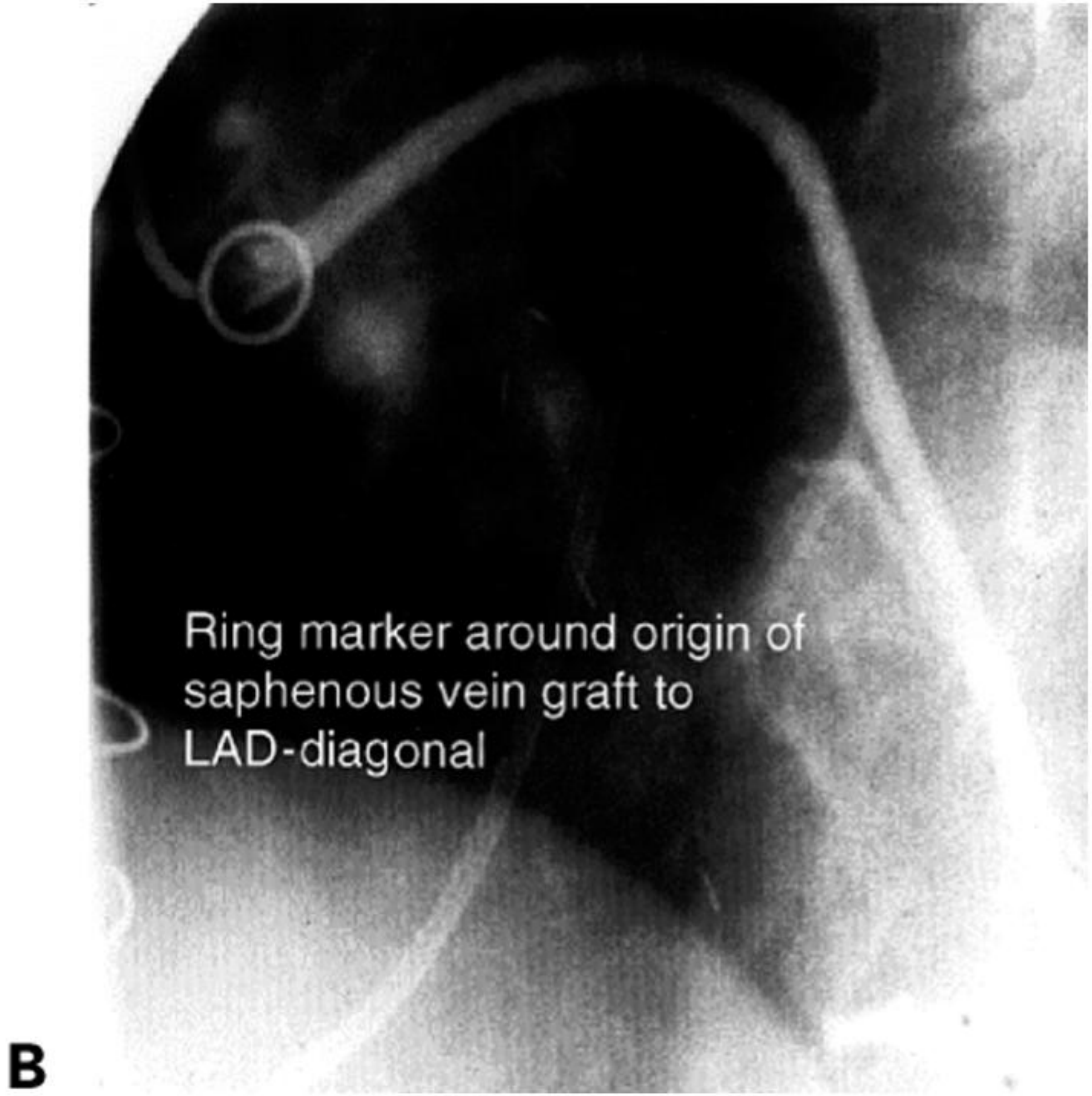


Figure 11.6 Catheters used for bypass graft angiography. Although the right Judkins or Amplatz catheters can be used for many anterior takeoff vein grafts, the catheters shown here may be useful. **Left to right.** Wexler, multipurpose, hockey stick shape, and internal mammary.



A

Figure 11.7A A. Sample of saphenous vein graft angiography, showing an occluded graft to the circumflex, filled with thrombus **(top left, *open arrow*)**. A drug-infusion catheter (Tracker, Target Therapeutics) was placed **(bottom left, *curved arrow*)** and used to administer Urokinase (50,000 IU/hour) overnight. The following morning **(top right),** the thrombus had been dissolved, revealing the underlying ulcerated culprit lesion. This was treated with a single Palmaz-Schatz coronary stent **(bottom right),** re-establishing full patency. **B.** Saphenous vein graft with origin localized by ring marker implanted at the time of surgery.



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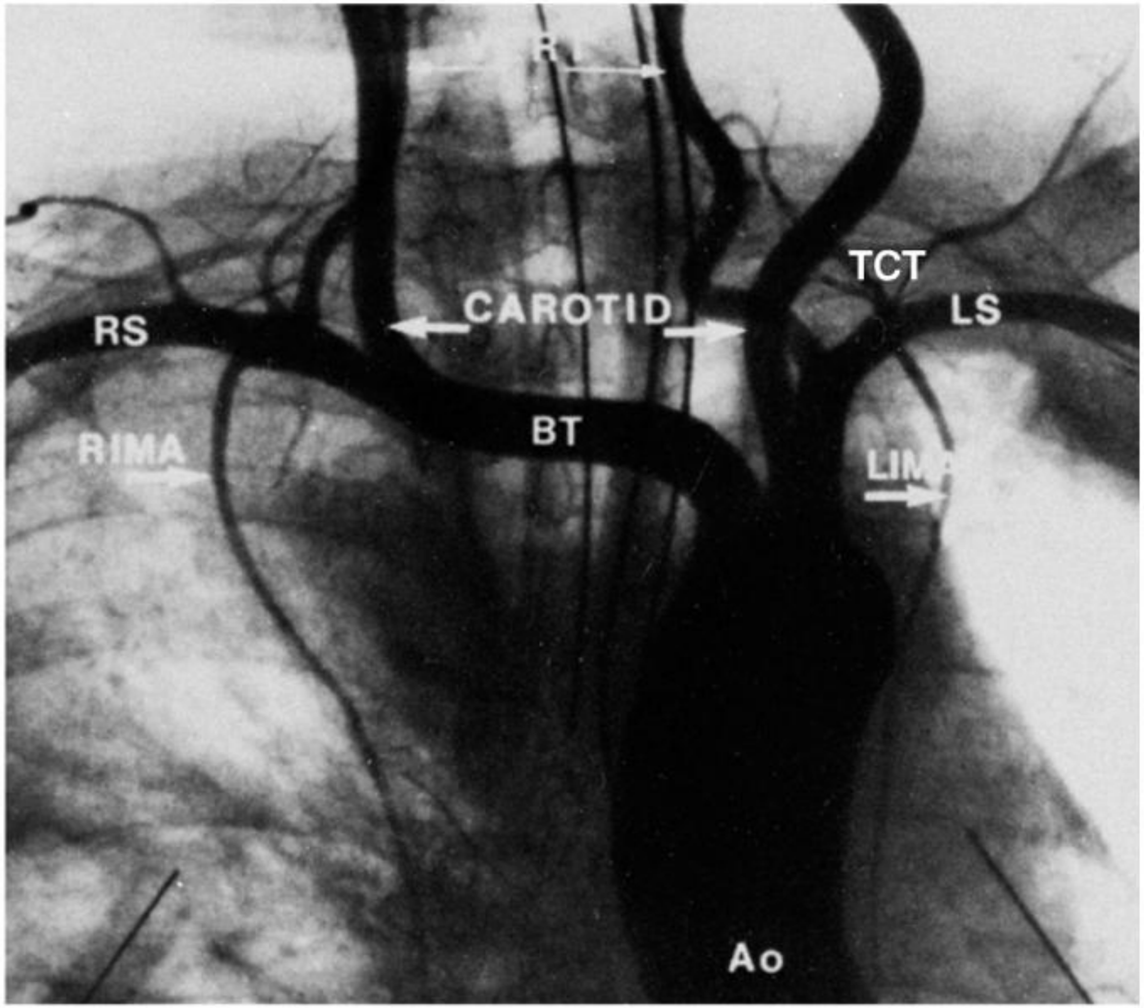
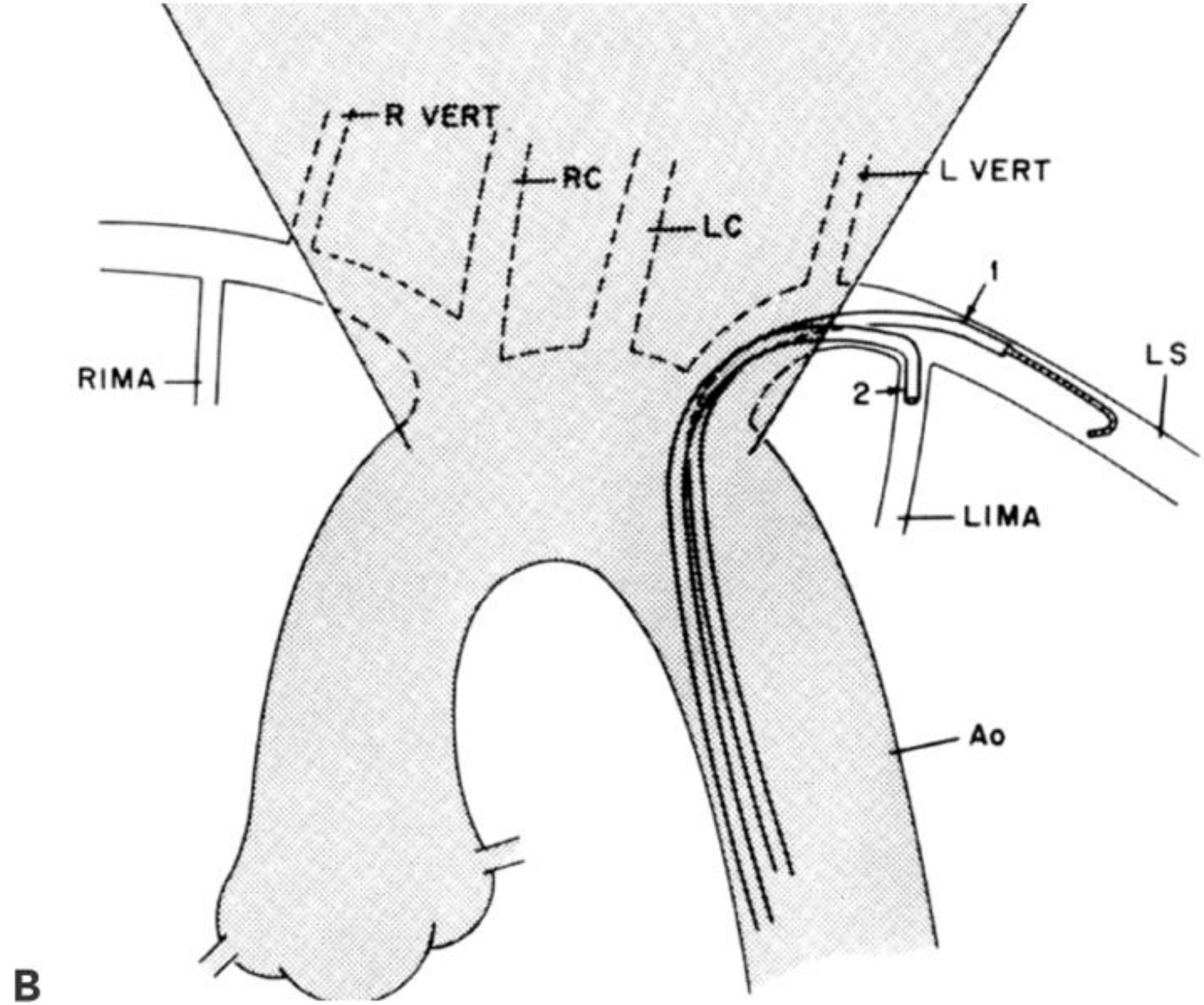


Figure 11.8A Internal mammary angiography. **A.** Aortic arch injection shows the left internal mammary artery (LIMA) originating from the left subclavian (LS), just opposite the thyrocervical trunk (TCT) and distal to the right vertebral artery (VERT). The right internal mammary artery (RIMA) originates from the right subclavian (RS) just distal to the bifurcation of the right carotid from the brachiocephalic trunk (BT). **B.** Schematic diagram shows the corresponding arch vessel origins. Note that the left subclavian originates just inside the patient's leftmost edge of the wedge-shaped shadow cast by the upper-mediastinal structures in the left anterior oblique projection. Catheter manipulation in this projection facilitates advancement of a guidewire into the LS (step 1), facilitating selective cannulation of the LIMA during catheter withdrawal and slight counterclockwise rotation (step 2, see text). **C.** Variant in which internal mammary originates in common with thyrocervical trunk, resulting in poor opacification. An angioplasty guide wire was placed down the internal mammary through the 6F diagnostic catheter and used to advance the tip of the diagnostic catheter selectively down the IMA. From that position, sufficient opacification was obtained to demonstrate occlusion of the distal left anterior descending (LAD) beyond the anastomosis as the cause of the patient's recurrent angina.



