

Chapter 7

Mammographic Positioning

Objectives

- Understand basic procedures and recognized standards involved with breast imaging.
- Understand the basic positions, projections, and techniques used for mammography and how they are accomplished.

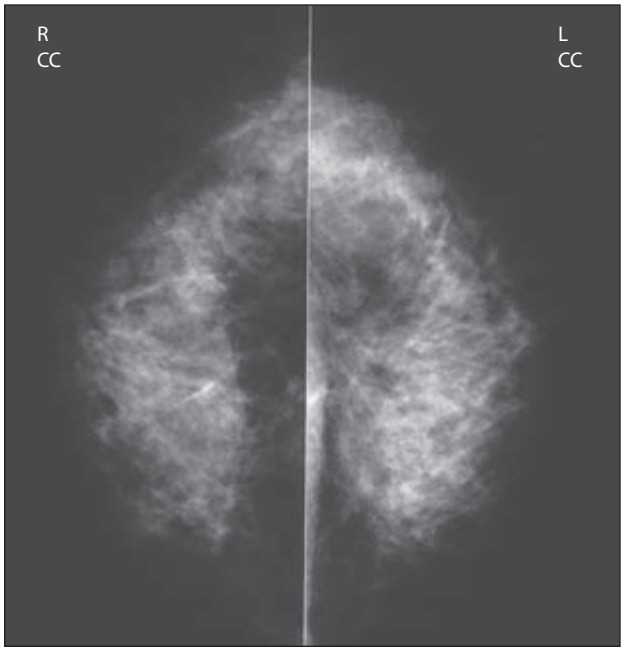
Key Terms

- motion
- mobile borders
- routine mammogram
- standardized labeling
- pendant positioning
- compression
- mosaic imaging
- respiration
- implant displacement
- structural overlap

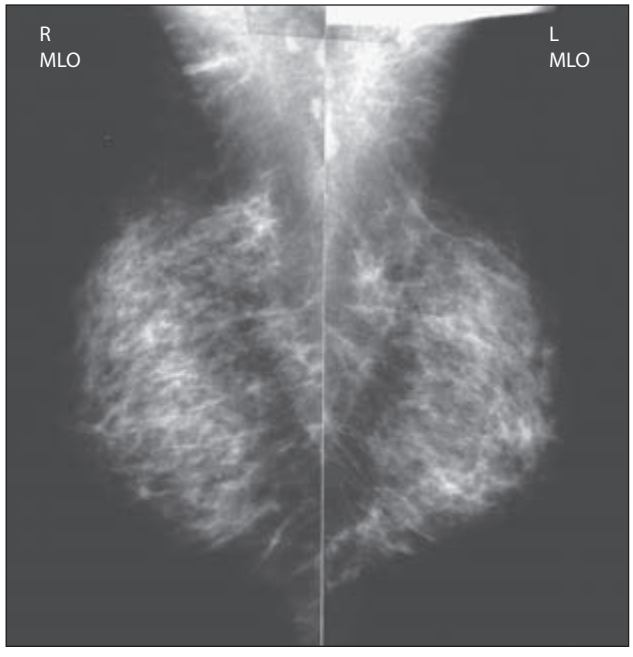
INTRODUCTION

Positioning is only one aspect of a complete breast diagnostic program, and encompasses much beyond the formal two-view study. The technologist must consider the patient's condition—body habitus, anomalies, breast symptoms, and other systemic diseases that impact the mammogram—and the patient's breast health. For example, the technologist may produce a "stellar" two-view study, but if she includes extra information or extra views specific to the patient's concerns, the result will be detection of an otherwise occult cancer (Figure 7-1).

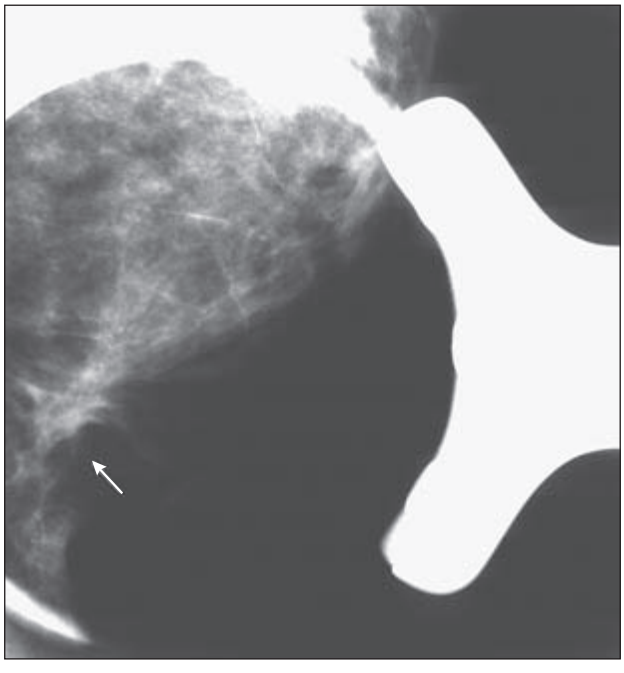
The goal of routine mammographic positioning is to screen the entire breast adequately. In most cases, the two-projection mammogram,[1,2] the cranial–caudal (CC) and the mediolateral oblique (MLO) projections, provides the best coverage of the breast tissue. The technologist has the responsibility to tailor the examination to each patient's individual features. This offers the best opportunity to visualize all the breast tissue, producing an accurate assessment of the breast from the mammographic perspective. Altering standard views or adding images may be necessary. The technologist must have the methods to meet challenges and the knowledge to use them.



A



B



C

Figure 7-1
Complete clinical picture. The mammogram does not always present the entire picture for the radiologist; the technologist must consider many factors, including the patient's concerns. This routine screening study (cranial–caudal **(A)** and mediolateral oblique **(B)** views) illustrates no abnormality. During the exam, the patient told the technologist about a lump that her doctor had found. The technologist included a tangential view of the palpable area **(C)**, revealing this area of architectural distortion. This was cancer upon biopsy.

In addition to detailing the standard mammographic views, this chapter describes the fundamentals and applications of the many projections available to the technologist to provide adequate visualization of all the breast tissue, allowing for an accurate mammographic picture of the breast.

QUANTIFYING POSITIONING—USING COMMON SENSE

The **routine mammogram** is a *combined* two-projection study. The CC and MLO complement one another. Each view demonstrates specific areas of the breast well and other areas not as well, *or not at all*. Together, they provide a complete image of all of the breast tissue for most patients. No single view alone provides all the required information. The focus of the mammogram should always be to adequately image the entire breast.

Great strides in positioning are evident in the field today. We are imaging more tissue than before, but not without experiencing some drawbacks. For example, imaging greater amounts of posterior tissue in thick breasts can reduce the amount of **compression** in the anterior breast—possibly obscuring a small anterior cancerous tumor. The technologist has the critical job of applying positioning methods using common sense, as in the previous case—an additional third projection to better compress the anterior tissue may be necessary. Use of available tools, such as the American Mammographics S.O.F.T. Paddle or Hologic FAST Paddle may be another option.

The advent of Full-Field Digital Mammography (FFDM) technology has also brought some changes to the traditional positioning used with film/screen mammography. Although compression is still an important part of acquiring a good image, uniform compression such as that needed in the aforementioned example is not as critical due to the technologies' ability to manipulate the image. Also, the image detector size and position have become less of an issue; now a single detector and grid can image most breasts with simple variations to accommodate the patient's body.

Breast anatomy is not fixed (such as the bones of an ankle). The structure and body habitus change from one patient to another and may change from year to year in the same patient. Many attempts to quantify positioning accuracy occur in literature.[3–6] Although these methods address important issues and detail excellent criteria to evaluate positioning, the technologist should not make this her only focus. Instead, focus on imaging the entire breast during positioning, rather than producing the "perfect" mammogram. An attempt to measure tissue or peruse landmarks on the resulting mammogram removes the focus from the patient. *The technologist is the only person who views the breast under compression. It is the responsibility of the technologist performing the mammogram to ensure visualization of the entire breast.* The mammogram may demonstrate all the landmarks and measure out well, but these criteria may be false security (Figure 7-2).

Do not assume that the entire breast has been imaged based solely on the resulting mammogram. For an experienced mammographic technologist, repeating a failed projection rarely yields better results; most often the technologist has done her best the first time. Instead of repeating the view, assess the mammogram to determine if part of the breast tissue was missed and add a more valuable third projection (see Chapter 9) to image the eliminated tissue.

Characteristics of an adequately performed study accompany each projection described in this chapter. The descriptions consider the recommendations cited earlier. Applying these guidelines requires common sense. Remember to always focus on the patient.

GUIDELINES FOR POSITIONING

Develop a Method

Each technologist should develop a positioning method, assimilating various techniques to achieve the best results. Where you stand in relation to the patient or how you go about positioning the breast is entirely individual. Approximately 15% of patients (about 3 of 20) in a workday will need another view to image tissue that was missed on the two-view mammogram.[7] This has more to do with body habitus than the positioning method. If you are routinely producing excellent studies on 85% of patients, then you can assume your method is working. If you are retaking or adding extra views on greater number of patients, then it's possible that the developed method may have some inherent problems. Identify and correct these problems.

Position Identification

The American College of Radiology (ACR)[4] suggests identification for positioning. This is a well-known standard method, and although it is important to standardize, accuracy is also important. For example, the MLO label can describe both a superomedial to inferolateral projection or an inferomedial to superolateral projection. An accurate label would describe the direction of the x-ray beam rather than the arbitrary or conflicting terms that have little relevance when removed from mammography. This is critical for stereotactic work, as positioning is circumferential to the breast. Most positions can be described by the direction of the x-ray beam[8] (Table 7-1). This type of identification provides descriptive terms for the technologist and can be

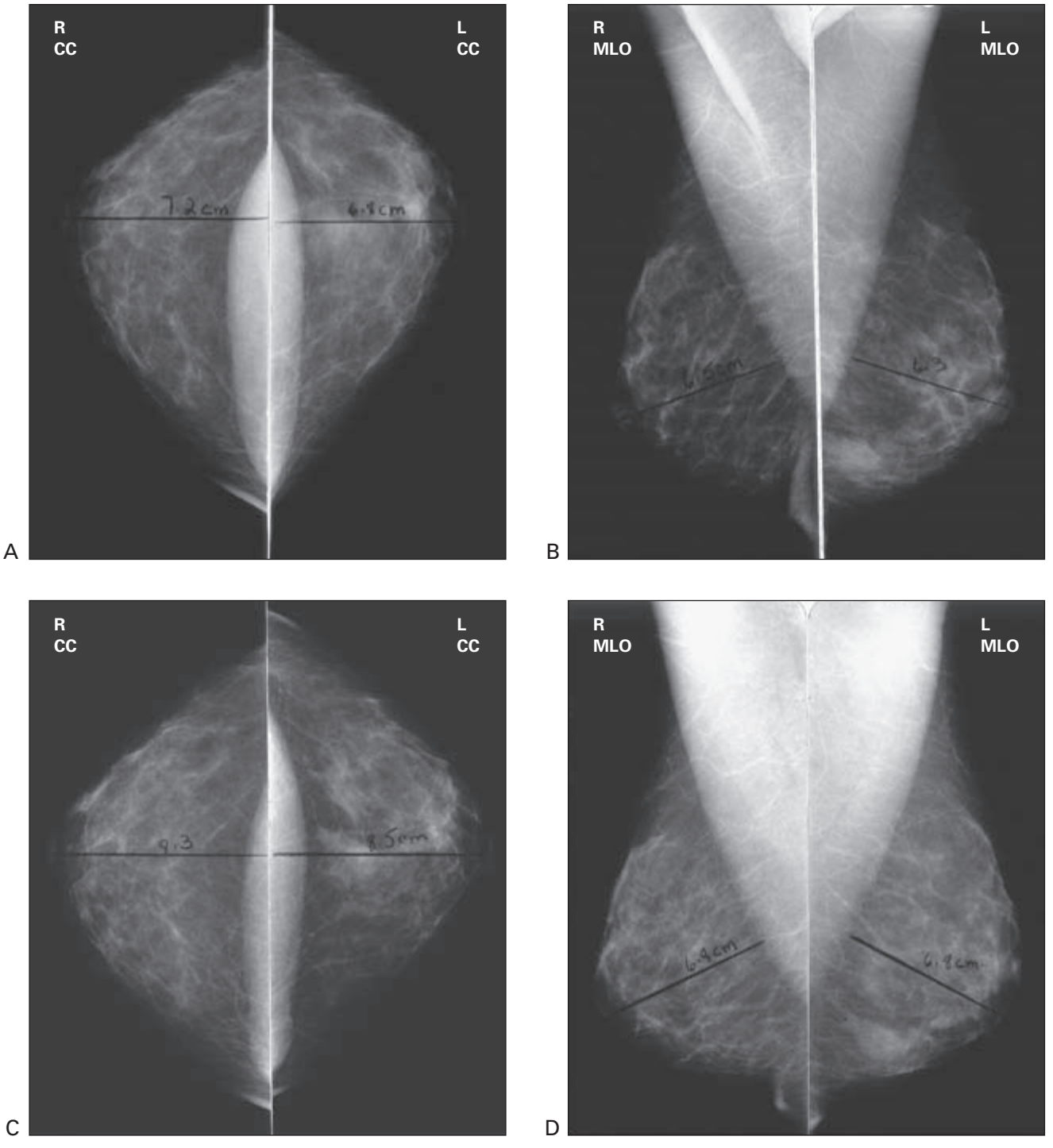
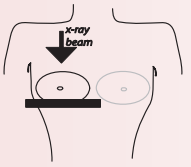
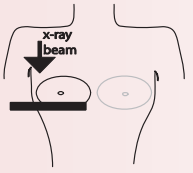
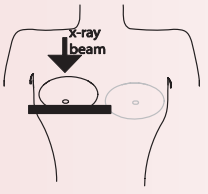
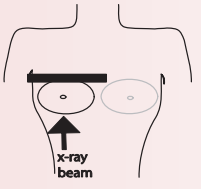
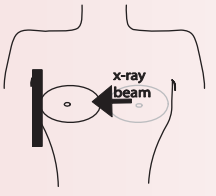
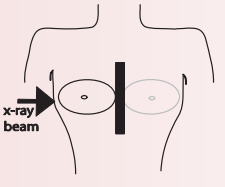
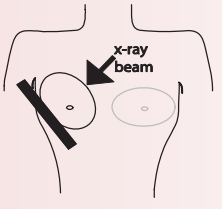
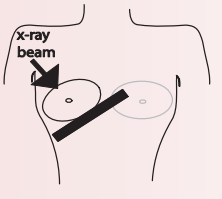
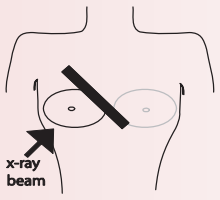
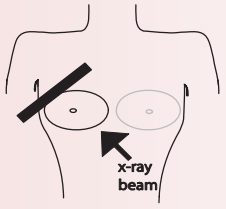
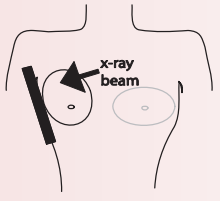
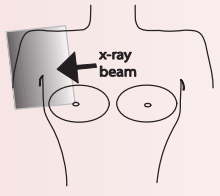
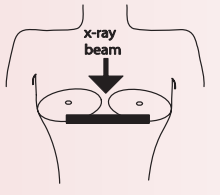
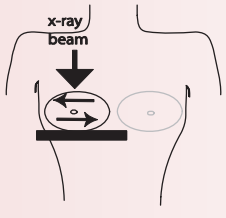
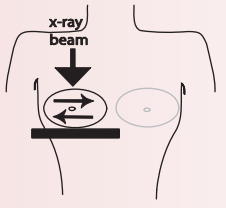
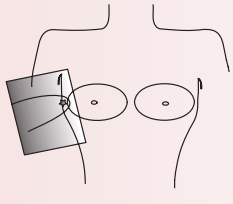


Figure 7-2

Measurement. Quantifying positioning is not an exact science and may lull the technologist into a false sense of security. The technologist should use any quantifying criteria with common sense and should primarily keep the focus on the patient when performing the study. The following studies illustrate the recommended measurement techniques; the measurement of the posterior nipple line (PNL) on the mediolateral oblique should be within 1 cm of the PNL measurement of the cranial–caudal projection. This figure illustrates two consecutive yearly mammograms on the same patient. The **(A,B)** measurement in the first study is within acceptable limits. The subsequent study **(C,D)** reveals measurements that exceed accepted limits; however, it is evident that the second mammogram clearly demonstrates more of the breast tissue because of the improved positioning of the breast.

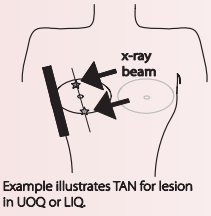
Table 7-1 • This Table Provides a Quick Reference for Each of the Views Used in Mammography, Detailing Indications for their Uses and the Tissue Best Visualized by Each View.

VIEW	ACR ID	SUGGESTED ID	PROJECTION	C-ARM ANGLE	IMAGE RECEPTOR PLACEMENT	TISSUE BEST VISUALIZED	APPLICATIONS
Cranial–Caudal	CC		Sup-Inf	0°		Subareolar, central, medial, and posteromedial tissue	Routine
Exaggerated Cranial Caudal	XCCL		Sup-Inf	0°		Posterolateral	"Wrap-around" breast
Elevated Cranial–Caudal or Pushed-Up CC	none	ECC	Sup-Inf	0°		Central and medial, high on chest wall	Superior lesion not seen on CC
Caudal–Cranial	FB		Inf-Sup	0°		Central and medial, high on chest wall	Nonconforming pt, superior lesion not seen on CC
Mediolateral Lateral	ML		Med-Lat	90°		Lateral, central, superior, and inferior	True orthogonal to CC for lesion localization, opens tissue for structural overlap
Lateromedial Lateral	LM		Lat-Med	90°		Medial, central, superior and inferior	True orthogonal to CC for lesion localization, opens tissue for structural overlap
Medial–Lateral Oblique	MLO		SM-IL	30°–60°		Posterior, upper-outer quadrant, axillary tail, lower-inner quadrant	Routine
Superolateral to Inferomedial Oblique	SIO		SL-IM	1°–90°		Posterior, medial, upper-inner quadrant, lower-outer quadrant	Additional view for encapsulated implants, nonconforming pt, ortogonal to MLO for localization

VIEW	ACR ID	SUGGESTED ID	PROJECTION	C-ARM ANGLE	IMAGE RECEPTOR PLACEMENT	TISSUE BEST VISUALIZED	APPLICATIONS
Inferolateral to Superomedial Oblique	LMO		IL-SM	90°–180°		Posterior, medial, upper-outer quadrant, lower-inner quadrant	Can replace MLO in pts with pacemakers, open heart surgical scars
Inferomedial to Superolateral oblique	none	ISO	IM-SL	90°–180°		Lateral, upper-inner quadrant, lower-outer quadrant	Stereotactic positioning
Axillary Tail	AT		SM-IL	60°–80°		Posterior–lateral, axillary tail	
Axilla	none	AX	SM-IL	70°–90°		Axillary content	Additional view for cancer patients on affected side, suspected inflammatory ca, lymphadenopathy, search for primary ca
Cleavage View	CV		Sup-Inf	0°		Medial	Extreme medial tissue, slippery medial lesions
Rolled Lateral	RL		Sup-Inf	0°		Subareolar, central, medial, and posteromedial tissue	Separation of superimposed glandular tissue
Rolled Medial	RM		Sup-Inf	0°		Subareolar, central, medial and posteromedial tissue	Separation of superimposed glandular tissue
Captured Lesion (Coat hanger View)	none	CL	All	0°–90°		Posterior	Palpable abnormality near chest wall or implant, often performed with magnification

(continued)

Table 7-1 • This Table Provides a Quick Reference for Each of the Views Used in Mammography, Detailing Indications for their Uses and the Tissue Best Visualized by Each View. *(cont.)*

VIEW	ACR ID	SUGGESTED ID	PROJECTION	C-ARM ANGLE	IMAGE RECEPTOR PLACEMENT	TISSUE BEST VISUALIZED	APPLICATIONS
Tangential View	TAN		All	0°–90°	 Example illustrates TAN for lesion in UOQ or LIQ.	All	Palpable abnormality, to visualize borders with better detail; often used in conjunction with magnification
TECHNIQUES							
Magnification	M						Improved resolution; better visualizes calcifications and borders of lesions
Implant Displacement	ID					Tissue anterior to sub-pectoral implants	Patients with implants
Nipple in Profile		NIP				Subareoloar	
Spot Compression							Palpable abnormality, to visualize borders with better detail; often used in conjunction with magnification

interpreted outside the field of radiology. In this chapter, we use the ACR nomenclature to be consistent; however, the more accurate descriptors are also included. In addition to the position of the breast, each image must also include the laterality. If the image is taken using magnification or **implant displacement** techniques, this must also be noted on the image.

The ACR has developed a method for **standardized labeling**,[4] so that they can be understood by anyone at any facility, when viewing the image. The view and laterality should be placed on the image in a position that is close to the axilla, thereby indicating the axillary aspect. The laterality should be listed first, followed by technique, ending with the position. For example, R M ML would indicate a magnified mediolateral lateral view of the right breast.

Patient Cooperation

Patient cooperation is one of the technologist's most necessary jobs. The examination is uncomfortable and awkward and usually the patient is scared and anxious. There are a number of methods described to help patients relax in Chapter 3. Without patient assistance, obtaining the mammogram can be difficult. As the exam proceeds, the following may also be useful in gaining the patient's trust:

Enlist the patient's help—The mammogram is a collaborative effort between the technologist and the patient. Enlist the patient's help, explaining the examination as it progresses. Help her to help you.

Give the patient control—Let the patient know that she can control the examination—even the amount of compression. The patient will almost always tolerate firm compression if she understands the reasons and knows the compressions will stop per her request. Pushing a patient to handle more than she wants to may yield a good mammogram, but she may never return for another one.

Listen—Listen to the patient before, during, and after the examination. This not only shows compassion, but may also reveal clues that lead to the detection of cancer that may not otherwise have been found.

Sanitizing the Imaging Surface

Wipe down both the compression paddle and the image receptor surface before performing each mammogram with a

nonallergenic, antibacterial solution or prepared cloths. If you do this in front of the patient, she will be more confident that the surface is clean. Having a protocol and procedure for disinfection is a requirement of the Mammography Quality Standards Act.

Posture

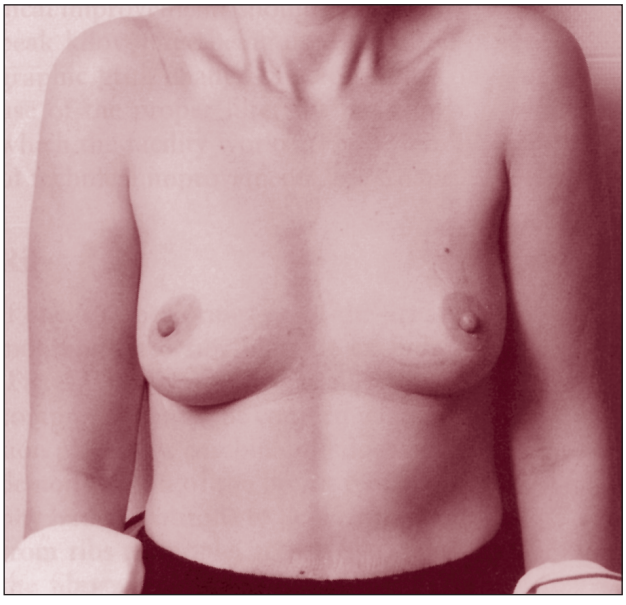
Both the patient and technologist will find it easier if the patient is standing rather than sitting for the mammogram. During positioning, the patient should assume a comfortable stance, with her feet turned in the appropriate direction for the position. In most cases, this is with the feet facing straight forward toward the unit, perpendicular to the front edge of the breast tray. In addition, for almost every mammographic projection, the best posture is a poor posture. Positioning and compression will be easier if the patient can assume a "sloppy" stance. If the patient slumps from the waist, the breast naturally falls forward (Figure 7-3). The skin and muscles of the chest area become looser and more mobile. The patient should hold the handrail loosely for stabilization. A "death grip" tightens the pectoral muscle, which makes positioning and compression even more difficult.

Kopans describes a maneuver he calls "**pendant positioning**."[3] When the patient is bent forward from the waist, the breast falls away from the chest wall. This posture naturally relaxes the shoulders forward, prohibiting stiff posture. At least two mammographic units (Bennet Corporation, a division of Trex Medical, Danbury Connecticut and Giotto, IMS, Balogna, Italy) have based their designs on this premise, allowing the C-arm to angle forward and back along the vertical axis (all C-arms allow rotation along the horizontal axis), however these units are not among the most popular in the United States. Even without this equipment, pendent positioning can still be utilized by having the patient step back slightly from the C-arm and bending forward slightly from the waist for all projections.

Although posture should be relaxed, it is important that the patient's back remain straight, not bending to either side (Figure 7-4). It is often easy to allow this to happen as you move the patient around to fit her breast on the image receptor, but this will make reproducibility of the view difficult, as the given angle will be distorted by the angle of the patient's body.

Motion

Motion, blurring that occurs from patient movement during x-ray exposure, interferes with the interpretation of the mammogram. Motion may exist across the entire projection, or in just one area. It may be readily apparent, but more often it is subtle, perceivable when compared with a prior or later mammogram. Technologists often have a difficult time assessing motion immediately after transitioning to FFDM technology.


A

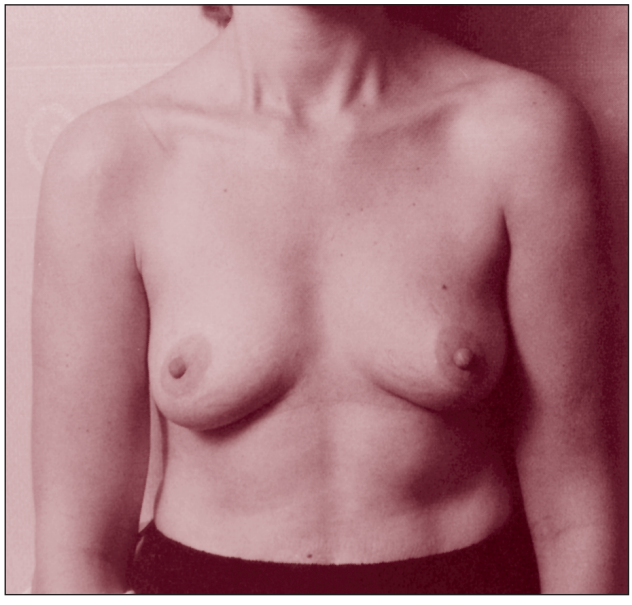

B

Figure 7-3
Posture. The breast will be easier to position if the patient can assume a poor posture. Raised shoulders and erect posture **(A)** prohibit the breast from falling forward and away from the chest wall in comparison to **(B)**; the same patient with a relaxed posture. A relaxed posture allows the breasts to naturally fall forward and loosens the skin and muscles of the chest.

