

Angiographic Projections Made Simple: An Easy Guide to Understanding Oblique Views



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Every year, we get a new group of cardiology fellows-in-training who are unfamiliar with angiograms and the angulations needed to best display the coronary arteries. Almost as frequently are the visitors to the cath lab or new trainees in the cath lab who need of an orientation to the angiogram, and its specific angulations and abnormalities.

For the past several years, whenever I give an introductory lecture on the cath lab and angiography, I use a simple method to show how the heart and the arteries move when changing from anterior-posterior (AP) projection to the left and right anterior oblique views (LAO, RAO) with cranial and caudal angulation. The method simply uses the fingers of the left hand to represent the coronary arteries. The entire demonstration can be seen on the DVD "Cath Lab Essentials" (www.cathlabessentials.com). I will take you through the easy steps of this angiography method.

Nomenclature

Before beginning, a common starting point for naming the angles is needed (see Table 1 and Figure 1). For all cath labs, the x-ray source is under the table and the image intensifier is directly above the patient. The body surface of the patient that faces the image intensifier (or flat panel) determines the specific view. This relationship holds true whether the patient is supine, standing, or rotated (Figure 1). To obtain an oblique (angulated from the perpendicular) view, the image intensifier is moved toward the patient's right or left shoulder. In the days before moving C-arms, angulated views were obtained by rotating the patient with his right or left shoulder propped upward (moved anteriorly) by a pillow or wedge. Thus, moving the left shoulder forward produces the LAO view and moving the right shoulder forward produces the RAO view. For the demonstrations of how the arteries change position with different angulations, the hand is kept in position, and either the right or left shoulder is rotated toward the observer (image intensifier) to duplicate the LAO and RAO views.

The cardiac silhouette in LAO and RAO

The heart is the size of one's fist (Figure 2). It is shaped like an ice cream cone, with the tip toward the sternum. In Figure 2, my open hand is positioned as it would be seen in an AP projection. When the left shoulder is moved forward (LAO projection) and the hand is seen more on end, that is the heart made shorter and rounder in the LAO (Figure 3). When the right shoulder is moved forward (RAO projection), the hand is seen in a profile that is made longer with the tip extending to the left chest wall. These 2 movements of the hand in the LAO and RAO will remind you how the heart should look in each projection, whether seen on a plain chest x-ray, or on fluoroscopy or ventriculography during cardiac cath (Figure 3).

Nomenclature of the LV segments

In the LAO view, the LV segments, moving from 12 clockwise are the high lateral, lateral, apical, septal, and base (Figure 4). In the RAO view, from the 1 o'clock position, the LV