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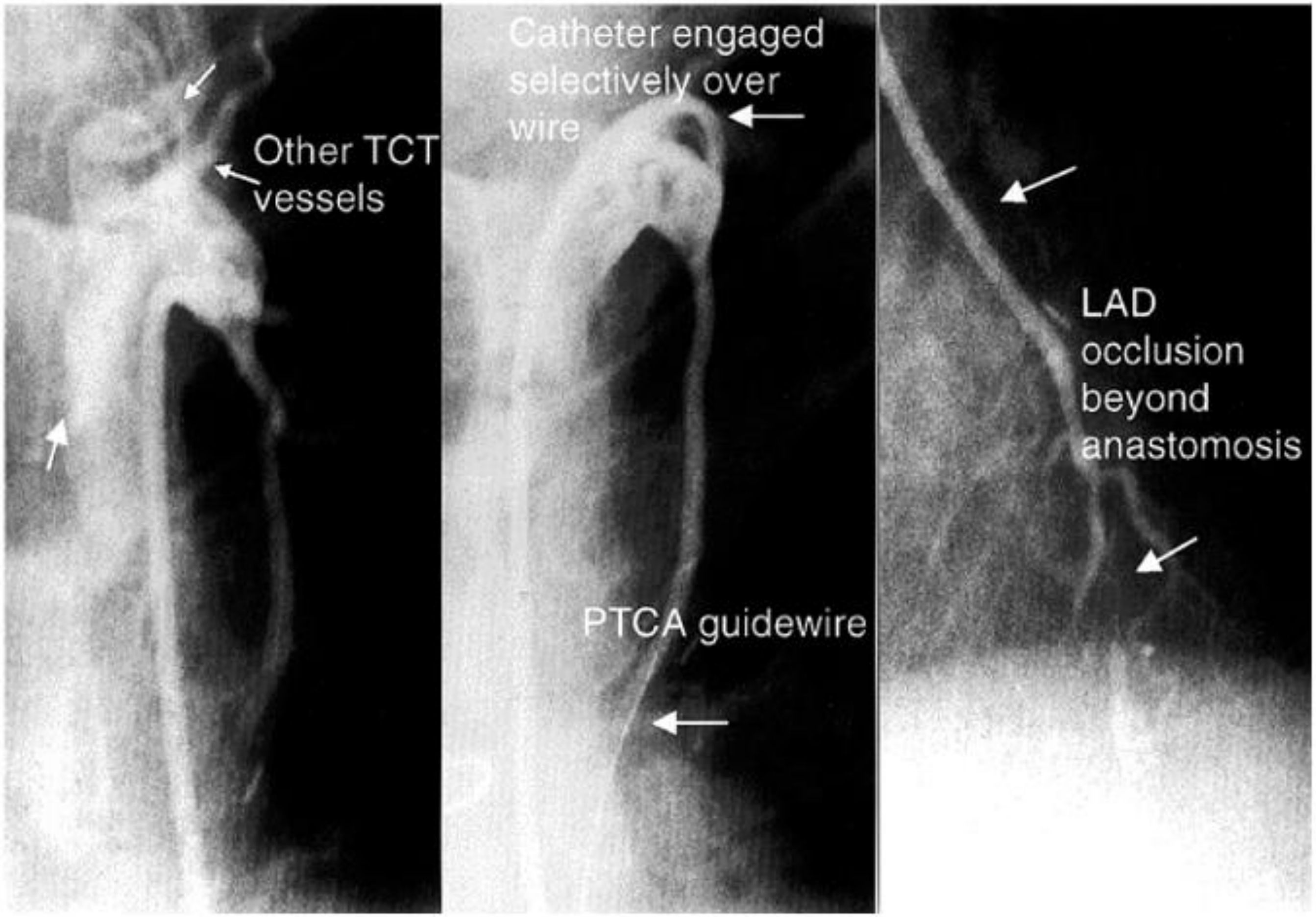
C



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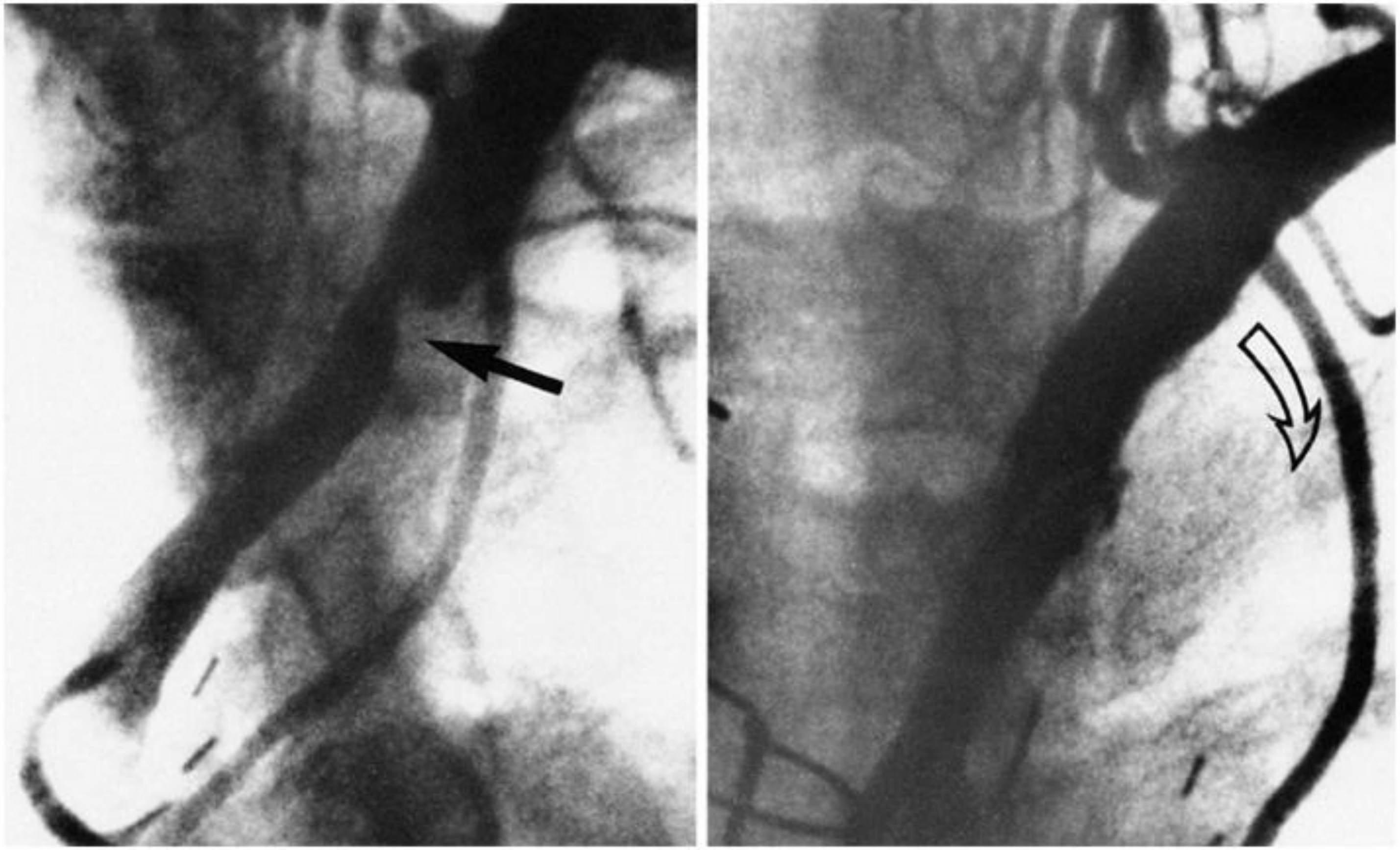
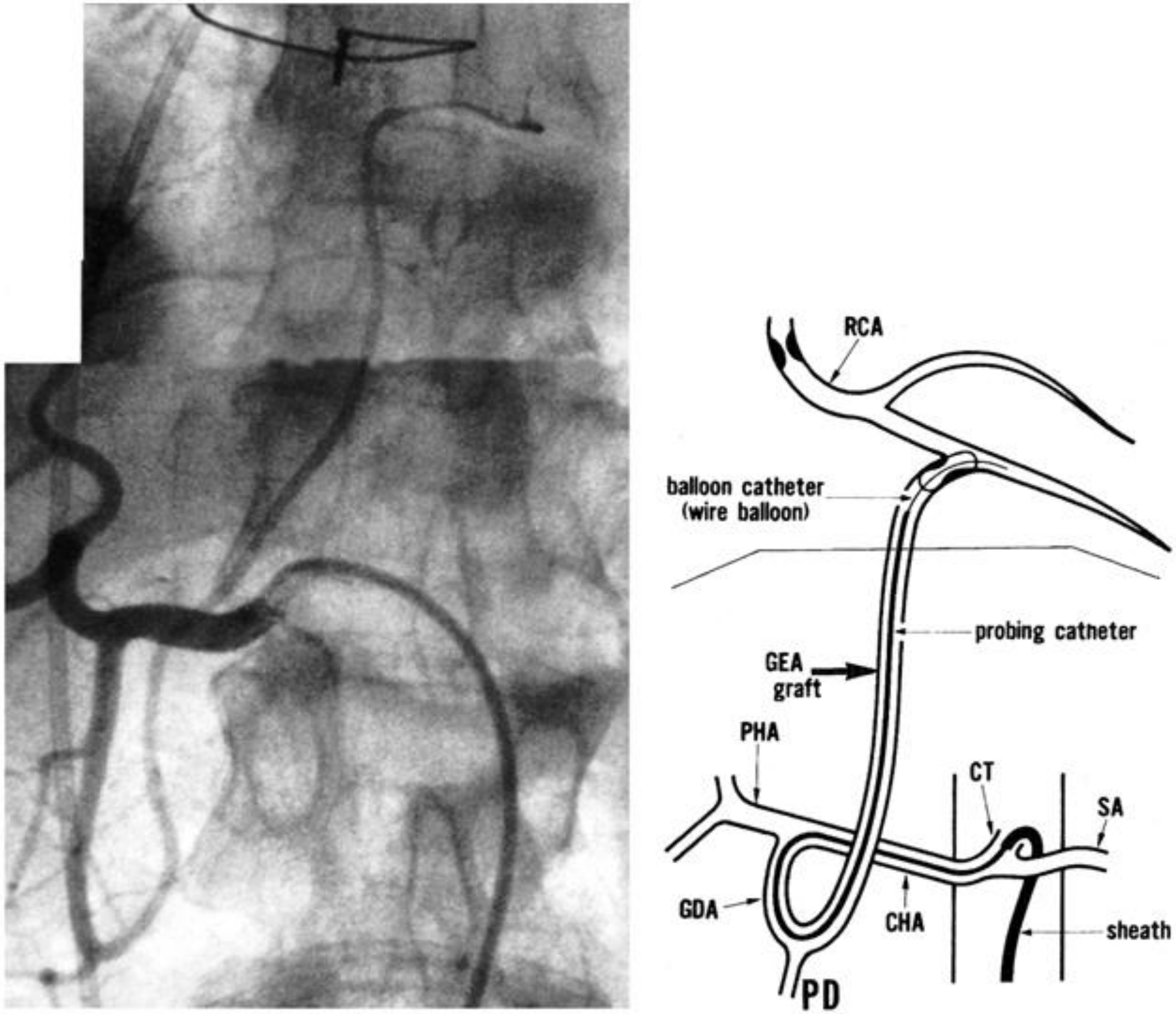
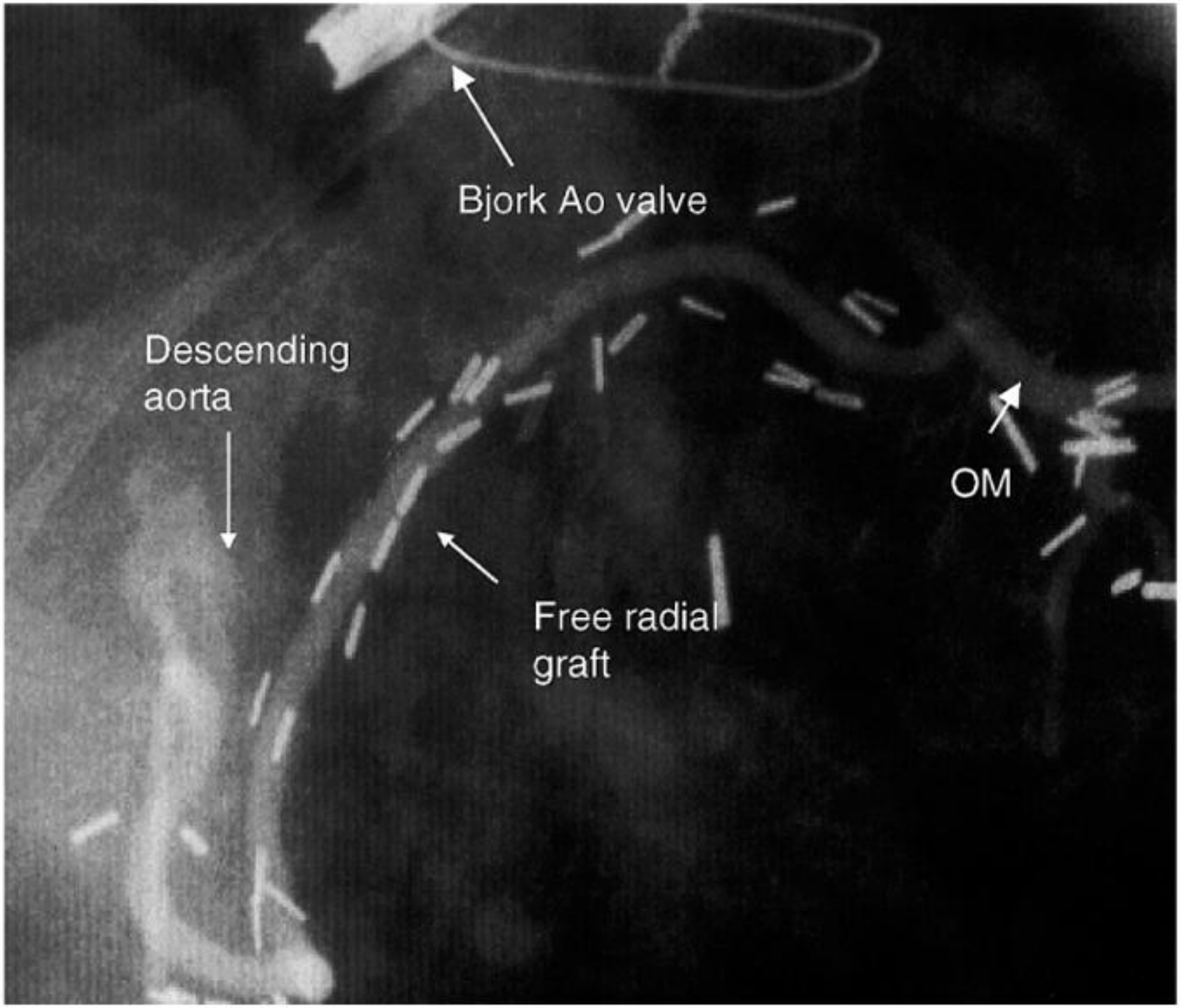


Figure 11.9 Left subclavian stenosis in a patient with recurrent angina in the distribution of the otherwise patent left internal mammary artery **(left)**, treated by stenting **(right)**.