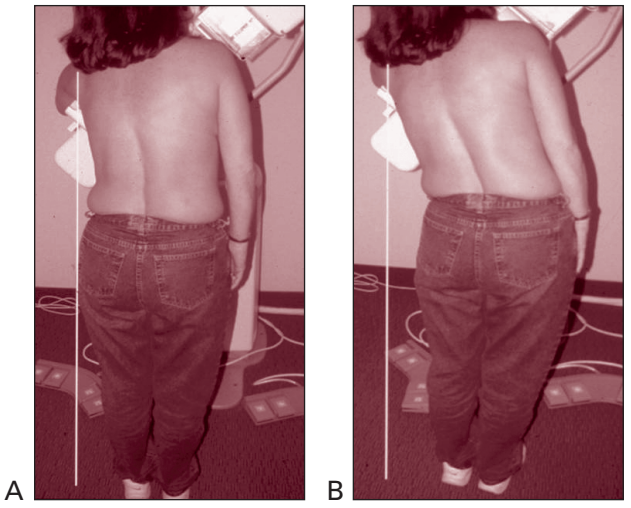


Figure 7-4
It is important that patient's back remain straight when positioning for oblique views **(A)**. Patients often lean onto the image receptor **(B)**, but this will create a false angle on the image, skewing the lesion location and making the image less reproducible. Only the breast should assume the angle of the image receptor.

This is partly because the technologist acquisition station monitor has only 2-mp resolution, while the radiologist views the image on a 5-mp monitor. Using the zoom feature on the workstation can help the technologist better perceive motion, even though resolution will not be increased when viewing the image this way.

Learning to recognize this insidious noise (Figure 7-5) takes time and patience. When examining the mammogram for motion, look for well-delineated lines, compare them across the study, if lines look sharp in one area compared with a slight blur in another, motion is most likely the reason. Motion most often occurs on the MLO projection because of the awkward and somewhat pendent nature of positioning. The area of the breast most vulnerable to motion in the MLO projection is the posterior/inferior and the anterior/central aspect. Patient cooperation and the positioning skill of the technologist are both essential to minimize this detrimental artifact. Additionally, changing the technique can reduce the chance of motion. Evaluate the patient's condition; if she is unstable or will tolerate only mild compression, decrease the exposure time by increasing the peak kilovoltage.

Mobility of the Breast

Eklund[9] describes the **mobile borders** of the breast, an important aspect for positioning. The lateral and inferior aspects of the breast are mobile rather than fixed, which can facilitate the positioning process. Look for further discussion on breast mobility as it applies to each individual projection below.

Skin Wrinkles

Eliminating skin wrinkles from under compression is a practice dating back to the days of xeromammography, in which the edge enhancement effect along the skin wrinkle would obliterate surrounding breast tissue. While edge enhancement is not a property of screen–film mammography or FFDM, skin wrinkles may produce a pseudoarchitectural distortion, or perhaps obscure surrounding structures. This may occasionally interfere with mammographic interpretation. The technologist should try to eliminate skin wrinkles by smoothing the skin of the breast, gently working the wrinkles toward the nipple, pulling forward away from the chest wall, rather than pulling the tissue out posteriorly (Figure 7-6). Avoid removing breast tissue from under compression when smoothing a wrinkle as this eliminated tissue may also elude visualization on the complementary projection. Often wrinkles are the result of the breast tray being too low for a CC view, or of using the wrong angle for an MLO view.

Not all images with wrinkles should be repeated. Repeat studies should be reserved for the skin wrinkle that truly interferes with interpretation; *do not* repeat just to produce a perfect mammogram.

Nipple in Profile

Bringing the nipple into profile comes from the older method of screen–film mammograms, where distinguishing the nipple from a mass was difficult. In addition, when performing a xeromammogram, if the nipple was not in profile, edge enhancement effect (just as with skin wrinkles) would obliterate surrounding information. Today, trying to bring the nipple to profile on every image is still important, but may lead to undetected cancer elsewhere in the breast if tissue is sacrificed from view in another area of the breast. It is more important to image as much tissue as possible than to image the nipple in profile.

In most women, the nipple naturally falls into profile in at least one view; if it does not, repositioning the breast to bring the nipple into profile may be counterproductive,[4,9] as it could sacrifice tissue either superiorly or inferiorly, and medially or laterally, depending on the projection and the location of the nipple on the breast. The tissue lost may elude visualization on either of the standard opposing views. Missed breast tissue contributes to undetected cancer.[7] Indications to take an additional view with the nipple in profile (label NIP) are as follows: when the nipple is indistinguishable from a mass (for further discussion, see Chapter 8), a suspected subareolar abnormality, and proper measurement for needle localization.

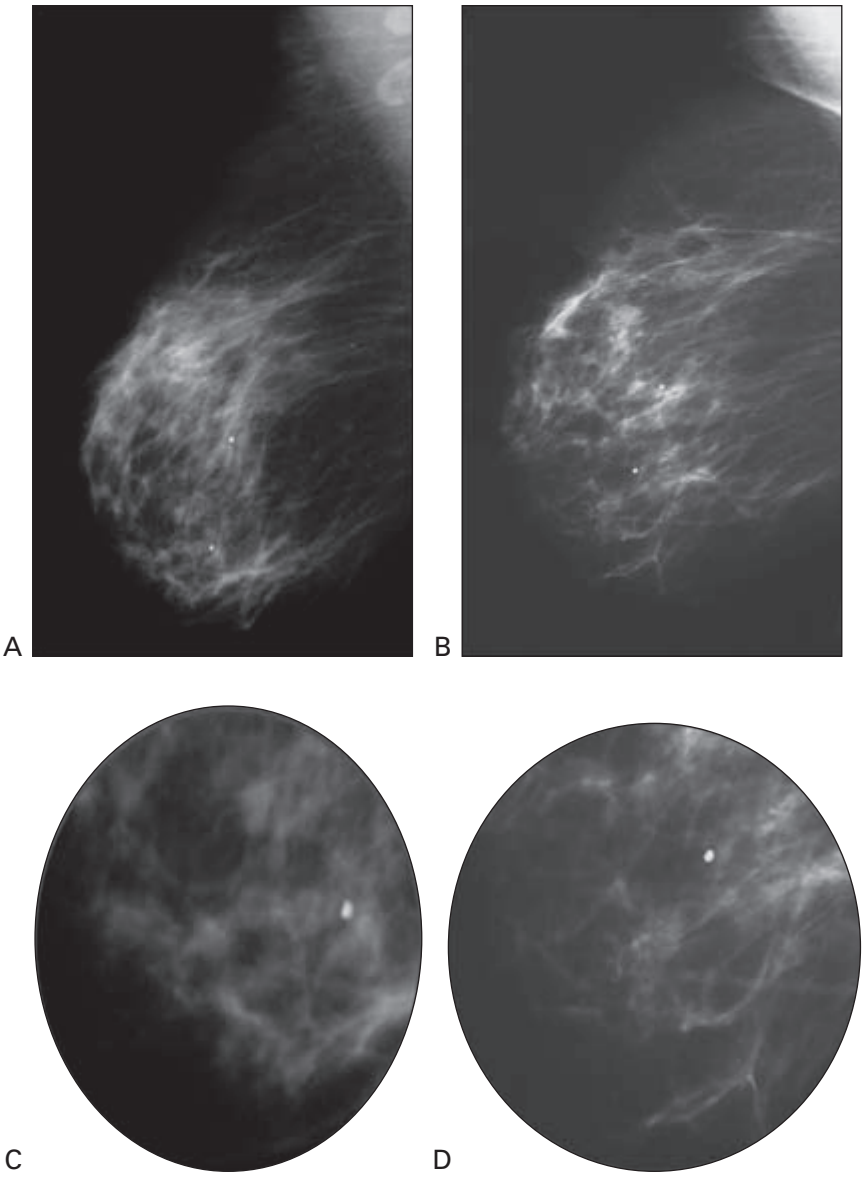


Figure 7-5
Motion may be subtle in nature. To perceive motion artifact, compare sharp, well-delineated structures to all areas of the mammogram; if other structures are less sharp motion is most likely the cause. Motion was noted **(A)**; the view was repeated **(B)**. Photographically magnified areas of each image **(C,D)** show the subtle unsharpness characteristic of patient motion during the exposure. The inferior–posterior and anterior–central areas on the MLO projection are the most common sites of motion.

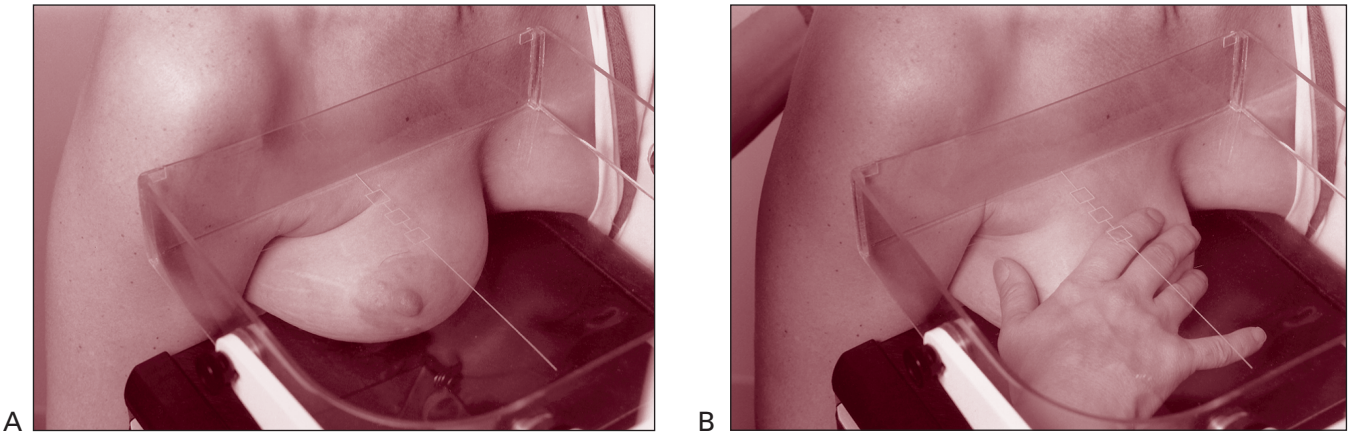


Figure 7-6
Skin wrinkles. Smooth skin wrinkles **(A)** toward the nipple **(B)** to avoid losing tissue from visualization.

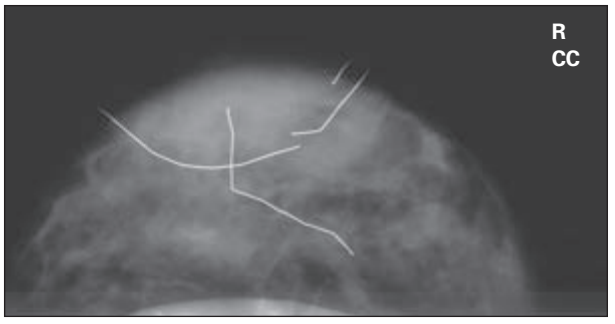


Figure 7-7
The well-decorated breast. Some types of extraneous scar, mole, and nipple markers can produce a type of noise that may interfere with the interpretation of the screening mammogram.

Scar, Mole, and Nipple Markers

Some radiologists require technologists to indicate scars, moles, and the nipple with radiopaque markers. While this technique may be useful in follow-up projections, radiopaque markers may interfere with interpretation of the screening mammogram, because they may be distracting to the reader (Figure 7-7). A diagram illustrating moles and scars can be just as effective for this purpose. Differentiating the nipple from a mass is best done as a third view with the nipple in profile (see above).

There are several companies that supply skin markers for mammography. One company has devised a complete system with lower density markers designed specifically for mammography. The Beekley Corp. (Bristol, CT) offers a skin marker system consisting of N-SPOTS for marking the nipple, the O-SPOT for marking moles, the A-SPOT, which is a triangle for marking palpable masses and S-SPOTS, which is actually a bendable wire, for marking surgical scars (Figure 7-8). The lower density of these markers is designed to prevent areas beneath the marker from being obscured and to be less distractive to the reader.

Breast Cushions

Patient comfort has always been a priority for mammography technologists, but in the past this was often counterproductive to image quality in some way. There was always a concern of introducing artifacts or attenuation of the beam that would reduce contrast if any additional cushioning material was used. In today's mammography facility, it is not unusual to find breast cushions (MammoPads—Hologic, Inc, Bedford, CT or Bella Blankets—Beekley Corp., Bristol, CT).

Breast cushions are single-use FDA-approved cushions that attach to the breast tray and compression paddle to provide a softer and warmer surface for the patient (Figure 7-9). It has also been noted that these pads may help to improve patient positioning by preventing breast tissue from slipping off the

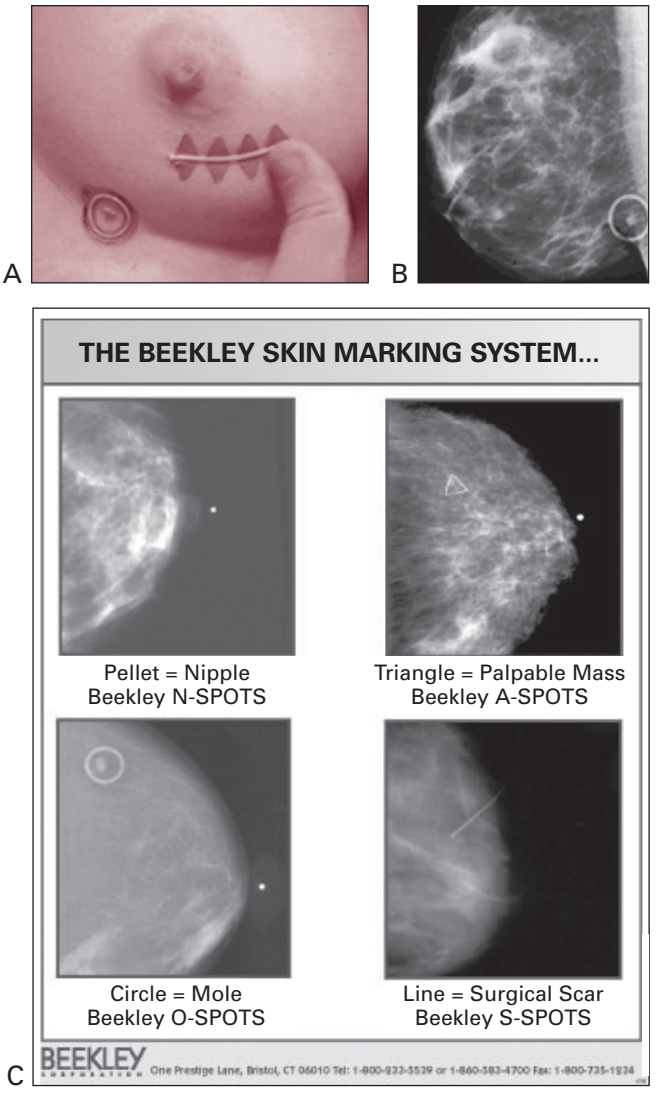


Figure 7-8
(A) Specialized breast markers are placed on the patient's breast to denote past surgical scars, moles, and palpable lumps. **(B)** These markers show on the mammogram as translucent so as not to obscure pathology within the tissue. **(C)** The Beekley Skin Marking System standardizes the shapes used to mark for different reasons: the pellet marks the nipple, the triangle is used to mark palpable masses, the circle is used to advise the radiologist of a skin mole or nevus, and lines are used to indicate surgical scars. (Images courtesy Beekley Corp, Bristol, CT.)

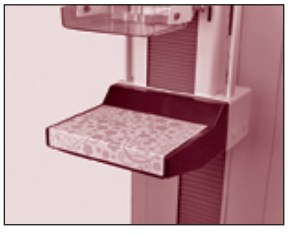


Figure 7-9
Breast cushions are sometimes used to make a more comfortable environment and exam for the patient. (Image courtesy Beekley Corp, Bristol, CT.)

surface of the breast tray on a patient whose skin is perspiring. They have not been known to introduce artifacts on the image, but technologists have anecdotally mentioned that the pad used on the transparent compression device prohibits them from seeing the breast and the final positioning, including skin wrinkles. At this time, these pads are not a reimbursable item through medical insurance. Therefore, facilities that use these must pay out of the pocket for them or pass the fee on to the patient.

Automatic Exposure Control (AEC)

When perfoming mammography with a film/screen unit the use of auto exposure control (AEC) is common. To produce adequate exposure, it is critical to position the glandular tissue over the AEC detector. If the detector is under the fatty tissue, the AEC will underexpose the glandular structures increasing the chances of missing a small cancerous tumor. The majority of the glandular breast tissue lies centrally and behind the nipple laterally. It is best to place the detector posterior to the nipple under the compressed portion of the breast. The size of the detector is also important to placement; the area of some detectors is large and placement too close to the nipple may cause a portion of the detector to be placed outside the area of the breast, causing an underexposed image. Manufacturers' applications specialists can address AEC detector size and placement for each unit.

Skin Detail

Early film/screen mammography studies did not provide adequate visualization of the glandular structures (Figure 7-10).

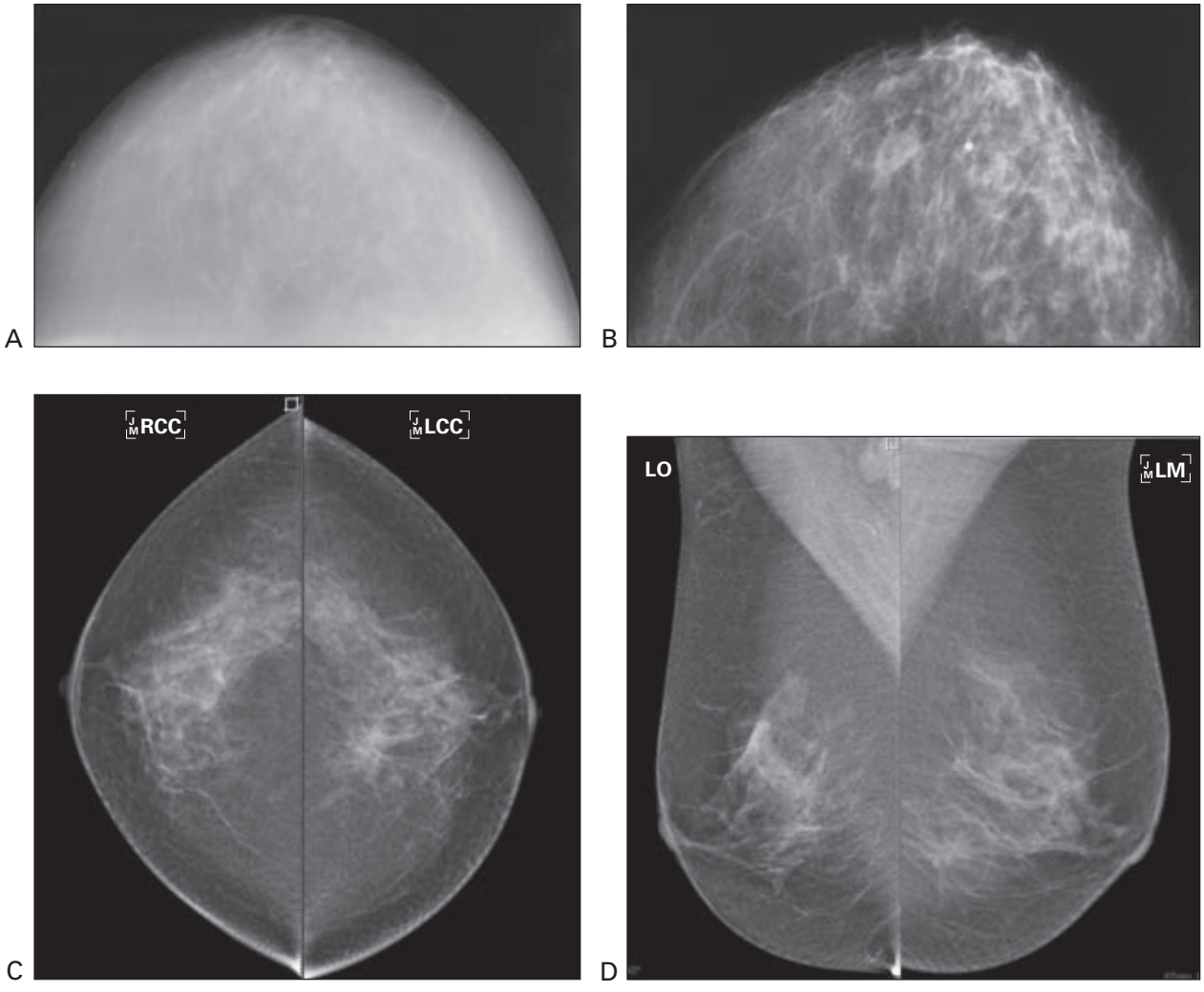


Figure 7-10
Skin detail. Two craniocaudad mammograms of the same woman in 1976 **(A)** and 1990 **(B)**. The older study **(A)**, which demonstrates skin line, does not image the glandular tissue adequately. The more recent mammogram **(B)**, while not demonstrating the skin line, offers excellent detail of the glandular tissue, where cancers arise. More current technology used for FFDM mammograms **(C,D)** can visualize both skin and glandular tissue on the same image.

Diagnosis of a small carcinoma was impossible, and the radiologist depended on skin thickening and retraction to help find even large cancerous tumors.

Over the years, there have been many technical developments in screen–film mammography, including the requisite of high contrast, allowing visualization of minute changes in glandular structure, which indicate early cancer. Diagnosing a carcinoma as small as 3 mm is possible, long before skin thickening and retraction occur. High-contrast imaging with film requires a "bright-light" to see skin detail in most cases. Visualization of the skin line as well as the glandular tissue on the same image is one of the benefits of digital mammography.

Compression

Compression is invaluable to the mammographic process, both in film/screen and digital mammography.[4,10] Gradually applied, vigorous compression allows for dose and scatter reduction, decreased motion and geometric unsharpness, increased contrast, and the separation of breast structures. Additionally, steady and even compression allows a more homogeneous thickness across the breast, providing a fairly uniform density over the mammogram. This prevents under- or overexposure of portions of the breast, and also allows for better assessment of mass densities (i.e., the radiologist uses relative density to perceive cancer only apparent by subtle density difference amid glandular structures) (Figure 7-11).

With continuing development in positioning technique, more breast tissue can be imaged, especially posterior breast tissue previously omitted from the study. This greater volume of breast tissue creates greater compression thickness, especially at the base of some breasts, near the chest wall. *Occasionally,* the thicker tissue being compressed at the base of the breast leaves the anterior breast tissue poorly compressed or uncompressed. This is especially evident in firm and large-breasted women. It would not be prudent to give up visualizing this posterior tissue, but it is also unacceptable to ignore the improperly compressed anterior breast.

One way to manage this problem is to add a subsequent projection to represent only the anterior portion of the breast. If the anterior breast is only compromised in the CC projection, then repeat the CC for the anterior portion of the breast. If the anterior breast is compromised on the MLO, the additional projection should be a lateral (mediolateral [ML] or lateral–medial [LM]) because overlap and distortion on the MLO projection makes this a poor projection for the anterior breast structures. Some have suggested modifications to compression devices[3] from a flat paddle to a tilt design that follows the contour of the breast on compression. In fact, some manufacturers will provide devices such as the Hologic FAST Paddle as an option when purchasing their unit (Hologic, Inc, Bedford MA) (Figure 7-11).

It is important to understand that these modifications nearly model older "problematic" paddle designs. The breast will be compressed to different levels across the mammogram. Tilting the compression paddle can cause a number of technical dilemmas with film/screen technology:

- Variation in compression levels may cause adequate exposure in one portion of the breast and *over- or underexposure* in another portion of the breast.
- Relative assessment of mass densities will no longer be possible because of uneven exposure.
- Under- or overexposure may cause a false-negative or false-positive mammogram.

Firmer, thicker, and larger breasts, where this is most apparent will increase the severity of the technical dilemmas. The compression device *should* remain parallel to the image receptor for best technical results.

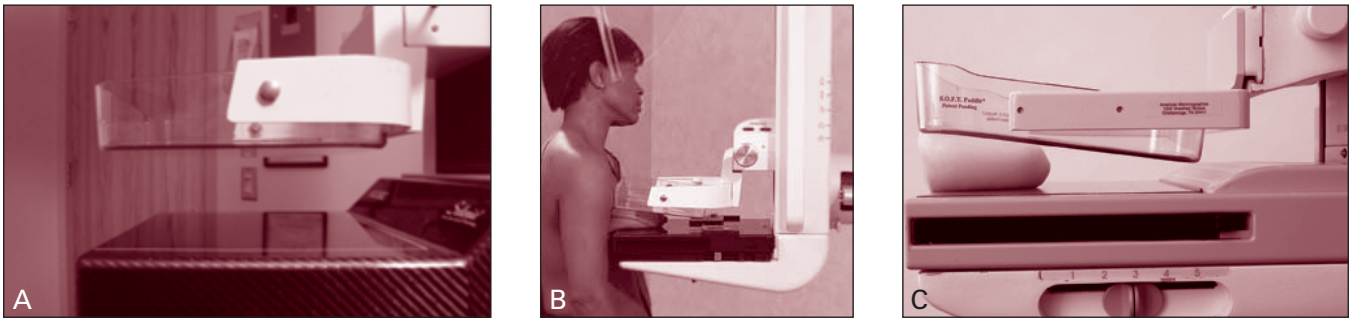
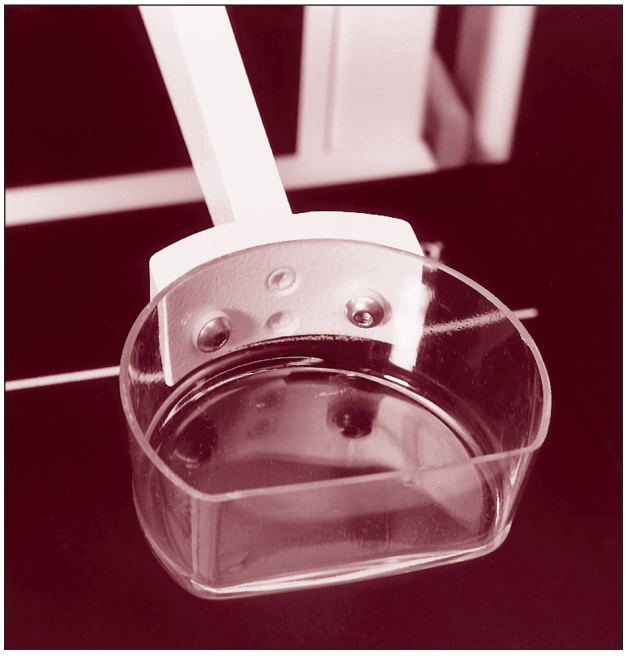
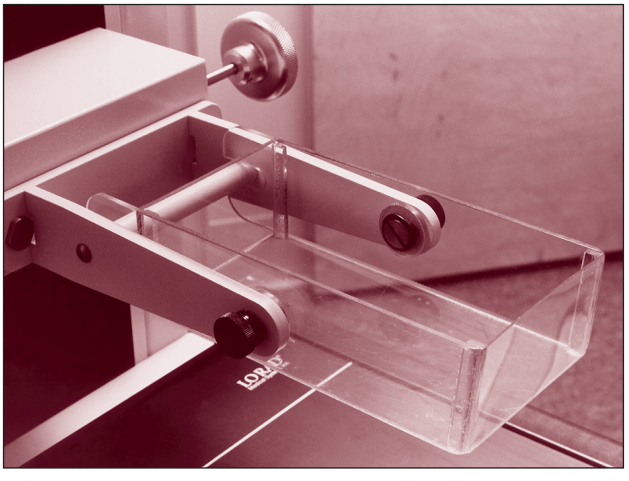


Figure 7-11
Compression design. The compression paddle should remain parallel to the imaging surface for optimal homogeneous compression **(A)**. Specialized paddles such as the Hologic FAST paddle **(B)** and the American Mammographics S.O.F.T. paddle **(C)** are able to tilt at the chest wall to enable compression of all tissue on patients with thick posterior tissue. (Images courtesy of Hologic, Bedford MA, and American Mammographics, Chattanooga, TN.)