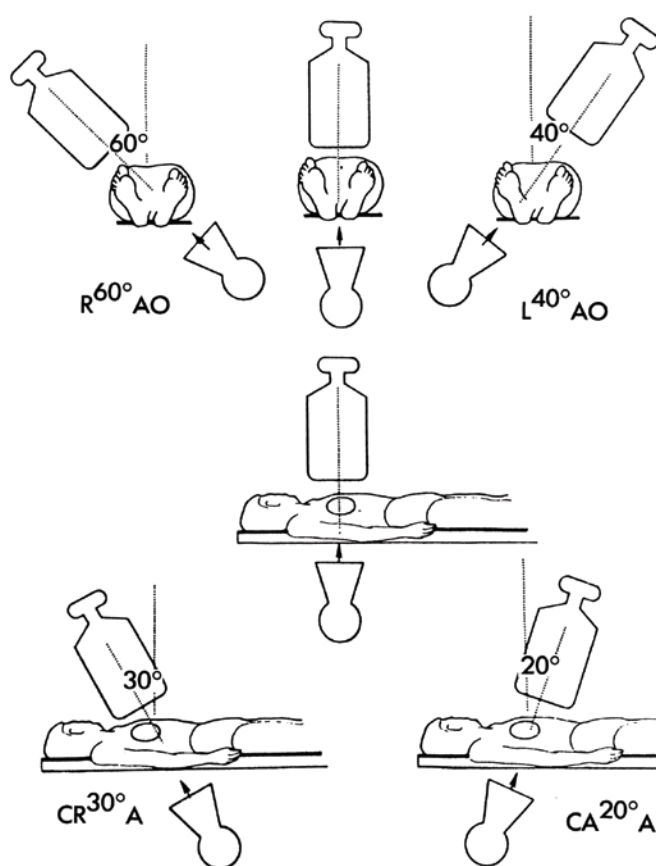


Figure 1. Nomenclature for radiographic projections. The small black arrowheads show the direction of the x-ray beam. Top 3 panels (left to right): right (R) Anterior oblique (AO), anterior-posterior, left (L) AO. Middle panel, anterior posterior viewed from patient's side. Bottom left: If the intensifier is tilted toward the head of the patient, a cranial view is produced. Bottom right: If the intensifier is tilted toward the feet of the patient, a caudal view is produced. (Redrawn from Paulin S. *Cathet Cardiovasc Diagn* 1981;7:341-344, and reproduced in Kern MJ (Ed.) *The Cardiac Catheterization Handbook*. 5th ed. Elsevier; Philadelphia: Pennsylvania, 2011: 152.)

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Table 1. Nomenclature for Angiography

- **Anteroposterior (AP) position.** The image intensifier is directly over the patient with the beam traveling perpendicularly back to front (i.e., from posterior to anterior) to the patient lying flat on the x-ray table.
- **RAO position.** The image intensifier is on the right side of the patient (A, anterior; O, oblique).
- **LAO position.** The image intensifier is on the left side of the patient.
Note: Think of the oblique view as turning the left or right shoulder forward (anterior) to the camera (image intensifier).
- **Cranial/caudal position.** This nomenclature refers to image intensifier angles in relation to the patient's long axis.
- **Cranial.** The image intensifier is tilted toward the head of the patient.
- **Caudal.** The image intensifier is tilted toward the feet of the patient.

Note: Cranial and caudal views are used to "open" overlapped coronary segments that are foreshortened or obscured in regular views. Cranial views are best for the LAD and diagonal arteries; caudal views are best for the circumflex and left main arteries.

From Kern MJ. *The Cardiac Catheterization Handbook*. 5th ed. Elsevier: Philadelphia, Pennsylvania; 2011.

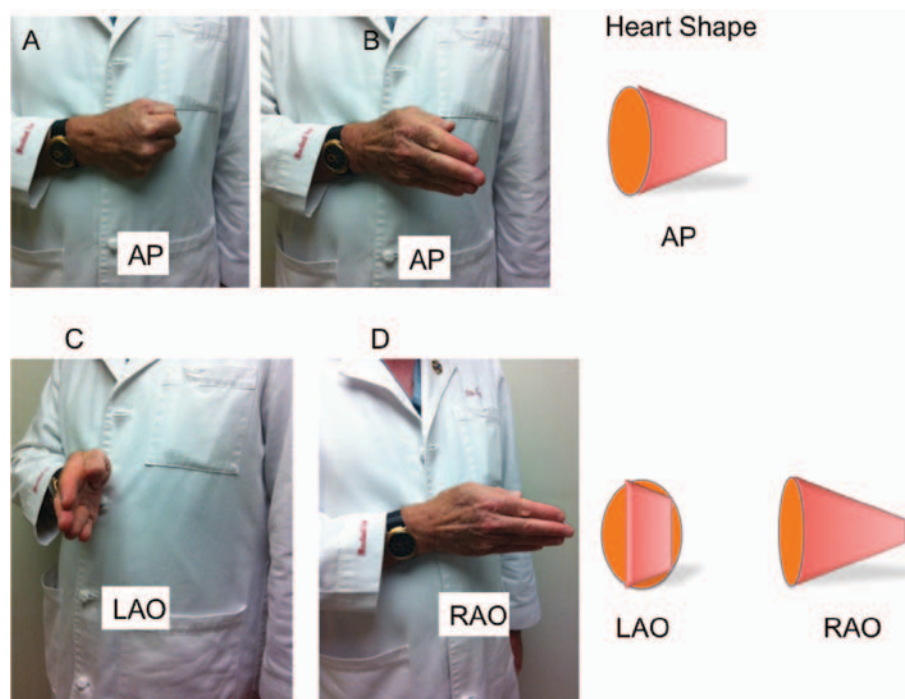


Figure 2. A) Anterior-posterior (AP) view of heart (closed fist) in chest. B) AP view of left ventricle (LV) shape (open hand) in chest. Diagram to right shows approximate shape as might be seen on x-ray. C) Left anterior oblique (left shoulder forward) LAO rotation causes foreshortening of LV with apex toward viewer and rounding of cardiac silhouette (diagram at right, LAO). D) Right anterior oblique (right shoulder forward, RAO) causes heart to elongate as it rotates with tip of heart to the left side. Diagram on right shows LV image as it might appear on x-ray. These images are put in perspective in the patients on Figure 3.