A1 A2

Figure 11.10A A. Gastroepiploic graft anatomy. The common hepatic artery (CHA) originates with the splenic artery (SA) from the celiac trunk (CT). The gastroduodenal artery (GDA) originates from the CHA, which then becomes the proper hepatic artery (PHA). The terminal branches of the GDA are the pancreatoduodenal (PD) and the right gastroepiploic artery (GEA), shown here undergoing angioplasty of a lesion at its anastomosis to the right coronary artery (RCA). (Diagram from Ishiki T, et al. Percutaneous angioplasty of stenosed gastroepiploic artery grafts. *J Am Coll Cardiol* 1993,21:727, 1993, with permission.) **B.** Free radial graft from the descending aorta to an obtuse marginal graft, cannulated using a Cobra visceral angiographic catheter. Localization of the graft ostium was aided by the presence of multiple surgical clips used to ligate small side branches of the radial artery at the time of bypass.



B

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Técnica Braquial

- “Dedo flexível”
- Cateter poliuretano ou dracon (tortuosidades)
- Com fio guia adequado para estenose aórtica
- Monitorização da artéria braquial, subclábvia, inominada com pressão e fluoroscopia
- Respiração profunda, encolher ombros, virar cabeça para esquerda

Técnica Braquial

- Engajamento seletivo da artéria coronária esquerda é realizada como se segue:
- - Abordagem usual
- - Cabeça de cobra
- - High take-off LCA
- CD rasa em OAE curvada em direção para CE realizar torque em sentido horário (passo 1)
- realizar torque em sentido horário e puxar para trás (passo 2)

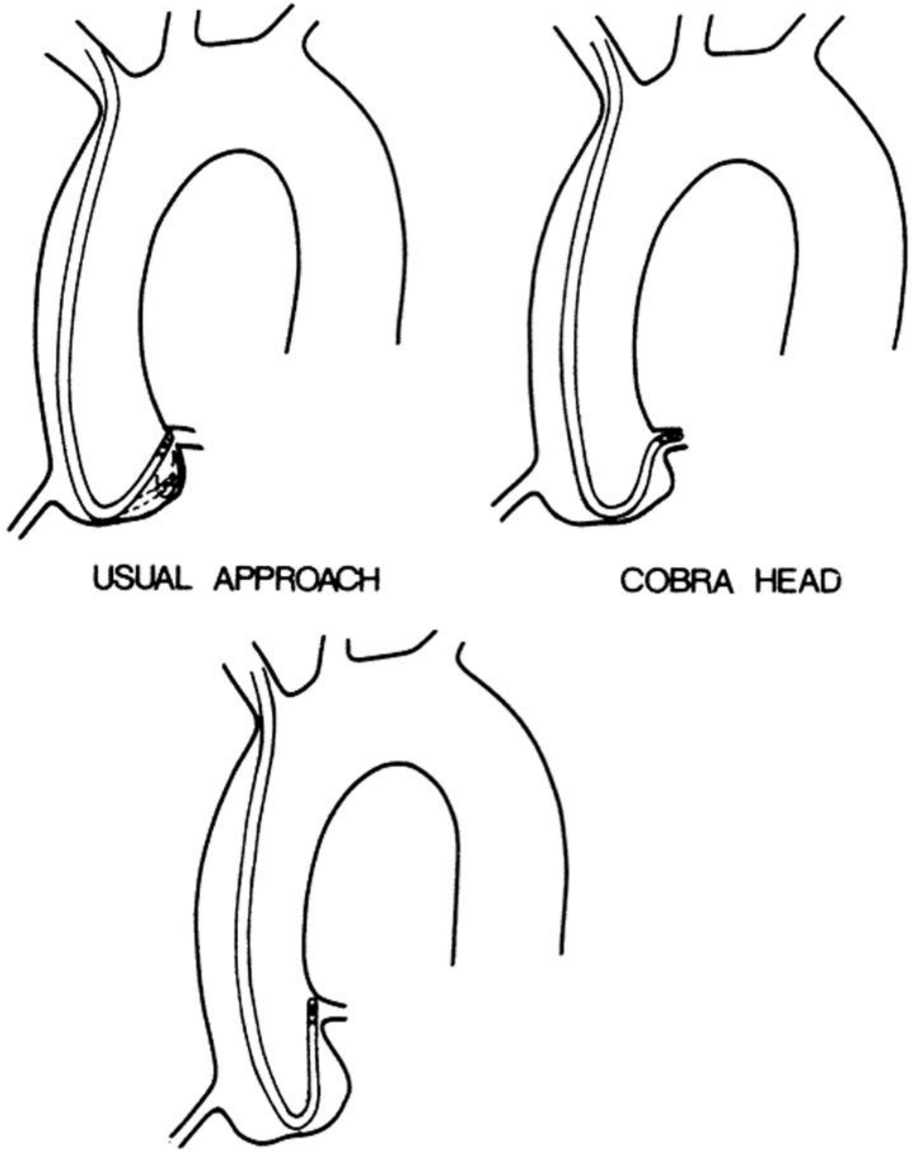

Figure 11.11 Selective catheterization of the left coronary artery using the Sones catheter. The standard approach involves forming a smooth shallow loop and gradually "inching up" to the ostium from below. If the distal 2 to 3 mm of the catheter tip bends downward during this inching-up process, the tip may enter the left coronary artery, giving a cobra head appearance (upper right). When the left coronary ostium originates high in the left sinus of Valsalva (high takeoff left coronary artery), the catheter may have the appearance seen in the bottom panel, where the tip is lying across the ostium at right angles to the course of the left main coronary artery. During coronary injection in this instance, coronary blood flow usually carries the contrast agent down the vessel, giving good opacification of the entire left coronary artery.

Técnica Braquial

- Outra técnica descer em direção ao seio coronário direito e solicitar respiração profunda
- Outros cateteres para auxílio: Amplatz (L2e R1), Schoonmaker, Bourassa, Judkins

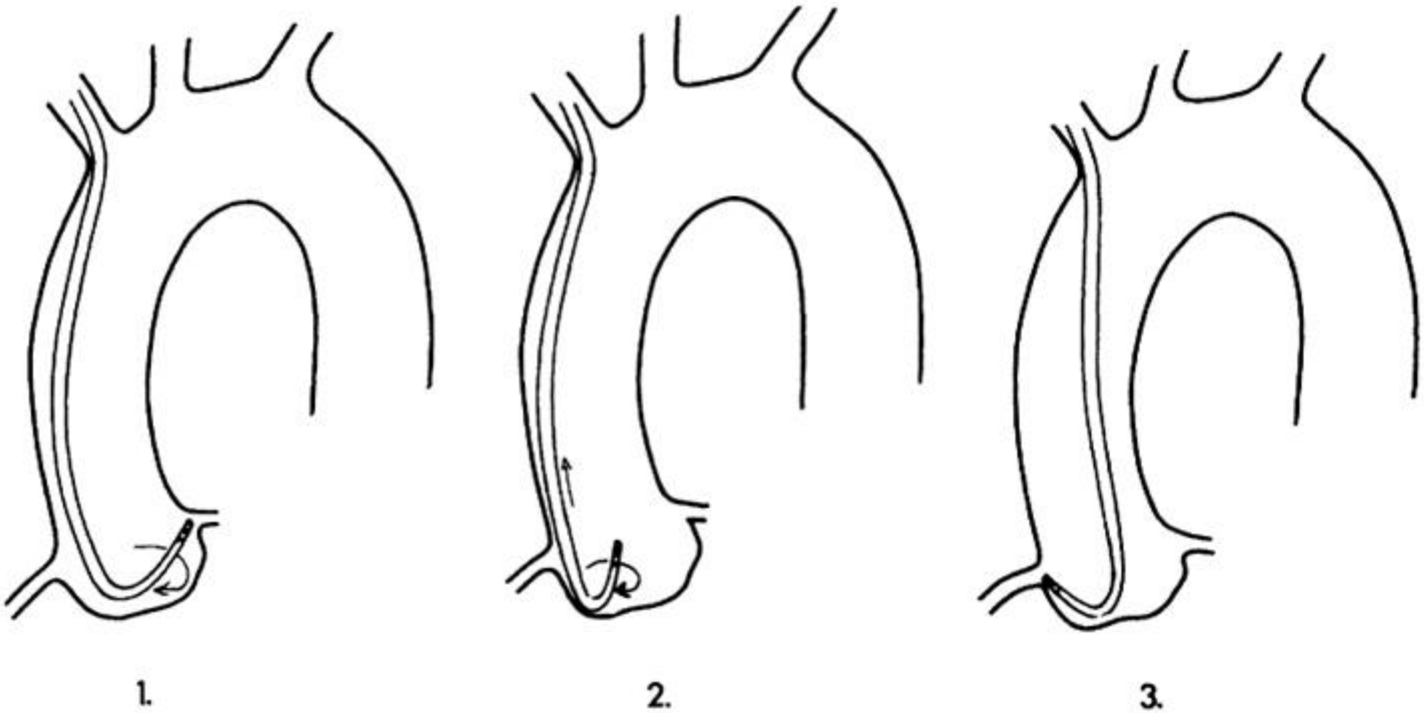

Figure 11.12 Selective catheterization of the right coronary artery using the Sones catheter. In the shallow left anterior oblique (LAO) projection, the catheter is curved upward and to the left **(1)** and clockwise torque is applied. While the operator is gradually applying clockwise torque, a gentle to-and-fro motion of the catheter helps to translate the applied torque to the catheter tip. When the tip starts moving in its clockwise sweep of the anterior wall of the aorta, the operator maintains (but does not increase) a clockwise torque tension on the catheter and simultaneously pulls the catheter back slightly **(2)**, because the right coronary ostium is lower than that of the left coronary artery. At this point, the catheter usually makes an abrupt leap into the right coronary ostium **(3)**, at which time the operator must release all torque to prevent the catheter tip from continuing its sweep and passing by the ostium. See text for details and alternative methods.

Monitorização

- ECG e PA devem ser monitorizados continuamente para canulação segura

Contrastes Radiológicos

- **Efeitos hemodinâmicos**: hipotensão, aumento Pd2, depressão miocárdica, quelação de cálcio
- - Não iônico
- **Efeitos ECG:** inversão onda T (II,III e AVF) na CD e T apiculadas na CE
- Assistolia, prolongamento PR, QRS e QT por injeção nas artérias do nó sinusal e AV, considerar atropina
- FV ou TV cardioversão

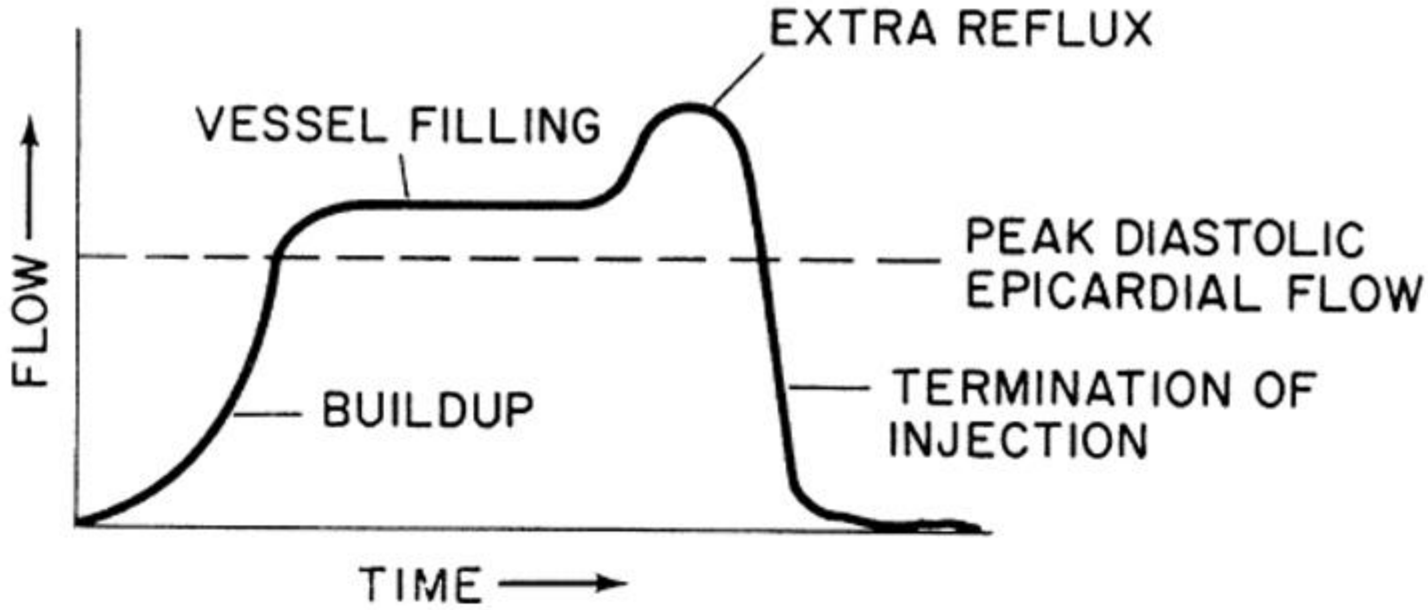

Figure 11.13 Suggested injection pattern for coronary angiography. To appropriately replace antegrade coronary blood flow with contrast medium throughout the cardiac cycle, the operator should build up the velocity of injection over 1 to 2 seconds until no unopacified blood is seen to enter the ostium and there is reflux of contrast medium into the aorta during systole and diastole. This injection is maintained until the entire coronary artery is filled with contrast medium. If the ostium has not been well seen, a brief extra push should be given to cause adequate reflux into the aortic root, and the injection should be terminated. Prolonged held inspiration with some degree of Valsalva maneuver is sometimes used during Sones angiography to reduce coronary flow and make it much easier to replace blood flow during manual contrast injection.