A



B

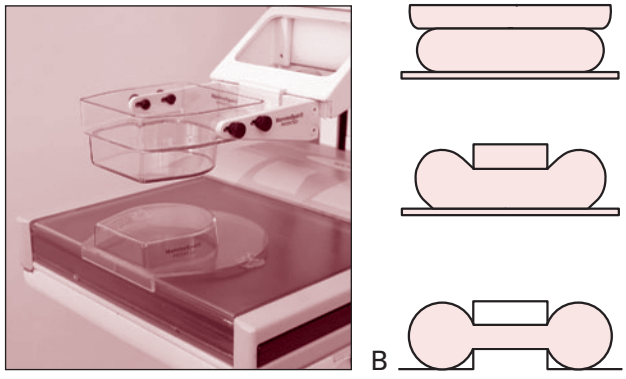
Figure 7-12
Compression paddles. In addition to the standard paddles, many different paddles of varying size and shape accompany the mammography unit and may be useful in multiple situations. **(A)** Spot compression paddle and **(B)** quad paddle are commonly used with both grid and magnified views.

Compression Paddles

In addition to the large and small standard paddles, many compression paddles of varying size and shape are included with each mammography unit. Although each paddle has specific indications, using the paddles creatively may facilitate the positioning process (Figure 7-12).

Positioning Platforms

To promote thinning of the breast tissue for coned views, Dr. Arthur Hixson devised a method to apply compression



A B

Figure 7-13
The MammoSpot **(A)** from American Mammographics provides compression to both the superior and inferior aspects of the breast **(B)**. This thins the breast tissue and allows a shorter exposure to be used, minimizing motion.

to both the top and bottom aspects called MammoSpot (Figure 7-13). The suspect tissue is placed over a small raised area on the breast platform, then compression is applied from above. This is referred to as "double compression." Because the tissue is thinner, it requires less exposure time for penetration and motion artifacts are reduced. MammoSpot devices are available through American Mammographics.[11]

Image Receptor Size

Most film/screen equipment includes two grid sizes; a smaller grid/bucky to accommodate the 18 × 24 cm cassette, and a larger grid/bucky to accommodate the 24 × 30 cm cassette. The same buckys are used for CR FFDM. Base the choice of grid size on the breast size, not the size of the patient, choosing the smaller surface whenever possible. Choosing the wrong size can adversely affect the image. For example, when positioning the MLO, using the larger grid surface on a smaller patient excessively raises the patient's arm beyond the recommended shoulder level, pulling breast tissue from view (Figure 7-14). The arm should rest at shoulder level, relaxing the pectoral muscle, and allowing the breast to fall forward. Additionally, an excessive amount of shoulder and upper axilla under the compression paddle will prohibit adequate compression of the breast.

Direct ray (DR) FFDM units supply only one detector and grid, which is used for all sizes of breasts. With DR equipment, the technologist will either choose the correct paddle size for the breast, or will perform additional overlapping images to visualize all of the tissue. This is referred to as **"mosaic" imaging**, as image tiles are fitted together to form a complete picture (Figure 7-15).

On some DR units, when performing an oblique or lateral view on a patient with a smaller breast, the paddle must be shifted toward the axilla before positioning the patient. This allows the technologist to position the breast so that the arm



Figure 7-14
Appropriate size and height of image receptor from the posterior **(A)** and anterior **(B)** of the patient. Using an incorrectly sized image receptor or placing it at the incorrect height for the patient will affect image quality, as it will affect positioning of the breast. If the image receptor is too large or placed too high in the axilla, the arm will be overelevated, preventing adequate visualization of posterolateral tissue and prohibiting adequate compression on the lower portion of the breast. If the image receptor is placed too low or is too small to image all of the tissue of a larger breast, axillary and posterior tissue may be missed. Place the image receptor at a height that allows the arm to remain parallel to the floor, which facilitates tissue acquisition and compression.

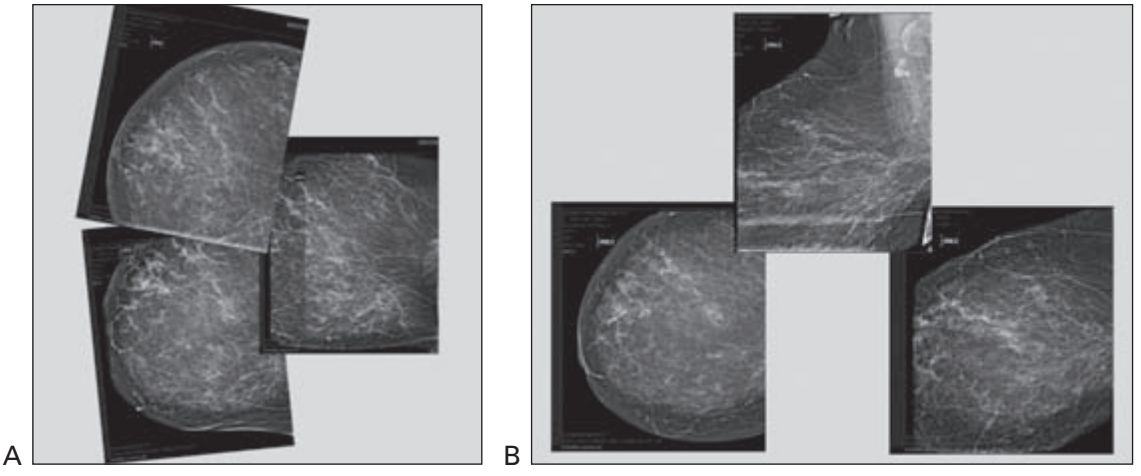


Figure 7-15
When the breast is larger than the image receptor, several images of the breast should be taken to visualize all the tissue. **(A)** Demonstrates three mosaic images of the CC view, taken to image the anteromedial, anterolateral, and posterior tissue. **(B)** Demonstrates mosaic images of the MLO view, imaging the inferior–posterior, anterior, and posteroaxillary tissue.

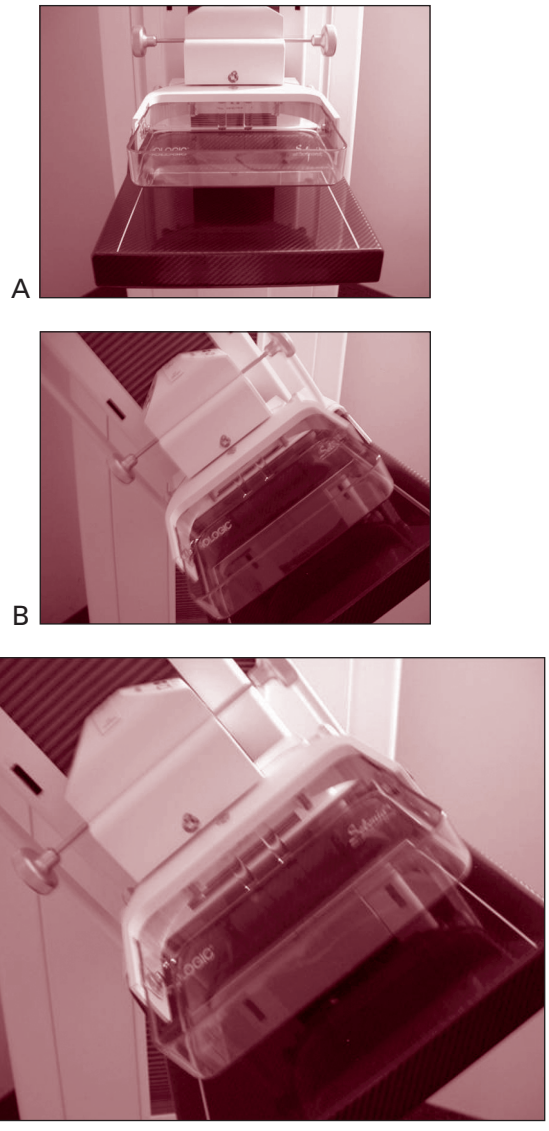


Figure 7-16
Some FFDM units require shifting the compression paddle to the left or right to facilitate correct positioning of the MLO view. **(A)** The compression paddle in the "neutral" position used for the CC view. Note how the two beebees at the back of the compression device are lined up. When the C-arm is angled for the MLO view **(B)** the compression paddle must be shifted superiorly to the larger image receptor **(C)**, cueing the image receptor to image tissue in the axillary area.

is not raised above shoulder level. Positioning the breast tissue over the AEC is not an issue with DR FFDM; the shifting of the paddle clues the unit to activate the detector in the area where the paddle is located (Figure 7-16).

Respiration

There are several schools of thought on whether it is correct to have the patient suspend breathing during each exposure. Many technologists believe that once compression is applied and the patient is instructed to stay still, that she is unable to draw a deep breath, so it is not necessary to suspend **respiration** to prevent motion. Others believe that if respiration is to be suspended, it is best to instruct the patient to "Stop breathing," rather than say "Hold your breath." When instructing a patient to "Hold your breath," many women will try to take in a deep breath to hold, as if she's about to go underwater. This may cause the patient to move slightly from the position she has just painstakingly been molded into.[12] The preference of the author is to simply state "Don't move and don't breathe," but each technologist must decide what will work best for each patient individually.

Magnification Mammography

Magnification is an invaluable technique used to increase the resolution of the breast tissue. It is used for confirming breast cancer detection and for examining extent of disease. Any mammographic view can be performed using magnification, but the amount of tissue that can be imaged will be confined to a much smaller area. Generally, the entire breast cannot be imaged in one view with this method due to limitations in the image receptor size. In addition, specialized compression paddles are also utilized with magnification (see Figure 7-12). These include quadrant and spot compression sizes, which allow better compression of a smaller area of tissue, increasing resolution in decreasing scatter by thinning the tissue, and better penetration of denser tissue. More information on magnification technique can be found in Chapter 11.

Confine the use of magnification to extra views for the following indications:

- To better delineate the borders of a mass.
- To characterize or search for calcifications (for proving similar calcifications in the contralateral breast).
- Specimen radiography.

Magnification may not be useful in women who have thick and dense breasts, where long exposure times and high peak kilovoltage, necessary to accomplish adequate exposure, degrade the quality of the image. Chapters 10 and 11 offer optional methods for these patients.

Collimation

Tight collimation to the breast, which was necessary to improve contrast in older film and equipment styles, is no longer recommended. The use of antiscatter grids, better-developed film/screen combinations and film processing techniques, improvements in film/screen equipment and the development of digital technology provide the image contrast necessary for mammography. Instead, field restriction to the image detector size, causing black opacity around the breast, prevents ambient light from degrading image contrast during mammogram interpretation.

MAMMOGRAPHIC PROJECTIONS

The CC Projection

Applications

The craniocaudal projection (Figure 7-17) will best visualize the subareolar, central, medial, and posteromedial aspects of the breast and is one of two complementary projections that make up the routine mammographic study.

Performing the Study

To achieve the craniocaudal projection, do not angle the C-arm. The breast tray should register 0°, with the tray parallel to the floor. The beam will be directed superiorly to inferiorly. The patient should face forward with her feet pointing perpendicular to, or toward, the mammography unit. Create a comfortable stance for the patient, making sure she is stable. Have the patient step back slightly away from the image receptor, bending forward at the waist just enough to allow the breast to naturally fall forward. This pendent positioning[3] brings the chest wall closer to the positioning surface and allows more medial and posterior tissue to be captured on the image. Instruct the patient to relax or to droop her shoulders. Have the patient hold the provided handrail with the contralateral hand, which will stabilize her, and bring medial tissue closer to the image receptor.

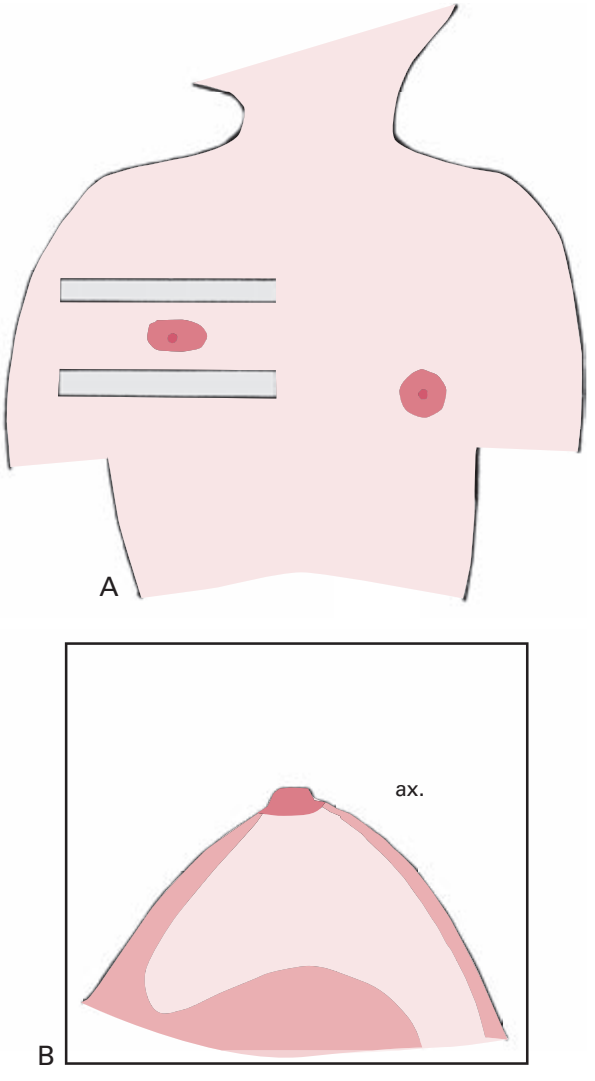


Figure 7-17
Craniocaudal projection. **(A)** The orientation of the breast to the C-arm for the craniocaudal projection. **(B)** Schematic demonstrating the amount of the "glandular island" imaged with the CC view.

The image receptor will be placed inferior to the breast. Gently but firmly lift and pull the breast forward and place it centrally on the positioning platform. Simultaneously, adjust the C-arm bringing the image receptor to meet the elevated inframammary fold (IMF). Eklund[12] describes the maneuver of elevating the IMF (Figure 7-18), to take advantage of the more mobile, inferior aspect of the breast. This movement allows for greater visualization of superior and posterior breast tissue in most cases; however, apply common sense with this method. Raising the image receptor too high may prohibit the patient from leaning forward and relaxing into position. Overelevating the IMF may also eliminate posterior and inferior breast tissue (lower-outer quadrant) from view (Figure 7-19A) and perhaps from the study. The centrally located breast tissue overlaps and may obstruct the lower-outer quadrant tissue on the MLO projection increasing the importance of showing this tissue on the CC projection. In contrast, if the image receptor is too low and the breast droops, superior and posterior tissue will be lost from visualization during compression (Figure 7-19B).

Have the patient keep the ipsilateral arm close at her side, prompting the patient once again to relax her shoulders (Figure 7-20). An elevated shoulder tightens the pectoral muscle and pulls up on the breast, removing breast tissue from view, and prohibits good compression. Rotate the patient's body slightly medially for best visualization of the medial and posterior tissue, even if this means losing some lateral tissue, which is best imaged with the oblique view. *This is the most important aspect of the craniocaudad projection*. It is extremely important to prevent eliminating any medial breast tissue from the craniocaudad mammogram, as this may eliminate the tissue from the study.[9] Even if the technologist makes every effort to demonstrate medial tissue on the MLO projection, superimposition of glandular structures and distance from the film often cause distortion (Figure 7-21).

To adequately bring the medial tissue of the breast onto the image receptor, check the patient's body position. As the patient is facing the C-arm, turn her head slightly to the [1]contralateral side, curving her neck and head around the face shield and toward the unit (Figure 7-22). Bring the opposite

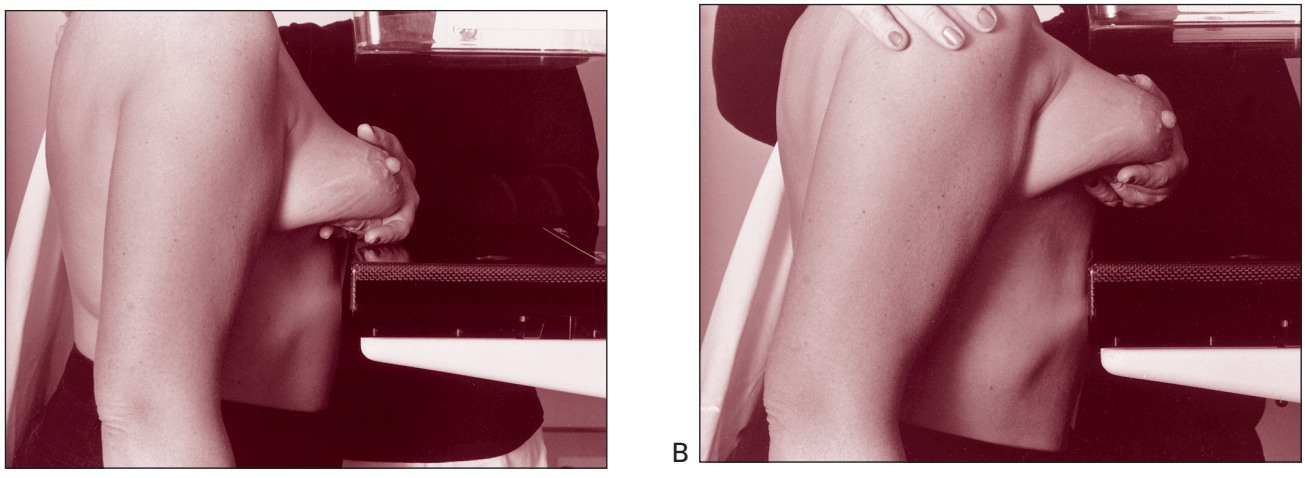


Figure 7-18
Elevating the inframammary fold. The mobile inferior and lateral breast tissue allows the elevation of the inframammary fold, thus allowing visualization of greater amounts of breast tissue. **(A)** The breast in its neutral position. Note the greater amount of breast tissue available **(B)** when elevating the breast.

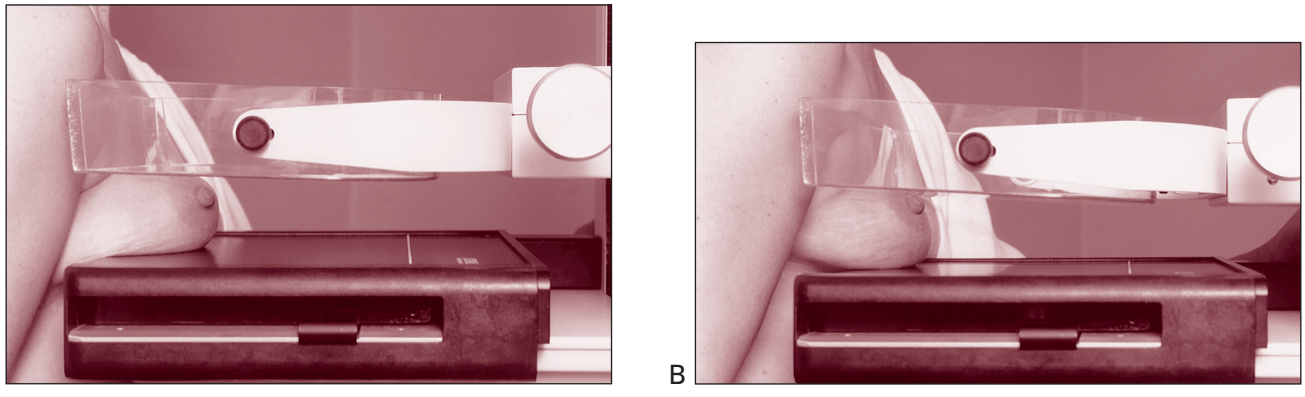


Figure 7-19
Common sense. **(A)** Raising the C-arm too high will overelevate the inframammary fold and result in a loss of inferior and posterior tissue. **(B)** If the level of the C-arm allows the breast to droop, the result will be a loss of superior and posterior tissue.

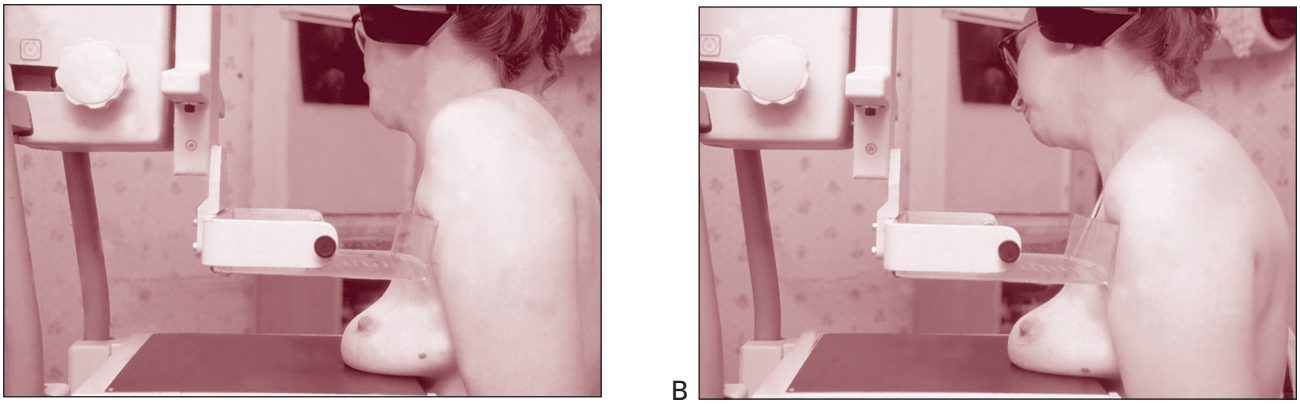


Figure 7-20
Dropping the shoulder. An elevated shoulder **(A)** pulls breast tissue from view, but relaxing the shoulder yields greater amount of tissue **(B)**.

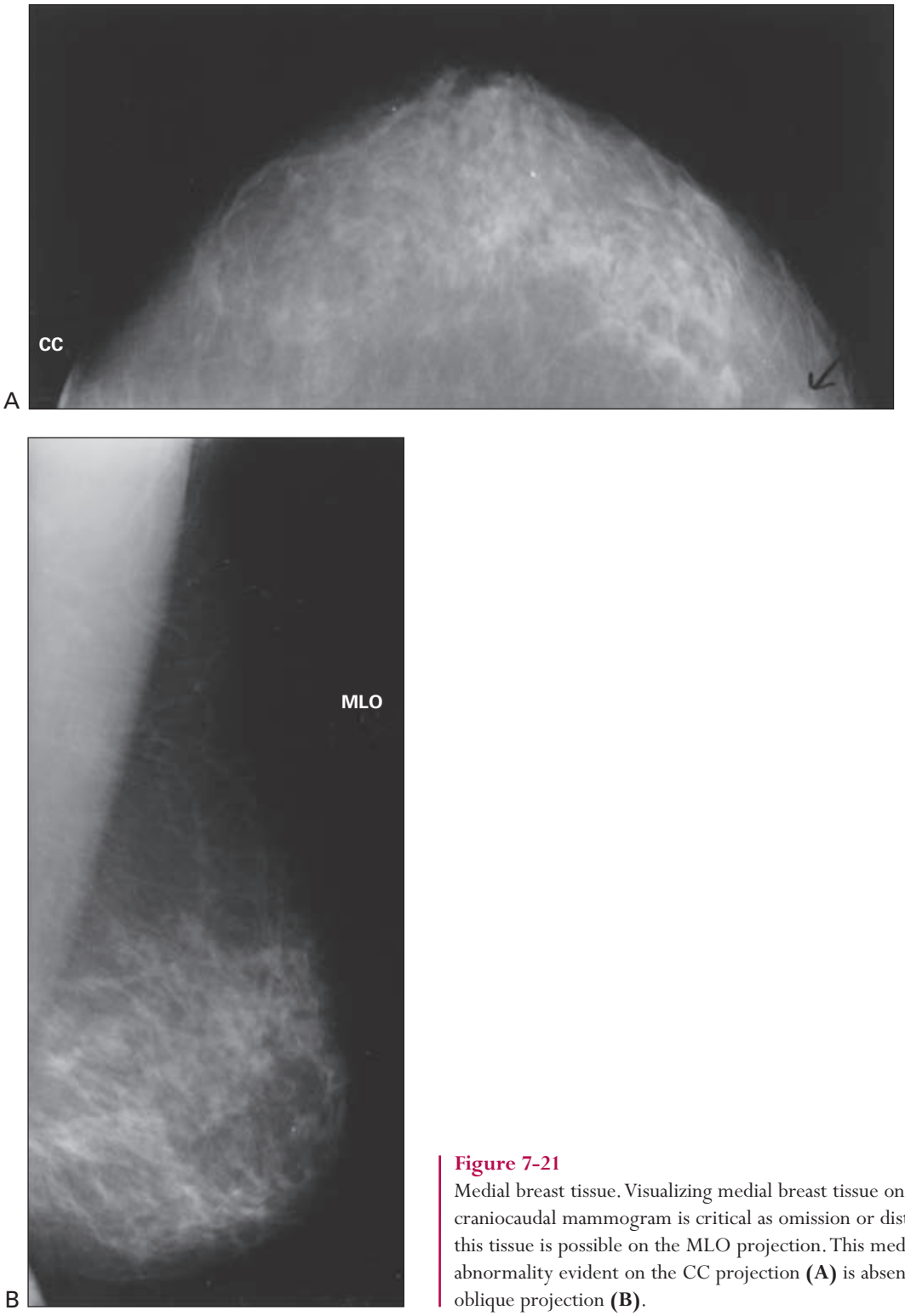


Figure 7-21
Medial breast tissue. Visualizing medial breast tissue on the craniocaudal mammogram is critical as omission or distortion of this tissue is possible on the MLO projection. This medial abnormality evident on the CC projection **(A)** is absent on the oblique projection **(B)**.

breast onto the image receptor (but out of the x-ray field). Tell the patient to lift her chin slightly; if she tucks her chin in toward her chest, the chest wall will draw away from the detector. After securing the medial aspect of the breast, try to capture more lateral tissue. Raise the breast between two hands, and while pulling forward, draw the lateral aspect of the breast forward and onto the image receptor; be careful not to rotate the breast (Figure 7-23). This maneuver will help to compensate for lost lateral tissue. Hold the breast in place, smoothing skin wrinkles toward the nipple, and apply compression. As the compression gradually fixes the breast in place, slide the stabilizing hand out toward the nipple. The technologist can place one hand gently on the woman's back to prohibit the natural movement away from the compression.