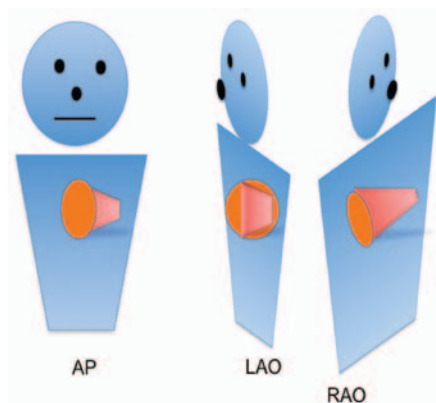


Figure 3. Left ventricle (LV) diagrams put in patients as the LV shape changes from anterior-posterior to LAO and RAO. Descriptions of LV shape as in Figure 2.

segments are the anterior base, anterior, apical, inferior, and inferior base. The lateral wall cannot be seen in the RAO projection.

The left coronary arteries – LAO views

By placing the left hand fingers over the clenched right fist, the index finger becomes the left anterior descending artery (LAD) and runs over the knuckles, which represent the anterior interventricular groove (Figure 5). The middle finger is spread, lying on the finger joints, and represents the circumflex artery (CFX). The thumb runs horizontal to the wrist joint and represents the initial course of the

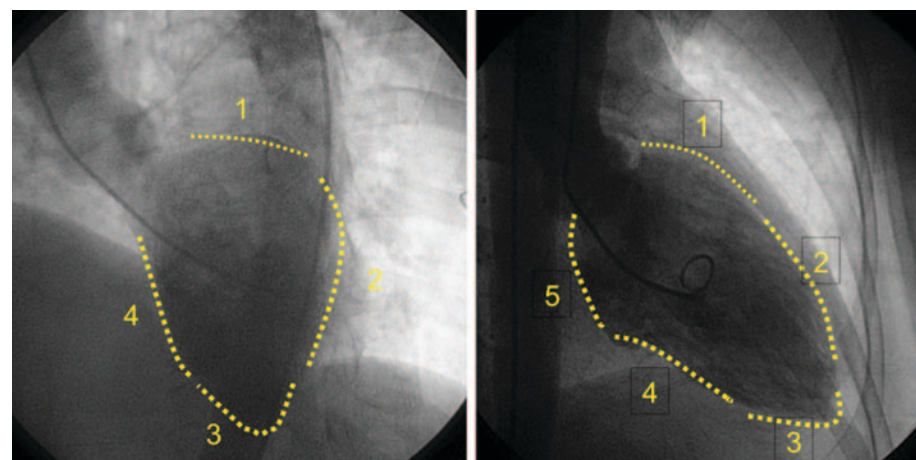


Figure 4. Left ventriculograms in LAO with cranial angulation (Left) and RAO (right). The LAO segments are 1) basal, 2) lateral, 3) apical, 4) septal. In this projection, the apex of the heart is tipped downward. The RAO segments are 1) anterior basal, 2) anterior, 3) apical, 4) inferior, 5) inferior basal.