Contrastes Radiológicos

- **Isquemia miocárdica:** isquemia transitória, considerar nitrato
- Em casos de taquicardia, considerar propranolol
- **Nefropatia induzida por contraste**
- **Reações alérgicas**

Projeções angiográficas e angiografia Quantitativa

- 2 planos IV (DA e DP) e AV (CD e CX)
- OAE 60’ e OAD 30’
- **CD 85% dominância (DP ou VP)**
- A. Cone (via saída VD)
- A. Sinusal (nó sinusal)
- DA (ramos septais e diagonais)
- CX (ramos marginais obtusos)
- TCE trifurcado (Diagonalis ou Marginalis)
- A. Cone (via saída VD)
- A. Sinusal (nó sinusal)

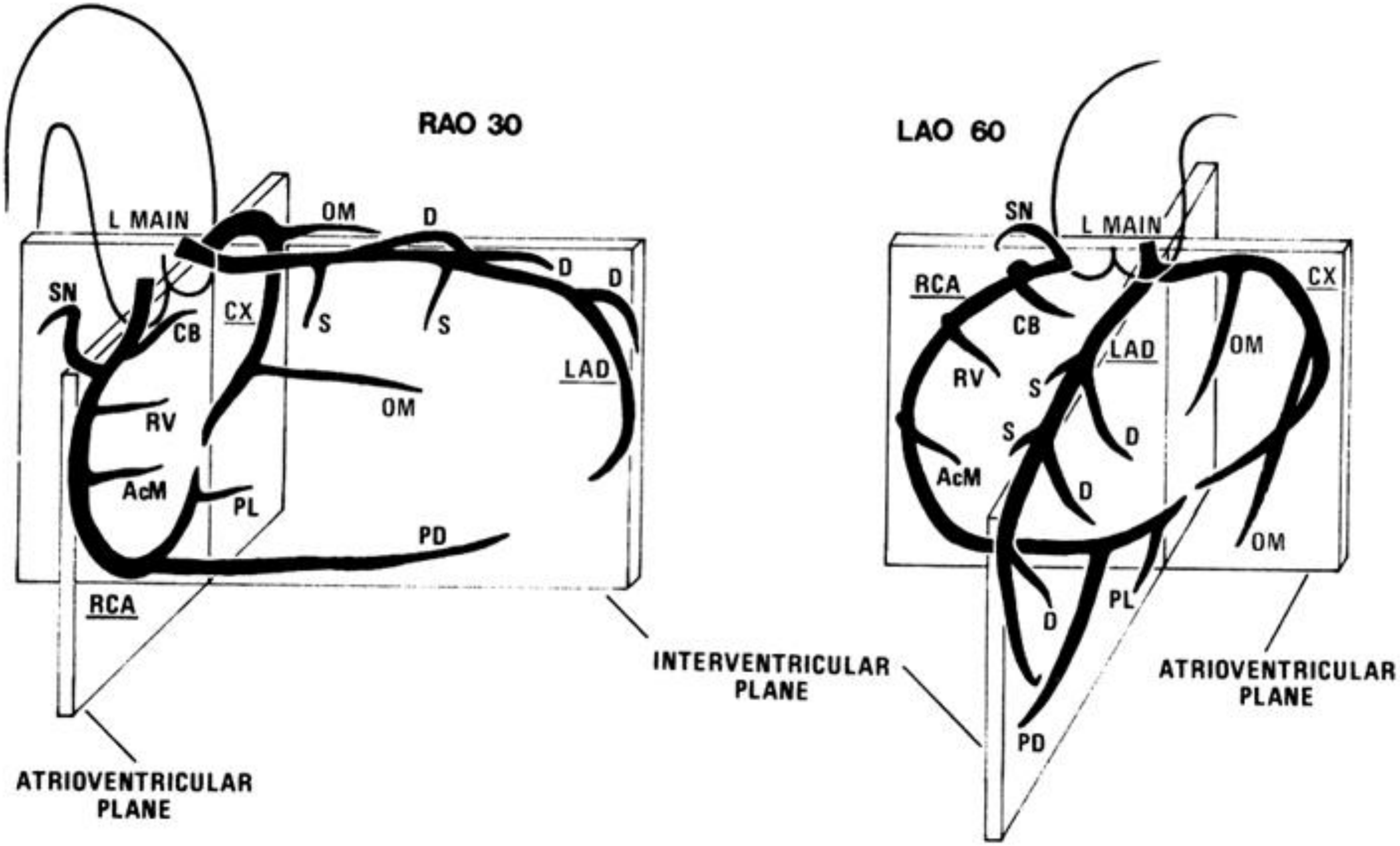

Figure 11.14 Representation of coronary anatomy relative to the interventricular and atrioventricular valve planes. Coronary branches are as indicated—L Main (left main), LAD (left anterior descending), D (diagonal), S (septal), CX (circumflex), OM (obtuse marginal), RCA (right coronary), CB (conus branch), SN (sinus node), AcM (acute marginal), PD (posterior descending), PL (posterolateral left ventricular).

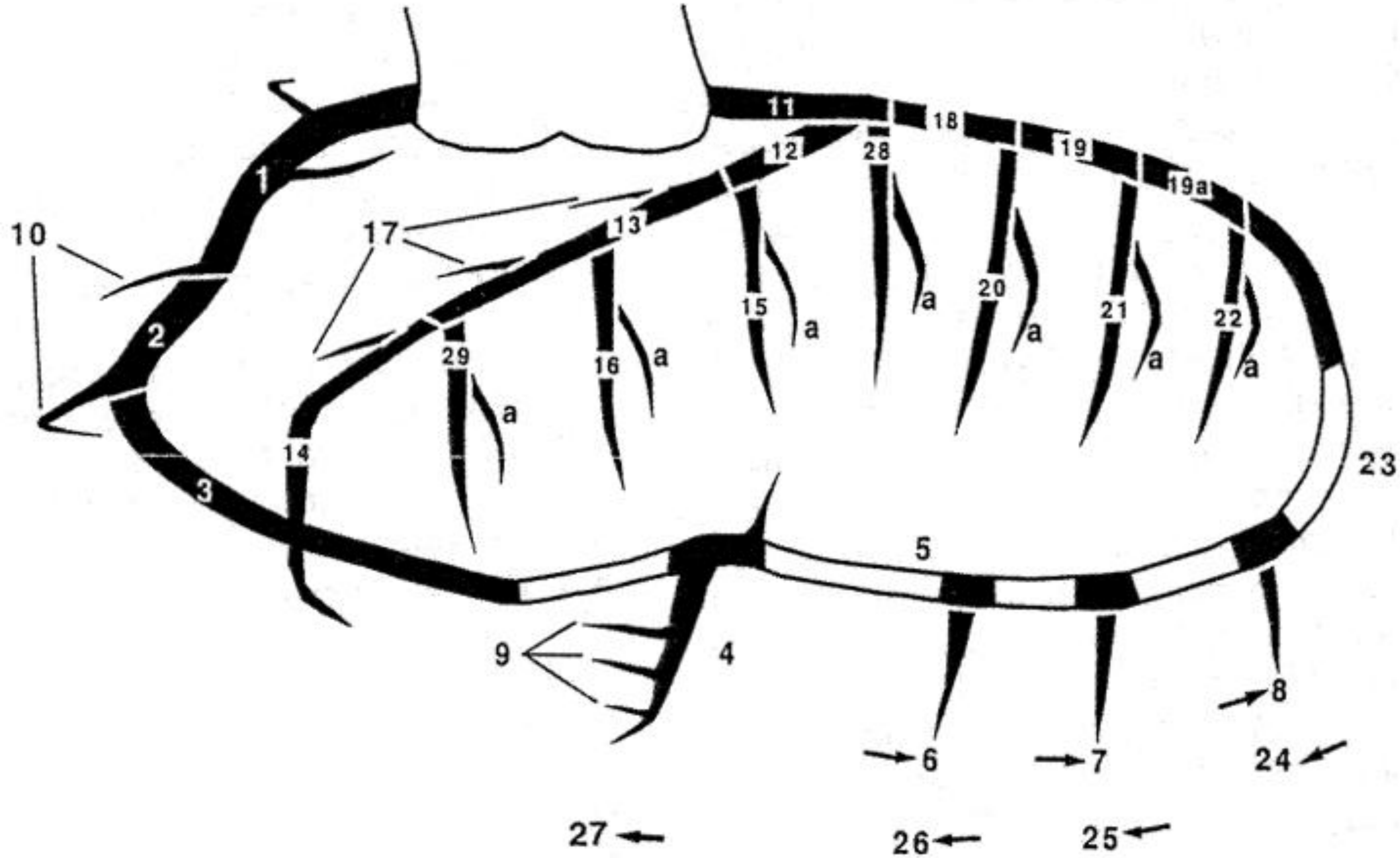

Figure 11.15 The numerical coding system and official names of the coronary segments, as used in the Bypass Angioplasty Revascularization Investigation (BARI) study. Right coronary: 1, proximal; 2, middle; 3, distal; 4, posterior descending; 5, posteroatrioventricular; 6, first posterolateral; 7, second posterolateral; 8, third posterolateral; 9, inferior septals; 10, acute marginals. Left coronary: 11, left main; 12, proximal left anterior descending; 13, middle left anterior descending; 14, distal left anterior descending,;15, first diagonal (a, branch of first diagonal); 16, second diagonal,;17, septals (anterior septals); 18, proximal circumflex; 19, middle circumflex; 19a, distal circumflex; 20, 21, and 22, first, second, and third obtuse marginals; 23, left atrioventricular; 24, 25, and 26, first, second, and third posterolaterals (in left- or balanced-dominant system); 27, left posterior descending (in left-dominant system); 28, ramus (ramus intermedius); 29, third diagonal. (From The BARI Protocol. Protocol for the Bypass Angioplasty Revascularization Investigation. *Circulation* 1991;84:V1, with permission.)

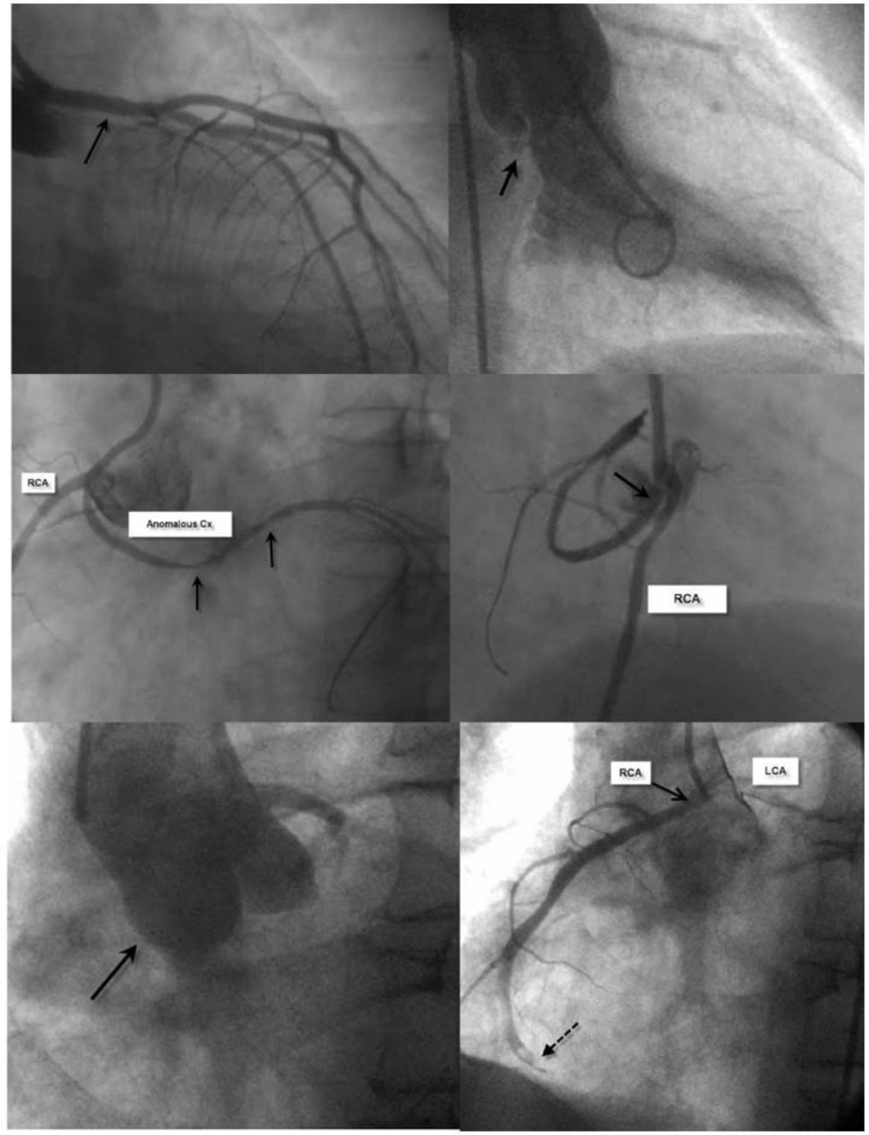

Figure 11.17 Anomalous origin of the circumflex from the right coronary artery. **Top left.** Note the long left main and absence of a circumflex during injection of the left coronary artery. **Top right.** Review of the right anterior oblique (RAO) left ventriculogram shows the telltale dot behind the aortic root, created by an end-on look at the anomalous circumflex coursing behind the aorta. **Center left.** The anomalous circumflex (Cx) originates from the right sinus of Valsalva with severe stenosis *(arrows)* responsible for the patient's unstable anginal syndrome. **Center right.** The RAO projection shows that the anomalous circumflex *(arrow)* has a separate ostium immediately posterior to the RCA origin, and then courses behind the aorta to reach the lateral wall of the left ventricle. **Bottom left.** In a different patient with an acute inferior wall myocardial infarction, a right sinus injection was performed after difficulty was encountered engaging the right coronary, and showed no right coronary ostium but faint filling of a vessel crossing the aorta. **Bottom right.** A left Amplatz catheter was used to cannulate the anomalous right coronary ostium originating from the left sinus of Valsalva (slightly anterior to the left coronary artery), revealing the RCA occlusion and thrombus *(dotted arrow)* responsible for the inferior MI, which then underwent primary angioplasty and stenting.