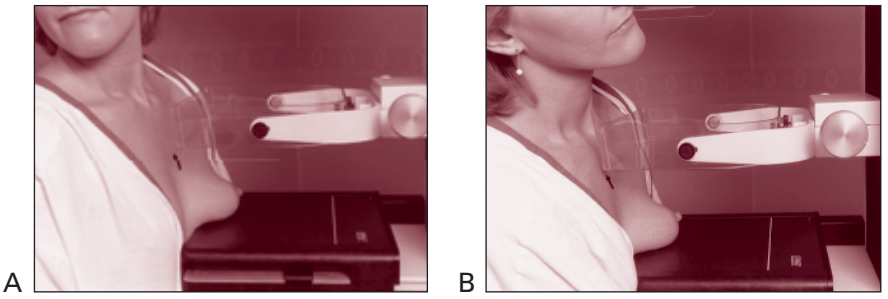


Figure 7-22
The chest wall is brought closer to the image receptor by turning the patient's head to the contralateral side, bringing it forward around the face shield **(A)**. This results in visualization of more medial, superior, and posterior tissue *(arrow)*. Just turning the head to the side **(B)** is contrary to the positioning process.

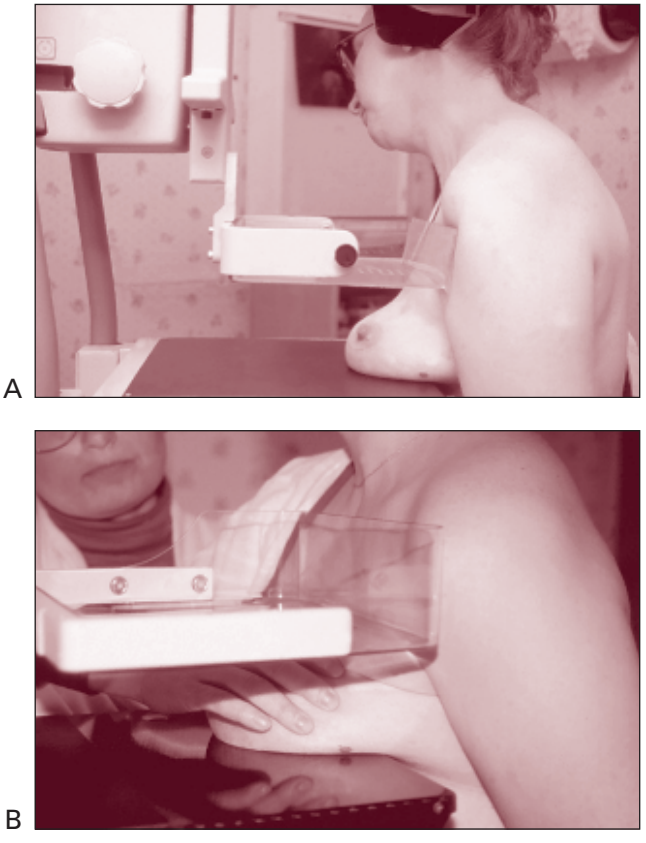


Figure 7-23
Tabar maneuver. After securing medial tissue during positioning for the CC projection **(A)**, greater amounts of posterior and lateral breast tissue may be brought into view by lifting the breast between two hands and pulling the lateral tissue forward **(B)**. Do not rotate the breast during this maneuver. Note the forward movement of the mole on the patient's breast.

Apply firm compression. In some women an axillary fat pad may overlap the lateral tissue after compression. To counteract this effect, supinate the ipsilateral hand, which flattens the shoulder area or adjust the shoulder back.

Helpful Hints CC Projection

1. The patient may be standing too straight and erect. Have the patient slouch drooping her shoulders. This relaxes the muscles and lets the breast fall forward onto the image receptor. Rather than telling the patient to relax, different words such as "slouch," "droop," and "forget good posture" are more specific and may be more helpful in obtaining the necessary results.
2. Many patients push their hips forward. Advise them to step back and lean forward from the waist.
3. The contralateral breast of a larger breasted woman may inhibit visualization of medial tissue. To overcome this, drape the medial aspect of the contralateral breast over the edge of the image receptor, which will allow more of the medial tissue of the imaged breast to also be pulled forward and onto the image.
4. If the technologist and radiologist are uncomfortable with visualizing less of the lateral tissue on the craniocaudad view, and the "Tabar" modification does not help, it may be useful to add a third view (either 20° MLO or exaggerated craniocaudad).

Assessing Results

To determine accurate positioning radiographically for the CC projection, inspect the image for the following (Figure 7-24):

1. Retroglandular fat space—This is a band of fatty tissue apparent posterior to the glandular island in most women. Although the lateral glandular tissue may extend off the image at the posterior aspect of the CC, this anatomical landmark should be in evidence posterior to the more central and medial glandular structures.
2. Pectoral muscle presenting at the medial aspect of the breast. This structure, evident on 20% to 30% of CC images, is a radiopaque density of varying size. Often it has a triangular shape and mirrors itself when apparent bilaterally. When appearance is unilateral, the pectoral muscle can imitate a carcinoma (Figure 7-25). An superolateral to inferomedial oblique (SIO) (see later discussion) of 5° to 20° will show more of the density to rule out cancer (Figure 7-26).
3. Skin thickening toward the cleavage of the breast. The skin at the base of the breast is thick and tapers as it approaches the nipple–areola complex.
4. The cleavage of the breast.

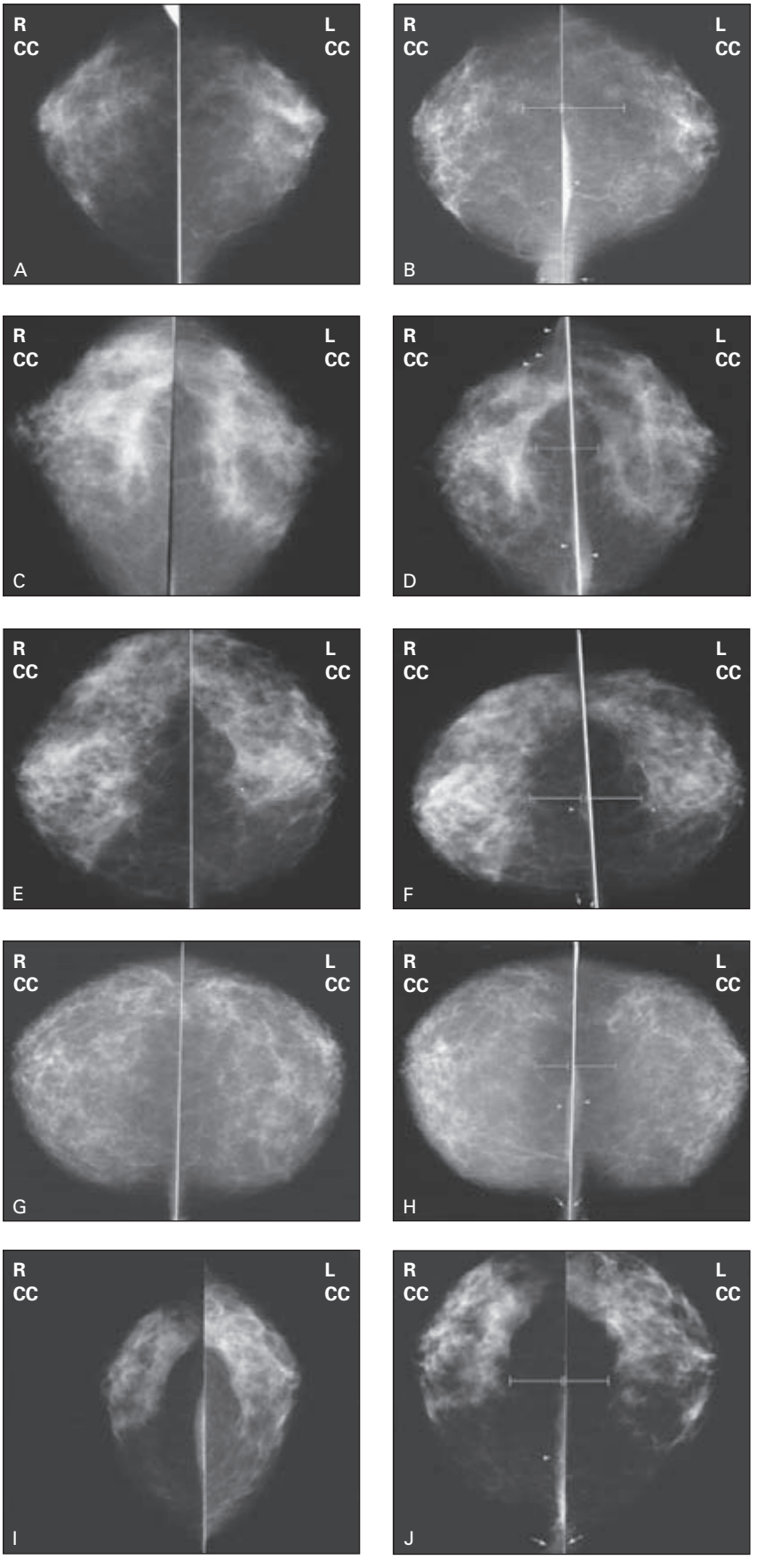


Figure 7-24
Craniocaudal mammogram—good versus better. **A, C, E, G,** and **I** represent four sets of well-positioned cranial-caudal mammograms. **B, D, F, H,** and **J** illustrate subsequent yearly mammograms on the same patients. In all cases adding modifications, such as, elevating the inframammary fold, bringing the head around the face shield, and the Tabar maneuver, produces better mammograms. **B, D, F, H,** and **J** exemplify various landmarks of good quality mammograms: retroglandular fat space *(brackets)*, skin thickening and cleavage at the medial aspect of the breast *(arrows)*, and pectoral muscle *(arrow heads)*. Note the skin folds evident *(open arrows)* on **D;** eliminate skin folds by smoothing toward the nipple, pulling tissue out laterally may result in loss of posterior and lateral tissue. Also, note the presence of pectoral muscle on **I** (R CC); in the following mammogram (**J**) less muscle is evident, but **J** demonstrates more of the breast tissue; the pectoral muscle is not always an indicator of positioning efficiency on the CC projection.

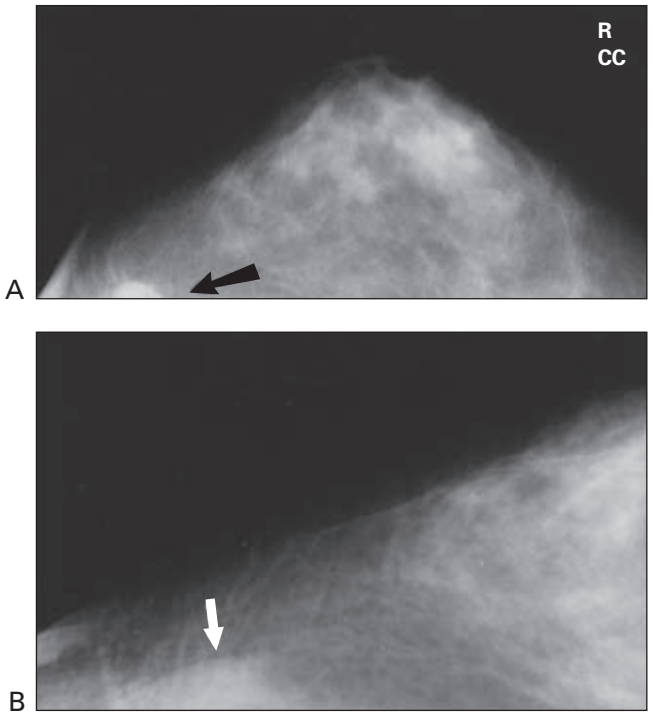


Figure 7-25
Pectoral muscle. **(A)** The pectoral muscle may appear unilaterally on the craniocaudal view imitating a carcinoma. **(B)** An SIO projection (in this case a 10°) provides more of the pectoral muscle *(arrow)* to satisfy the pseudocarcinoma dilemma.

One or all of these indicators may be absent in one or both CC mammograms because of anatomical differences from one woman to another and from the left breast to the right breast. If most of the images do not show these landmarks, consider refining the positioning method. The technologist should use discretion in adding subsequent images: remember, the goal is to image the whole breast, not the anatomical landmarks.

Summary of Craniocaudal Positioning

Figure 7-27 illustrates the step-by-step positioning process for the craniocaudal mammogram.

Variations of the Craniocaudal Projection

Exaggerated Lateral Craniocaudal (XCCL) Projection

Applications

The XCCL projection will best visualize posterolateral tissue of the breast (Figure 7-28). However, this position will not spread the glandular tissue and "open up" the structures in the same way as a 20° MLO (see later discussion). The XCCL may be limited in reaching extreme posterolateral structures.

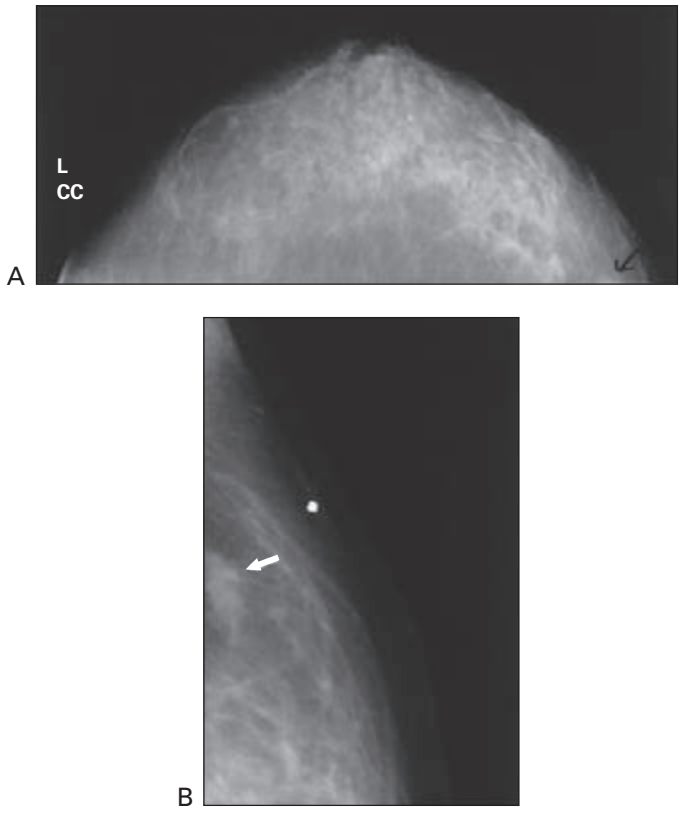


Figure 7-26
Medial cancer. **(A)** A density in the posterior medial aspect on this craniocaudal mammogram could be the pectoral muscle. **(B)** An SIO of 20° shows this to be a true mass *(arrow)* and not the pectoral muscle. This was carcinoma on biopsy.

Performing the Study

To achieve the exaggerated CC projection, the C-arm is not angled. Direct the beam superiorly to inferiorly as you would for a standard craniocaudal. Start with the patient facing the unit. Turn the contralateral side away from the image receptor. The lateral aspect of the ipsilateral breast should be closest to the image receptor. Tell the patient to lean slightly toward the ipsilateral side, relaxing her shoulder down and back. Gently lift the breast and rest it on the image receptor. Raise the C-arm to elevate the image receptor to meet the posterior lateral tissue. Pull the breast forward and apply compression (Figure 7-29).

Helpful Hints XCC Projection

The XCC is limited in its ability to capture the posterolateral tissue. It may be helpful to angle the C-arm slightly (5° to 10° in the MLO direction) to allow the breast tissue to fall evenly on the image receptor. Indicate any rotation of the C-arm, as the radiologist may use this view to localize an abnormality; any rotation of the C-arm changes the orientation of the abnormality to the nipple.



Figure 7-27

(A) Have patient stand with her feet toward unit. **(B)** The patient should bend forward at the waist, and assume a "droopy" posture. **(C)** Elevate the IMF, adjusting the height of the C-arm. Bring the breast forward to rest on the image receptor. Relax the ipsilateral arm comfortably at her side (or over her abdomen). **(D)** Have the patient bring her head to the contralateral side, around the face shield. This maneuver brings the chest wall closer to the positioning surface and allows visualization of more medial tissue. **(E)** For balance and stability, the patient should hold onto the handrail with the contralateral hand. **(F)** Bring the opposite breast onto image receptor (but not within the x-ray field) to help visualize additional medial tissue. **(G)** Lift the breast between two hands and gently pull forward, implementing the Tabar modification to pull lateral tissue forward. **(H)** Gentle placement of the technologist's hand on the patient's back will prohibit backward reaction to the compression. **(I)** Using the foot pedal, lower the compression paddle while holding the breast in place. **(J)** Complete compression using the manual controls to lower the paddle. To avoid losing posterior tissue on the image, always smooth wrinkles toward the nipple; never pull skin wrinkles posteriorly. **(K)** Completed craniocaudal projection.

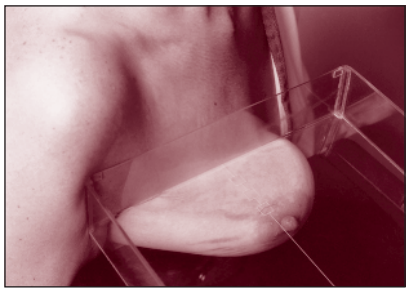


Figure 7-28
XCCL projection. Completed positioning of the exaggerated craniocaudal projection. This view places emphasis on imaging the lateral tissue, rather than the medial tissue.

Summary of Exaggerated Craniocaudal Positioning

1. Direct the beam superior to inferior.
2. Turn the patient toward the contralateral side.
3. Lift, and gently pull the breast onto the imaging surface.
4. Raise the C-arm so that the posterolateral breast is in contact with the image receptor.
5. Lean the patient slightly toward the ipsilateral side.
6. Relax the shoulder down and back.
7. Apply compression, while holding the breast in place.

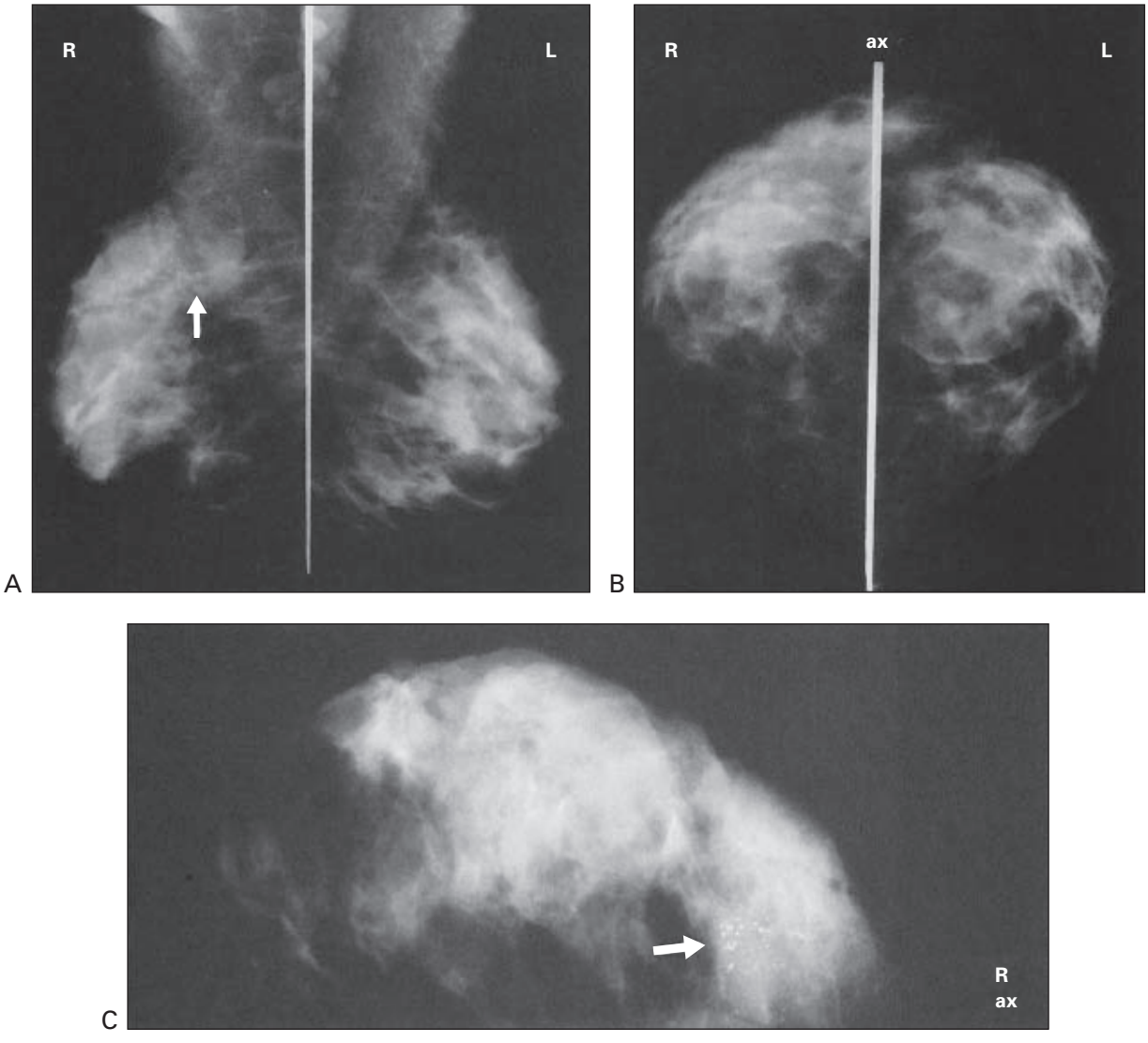


Figure 7-29
XCCL projection. **(A)** Right and left MLO mammograms demonstrating calcium superiorly in the right breast, not evident on the craniocaudal projection. **(B)** An exaggerated craniocaudal, **(C)** demonstrates the posterolateral aspect of the breast, including the calcium *(arrow)*.

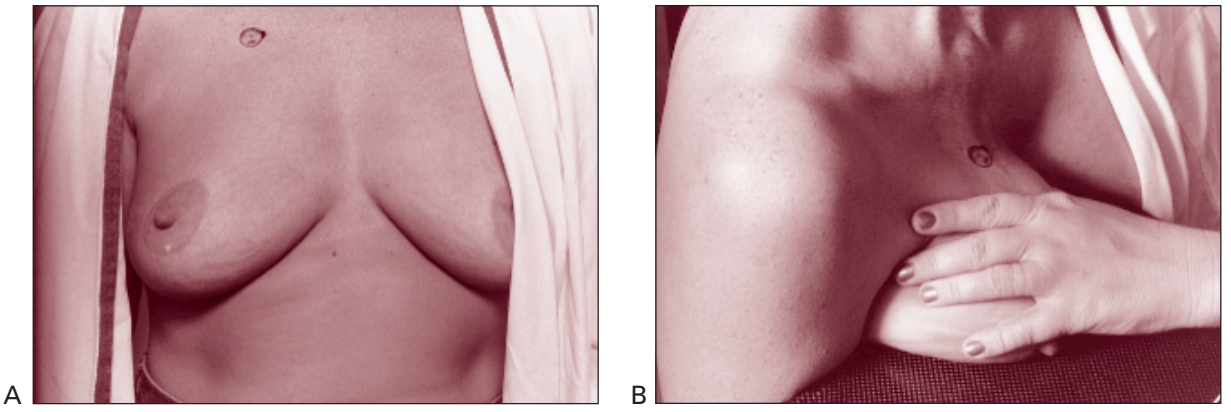


Figure 7-30
Elevated CC. Abnormalities high on the chest wall **(A)** may be brought into view with an elevated CC. **(B)** To accomplish this view, overelevate the IMF eliminating the inferior breast tissue and use minimal compression to maintain tissue visualization.

Elevated Craniocaudal Projection

Applications

The elevated craniocaudal projection best visualizes central and medial abnormalities high on the chest wall. This projection is an option when an abnormality presents in the superior aspect of the MLO and lateral projections but is absent from the standard CC projection.

Performing the Study

Direct the beam superiorly to inferiorly. Do not angle the C-arm. Turn the patient forward, to face the unit. Position the patient as you would for a standard craniocaudad projection, leaning her excessively forward, toward the unit. Overelevate the breast, raising the image receptor *above* the IMF, taking advantage of the mobile inferior border of the breast.[12] This should access tissue high on the chest wall. Use common sense when elevating the image receptor; at some point elevating the image receptor too high will defeat the purpose of the view. Gently but firmly pull the breast outward and forward, centering it on the image receptor. Apply minimal compression to hold the breast in place (Figure 7-30). Vigorous compression may prohibit visualization (Figure 7-31).

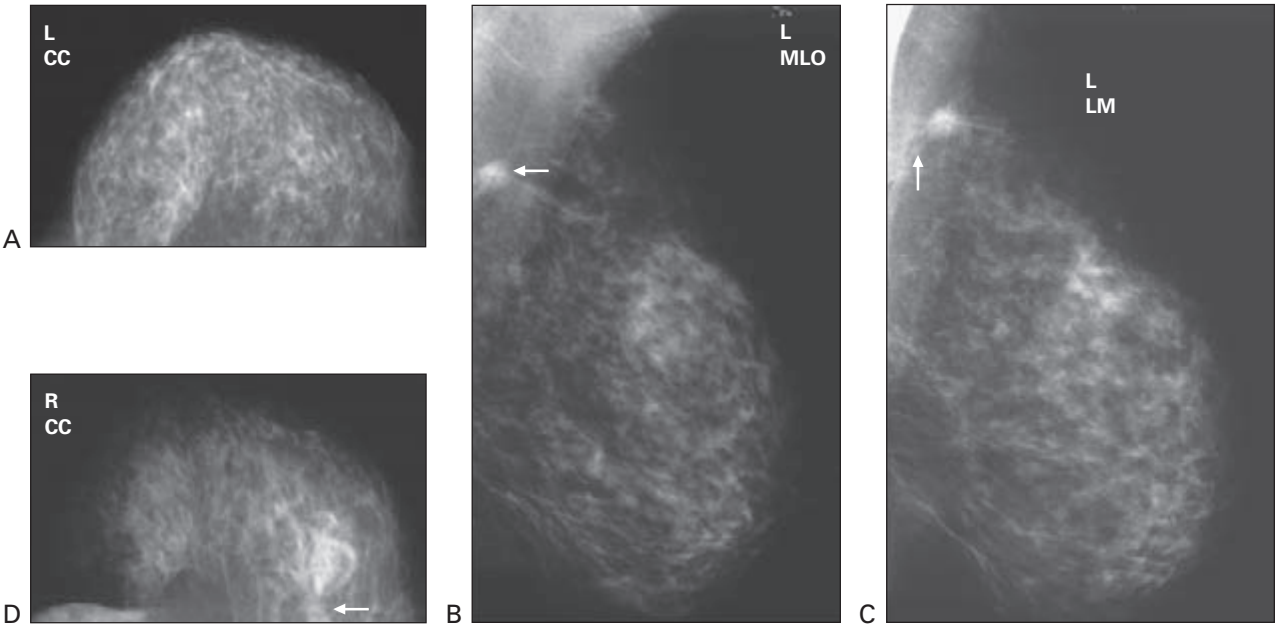


Figure 7-31
Elevated CC. This routine screening left mammogram (**A**-CC and **B**-MLO) reveals a spiculated mass *(arrow)* on the MLO *(arrow)*. A true lateral **(C)** indicates that the mass's location is medial, because it moves up (see Chapter 9). An elevated CC **(D)** using minimal compression reveals the medial location of this proven carcinoma *(arrow)*.