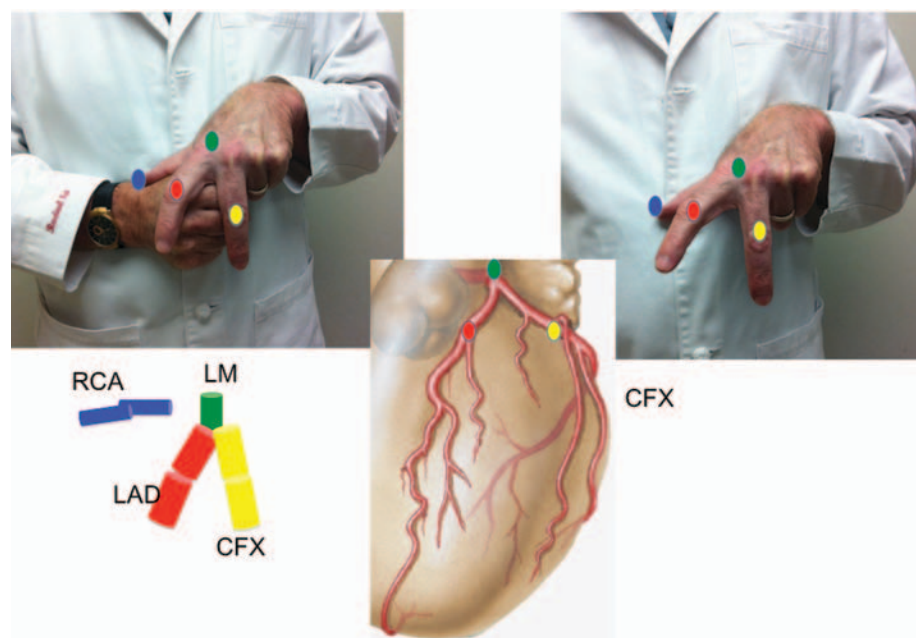


Figure 5. Top left: The fingers of the left hand represent the coronary arteries. The colored bars depict the coronary arteries of the drawing in the center. When placed over the heart (fist), the left anterior descending coronary artery (LAD) (red, index finger) runs down the anterior interventricular groove. The circumflex artery (yellow, middle finger) runs over the left side of the fist. The proximal portion of the right coronary artery (RCA) (blue, thumb) starts at the top of the fist and runs to the wrist then down the anterior interventricular (AV) groove (wrist). The posterior descending artery (PDA) will be shown below. Top right: The coronary arteries (fingers) are shown with the heart (fist) removed in the anterior-posterior (AP) projection. The green block represents the left main artery (LM) segment position.

right coronary artery (RCA) arising from the right sinus of Valsalva. Later, we will see that the posterior descending artery (PDA) of the RCA can be shown by the index finger placed along the bottom of the fist to demonstrate the course of the PDA in the oblique views.

The left coronary arteries – LAO with cranial and caudal angulations

In cranial angulation, the image intensifier moves toward the head of the patient and produces a downward tilt of the LAO view, exaggerating the left main segment but keeping the relationship between LAD and CFX almost the same (Figure 6a).

To show the effect of caudal angulation, think of the image intensifier moving toward the foot of the patient. This position views the coronary arteries from underneath, tipping the LAO view upward and producing a branching appearance some call the "spider" view. Figure 6b and similar images provide a CTA reconstruction

of the coronary arteries, with the lower panels showing a subtracted image duplicating what would be seen on traditional coronary angiography in the cath lab. The lower right panel of Figure 6b shows the LAO, caudal angulation, and is called the 'spider' view of obvious reasons.

The left coronary arteries – RAO projections

When demonstrating how the coronary arteries move in relationship to one another, it is now easy to visualize that in the LAO projection, the LAD (index finger) is on the right side and the CFX (middle finger) is on the left side. If you rotate over to RAO, then the position of the fingers (LAD/CFX) changes orientation such that the LAD is now on the left, and the CFX is in the middle or more rightward than in the LAO view (Figure 7a).

The RAO with caudal angulation (Figure 7a, top left) tips the CFX downward, separating it more from the LAD. For the RAO with cranial

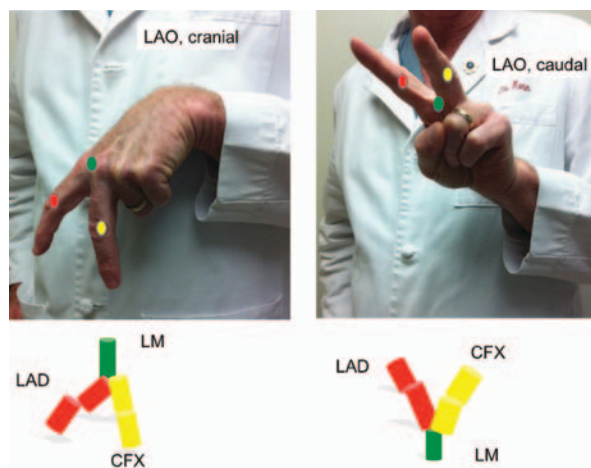


Figure 6a. Coronal angulation showing left anterior oblique (LAO) with cranial (left) and caudal (right) angulations. The coronary arteries (fingers) are tipped downward as the image intensifier (II) moves toward the head (cranially). The arteries are tipped upward (right) as the II moves toward the feet (caudally). The green bar represents the left main artery.