Projeções angiográficas e angiografia Quantitativa

- **CE dominância 8%**
- CX (VP, DP e a. Sinusal)
- CD apenas AD e VD
- **Dominância balanceada 7%**
- CD (DP) e CX (VP)
- **Anomalias de coronárias 1 a 2%**
- Origem CX (CD) e Anomalia Coronária Única

Projeções angiográficas e Angiografia Quantitativa

- Importância das diversas projeções:
- Encurtamento ou Osfucação
- Excêntrico ou Fenda
- Tortuosidade ou Sobreposição
- *Desde um diâmetro 50% (75% da secção transversal) estenose é praticamente "hemodinamicamente significativa“*
- *Diâmetro 70% (90 % secção) é muito grave*

Projeções angiográficas e Angiografia Quantitativa

- Utilizar 45’de angulação cranial ou caudal
- AP e Perfil (TCE)
- Circulação colateral (intracoronária e intercoronária)

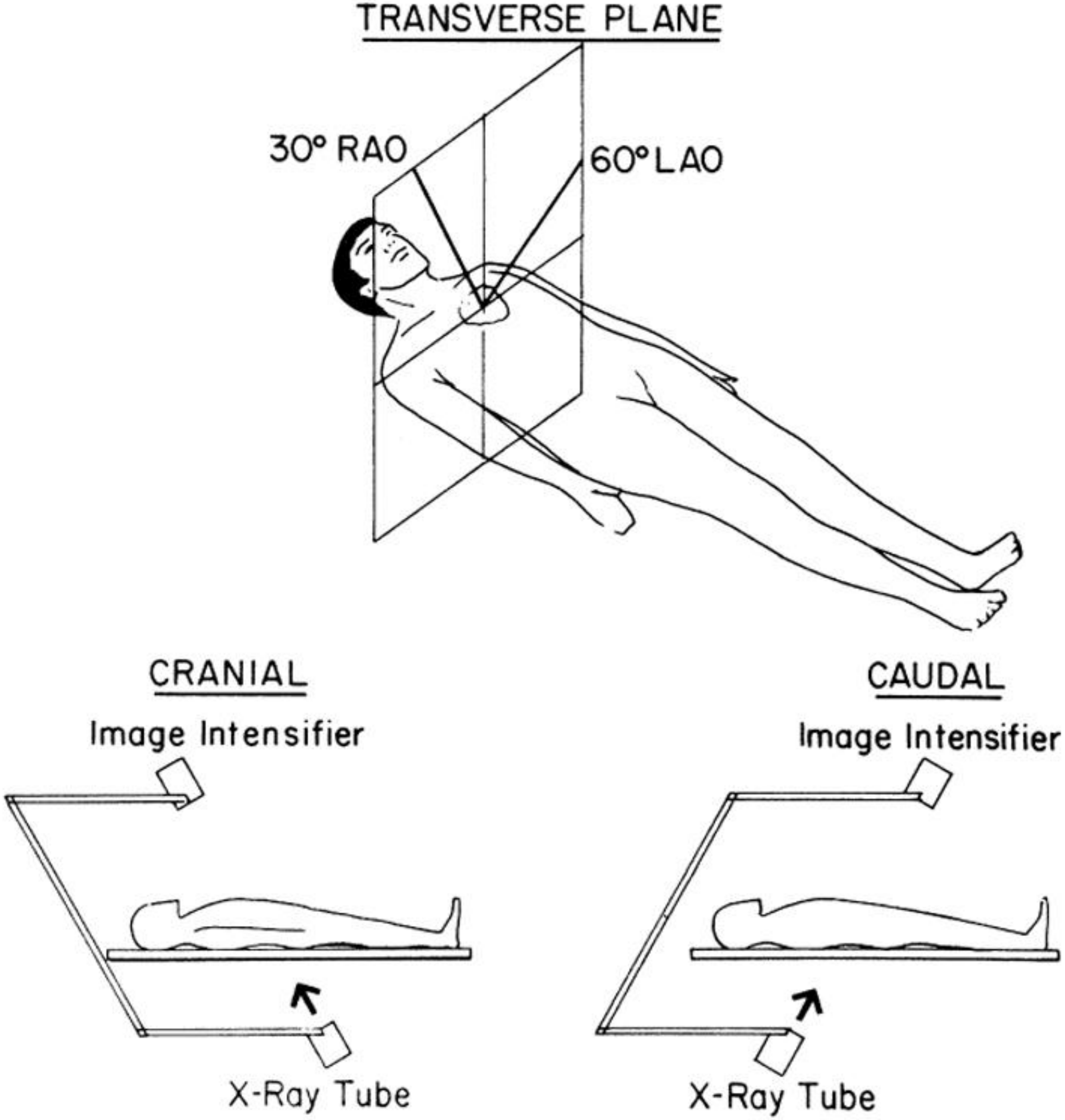

Figure 11.18 Geometry of angulated views. Conventional coronary angiography was performed previously using angulation only in the transverse plane **(top),** as demonstrated by the 60° left anterior oblique (LAO) and 30° right anterior oblique (RAO) views. Currently, improved x-ray equipment permits simultaneous cranial or caudal angulation in the sagittal plane. Each view is named based on the location of the image intensifier, rather than the older nomenclature specifying the location of both the x-ray tube and intensifier (i.e., cranial is equivalent to caudocranial).

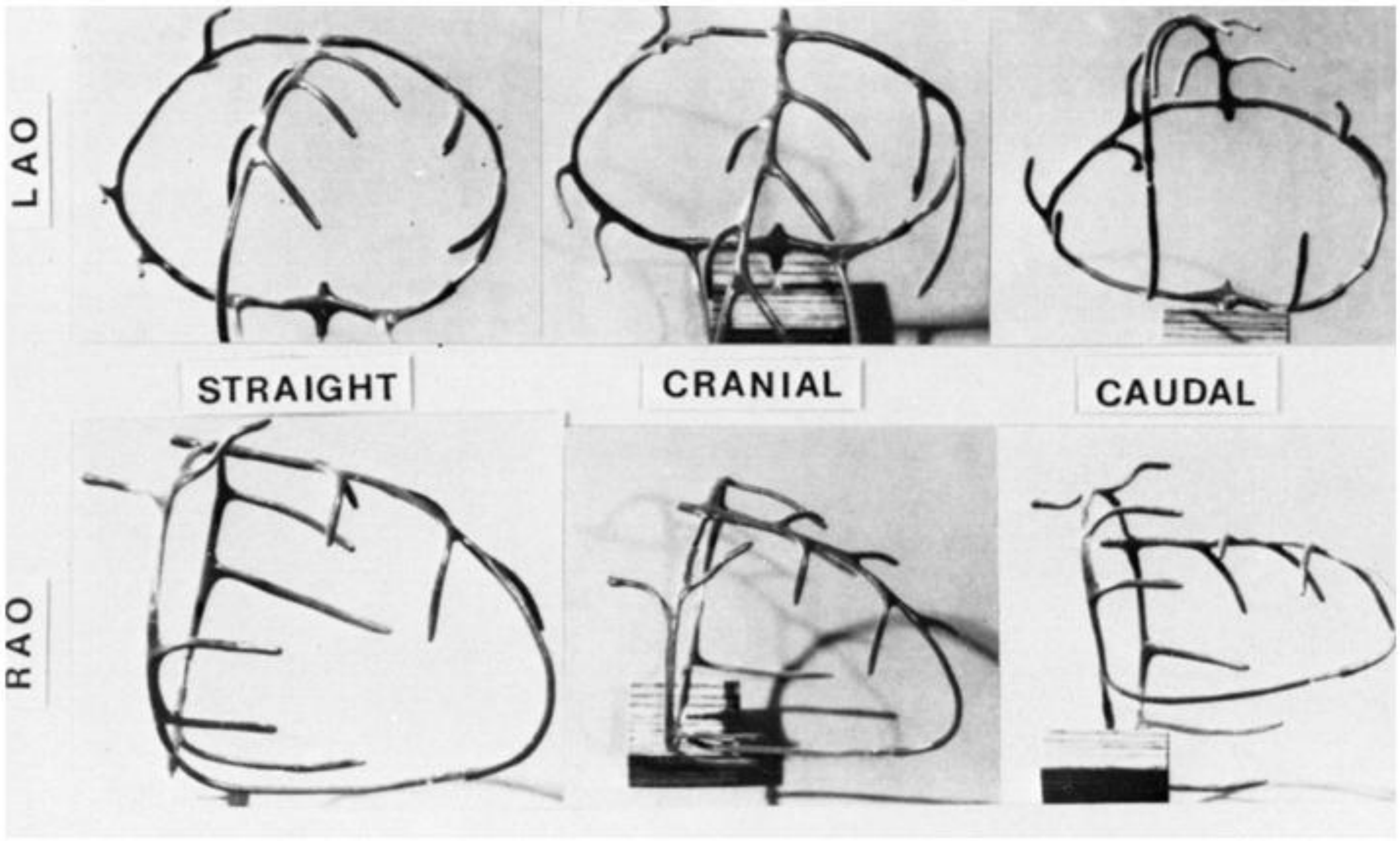

Figure 11.19 Demonstration of angiographic projections using the author's coronary model. LAO and RAO projections are photographed straight (i.e., with no cranial or caudal angulation) as well as with moderate cranial and moderate caudal angulation (see text for details).

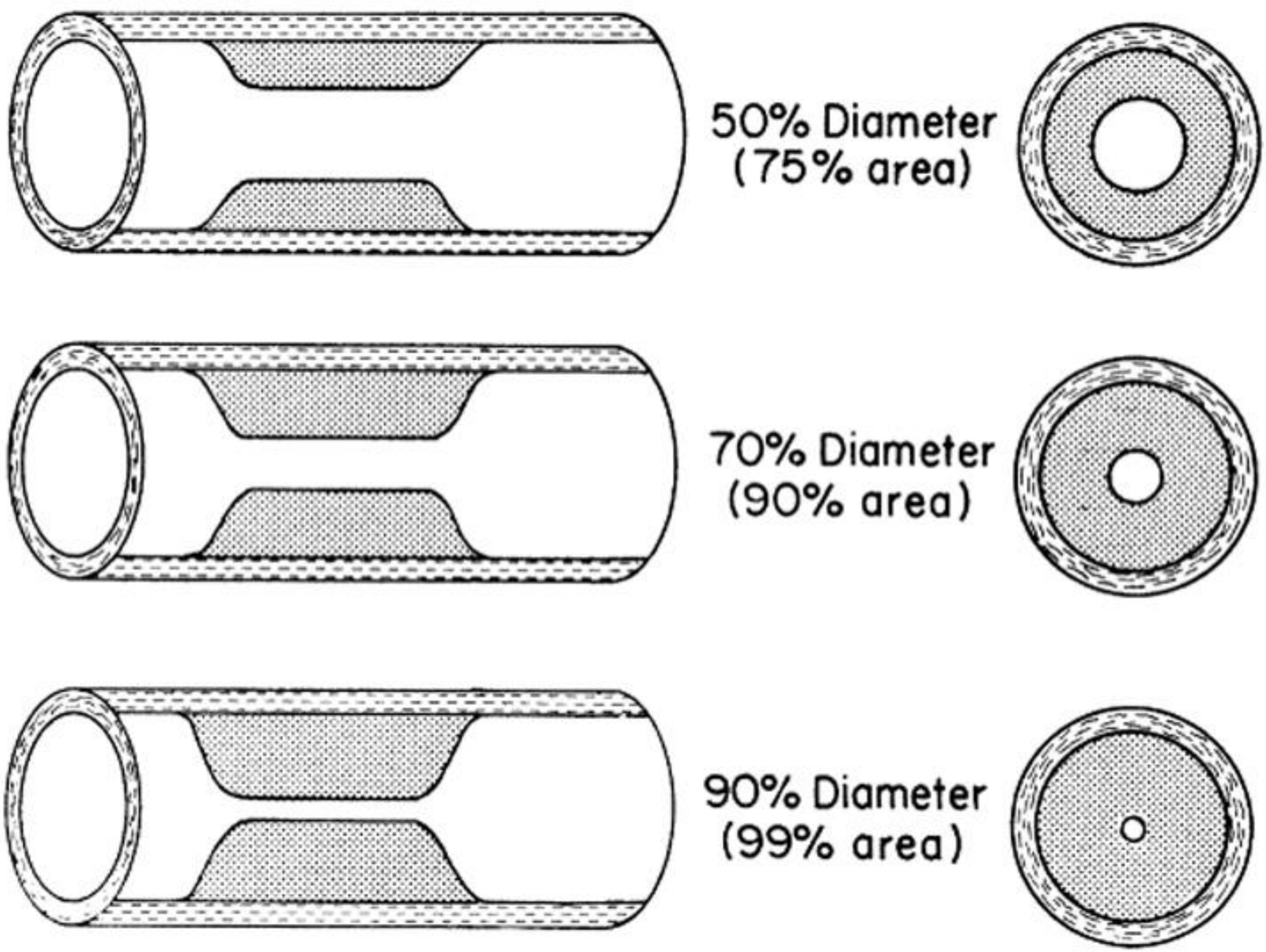

Figure 11.21 Coronary stenoses of 50, 70, and 90% diameter reduction are shown in longitudinal and cross section. The corresponding reductions in cross-sectional area are indicated in parentheses.