Summary of Elevated Craniocaudal Positioning

1. Direct beam superiorly to inferiorly.
2. Face patient toward unit, feet forward.
3. Lean patient inward, relaxing the shoulders.
4. Bring inferior aspect of breast onto the image receptor.
5. Pull breast outward and forward.
6. Raise C-arm above IMF, pushing breast tissue up and bringing superior tissue under the compression paddle.
7. Apply *minimal* compression while holding the breast in place.

The Caudal-Cranial Projection (FB—From Below)

Application

The CC projection may be useful in the nonconforming patient, or in trouble shooting abnormalities high on the chest wall that slip from view on the routine CC projection. It is used minimally, as it is uncomfortable for both the technologist and the patient, and often overlapping of the abdominal tissue prevents visualization of the breast tissue this view is designed to see.

Performing the Study

Invert the C-arm as for a CC projection. Step the patient forward and have her bend excessively forward at the waist to ensure that the abdomen does not encroach in the x-ray field. Place the image receptor above the breast at a level that allows adequate visualization of the breast/or high abnormality. Elevate the IMF, holding the breast in place against the image receptor. Bring the compression paddle up toward the image receptor to hold the breast in place (Figure 7-32).

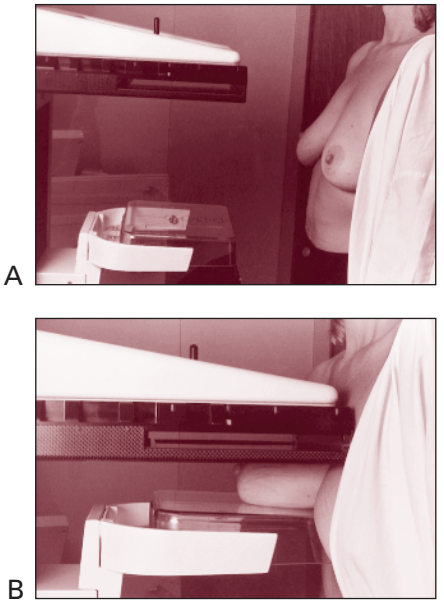


Figure 7-32
CCFB. **(A)** Orientation of the patient to the C-arm for the CCFB and **(B)** completed CCFB.

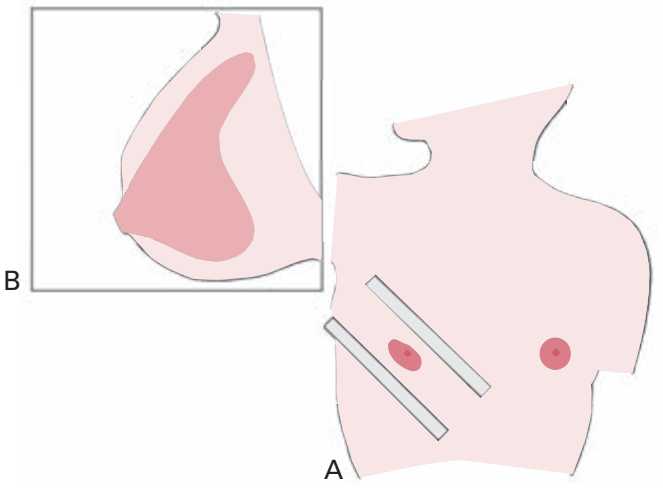


Figure 7-33
MLO projection. **(A)** Schematic of the orientation of the breast to the image receptor for the MLO projection. **(B)** Schematic demonstrating the amount of the "glandular island" usually evident with this view.

The MLO Projection

Applications

The MLO projection[13,14] (Figure 7-33) best visualizes the posterior and upper-outer quadrants of the breast. This position is preferred as the complementary second projection in the routine two-view mammogram because it is effective in visualizing the posterior and upper-outer quadrant breast tissue. This is intrinsic to the anatomy of the breast, which lies anterior to and follows the line of the obliquely coursing pectoral muscle. By positioning the breast parallel to this oblique line, which is the natural course of the tissue, it is possible to demonstrate most of the glandular tissue. However, even though the MLO images the breast in its entirety, it does so with much overlap and distortion of anterior structures (Figure 7-34).

Performing the Study

Angle the C-arm as for a superomedio–inferolateral projection to the appropriate obliquity. The degree of the angle will be in the neighborhood of 45°, but varies from 30° to 60° depending on the patient's body habitus. Be flexible; what works for one patient will not work for all. By "adjusting" the angle to the patient's build, the technologist can best demonstrate breast tissue as far posterior as possible. As a guideline, draw an imaginary line from the patient's shoulder to midsternum (Figure 7-35) and angle the C-arm to parallel this line.

The patient should stand with her hips slightly anterior to the lower end of the image receptor. If the hips are behind the image receptor, the technologist will have to work harder to pull lateral tissue into view (Figure 7-36). Turn the patient's

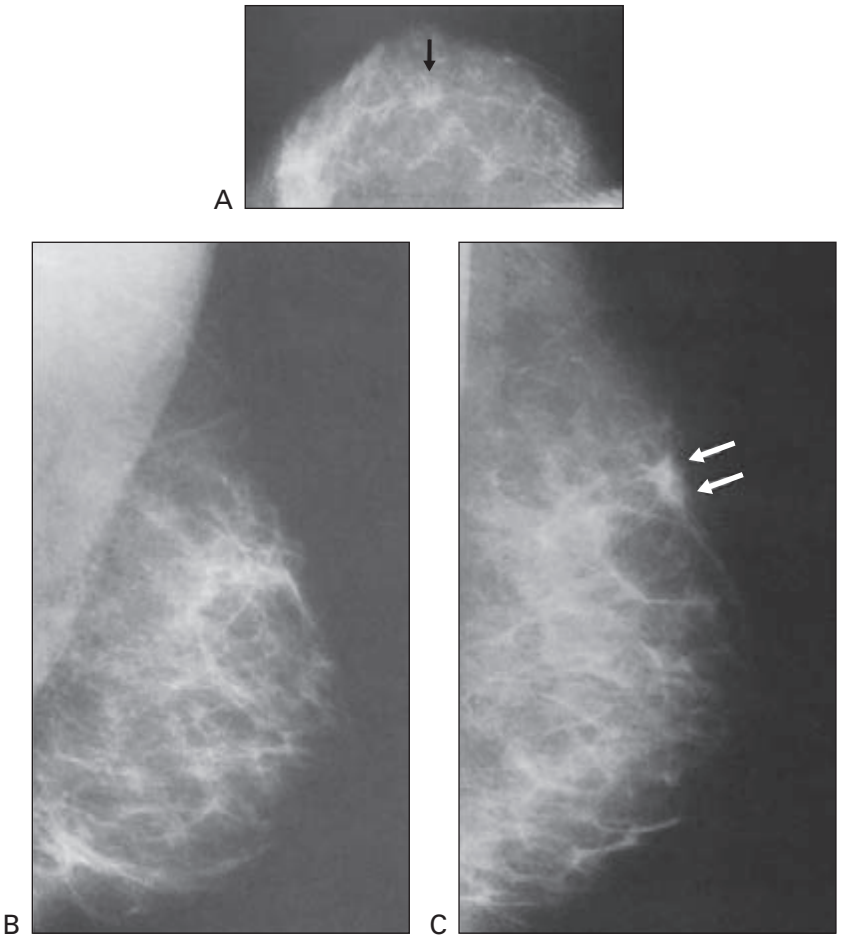


Figure 7-34
Distortion of tissue. Distortion or overlap of the anterior and central breast structures often occurs on the MLO. **(A)** The left CC demonstrates a spiculated abnormality *(arrow)*. **(B)** The MLO is inconclusive for the abnormality. **(C)** A lateral medial–lateral (LML) demonstrates the abnormality free of superimposition *(arrows)* and in closer contact to the image receptor. This orthogonal view is also used to triangulate the position of the abnormality (see Chapter 9).

feet and body toward the unit. The patient should relax her shoulders and upper torso, reflecting a poor posture. Dropping the shoulders inward or gently drawing them together further relaxes the breast structures forward. Raise the ipsilateral arm to shoulder level, forming a right angle with the body. This will determine the height of the image receptor, which should position the AEC detector of an analog unit just above the nipple (see Figure 7-14).



Figure 7-35
C-arm angle. When positioning for the medial–lateral oblique (MLO) projection, it is important to adjust the angle to the patient's body build. Draw an imaginary line from the shoulder to midsternum matching the angle of the C-arm with this line.

At the proper image receptor level, most of the axilla is visible with good presentation and compression of the breast. The *height* of the image receptor will directly affect the level of the arm (Figure 7-37). Raising the image receptor too high will elevate the arm higher, stretching the pectoral muscle and causing difficulty in pulling the breast into view. Additionally, if too much of the shoulder and upper axilla are under the compression paddle, it will prohibit proper compression on the lower portion of the breast. The same effect occurs when using the larger grid surface on a smaller patient with an analog unit (see earlier discussion of image receptor size—Figure 7-14).

Occasionally, an occult breast cancer will present with metastatic axillary lymph nodes. These are usually evident on the MLO without using extraordinary measures. Although it is important to image the axillary tail of the breast and a good amount of axillary tissue, focusing on the axilla on the two-view mammogram will increase the possibility of missing a small carcinoma elsewhere within the breast.

Next, bend the elbow and *gently* rest the patient's hand (rather than gripping), on the handrail. If the patient grips the handrail tightly, the pectoral muscle will tighten, inhibiting

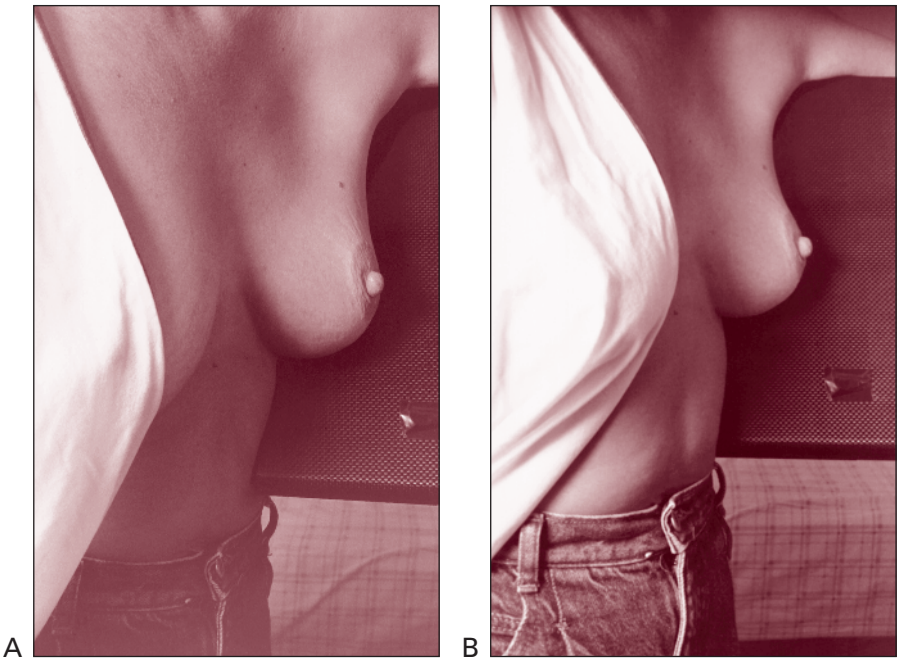


Figure 7-36
Hip placement. If the inferior corner of the image receptor is in front of the hip **(A)**, acquiring good visualization of posterolateral tissue will be difficult. Place the patient's hips anterior to the image receptor **(B)** to facilitate positioning.

the positioning and compression process. Place one hand behind the ipsilateral shoulder and the other posterolateral to the breast tissue. (Remember: breast tissue can extend to the midcoronal line of the body.) Lift and pull the breast gently but firmly upward and outward, bringing the lateral portion of the breast to rest on the image receptor. The upper corner of the image receptor should rest slightly posterior to the axilla (Figure 7-37).[9] Some positioning methods recommend placing the corner of the image receptor in the axilla. This may result in missed posterolateral tissue. However, placement of the image receptor too far posterior to the axilla will force more of the shoulder under the compression paddle; this will prohibit adequate compression of the breast structures and cause the breast to droop, not only decreasing visualization of the structures, but also increasing the chance of motion. This drooping breast tissue is often referred to as "camel nose,"[4] as its shape resembles the silhouette of a camel face.

The ipsilateral arm should *not* entirely rest along the top of the image receptor. Instead, bend the elbow, rotating the triceps muscle posteriorly and superiorly (Figure 7-38) bringing the lateral portion of the breast closer to the positioning surface, resting only the upper arm on the image receptor. The elbow should rest posterior to the image receptor. This maneuver minimizes the thickness of the upper breast and axilla under compression and also eliminates skin folds in the superior aspect of the MLO image.

With the lateral portion of the breast on the image receptor, rotate the patient's hips and shoulders inward to include posterior tissue and the IMF. Excluding the IMF may eliminate posterior breast tissue from being visualized. The IMF should be in the "open" position on the image, with no evidence of creasing or wrinkles.

Rotating the patient inward will also bring the superior, posterior breast tissue into view. The upper proximal aspect of the compression paddle will rest in the hollow between the humeral head and the clavicle. The chest wall edge of the compression paddle will touch the sternum. Continue to hold the breast outward and upward at all times while applying compression to ensure visualization of posterior tissue and the IMF. This tactic will also properly present the ductal structures.

If the breast is left to droop, the ductal structures will not be properly separated, and the detection of architectural distortion (a common sign of cancer) will be more difficult, if not impossible (Figure 7-39). Additionally, straighten the anterior breast to flatten the tissue, reducing **structural overlap**. Lower the compression paddle, skimming the chest wall, just enough to hold the posterior portion of the breast in place, sliding the supporting hand anteriorly toward the nipple, as the compression takes over holding the breast in place. This will prevent the breast from drooping and hold posterior tissue in view. The patient may have to gently hold her other breast out of the way (without pulling the ipsilateral breast from view) to avoid superimposition.

At some point during the final steps of positioning for the MLO, check the posterior aspect of the breast. The technologist should run a hand between the patient's back and the image receptor to make certain that the skin is tight and that no posterior tissue is folded or lost. Beware: the positioning may look ideal from the anterior perspective despite exclusion of the posterolateral tissue (Figure 7-40).

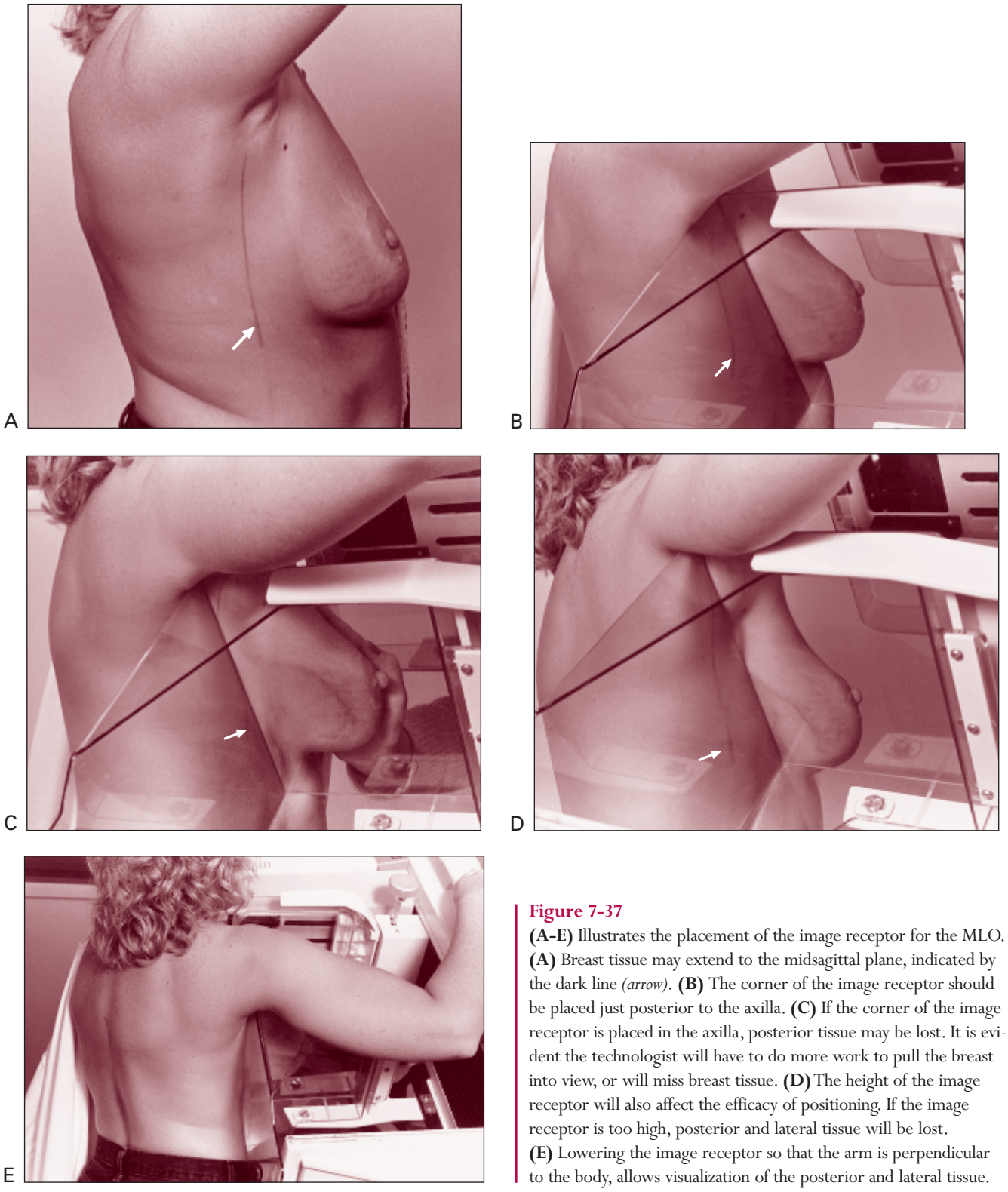


Figure 7-37
(A-E) Illustrates the placement of the image receptor for the MLO. **(A)** Breast tissue may extend to the midsagittal plane, indicated by the dark line *(arrow)*. **(B)** The corner of the image receptor should be placed just posterior to the axilla. **(C)** If the corner of the image receptor is placed in the axilla, posterior tissue may be lost. It is evident the technologist will have to do more work to pull the breast into view, or will miss breast tissue. **(D)** The height of the image receptor will also affect the efficacy of positioning. If the image receptor is too high, posterior and lateral tissue will be lost. **(E)** Lowering the image receptor so that the arm is perpendicular to the body, allows visualization of the posterior and lateral tissue.

Assessing Results

Examine the mammogram for the following elements (Figure 7-41):

1. The breast should not appear to droop on the image, although with some large-breasted women, drooping is unavoidable. In these cases, add a third projection of a lateromedial lateral or mediolateral lateral to image anterior structures.
2. The pectoral muscle should be visualized to the nipple (posterior nipple line [PNL] or nipple axis line [NAL]).

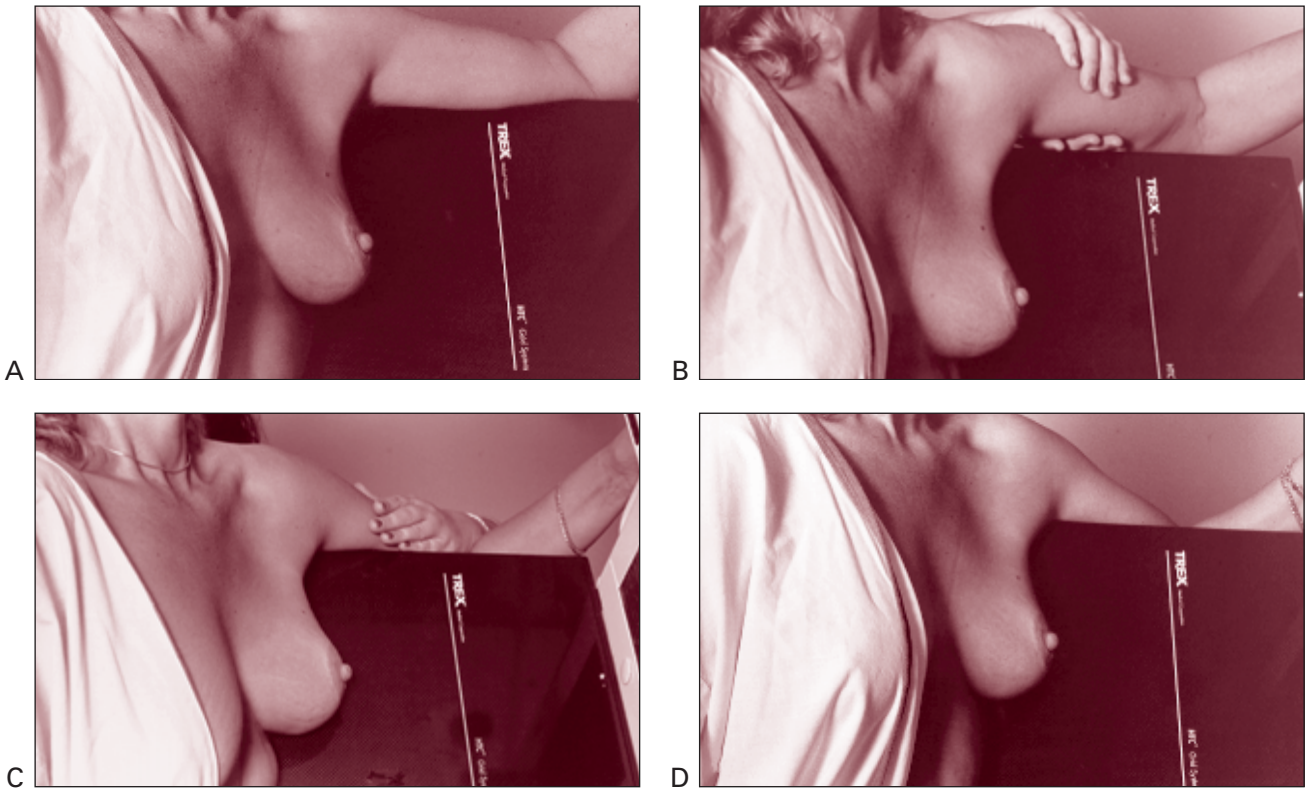


Figure 7-38
Arm placement. **(A-D)** Illustrate the step-by-step process to bring the breast in closer contact with the image receptor. The humerus should not rest across the image receptor; once positioning is completed, it should rest just posterior to the image receptor. Rotating the triceps muscle and overlying tissue posteriorly and superiorly will flatten the superior breast, eliminating folds and wrinkles, and also reduce the thickness at the shoulder, providing better compression on the lower breast.

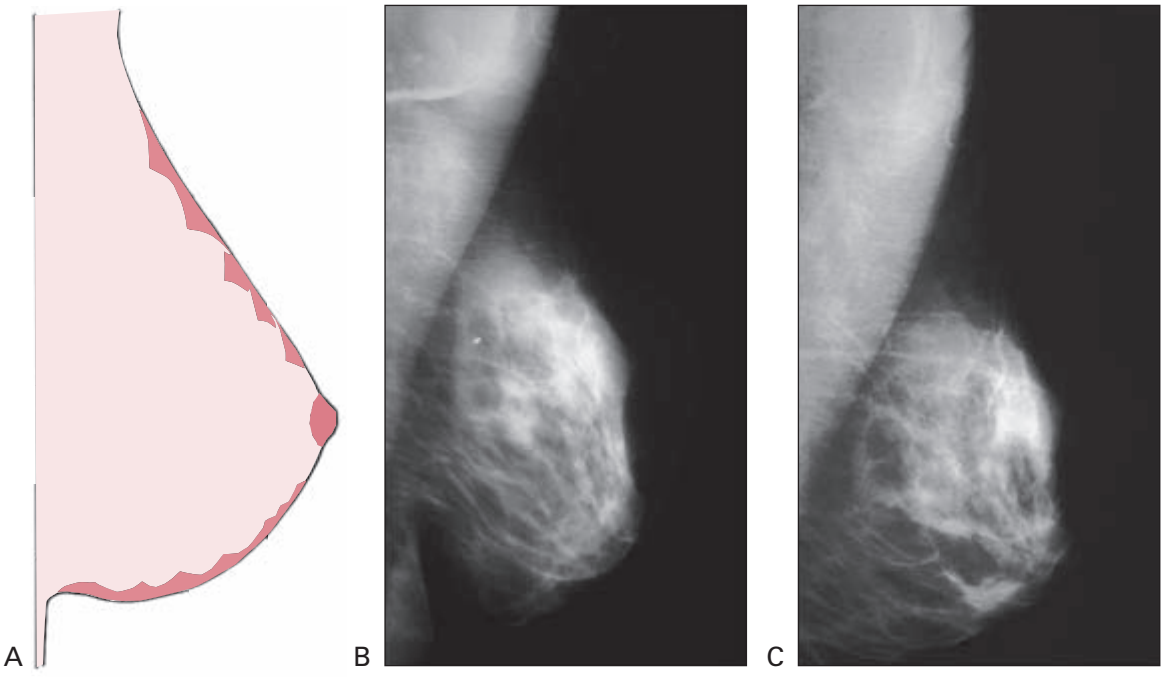


Figure 7-39
Breast architecture. **(A)** If the ductal structures are left to droop, the ductal structures will overlap. Detection of architectural distortion will be more difficult if not impossible. **(B)** When drooping occurs, the silhouette of the breast will appear as the shape of a camel's face, earning it the nickname of "camel nose" appearance. **(C)** When positioning for the MLO projection, pull the breast upward and outward to properly demonstrate ductal structures and alleviate tissue overlap.