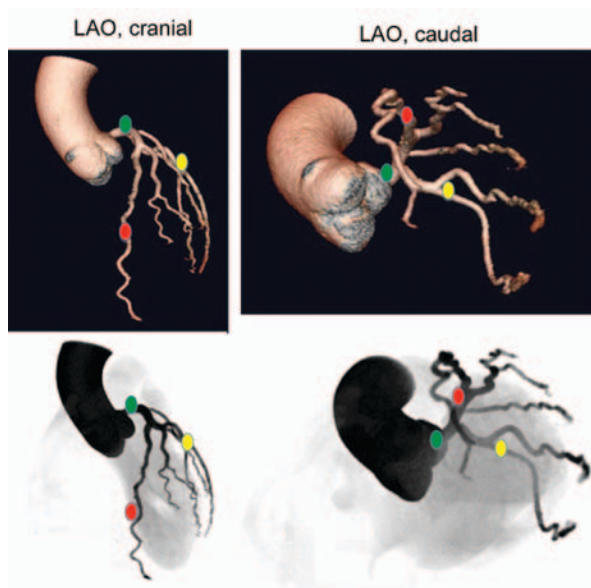


Figure 6b. Computed tomography angiography (CTA) reconstruction of left coronary arteries in the left anterior oblique (LAO), cranial (left) and LAO, caudal (right) angulations. The lower drawings are simulations of the images that are seen on contrast angiography. The lower right image of the left coronary artery in the LAO caudal view is called the 'spider' view for obvious similarities to the arachnid of the same name. Color coding: green = left main; yellow = circumflex; red = left anterior descending coronary artery.

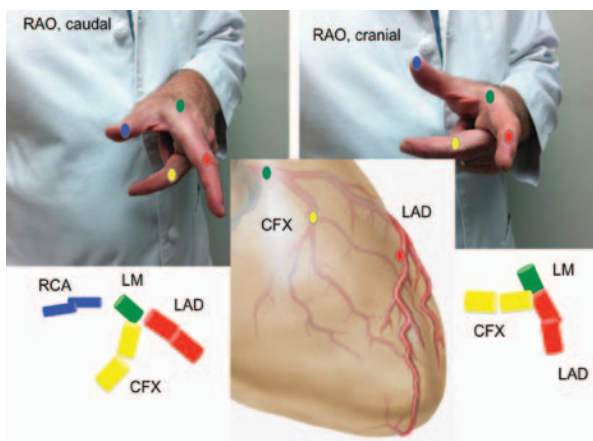


Figure 7a. Top left: The coronary arteries in the right anterior oblique (RAO) view with caudal angulation. As the right shoulder moves anteriorly, the position of the left anterior descending artery (LAD) moves from left side to the right side of the cardiac silhouette. The circumflex artery moves toward the left side or center of the heart. Top right: RAO with cranial angulation showing the turning upward with foreshortening of the circumflex artery.

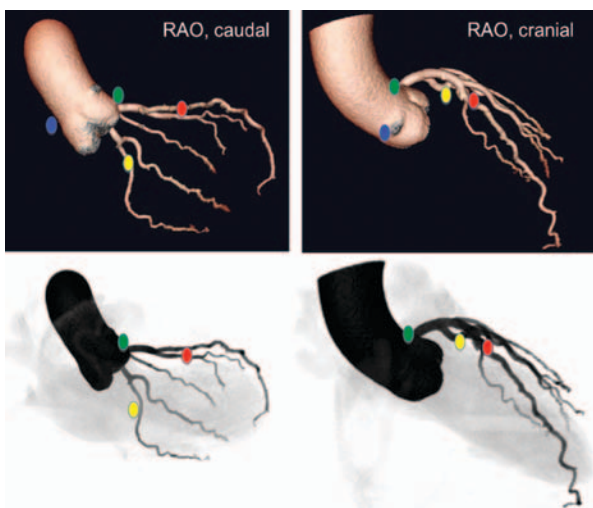


Figure 7b. CTA reconstruction of left coronary arteries in the RAO, caudal (left) and RAO, cranial (right) angulations. The lower drawings are simulations of the images that are seen on contrast angiography. Color coding: green = left main; yellow = circumflex; red = left anterior descending coronary artery; blue = right coronary artery.