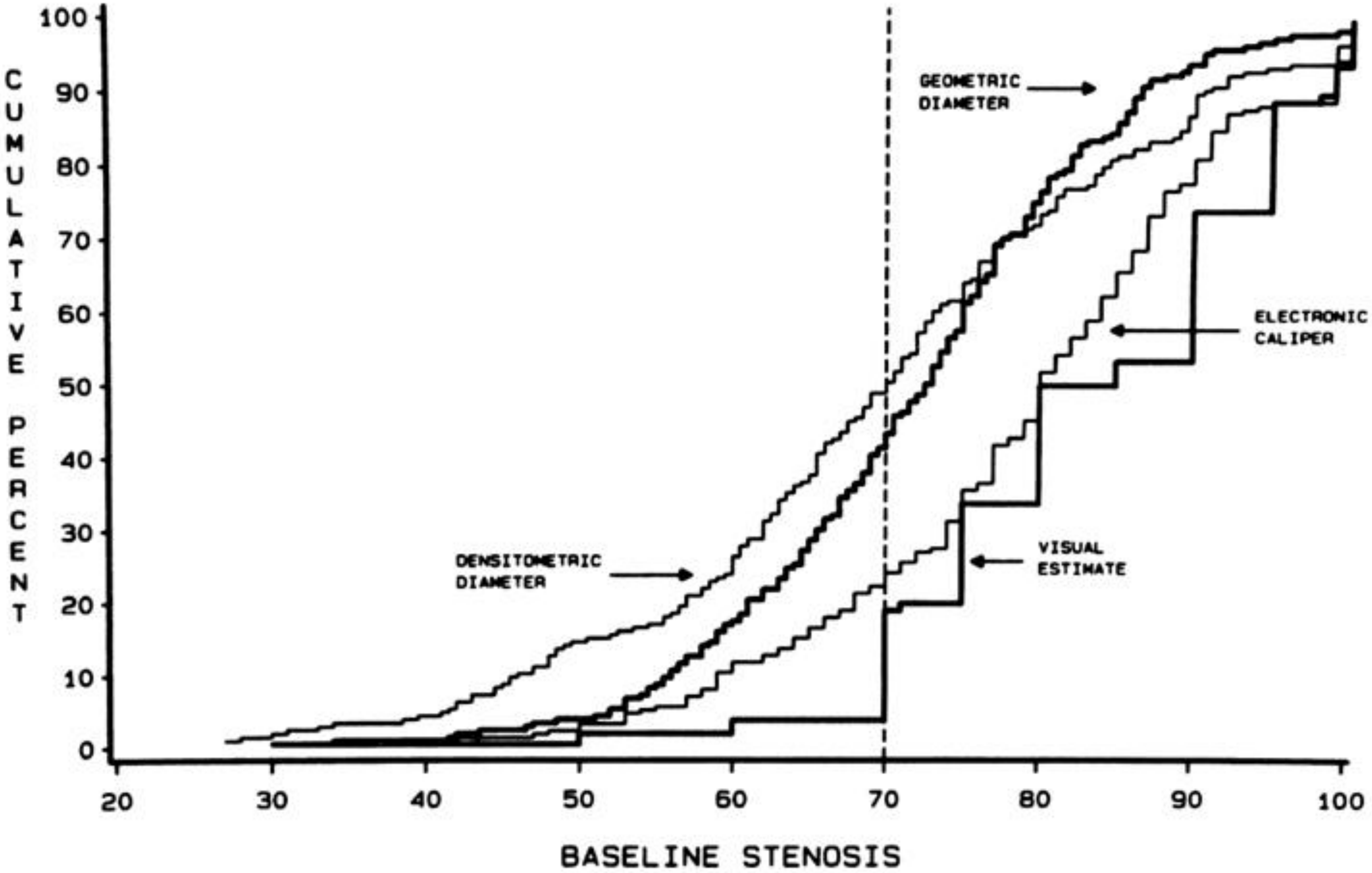

Figure 11.22 In a series of 227 patients with single-vessel disease, visual estimates (right curve, average nearly 90%) were consistently higher than either caliper measurements (average near 80%) or computer-assisted quantitative angiography by either geometric or densitometric techniques (left curves, average near 70% diameter stenosis). (From Folland, Vogel RA, Hartigan P, et al. Relation between coronary artery stenosis assessed by visual, caliper, and computer methods and exercise capacity in patients with single-vessel coronary artery disease. *Circulation* 1994;89:2005, with permission).

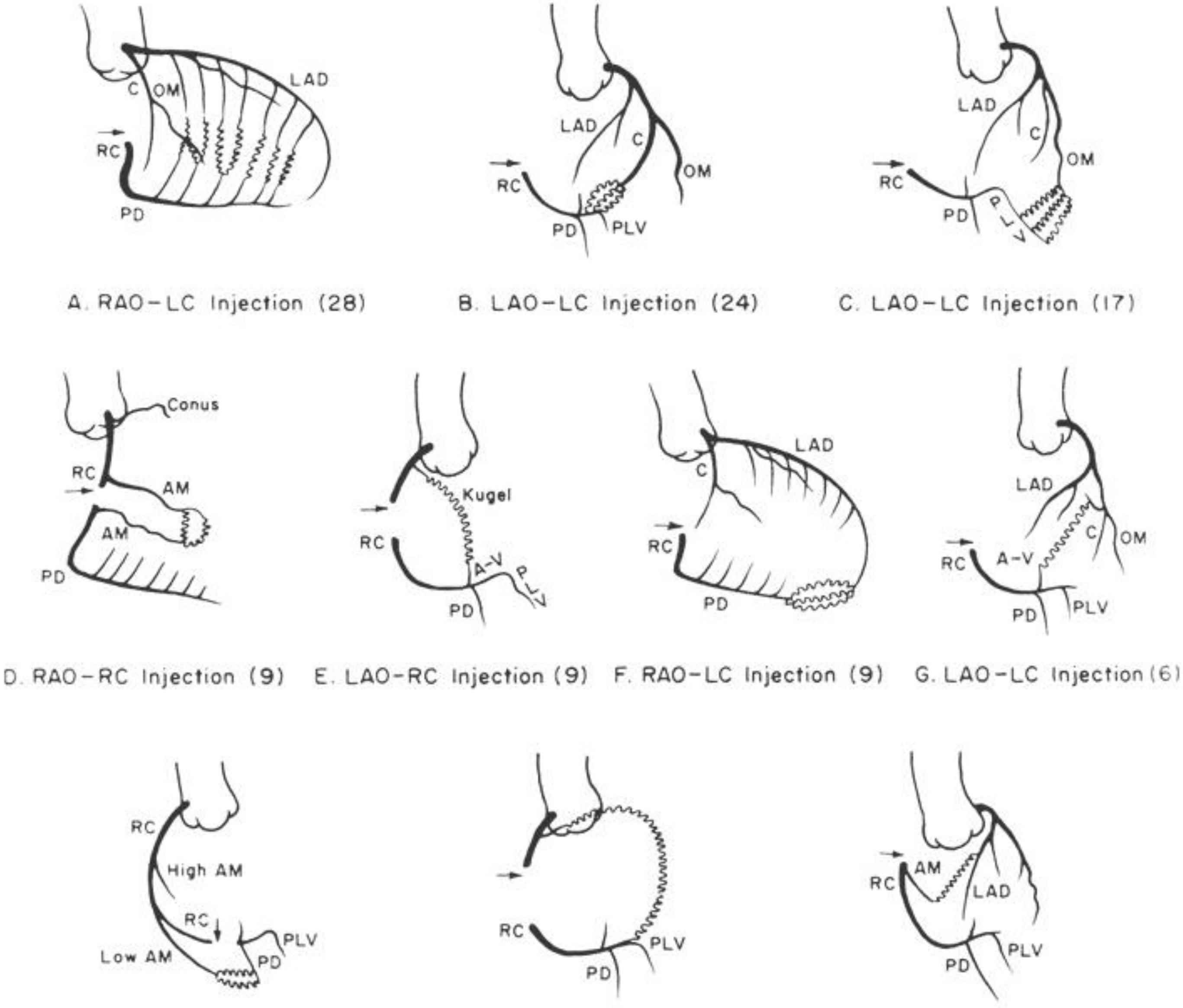

Figure 11.23 Ten collateral pathways observed in patients with right coronary (RC) obstruction (total occlusion or >90% stenosis). LAD, left anterior descending; C, circumflex; OM, obtuse marginal; PD, posterior descending; PLV, pos-terior left ventricular branch; AM, acute marginal branch of right coronary artery; AV, atrioventricular nodal; LC, left coronary. Numbers in parentheses represent numbers of cases in this series. (From Levin DC. Pathways and functional significance of the coronary collateral circulation. *Circulation* 1974; 50:831. By permission of the American Heart Association, Inc.)

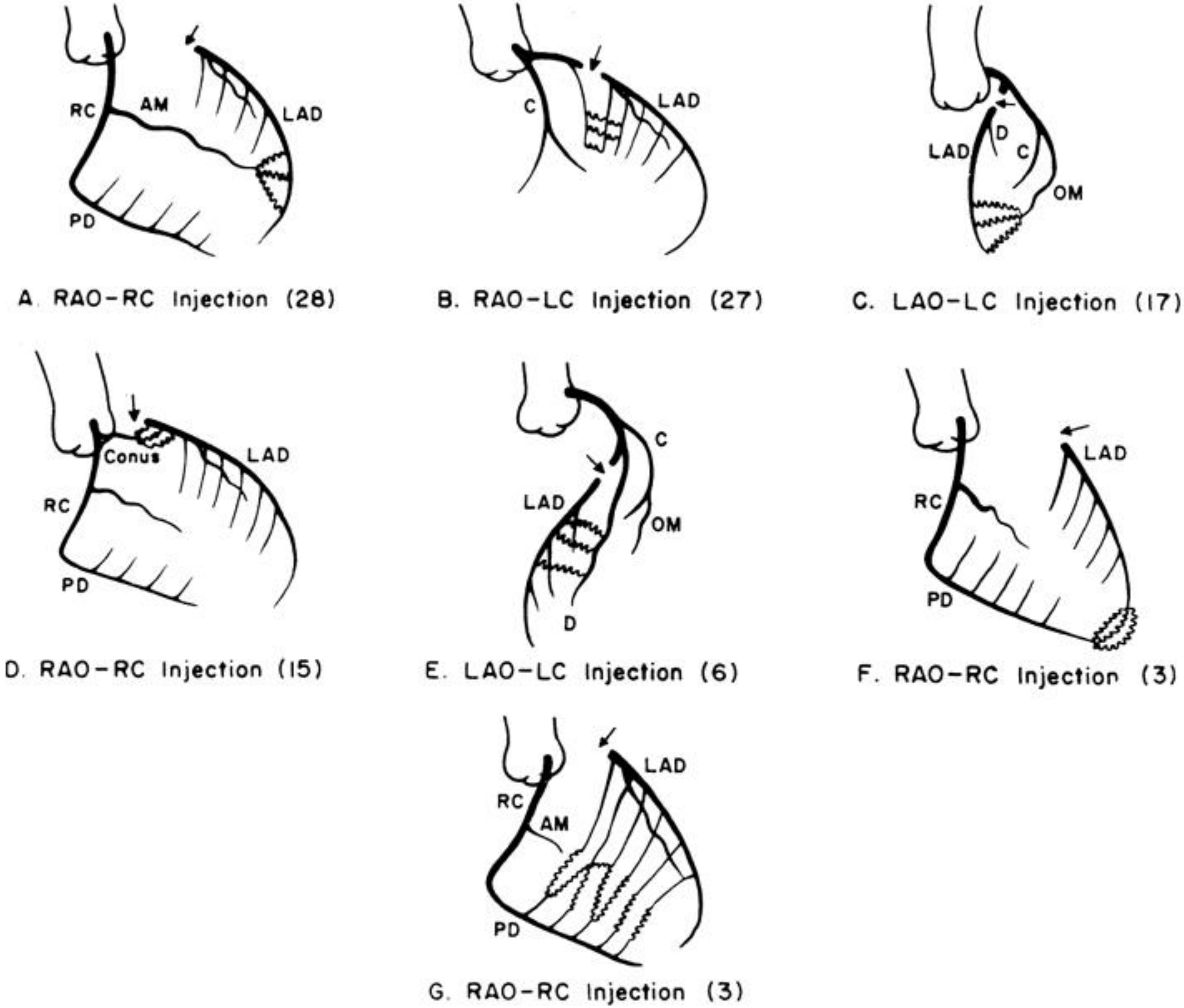

Figure 11.24 Seven collateral pathways observed in patients with left coronary artery obstruction. Abbreviations and format are the same as in Figure 11.23. (From Levin DC: Pathways and functional significance of the coronary collateral circulation. *Circulation* 1974;50:831. By permission of the American Heart Association, Inc.)