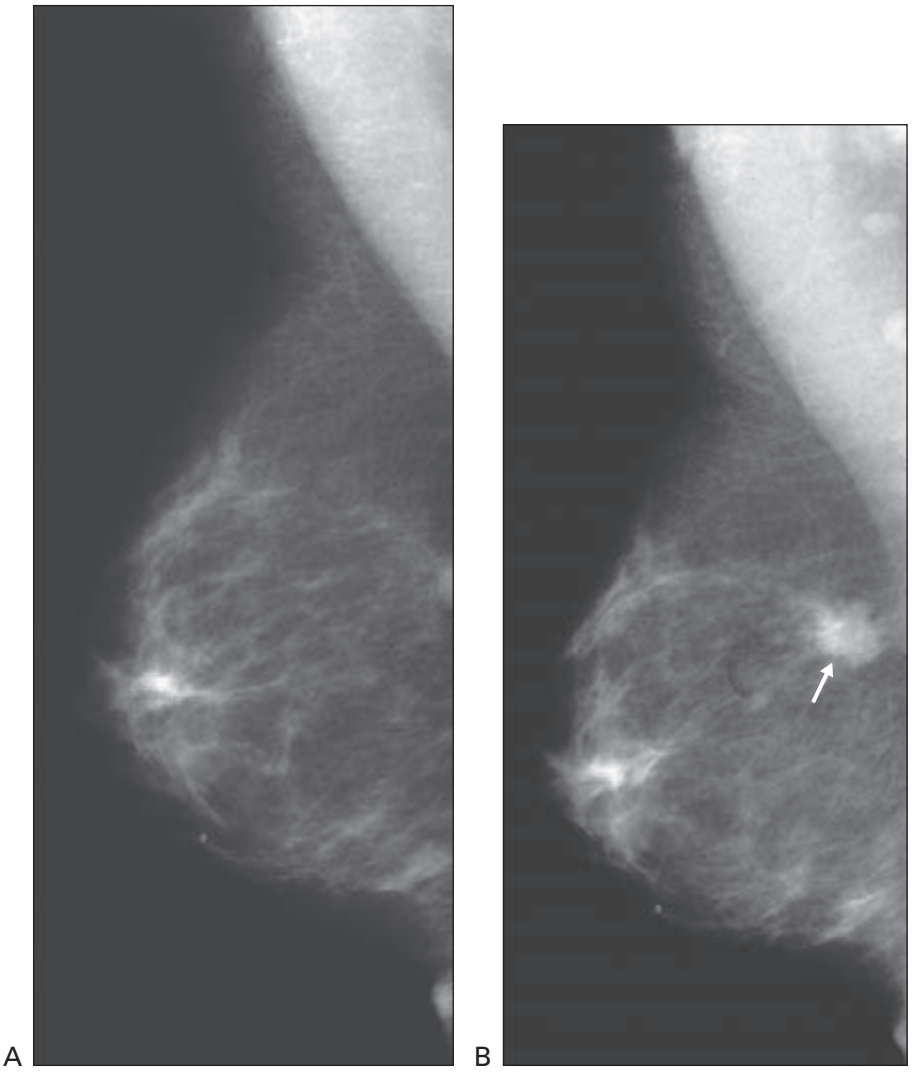


Figure 7-40
Checking the posterior aspect. Positioning of the MLO can appear to be adequate from the anterior perspective, especially when the IMF is evident. However, this is only half the "story." The technologist should check the posterior aspect as well to ensure inclusion of the lateral and posterior tissue. **(A)** On this poorly positioned MLO, the IMF is evident, as well as a portion of the pectoral muscle. **(B)** On a subsequent mammogram, much more lateral and posterior tissue is brought into view, demonstrating a cancer *(arrow)*.

This may not be possible on all patients; however, it should be the rule rather than the exception. The muscle should also be imaged as convex, rather than concave or flat. A concave or flattened muscle indicates lack of relaxation of the muscle, an inappropriate angle of obliquity, inadequate use of the mobile medial border, or allowing the patient to lean back slightly.[15]

3. The IMF should be "open" rather than falling on itself, indicating that the breast is in the "up and out" position.

The aforementioned are guidelines; if one or two of these elements are missing, it is up to the technologist to determine whether a third view is necessary, based on observation of the patient while performing the mammogram. (Refer to Chapter 10.)

Often, the technologist can identify two indented lines on the patient's body from the compression plate and image receptor; one from behind the breast running obliquely, superiorly to inferiorly and laterally to medially, and the other at the medial aspect near the sternum. Aim to include the entire breast between these two lines. It will not be possible to include all the medial tissue on the MLO projection on all patients, but the CC projection covers this portion of the breast well (remember the two projections are complementary). However, the lateral line should include the lateral and posterior breast tissue. If not, demonstrate this area of the breast with an extra view (see Chapter 10).

Summary of MLO Positioning

Figure 7-42 illustrates the step-by-step process of patient positioning for the MLO. The basic steps are listed here.

1. Choose the appropriate receptor size and compression paddle.
   Angle the C-arm in the direction you would for a superomedio–inferolateral projection to the appropriate obliquity.
2. The patient should stand with her hips slightly anterior to the lower end of the image receptor.
3. Turn the patient's feet and body toward the unit.

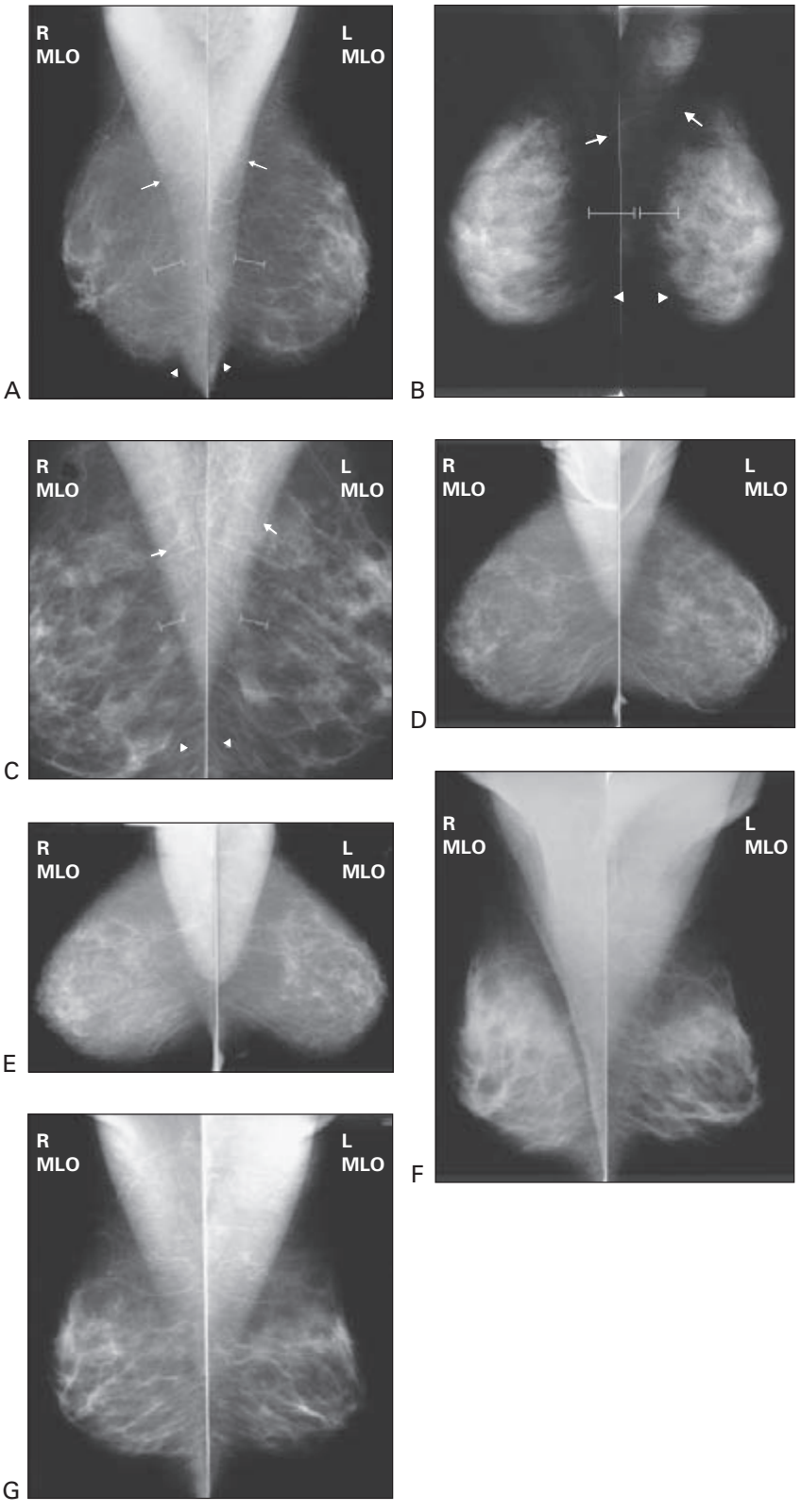


Figure 7-41

The MLO. Getting results. **(A-C)** Three sets of well-positioned MLO mammograms demonstrating varying degrees of pectoral muscle *(arrows)*, retroglandular fat space *(brackets)*, and the open inframammary fold *(arrowheads)*. **(D-G)** Prior and subsequent studies on the same women. Modifications such as appropriate image receptor size and height, correct placement of the image receptor to the axilla, correct body and arm placement, and holding the breast in the up and out position during compression, all result in greater amounts of visualized breast tissue with better compression on the lower breast.



Figure 7-42

Step-by-step positioning of the MLO. **(A)** Choose the appropriate obliquity; the patient should face the unit. **(B)** Have patient stand slightly anterior to the lower corner of the image receptor. **(C)** Place one hand posterolateral to breast tissue. **(D)** Place the other hand behind the ipsilateral shoulder. **(E)** Lift and pull breast upward and outward; bring lateral portion to rest on image receptor. **(F)** The corner of image receptor rests just posterior to the armpit, not in it. **(G)** Rest the breast on the image receptor. **(H)** Gently rotate the triceps muscle posteriorly and superiorly bending the elbow and resting just the upper portion of the humerus on the top of the image receptor. This will flatten the shoulder and axilla area. Check posteriorly to assure the patient's skin is taut between her side and the image receptor.



Figure 7-42 *(continued)*
(I) Continue to hold the breast "up and out." **(J)** Rotate patient so the compression paddle touches the sternum, continuing to pull breast "up and out" on the breast; turn the patient to visualize the inframammary fold. Lower the compression moving the supporting hand anteriorly to prevent drooping and loss of tissue as the compression takes over holding the breast in place. **(K)** Completed MLO projection. Note that the superior corner of the compression paddle rests in the hollow created by the head of the humerus and the clavicle; the inframammary fold is in the open position; the breast is in the "up and out" position with no drooping; the AEC indicators are above the nipple. **(L)** Posterior view of completed projection.

4. The patient should relax her shoulders and upper torso reflecting a poor upper posture, but keeping her knees straight.
5. Raise the ipsilateral arm to shoulder level, forming a right angle with the body; elevate the image receptor to this level.
6. Place one hand behind the ipsilateral shoulder and the other posterolateral to the breast tissue.
7. Lift and pull the breast gently but firmly upward and outward, bringing the lateral aspect of the breast to rest on the image receptor.
8. The upper corner of the image receptor should rest slightly posterior to the axilla.
9. Bend the elbow, rotating the triceps muscle posteriorly and superiorly, which brings the lateral portion of the breast closer to the image receptor; leave only the upper part of the arm to rest on the image receptor.
10. With the lateral portion of the breast on the image receptor, rotate the patient's hips and shoulders inward to include posterior tissue and the IMF, allowing the superior edge of the compression paddle to rest in the hollow between the humeral head and clavicle.
11. Hold the breast upward and outward, turning the patient's hips in toward the positioning surface, bringing the IMF into the open position.
12. Straighten the anterior breast to flatten the tissue, reducing structural overlap.
13. Slowly lower the compression paddle, skimming the chest wall surface, removing the supporting hand as the compression takes over holding the breast in position.

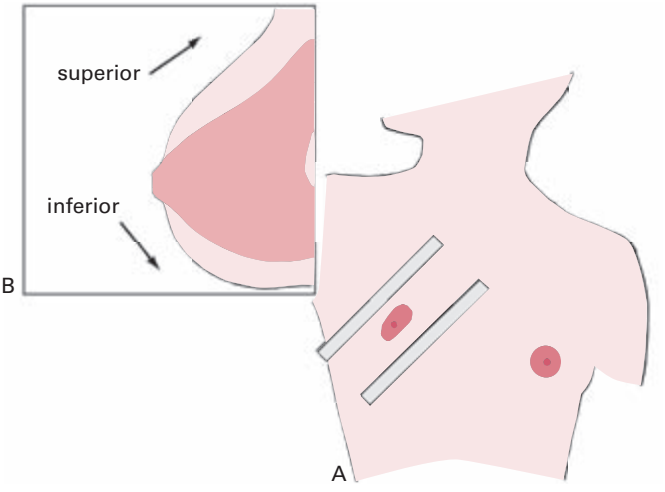


Figure 7-43
SIO Projection. **(A)** Schematic of the orientation of the breast to the C-arm for the SIO projection. **(B)** Schematic demonstrating the amount of the glandular tissue island usually apparent in this view.

Other Oblique Projections

The SIO Projection

Application

The SIO (Figure 7-43) best demonstrates the upper-inner quadrant (UIQ) and lower-outer quadrant (LOQ) of the breast, free of superimposition of the upper-outer and lower-inner tissue. It has four applications:

- As a tangential study of abnormalities in the UIQ or LOQ, the angle of obliquity changes depending on the location of the abnormality (see later discussion).
- For women who have encapsulated implants, and using the Eklund modified compression technique is not feasible, a 60° SIO serves as a third projection to image the UIQ and LOQ hidden on the CC and MLO views. This ensures at least some visualization of these quadrants, free of superimposition of the implant. In these patients, the MLO is also performed at an angle of 60° (Figures 7-44 and 7-45).
- In the nonconforming patient, such as a patient with severe pectus excavatum (see Chapter 8), to image breast tissue not evident on the CC and MLO projections, a 45° SIO provides a means to capture this lost tissue.
- A 45° SIO also provides a perpendicular projection to the MLO and may be useful in distinguishing pseudomass from carcinoma (see Chapter 10).

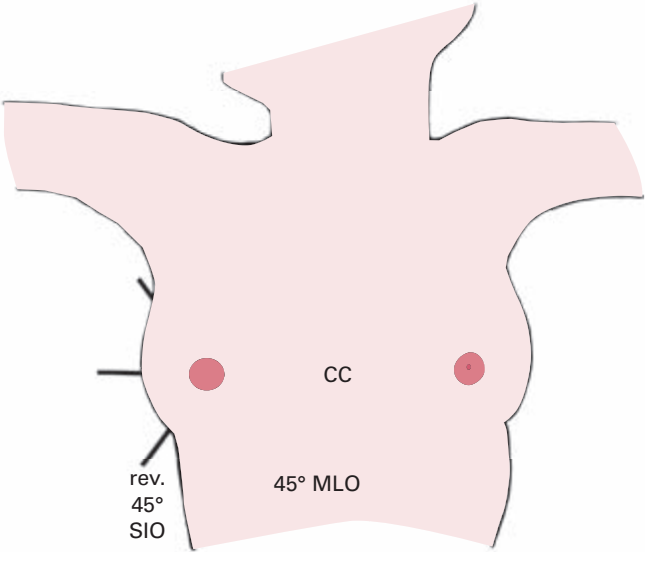


Figure 7-44
Encapsulated implants. Imaging the breast with encapsulated implants in three projections: the craniocaudal (CC), MLO, and SIO ensures visualization of some part of all four quadrants.

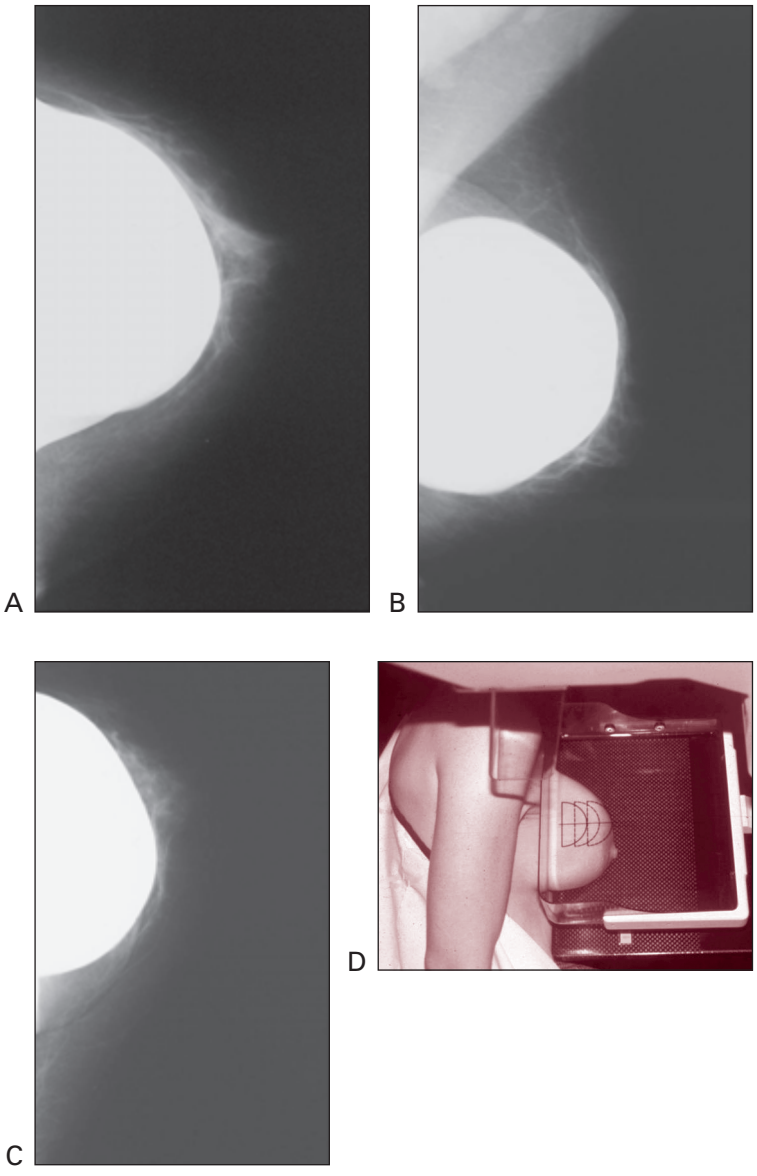


Figure 7-45
The craniocaudal **(A)**, mediolateral oblique **(B)**, and superoinferior oblique **(C,D)** projections of a breast with encapsulated implants images the tissue anterior to the implant.

Performing the Study

The SIO is a superolateral to inferomedial projection. Angle the C-arm as you would for an MLO of the contralateral breast. The patient should stand facing the unit. Ask the patient to lean forward from the waist. Place the edge of the positioning surface at midsternum. The patient should hold onto the handrail with the contralateral hand and the ipsilateral arm should remain at the patient's side. The height of the C-arm should allow the midbreast to rest over the AEC detector. Lift the breast and pull outward and upward, bringing the medial portion of the breast to rest on the image receptor. Gently apply compression from the lateral side of the breast (Figure 7-46). Check to make sure the ipsilateral shoulder is not superimposing the field.

Variation of the SIO Projection

To image the most posterior and inferior portion of the lower-outer quadrant, position the patient as you would for a 45° SIO, then raise the ipsilateral arm up and over so the upper arm rests on the superior part of the image receptor (Figure 7-47).

Summary of SIO Positioning

1. Turn the C-arm to approximately 45° for a SL-IM oblique.
2. Ask the patient to face the unit, ipsilateral arm at her side.
3. Place the image receptor at midsternum, and have the patient hold the handrail with her contralateral hand.
4. Ask the patient to lean in the direction of the image receptor as she slumps forward or hunches over.
5. Bring the medial portion of the breast to rest on the image receptor.
6. Adjust the height of the C-arm to center the breast over the AEC detector.
7. Lift the breast and pull outward and upward.
8. Compress, holding the breast in place.

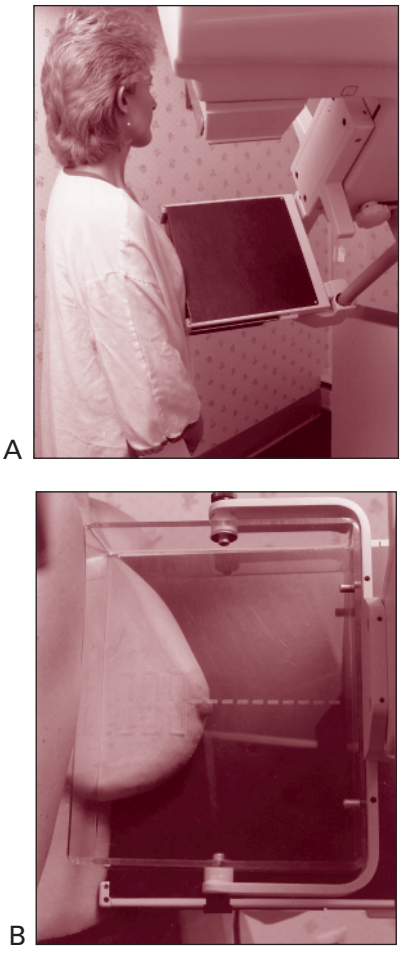


Figure 7-46
SIO projection. **(A)** Orientation of the C-arm rotation for a SIO (SL-IM) projection of the right breast. **(B)** Completed SIO (SL-IM) projection.

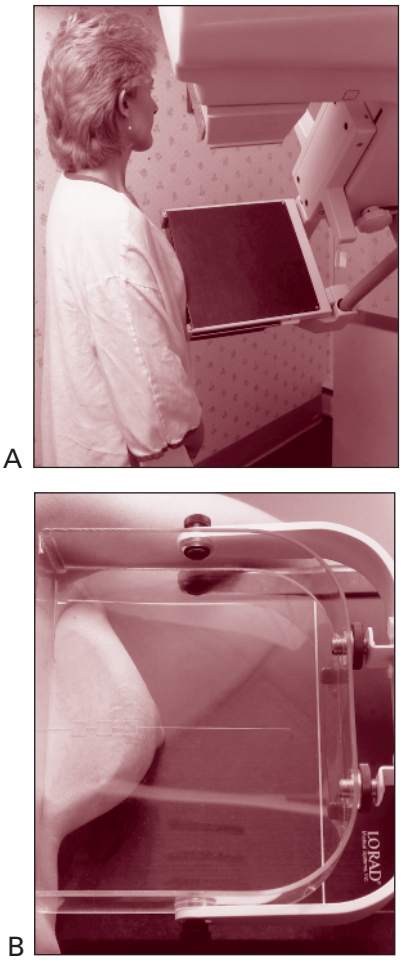


Figure 7-47
SIO projection–arm up and over. **(A)** Orientation of the C-arm rotation for a SIO projection with the arm up and over. **(B)** Completed SIO positioning with the arm up and over.

For Modified SIO

1. Follow steps 1 to 7 above.
   Ask the patient to raise the ipsilateral arm up and over the image receptor, resting the upper portion of the humerus on the superior portion of the positioning platform. This visualizes the most posterior and inferior portion of the lower-outer quadrant.
2. Lower the compression paddle along the posterior and lateral ribs, including as much lateral tissue as possible.
3. Compress, holding the breast in place.

The 20° Oblique Projection\20° MLO

Application

The 20° oblique (Figure 7-48) demonstrates the entire glandular island with less superimposition than the two-projection mammogram.[12] This view is especially useful for visualizing the upper-outer quadrant of the breast, however, it has many applications.

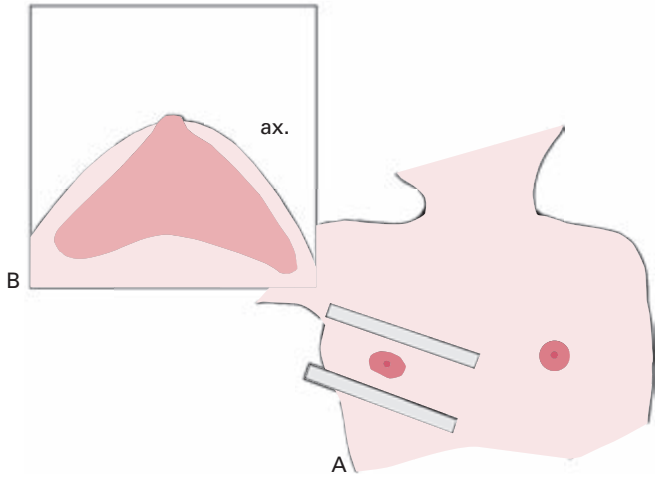


Figure 7-48
20° MLO. **(A)** Schematic of the orientation of the breast to the film tray for the 20° MLO projection. **(B)** Schematic demonstrating the amount of the "glandular island" evident with this view.

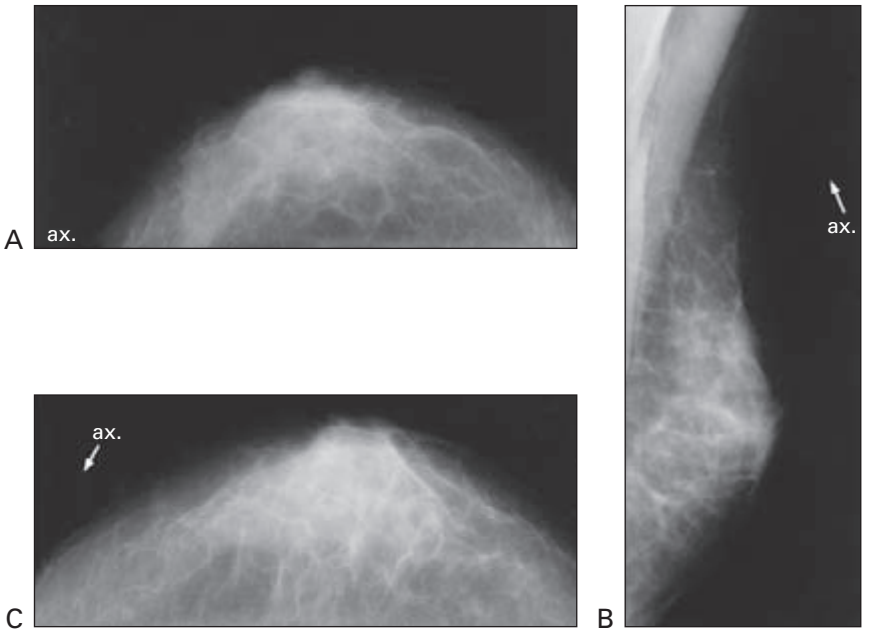


Figure 7-49
20° MLO. Craniocaudal **(A)**, MLO **(B)**, and 20° MLO **(C)** projections of the remaining breast in a woman who has had a mastectomy. The 20° oblique projection will generally demonstrate the entire glandular island and give the radiologist an additional projection of the tissue.