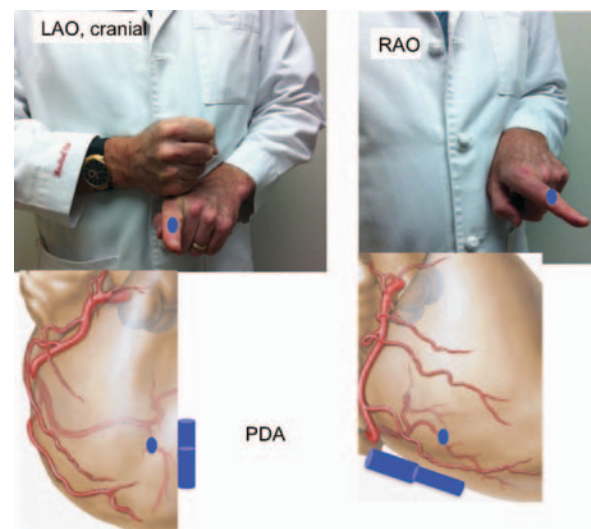


Figure 8a. The posterior descending (PDA) portion of the right coronary artery (RCA) runs along the inferior interventricular groove. Top left: In the left anterior oblique (LAO) view, cranial angulation, the PDA runs along the bottom of the heart and is tipped downward to better visualize the length without foreshortening. Top right: In the right anterior oblique (RAO) view without cranial or caudal angulation, the PDA is seen lengthwise, running from the base to the apex of the heart.

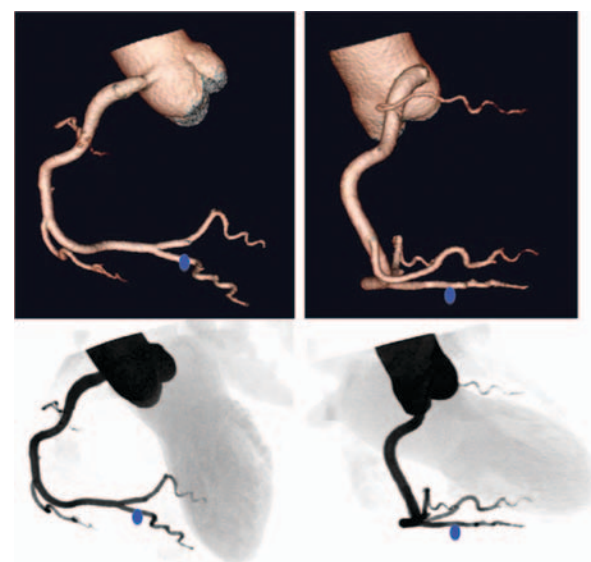


Figure 8b. CTA reconstruction of the right coronary artery in the left anterior oblique (LAO) view, cranial (left) and right anterior oblique (RAO) (no cranial or caudal) angulations. The lower drawings are simulations of the images that are seen on contrast angiography. Blue = right coronary artery.

angulation (Figure 7a, top right), the CFX is tipped upward, foreshortened, and overlapped with the LAD. Cranial views are best used to see the LAD and diagonals, while caudal views are best to see the CFX and LM segments. Figure 7b shows the angiograms of the RAO, caudal and cranial angulations. Note that the colored dots (red for LAD, yellow for CFX, green for LM, and blue for RCA) correspond to the same arteries for all figures.

Naming branches

For review, in the RAO, the branches of the LAD are the septal branches running downward from the LAD to the bottom of the heart, and the diagonal branches running almost parallel to the LAD. In the LAO projection, the diagonals run leftward to the margin of the heart.

For branches arising from the CFX, there are only obtuse marginal arter-

ies. In the RAO, they originate from the CFX (traveling in the AV groove over the coronary sinus) and run toward the tip of the heart. In the LAO, the obtuse marginal branches run to the edge of the heart (the margin).

The posterior descending artery from the RCA

The posterior descending (PDA) portion of the RCA runs along the inferior interventricular groove. The PDA along the bottom of the heart can be represented by the index finger (Figure 8a). In the LAO, cranial angulation, the PDA runs along the bottom of the heart and is tipped downward to better visualize the length without foreshortening (Figure 8a). In the RAO without cranial or caudal angulation, the PDA is seen lengthwise, running from the base to apex of the heart (Figure 8a, right panels). Figure 8b shows the CTA and contrast-filled

angiograms of the RCA in the LAO, cranial, and RAO projections.

Using the finger model, it should be easy to visualize and understand the coronary and ventriculographic images with the different oblique views, both with and without cranial and caudal angulations. I hope this will be as helpful to your "angiographic IQ" as it was to mine. ■