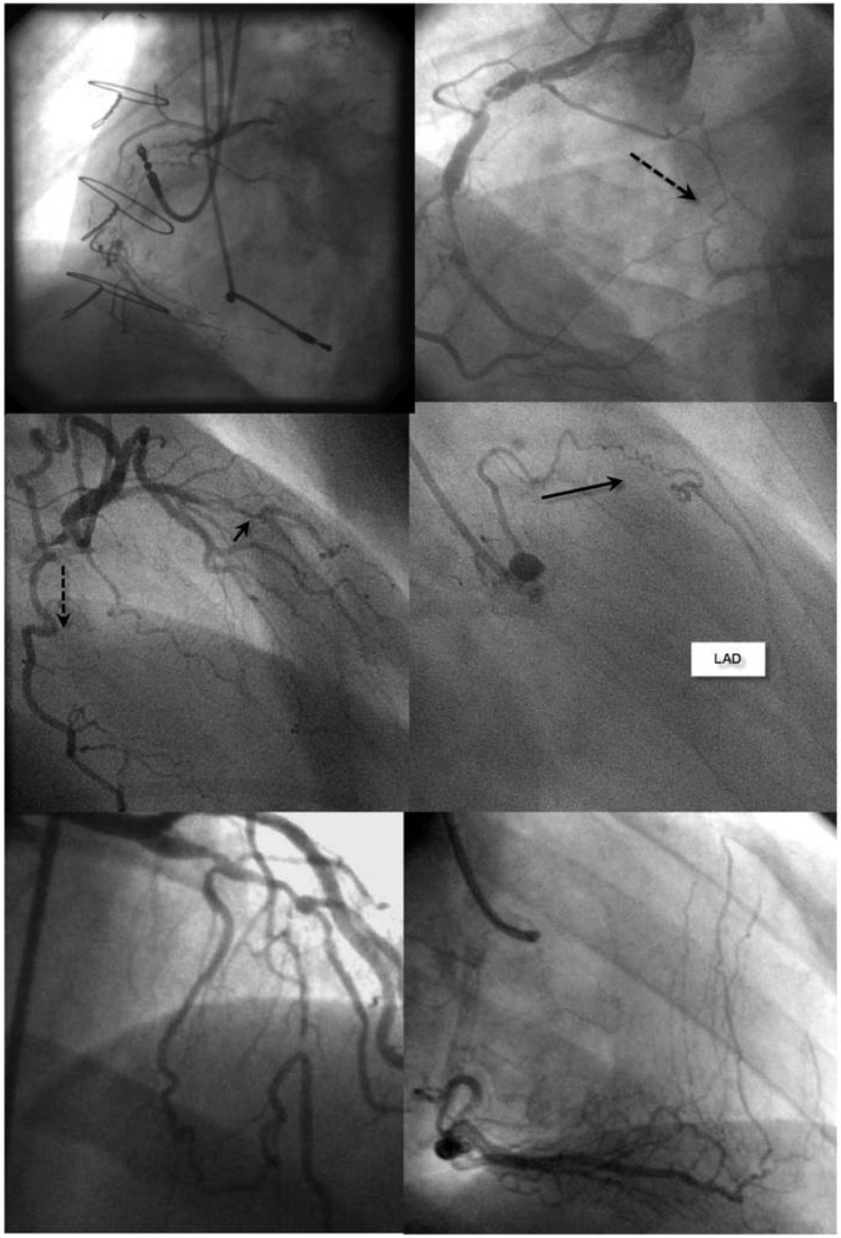

Figure 11.25 Angiographic appearance of some common collateral pathways. **Top left.** Bridging or vasa vasora collaterals in an occluded right coronary artery (RCA). **Top right.** Kugel collateral (sinus node to atrioventricular node, *dotted arrow*) supplying the distal RCA. **Center left.** Full-bore connection (*dotted arrow*) between the distal circumflex and the distal portion of an occluded RCA, in a patient with coexisting left anterior descending (LAD) occlusion (*short arrow*). **Center right.** Classic Vieussens (Raymond de Vieussens, 1641–1715) collateral connecting the conus branch of the RCA to the LAD in the same patient as shown in the previous example. **Bottom left.** Septal-to-septal collateral in severely stenotic LAD. **Bottom right.** Posterior descending septal branches connecting to septal branches of an occluded LAD.

DAC Não Aterosclerótica

- Anomalias congênitas de origem de coronária, fístulas de coronária e pontes miocárdicas
- Anormalidades cardíacas de origem não coronária (prolapso mitral, cardiomiopatia hipertrófica, estenose aórtica e miocardite)
- Condições extracardíacas (Espasmo esofageano e colecistopatia)
- Coronária vasoespástica

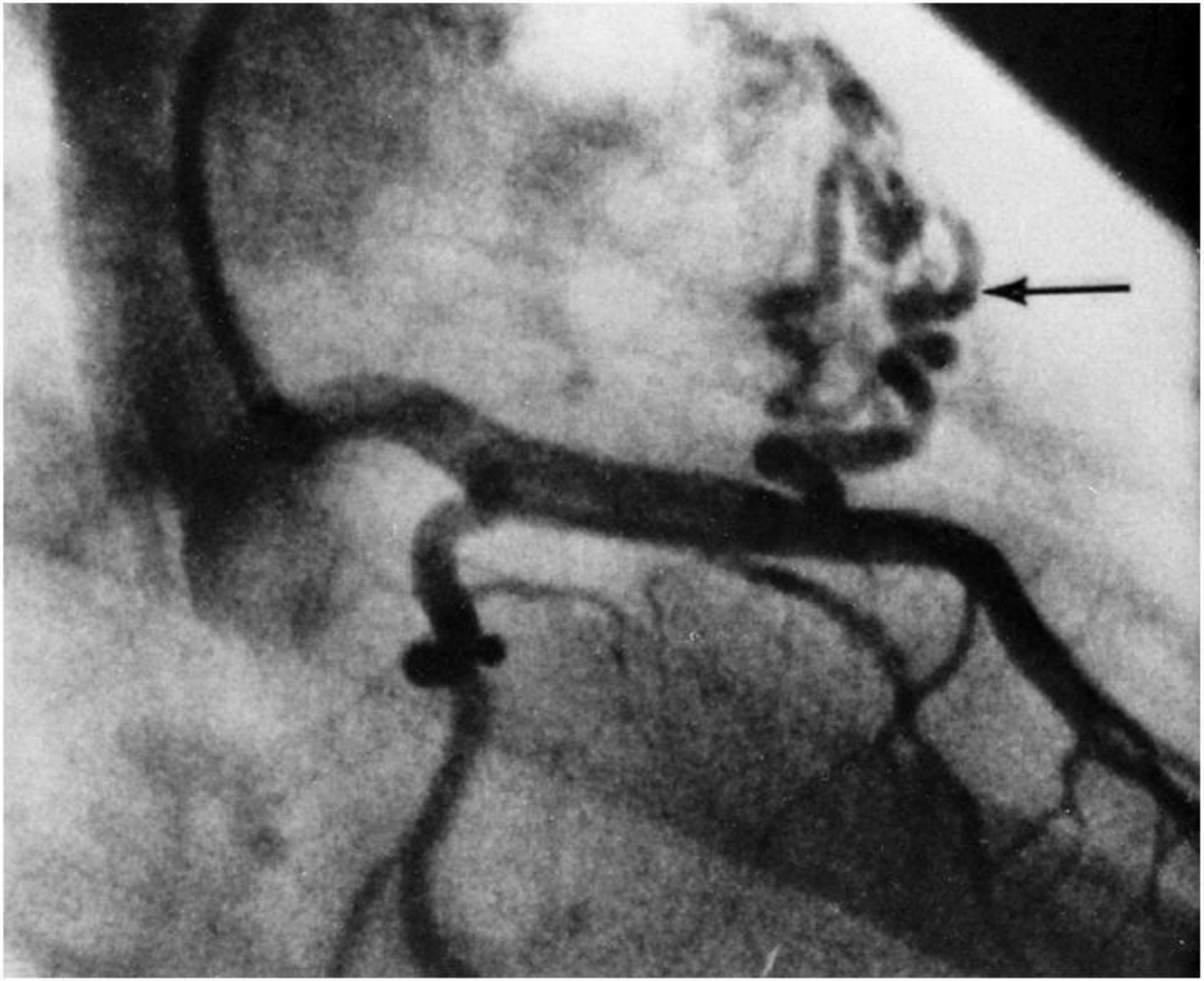

Figure 11.26 Coronary artery fistula (*arrow*) between the midleft anterior descending coronary artery and the pulmonary artery, shown in the right anterior oblique view.

Detecção de Vasoespasmo Coronariano

- Se o teste provocativo para o espasmo coronário é contemplado, deve se retirado do paciente bloqueadores dos canais de cálcio por pelo menos 24 horas e nitratos de longa duração durante pelo menos 12 horas antes da pesquisa, e não ser pré-medicados com qualquer atropina ou nitroglicerina sublingual

Detecção de Vasoespasmo Coronariano

- O agente provocativo mais comumente usado é maleato de ergonovina, um estimulante alfa-adrenérgico e de receptores de serotonina no músculo liso vascular da coronária
- Antídoto nitroglicerina
- Avaliação de sintomas e ECG

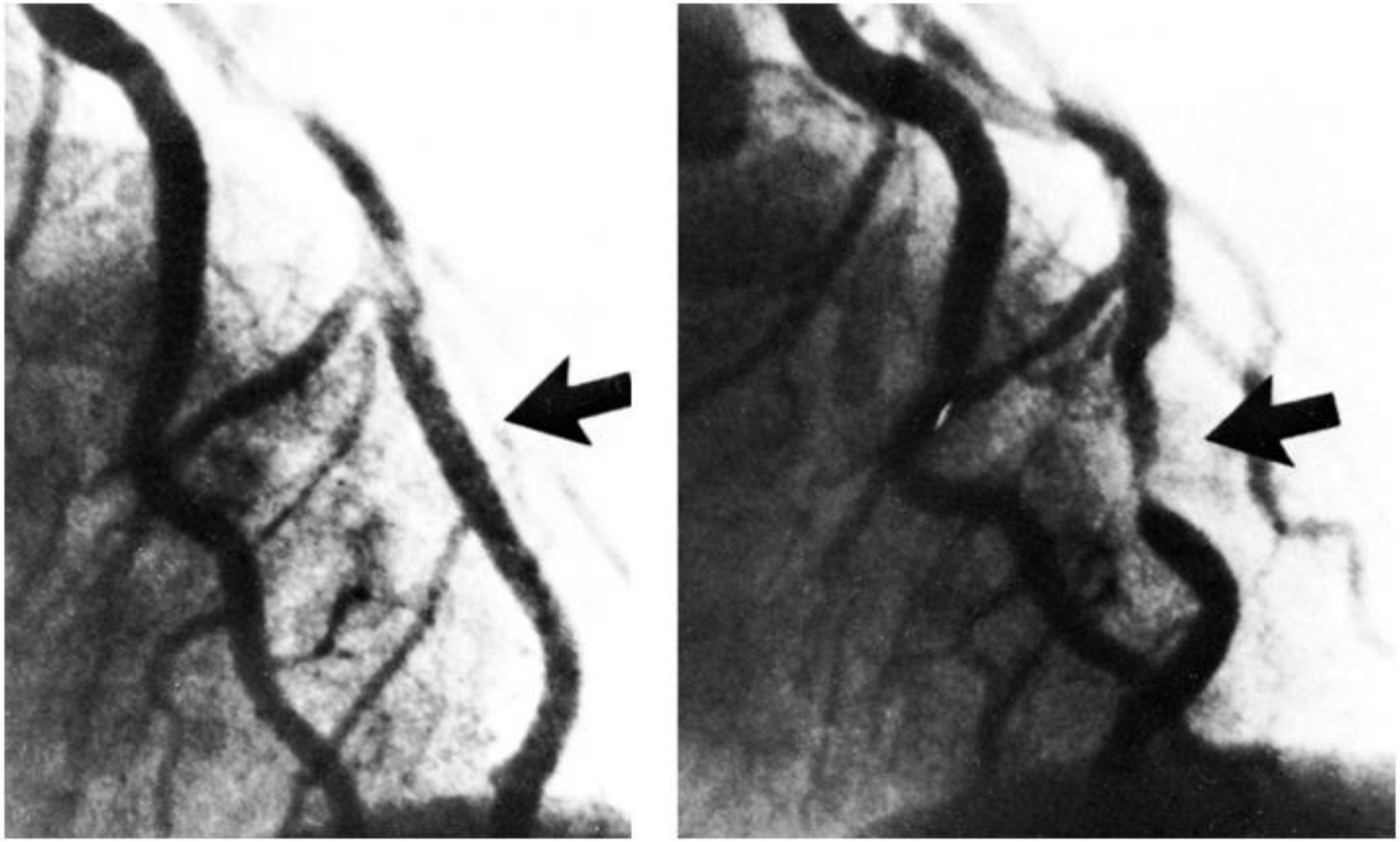

Figure 11.27 Muscle bridge. Moderately severe muscle bridge of the left anterior descending coronary artery (*arrow*) as seen in diastole **(left)** and systole **(right)**.