It will not visualize tissue as far posterolateral or posteromedial as well as the craniocaudad or MLO projections and for this reason, should not replace either one in a two-view study. However, when performing a single view mammogram for follow-up or because of a patient's young age or other similar circumstances, it is the preferred position.

The 20° oblique projection spreads the glandular tissue, separating overlapped structures. It is useful as a third projection when seeking further evidence about a possible abnormality imaged on the MLO projection. The 20° oblique projection is also useful as a third view for both the unaffected and affected breasts in patients who have had breast cancer (see Chapter 10). These patients have an increased risk of either developing another carcinoma in the unaffected breast or of recurrence in the affected breast. A third projection gives the radiologist and patient an advantage in early diagnosis (Figures 7-49 and 7-50).

Performing the Study

Turn the C-arm approximately 20° for a superomedio–inferolateral oblique (Figure 7-51). With the patient's feet pointing toward the unit (as for a CC projection) and her torso turned slightly outward with the lateral portion of the ipsilateral breast closer to the unit, the breast is placed on the image receptor. Turn the patient's head in either direction,

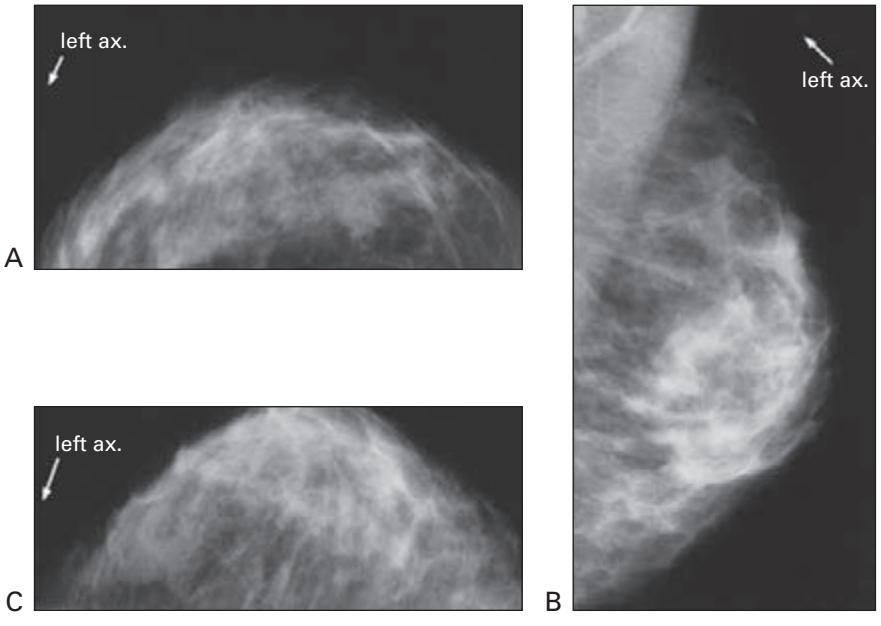


Figure 7-50
20° MLO. Craniocaudal **(A)**, MLO **(B)**, and 20° MLO **(C)** projections of the left breast. The 20° MLO projection, visualizing the entire glandular island (in most cases), demonstrates the glandular tissue free of the superimposition of the MLO projection. The 20° oblique projection will demonstrate (in most cases) the entire glandular island and give the radiologist a different projection of the glandular tissue.



Figure 7-51
20° MLO. **(A)** Orientation of the C-arm rotation for a 20° MLO of the left breast and **(B)** the completed 20° MLO projection.

whichever is most comfortable and facilitates acquisition of the lateral and posterior tissue. In this position, the patient will not be able to reach the handrail with either hand without comprising the acquisition of breast tissue. The contralateral arm should remain at her side and the ipsilateral hand may grip the lower aspect of the image receptor. Raise the C-arm so that posterolateral tissue comes to rest on the image receptor. Relax the shoulders to better image the upper-outer quadrant.

To successfully open the glandular structures, try to flatten the breast. The patient should press toward the unit, trying not to lean toward the ipsilateral side because the resulting image will imitate the MLO projection of the glandular tissue. Gently pull the breast outward and forward. While holding the breast in place, apply compression.

Summary of 20° Oblique Positioning

1. Angle the C-arm approximately 20° in the superomedial to inferolateral direction, as for a MLO oblique.
2. Have the patient face toward the unit, turning her upper torso to bring the lateral aspect of the breast closer to the image receptor. Lift and place the breast on the image receptor.
3. Turn the patient's head to the side that best allows for adequate positioning of the breast and maintains patient's comfort.
4. Raise the image receptor to meet posterolateral breast.
5. Instruct the patient to relax her shoulders.
6. Straighten the breast tissue so that it is flat.
7. Pull the breast outward and forward, holding it in place, and apply compression.

The Axillary Tail (AT)

Application

The AT view (Figure 7-52) may be used to better demonstrate the entire axillary tail, glandular breast tissue very high in the axilla that is perhaps inadequately imaged on the MLO, as well as most of the lateral aspect of the breast. It is performed very much like the axillary view (AX), with more emphasis placed on the breast tissue than on the axillary tissue.



Figure 7-52
Axillary tail view. The AT view is designed to visualize glandular tissue that extends high into the axillary region, without superimposition of pectoral muscle.

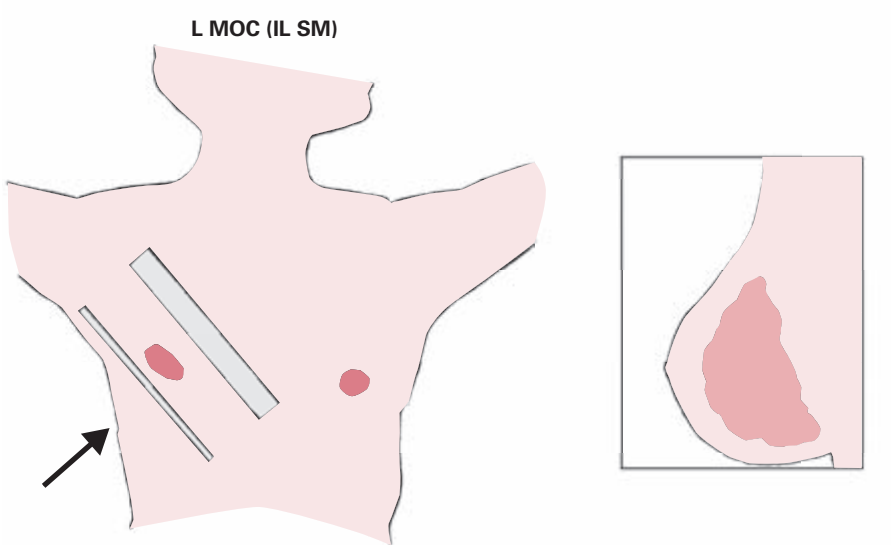


Figure 7-53
LMO projection. Schematic, illustrating the orientation of the C-arm for the LMO projection and the amount of the glandular tissue evident with this view.

Performing the Study

The C-arm is rotated parallel to the axillary tail of the patient; this degree will vary from one patient to another, but will generally be 60° to 80°. The image receptor is placed just below shoulder level, and the patient's ipsilateral arm is draped over and behind it, with the elbow flexed and the hand resting on the positioning bar. Gently pull the axillary aspect of the breast out and away from the chest wall so it lies on the image receptor. Hold the axillary tail in place while applying compression.

Lateromedial Oblique (LMO)

Application

The LMO (Figure 7-53) is useful as a replacement view for the MLO in those patients who have a pacemaker, or have had previous open heart surgery where skimming the scar with the compression paddle could cause discomfort, and other nonconforming situations. This projection is the reverse of the MLO and the resulting image will mimic the projection of tissue.

Performing the Study

The LMO is an inferolateral to superomedial projection. Turn the C-arm approximately 125° laterally to the ipsilateral side. Step the patient forward so that the medial aspect of the ipsilateral breast will rest against the image receptor. Place the edge of the image receptor above the medial aspect of the breast. Adjust the height of the C-arm to center the breast over the AEC detector. Raise the ipsilateral arm up and across the image receptor, so that the upper humerus rests on the image receptor. The contralateral hand will hold the handrail. Lift the breast and pull upward and outward holding the breast in place. It helps to have the patient bend laterally to the ipsilateral side. Rotate the patient inward to capture more lateral breast tissue. Apply compression (Figure 7-54).



Figure 7-54
LMO projection. Completed positioning for the LMO projection.

Summary of LMO Positioning

1. Turn the C-arm to approximately 125° for an IL-SM oblique.
2. Step the patient forward so that the medial aspect of the ipsilateral breast will rest against the image receptor.
3. Place the edge of the image receptor at midsternum.
4. Adjust the height of the C-arm to center the breast.
5. Raise the patient's arm up and across the image receptor, so that the upper humerus rests on the image receptor.
6. The contralateral hand will hold the handrail.
7. Lift the breast and pull upward and outward.
8. Rotate the patient inward to capture more lateral breast tissue.
9. Apply compression.

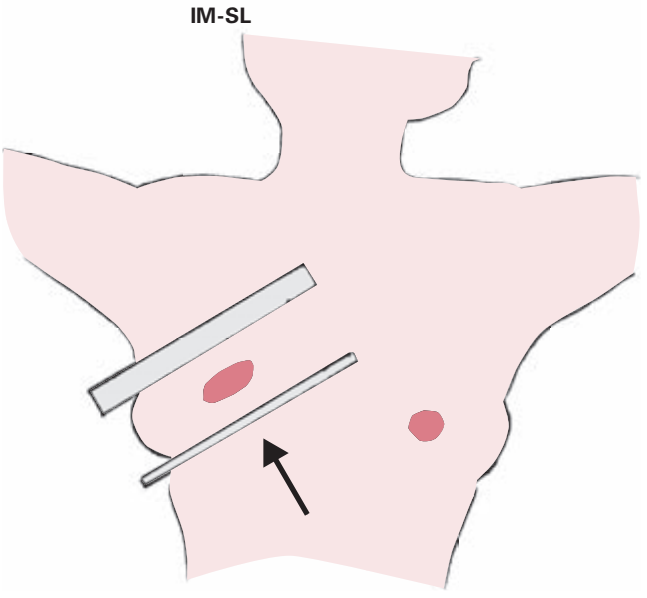


Figure 7-55
IM-SL projection. Schematic illustrating the orientation of the C-arm to the patient.

The Inferomedial–Superolateral Oblique (ISO)

Application

The ISO (IM-SL) (Figure 7-55) projection is useful for stereotactic biopsy positioning. This projection imitates the SIO but allows access to the inferior aspect of the breast to achieve shortest skin to abnormality distance and maintain stroke margin during stereotactic biopsy. The IM-SL may also have practical use in the nonconforming patient.

Performing the Study

Rotate the C-arm about 125° for an IM-SL projection. The patient should face the unit. Step the patient forward to bring the lateral portion of the breast against the image receptor. The patient's ipsilateral arm should remain at her side or rest on the image receptor; the contralateral hand should grasp the handrail. Lift the breast, pull outward and upward and hold in place until the compression takes over. You may need to bend the patient forward at the waist to prohibit the abdomen from interfering with the image.

Other Supplementary Projections

Mediolateral (ML) Lateral Projection

Application

Completing the ML (Figure 7-56) projection with the nipple in profile provides a true representation of breast structures to the nipple, and is useful for localization of nonpalpable lateral abnormalities (use the lateromedial lateral for localization of medial abnormalities). Additionally, the ML projection is useful as a third view to open structural overlap. The ML projection is poor at visualizing the most posterior and lateral aspect of the breast and is *not* useful as a third projection to image breast tissue that was missed on the MLO.

Performing the Study

Turn the C-arm to 90° so that the lateral aspect of the breast will rest against the image receptor. The patient should face the unit with her feet forward. Have the patient raise her arm to shoulder level and lean forward from the waist to facilitate compression. Place the edge of the image receptor posterolateral to the breast tissue. Adjust the height of the C-arm to center the midbreast to the AEC detector. Lift the breast and pull upward and outward. For localization purposes, rotate the breast or patient to bring the nipple into profile. Lower the compression as the breast is held in place (Figure 7-57).

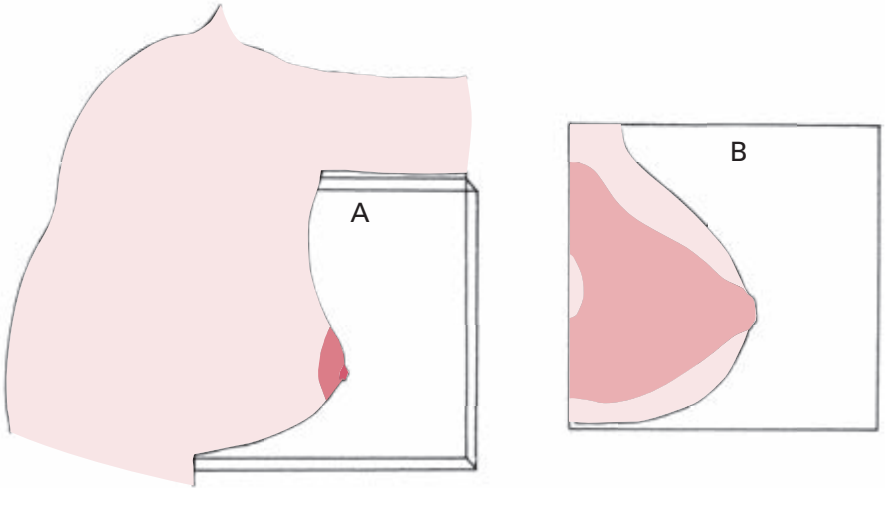


Figure 7-56
Mediolateral lateral projection.
(A) Orientation of the C-arm to the breast for the mediolateral lateral projection.
(B) Schematic of the amount of the "glandular island" usually evident with this projection.

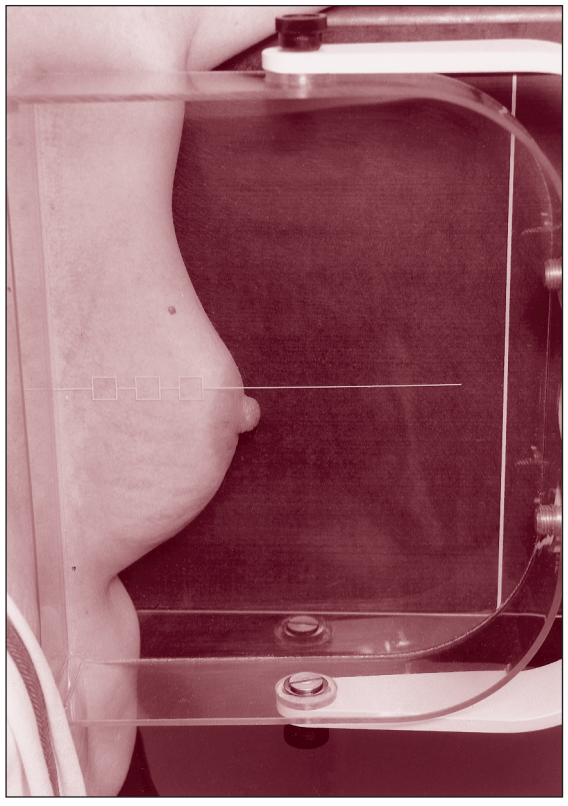


Figure 7-57
Mediolateral lateral projection. Completed mediolateral lateral position.

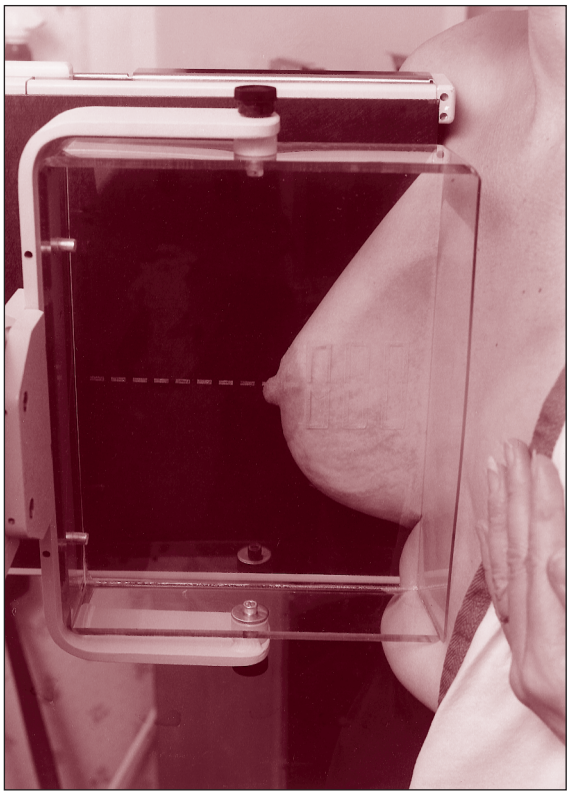


Figure 7-58
Mediolateral lateral projection–variation. Completed variation of the mediolateral lateral projection with the arm down. The nipple should always be brought into profile for localization purposes (label NIP).

Summary of ML Projection

1. Angle the C-arm to 90°, with the image receptor at the lateral aspect of the breast being imaged.
2. Face the patient towards the unit.
3. Ask the patient to raise her arm to shoulder level (possibly higher to accommodate image receptor). Have patient lean forward from the waist.
4. Bring posterolateral tissue to rest on image receptor.
5. Adjust height of C-arm to center breast to AEC detector.
6. Pull breast upward and outward bringing the nipple into profile (for localization).
7. Apply compression.

Variation of the Mediolateral Lateral Projection

A variation of the mediolateral lateral projection is appropriate for localization of anterior lateral lesions. If the lesion is anterior enough, the ipsilateral arm can remain comfortably at the patient's side; other positioning steps are the same. Always bring the nipple into profile for localization purposes (Figure 7-58).

Lateral–Medial (LM) Lateral Position

Application

Completing the LM projection (Figure 7-59) with the nipple in profile provides a true representation of breast structures to the nipple. The LM projection is suitable for localization of nonpalpable, medially located abnormalities (use the ML projection for localization of lateral abnormalities). The LM is also a legitimate replacement for the MLO projection in the nonconforming patient (see Chapter 8). In fact, the resulting image should mimic the results of the MLO, however, the MLO images the lateral portion of the breast (where most cancer occurs) closer to the image receptor for sharper detail. The LM also serves as a third projection to the two-projection study to adequately image missed breast tissue (Figure 7-60). Additionally, this projection is useful to image suspected abnormalities located medially, high on the chest wall or those that are extremely posterior in the inferior half of the breast.

Performing the Study

The LM is a lateromedial projection. Rotate the C-arm 90° so that the medial aspect of the breast rests against the image

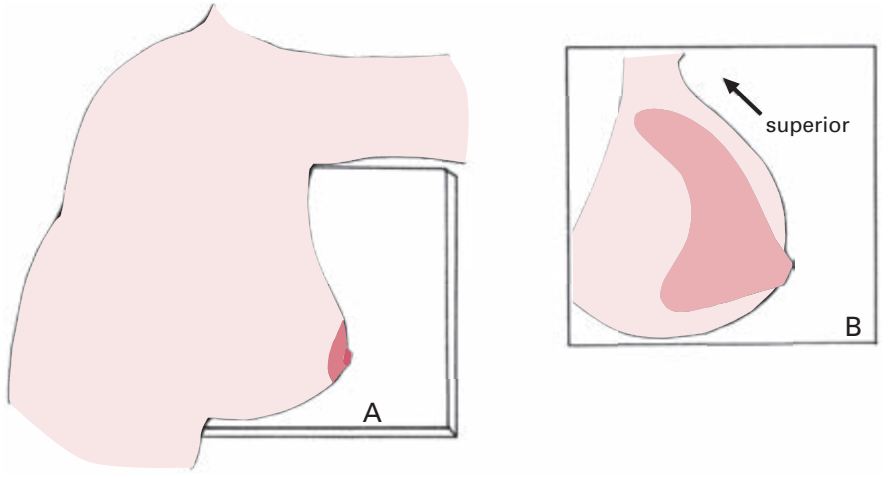


Figure 7-59
Lateromedial lateral projection. **(A)** Schematic of the orientation of the breast to the C-arm for the lateromedial lateral projection. **(B)** Schematic of the amount of the "glandular island" usually evident with this projection.

receptor. The patient should stand with her feet facing the unit. Place the edge of the image receptor at the sternum. Have the patient lift the ipsilateral arm up and over the image receptor, letting the upper humerus rest on the superior aspect of the image receptor. Rest the ipsilateral hand on the contra lateral shoulder. The patient should relax her shoulders and bend slightly at the waist. Adjust the height of the C-arm to center the breast over the AEC detector. Lift the breast and pull up and outward, slightly rotate the patient inward toward the image receptor to include all lateral breast tissue and the IMF. Pulling upward and outward while holding the breast in place, lower the compression paddle slightly posterior to the axilla. Bring the compression paddle down while holding breast in place (Figure 7-61).

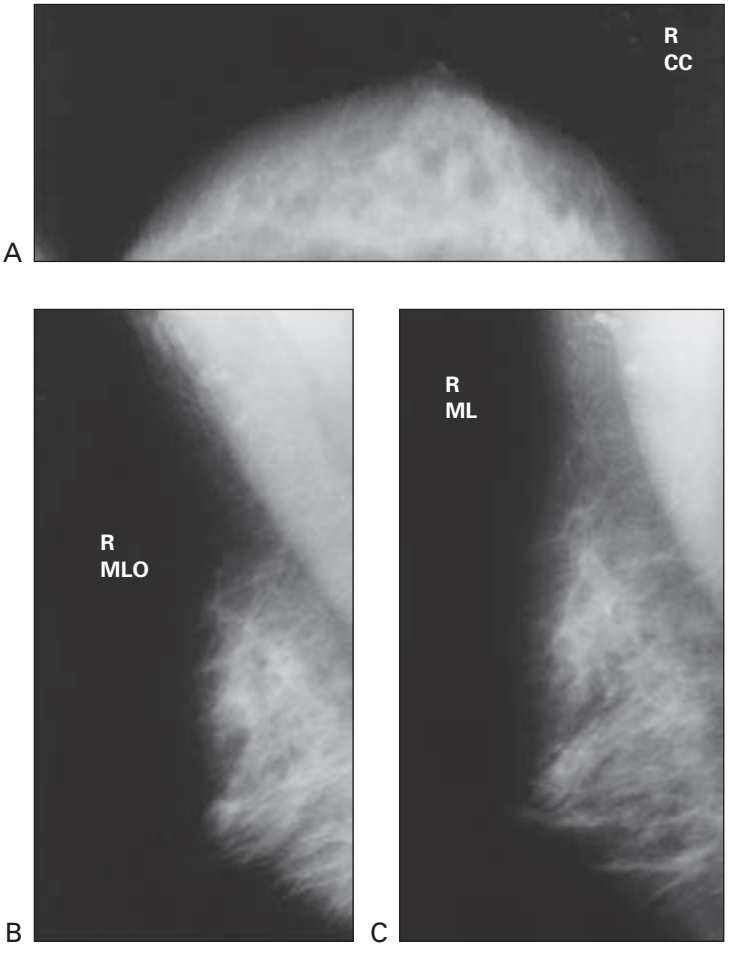


Figure 7-60
Lateromedial lateral projection. Craniocaudal **(A)** and MLO **(B)** mammograms of a woman with pectus excavatum. The MLO image shows glandular tissue running off the film. A lateromedial lateral projection **(C)** (with the arm up and over) provides better visualization of the missed tissue.



Figure 7-61
Lateromedial lateral projection. Completed lateromedial lateral position with the arm up and over.

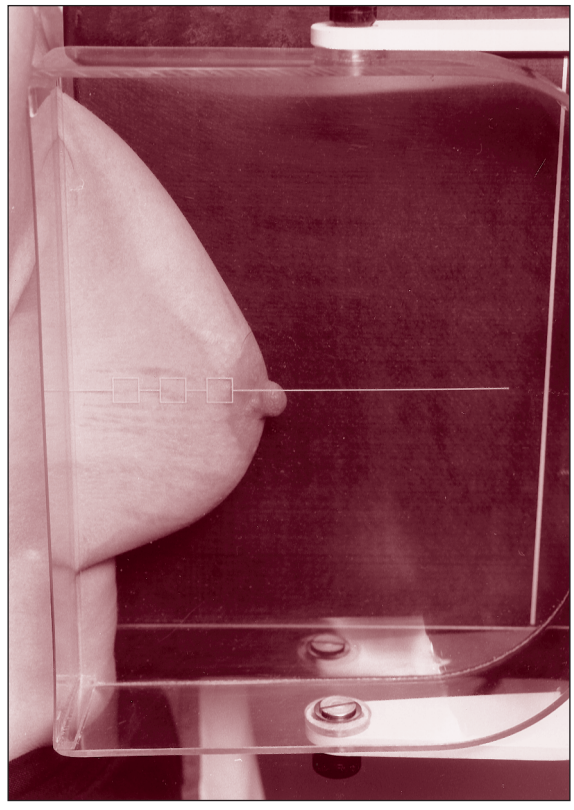


Figure 7-62
Lateromedial lateral projection–variation. Completed variation of the lateromedial lateral projection. *Note:* The nipple should always be presented in profile when used for localization purposes (Label NIP).

Summary of Lateral–Medial Lateral Projection

1. Rotate the C-arm 90° so that the medial aspect of the breast will rest on the image receptor.
2. Patient should stand with her feet toward unit and lean in from the waist.
3. Place edge of image receptor at midsternum.
4. Raise the ipsilateral arm up and over so that the upper humerus rests on the superior aspect of the image receptor.
5. Bring the upper arm to rest on top of the image receptor, bending the patient's elbow and resting her hand on the opposite shoulder.
6. Adjust the height of the image receptor to center the breast over the AEC detector.
7. Lift the breast, pulling upward and outward (for localization, bring nipple into profile).
8. Lower the compression paddle just posterior to the axilla, to include all lateral tissue and the IMF.

Lateromedial Lateral Variation

A variation of the lateromedial lateral position is appropriate for localization of anterior medial abnormalities. The patient's arm can be left at her side; other positioning steps are the same. Always bring the nipple into profile for localization purposes (Figure 7-62).