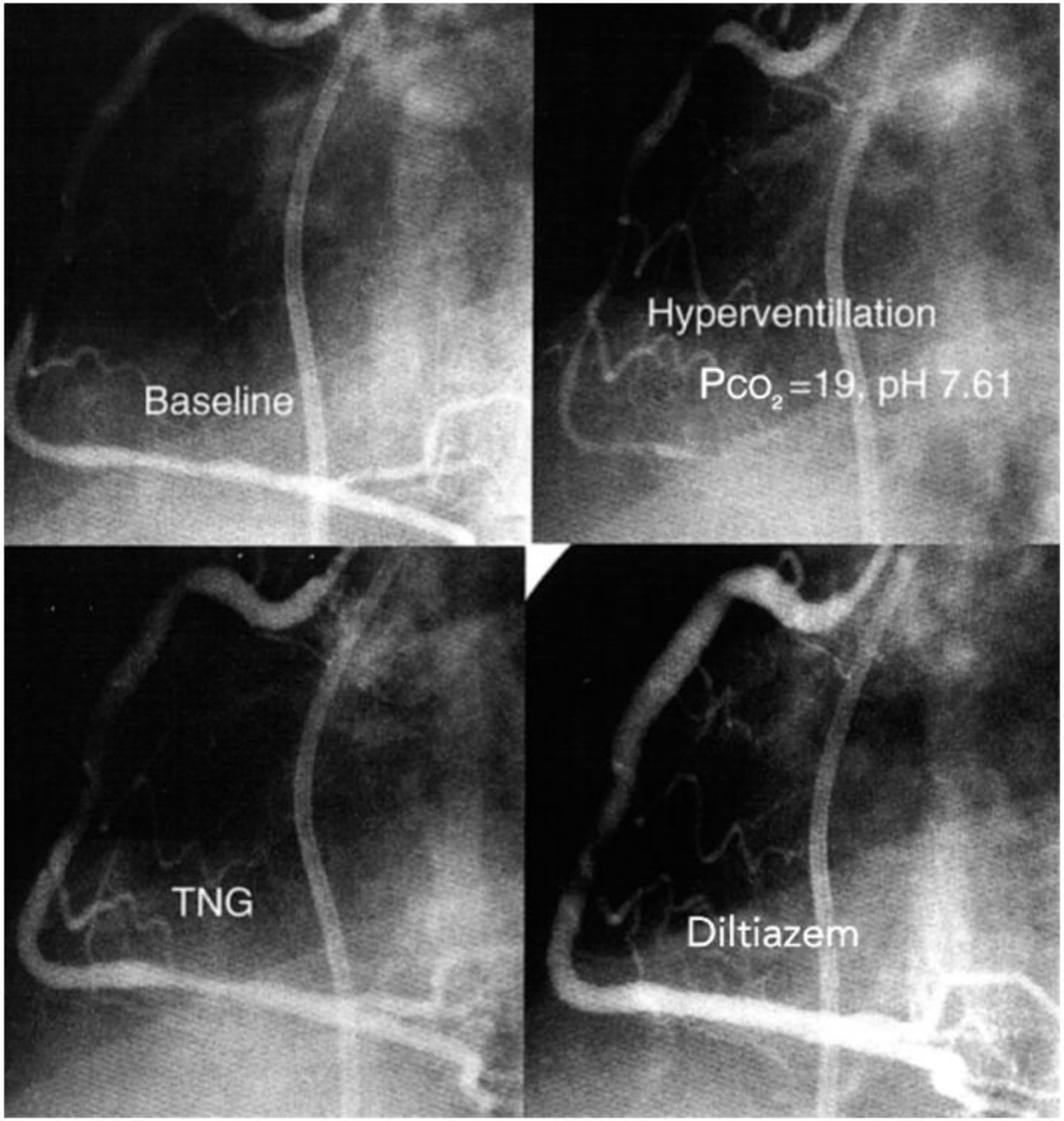

Figure 11.29 A 37-year-old man was admitted with chest pain and ST-segment elevation in the inferior leads. Emergency catheterization was performed for presumed acute myocardial infarction within 30 minutes of presentation **(top left)**, but disclosed a dominant right coronary artery with only mild disease at a time when pain had resolved after nitrate and heparin therapy. Hyperventillation (30 breaths per minute for 5 minutes) was performed with reduction of PCO_2 to 19 mm Hg and elevation of pH to 7.61, resulting in provocation of occlusive focal spasm of the distal right coronary artery with return of chest pain and ST-segment elevation **(top right)**. Relief of vasospasm and marked general dilation of the RCA was produced by intracoronary administration of trinitroglycerin (TNG) 200 μg **(bottom left)** and diltiazem 500 μg **(bottom right)**.

Reserva vasodilatadora coronária anormal

Erros na interpretação

- Números inadequados de projeções
- Injeção pulsátil de material de contraste
- Cateter induzir espasmo coronariano
- Injeções superseletivas
- Variantes congênitas de origem coronária e distribuição
- Pontes de miocárdio
- Oclusão Total

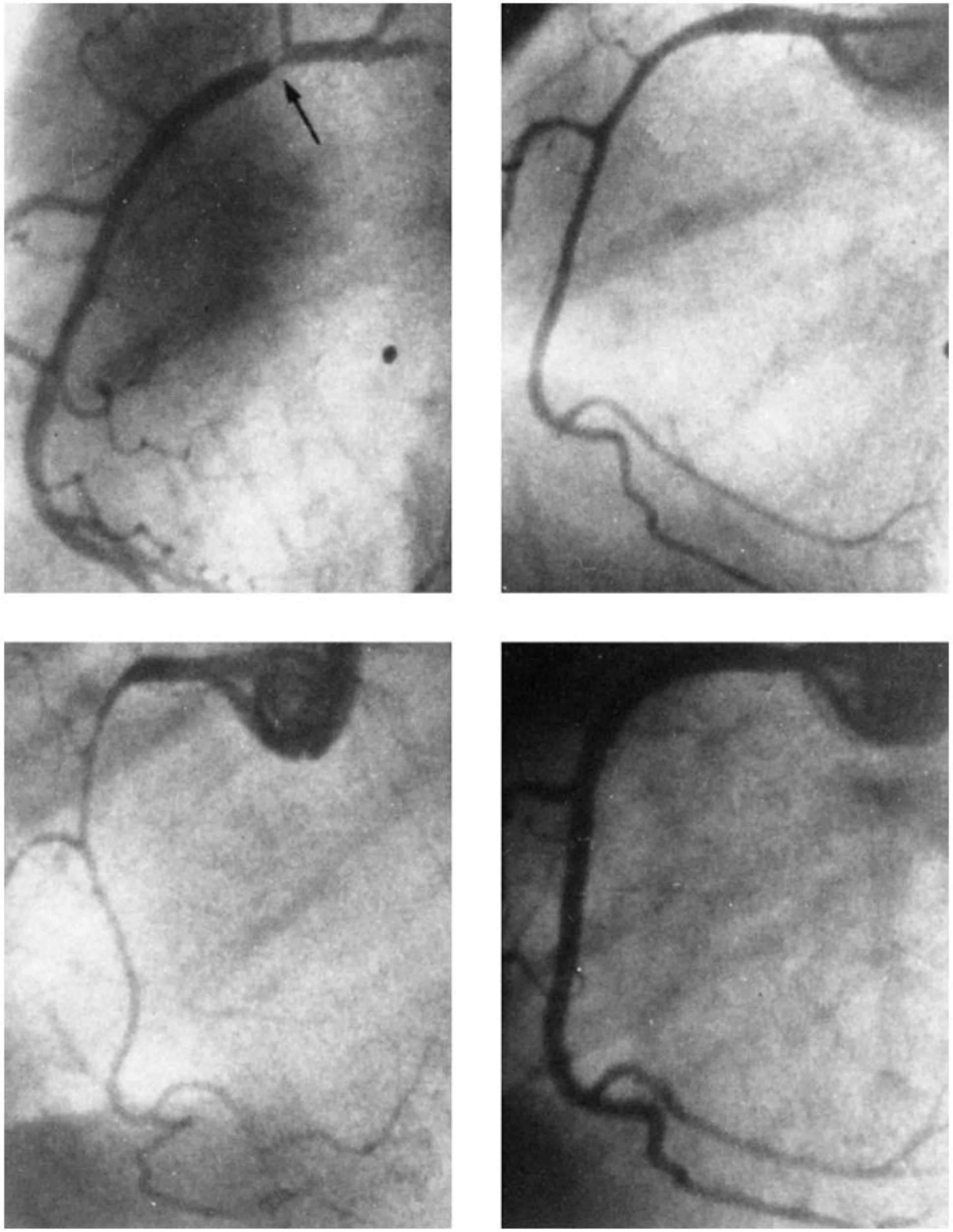

Figure 11.30 Vasomotor changes not representing true coronary spasm. During right coronary catheterization with a Judkins catheter **(top left),** this patient developed severe catheter-tip spasm. Recatheterization 24 hours later with an Amplatz catheter **(top right)** showed neither catheter-tip spasm nor an atherosclerotic stenosis. Following ergonovine 0.4 mg, marked diffuse coronary narrowing was observed **(bottom left)** without angina or electrocardiographic changes. After the intracoronary administration of nitroglycerin 200 mcg **(bottom right),** there is marked diffuse vasodilation.

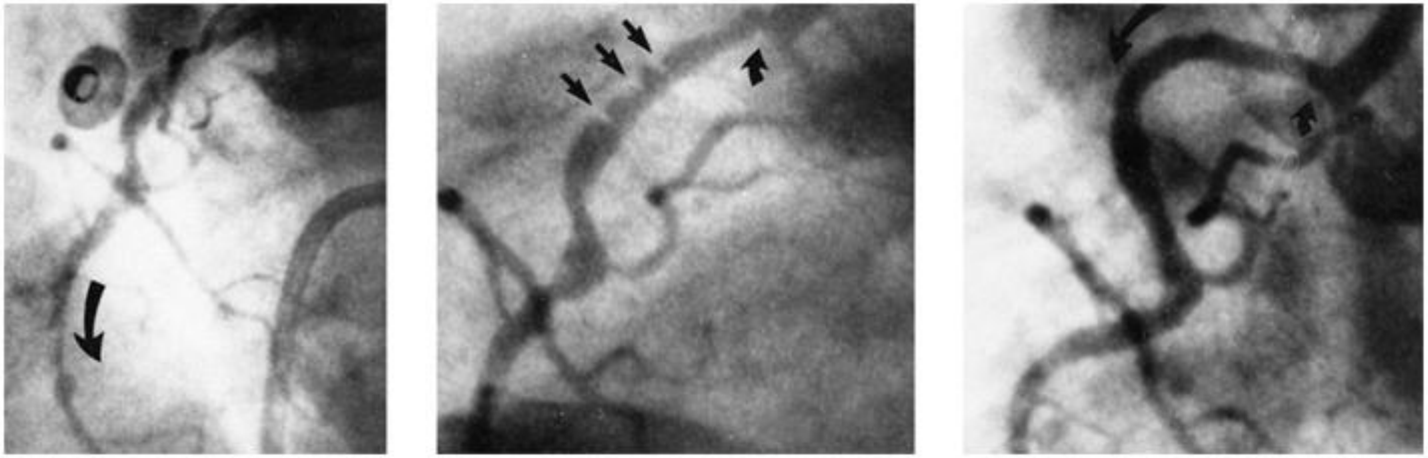

Figure 11.31 Right coronary artery "pleating" artifact. **Left.** Baseline injection shows diffuse disease in this tortuous right coronary artery selected for rotational atherectomy. **Center.** shows straightening of the proximal vessel by the stiff type C wire, creating three areas of infolding of the vessel wall *(arrows)* as well as the appearance of ostial stenosis *(curved arrow).* Immediately on withdrawal of the guidewire, the artery returned to its baseline curvature and these defects resolved *(arrows).*

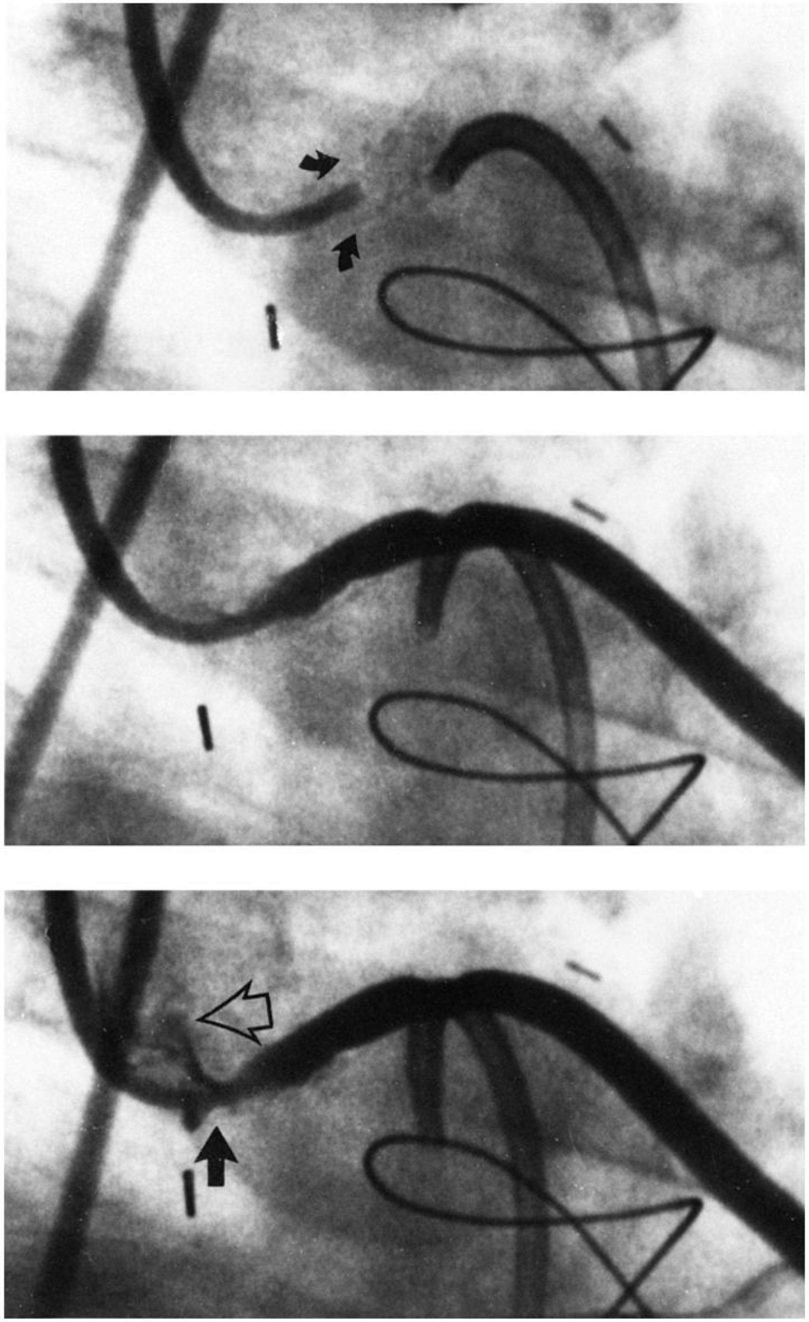

Figure 11.32 Masking of ostial stenosis during superselective cannulation. Ostial stenosis of previously stented vein graft is not apparent with the tip of the catheter well beyond the stenosis **(top and center).** Continued injection during catheter withdrawal **(bottom)** causes reflux into the aorta *(solid arrow)* and clearly shows significant ostial stenosis.