Implant Displaced (ID)\Modified Compression Technique for Augmented Breasts\Eklund Method

Application

This method is applicable for patients with implants, both from augmentation and reconstruction following mastectomy.[13] The purpose of this modified compression technique is to image portions of the breast that escape visualization because of superimposing the implant. The method suggests displacing the implant posteriorly to exclude it from view (Figure 7-63). Increased compression and lack of superimposition of the implant is possible showing an improvement in breast tissue visualization in 99% of patients (Figure 7-64). The modified compression technique is possible regardless of whether the implant is posterior or anterior to the pectoral muscle, as long as the implant remains soft and free of encapsulation. The implant displacement (ID) method is an addition to the routine two-projection mammogram, and not a

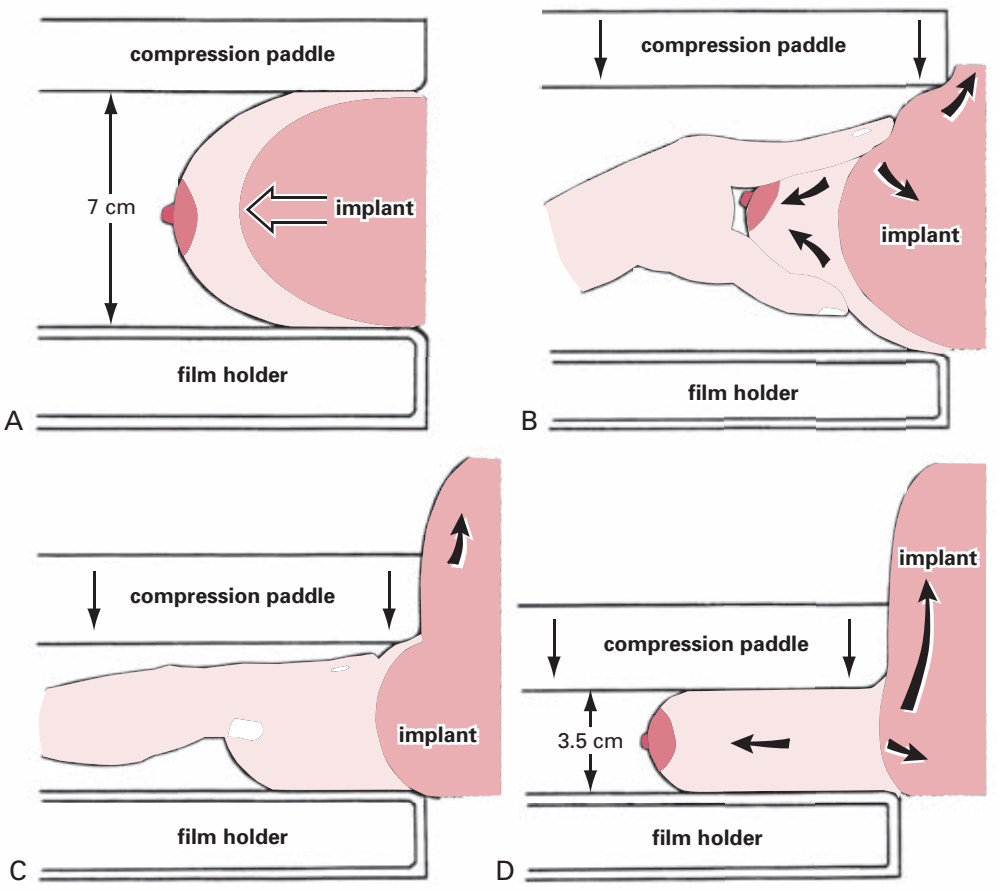


Figure 7-63
Modified compression technique. **(A)** Mammography schematic of the breast with implants illustrating normal positioning and compression. **(B-D)** Use of the *modified compression technique,* displacing the implant posteriorly and superiorly, to image the breast free of superimposition and with better compression. (Courtesy Dr. G. Eklund.)

substitution, as it does not image the most posterior portions of the breast. According to Eklund et al., mammography for women with implants should include the following four projections:

1. Routine CC
2. Routine MLO
3. CC with modified compression (CC-ID)
4. MLO with modified compression (MLO-ID)

Recommended Views for the Patient with Implants (for Augmentation)

Soft Implants

For implants anterior or posterior to pectoral muscle.

CC

CC-ID

MLO

MLO-ID

SIO-ID

Encapsulated Implants

CC

MLO

SIO

Performing the Study

Position the patient as usual for the intended view (CC or MLO). Lift the breast and feel for the anterior portion of the implant. Place the thumb and forefinger between the breast tissue and the implant. Bring this portion of the breast to rest on the image receptor. Encourage the patient to relax her upper torso to encourage the breast tissue to fall forward. Still holding the breast between the thumb and forefinger, lower the compression paddle while pulling the breast tissue forward and outward, allowing the implant to be displaced posteriorly. Compress as usual. If the breast tissue is over the AEC detector, automatic exposure control is possible; if the implant rests over the detector, manual technique should be used.

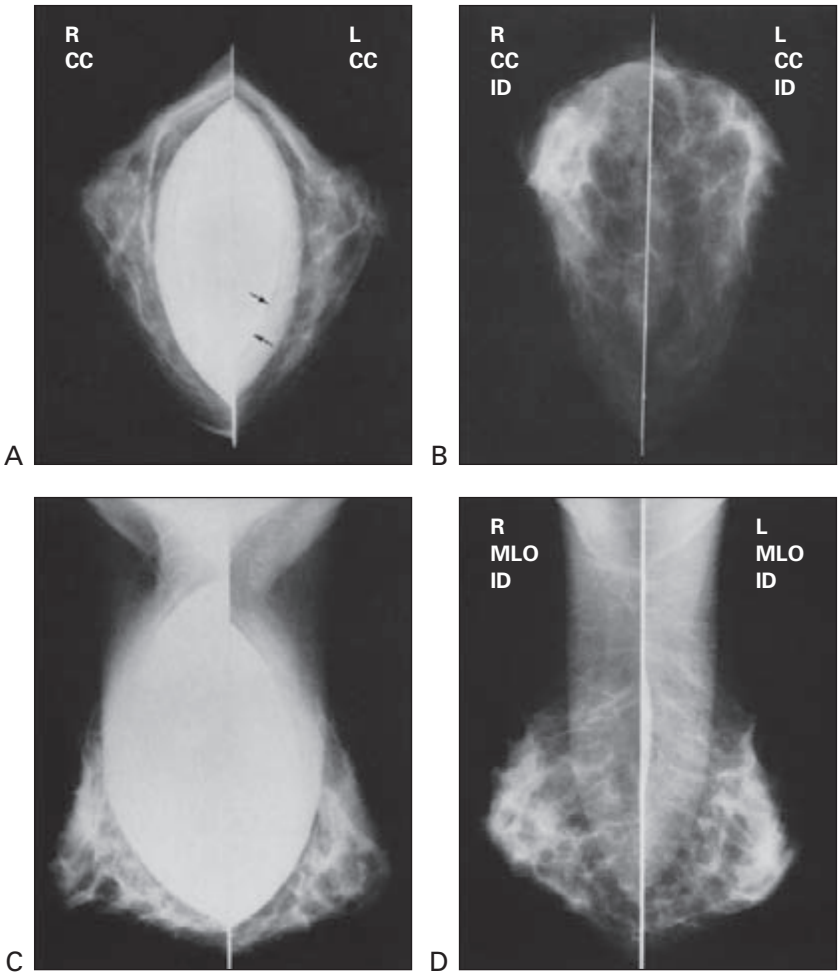


Figure 7-64
Modified compression technique. Craniocaudal **(A)** and MLO **(C)** projections of a woman with silicone implants, and modified compression views in the same projections **(B,D)**.

Axilla Position

Application

The axilla position, an anterior–posterior projection, visualizes the axillary contents. An axillary view is often included as a routine view for breast cancer patients and for suspected inflammatory breast cancer. It is also used for patients who present with lymphadenopathy (swollen lymph nodes) and when searching for primary cancer (after a diagnosis of unspecified cancer elsewhere in the body). Unilateral involvement of the lymph nodes is suggestive of an underlying occult breast cancer. Bilateral involvement indicates a systemic cause (e.g., infection, rheumatoid arthritis, lymphoma, and acquired immune deficiency syndrome).

Performing the Study

Rotate the C-arm 70° to 90°; adjust the angle to best accommodate the patient's body. The patient should at first stand sideways to the unit. Raise the image receptor to allow visualization of the head of the humerus at the superior aspect of the image. Lift the ipsilateral arm to shoulder level and extend laterally. Bring the posterior aspect of the shoulder to rest against the image receptor. The arm may be kept straight or be bent at the elbow, resting on the C-arm.

Have the patient bend forward at the waist and lean laterally toward the unit, so that the rib cage comes in contact with the image receptor. The head of the humerus should be at the superior aspect of the imaging field; the posterior aspect of the imaging receptor should include the glenoid fossa and possibly the ribs. Metastatic lymph nodes and recurrence can arise not only in the axilla but also, inferior to the axilla and close to the rib cage. Have the patient turn her feet and body inward toward the image receptor to image more medial tissue. Apply enough compression to minimize motion (Figure 7-65). If the patient has not had a mastectomy, it is sometimes necessary to bring a portion of the breast under compression (Figure 7-66).

Average kilovoltage range from 28 to 35 kVp at 200 to 300 mAs depending on the specifications of the unit, to adequately image the thickness of tissue and muscle in this area. Manual technique may be necessary to achieve adequate exposure.

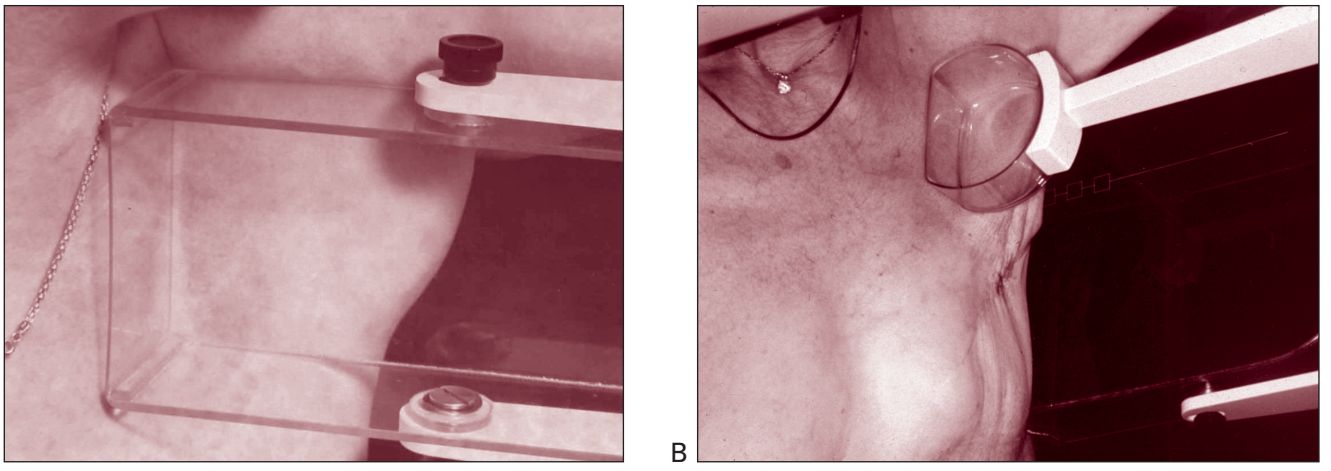


Figure 7-65
Axilla position. Completed axilla position utilizing **(A)** the quadrant paddle and **(B)** the spot compression paddle.

Summary of Axilla Position

1. Rotate the C-arm 70° to 90° to accommodate the patient's body.
2. Have patient at first stand sideways to the unit.
3. Extend the patient's arm laterally and lift to shoulder level.
4. Adjust the height of the image receptor to allow visualization of the inferior aspect of the head of the humerus.
5. Bring the posterior aspect of the shoulder to rest against the image receptor.
6. Have the patient bend at the waist and lean in laterally toward the unit.
7. Turn the patient's feet and body inward toward the unit to image more medial tissue.
8. Apply enough compression to hold the tissue in place and prevent motion.
9. Use manual technique if coverage of the AEC detector is not complete.

Tangential (TAN) View

Application

The basis of the tangential view first described by Logan-Young[10] is to skim the area of interest with the x-ray beam and image it within the subdermal fatty layer of tissue, where it will

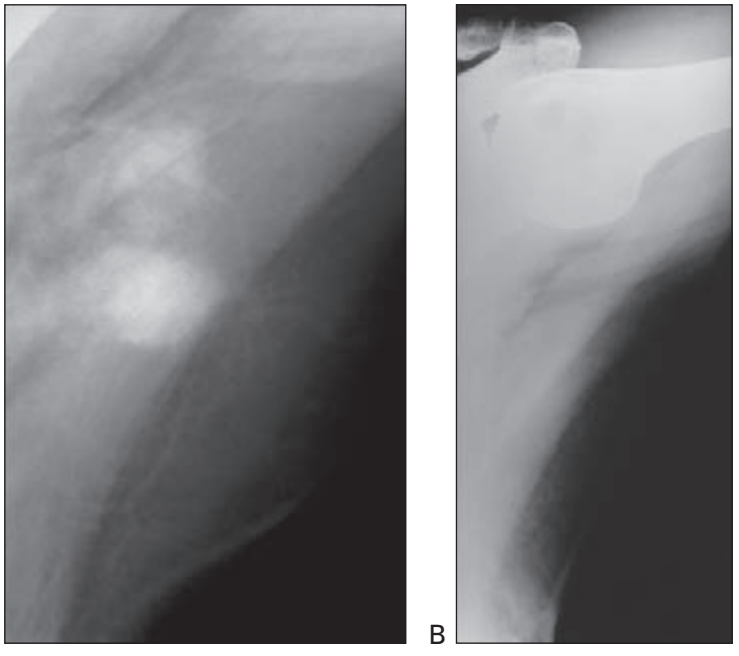


Figure 7-66
Axilla position. Variations of well-positioned axilla views. **(A)** Metastasized lymph nodes. **(B)** Image of complete axillary region.

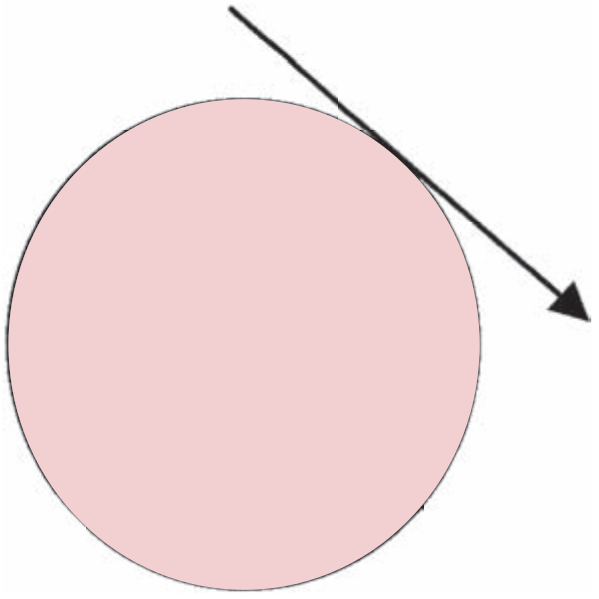


Figure 7-67
Tangential view. The premise of the tangential view is that the x-ray beam will form a tangent to the palpable area of interest in the breast. This eliminates overlapping structures and brings the area of interest into the fatty tissue just beneath the skin, providing increased contrast to better discern its features.

be distinguishable from the surrounding tissue (Figure 7-67). The tangential view is often the best image for a suspected abnormality because it screens an area free of superimposition and often brings it closer to the image receptor, for optimum detail.

To obtain a tangential view, the abnormality must be palpable or, if nonpalpable, observable on any two projections to determine approximate location (see "Triangulation" in Chapter 9). This view is especially useful for visualizing palpable abnormalities that remain occult on the two-view mammogram and for demonstrating areas of interest in a dense breast. Situating the abnormality adjacent to subcutaneous adipose tissue results in an increase in subject contrast to enhance radiographic characteristics. Additionally, a tangential view is useful to determine skin calcium.

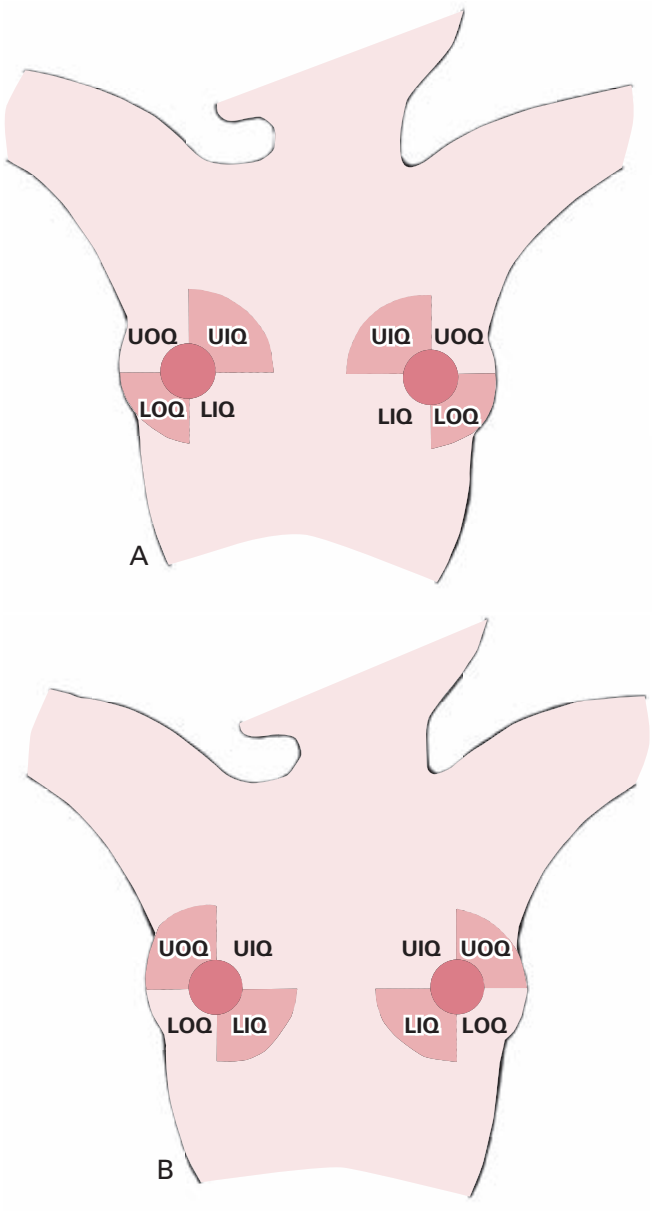


Figure 7-68
Appropriate projections for tangential view. **(A)** Areas in the upper-inner quadrant (UIQ) or lower-outer quadrant (LOQ) require a SIO oblique of some degree. **(B)** Areas in the upper-outer quadrant (UOQ) or lower-inner quadrant (LIQ) require a MLO of some degree.

Performing the Study

The angle of obliquity will depend on the location of the abnormality. To determine the angle and direction of obliquity, draw an imaginary line from the nipple to the abnormality. Turn the C-arm so that the image receptor parallels this line. Rules of thumb for determining the direction of the C-arm are:

- Abnormalities in the upper-inner or lower-outer quadrant require an SIO of some degree depending on the location of the abnormality (Figure 7-68).
- Abnormalities in the upper-outer or lower-inner quadrant require a mediolateral oblique of some degree depending on the location of the abnormality (Figure 7-69).
- A true lateral projection best visualizes abnormalities that approximate 12:00 or 6:00.
- A CC projection or (variation of the CC) best visualizes abnormalities that approximate 3:00 or 9:00.

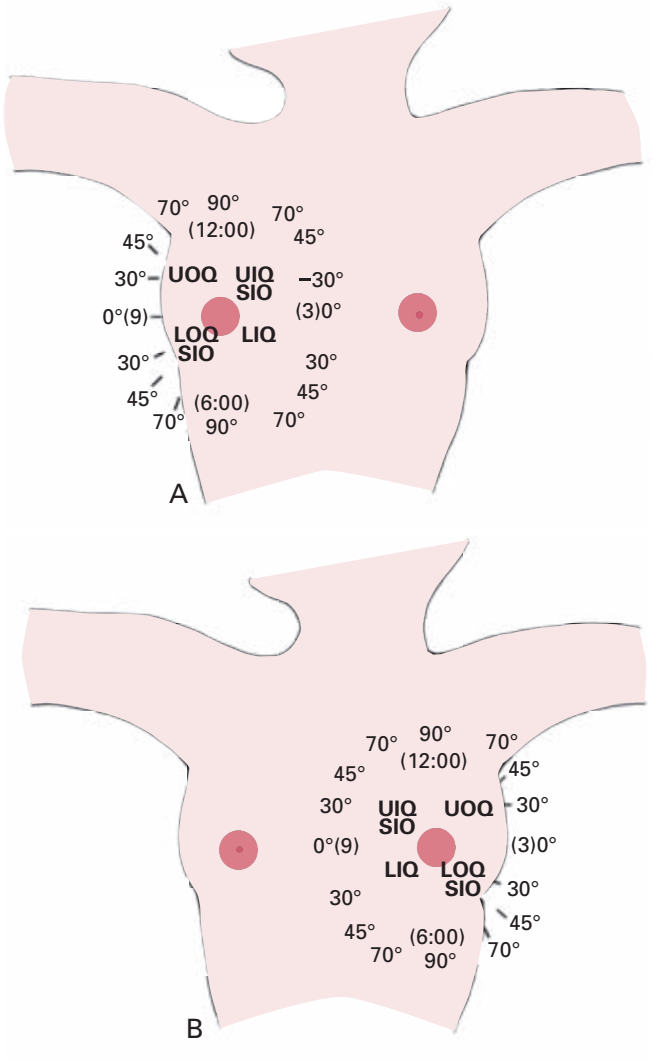


Figure 7-69
Degree of angle for tangential view. Correlation of the location of the abnormality with the degree of rotation of the C-arm; note that an angle of the C-arm will demonstrate both an upper quadrant and a lower quadrant abnormality tangentially.

Figures 7-70 and 7-71 illustrate correlation of the location of the abnormality with the appropriate angle of the C-arm, and Figures 7-72, 7-73, and 7-74 illustrate the application of tangential positioning. The projection and angle of the C-arm should always be marked on the TAN image to document the location of the lesion being imaged.

Tangential View for Skin Calcium

If the suspicious calcium is observable in two projections, determine the location and proper C-arm angle as mentioned earlier (see Chapter 9 for localizing techniques). If the calcium is only visible on one projection, follow these steps to produce the tangential view.

Calcium Visible on One Projection

1. Using a localization compression paddle, place the patient in the same projection where calcium was visible.
2. Image only the affected area of the breast.
3. Apply compression lightly.
4. Take exposure, but do not release compression at conclusion.
5. Process image.
6. Determine, via the localization grid, the location of the abnormality.
7. At this point, place a lead marker on the skin surface.
8. Release compression.
9. Draw an imaginary line from the nipple to the lead marker and match the angle of the C-arm with this line.

When only visible on one projection, skin calcium may be located in the superior or inferior aspect (CC) or the medial or lateral (MLO) aspect of the breast. For this reason, if the initial tangential view does not yield results, add another tangential view, mirroring the angle in the opposite direction (Figures 7-75 and 7-76).

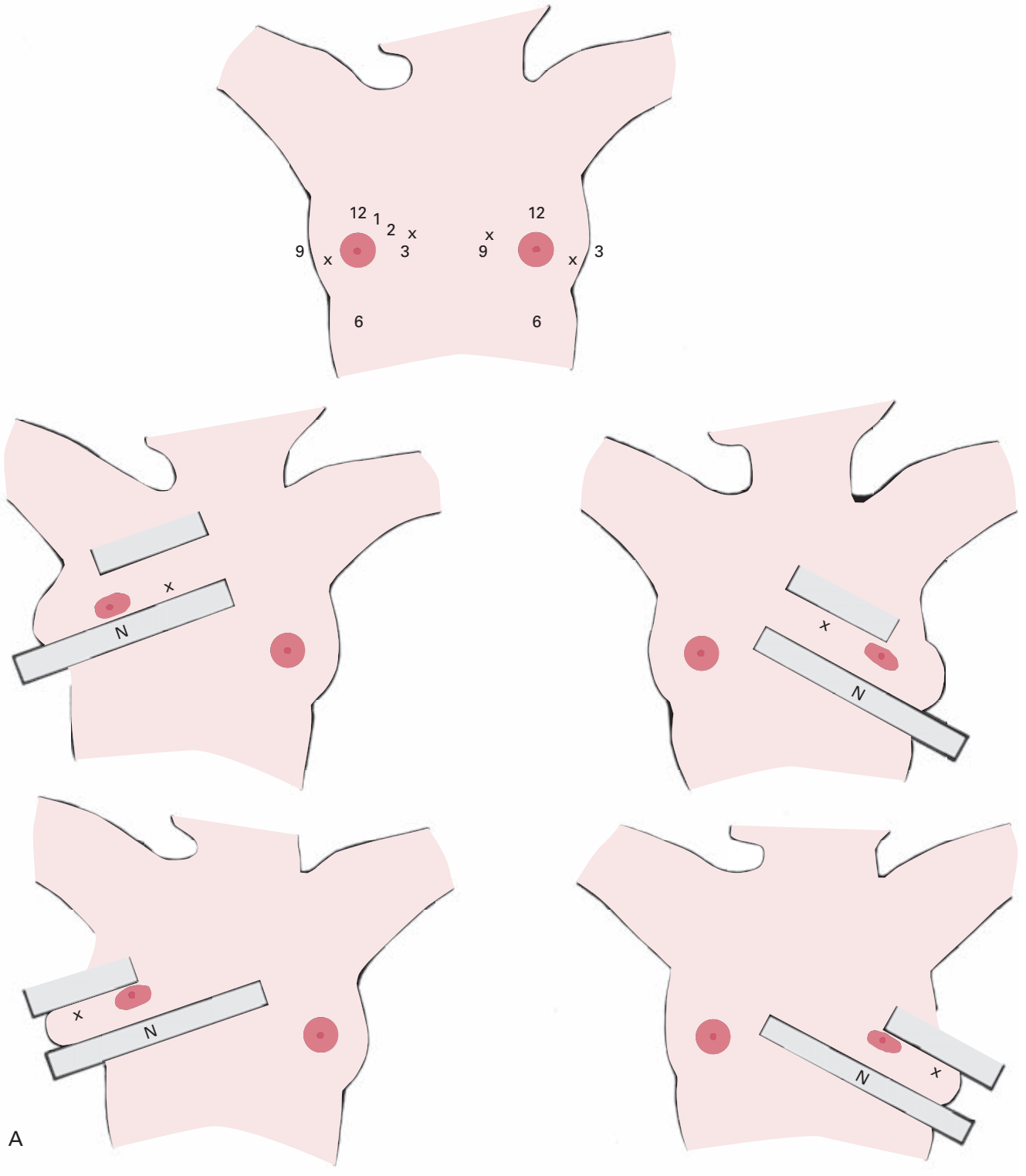
Cleavage View (CV)

Application

This cranial–caudal projection provides imaging of the extreme medial aspect of the breast. The standard CC position does require emphasis on the medial tissue of the breast, however, there are occasions when the most medial tissue of the breast is not imaged adequately on the routine views due to the patient's body habitus or physical anomalies. This view may also be used to image a palpable lesion in the extreme medial portion of the breast.

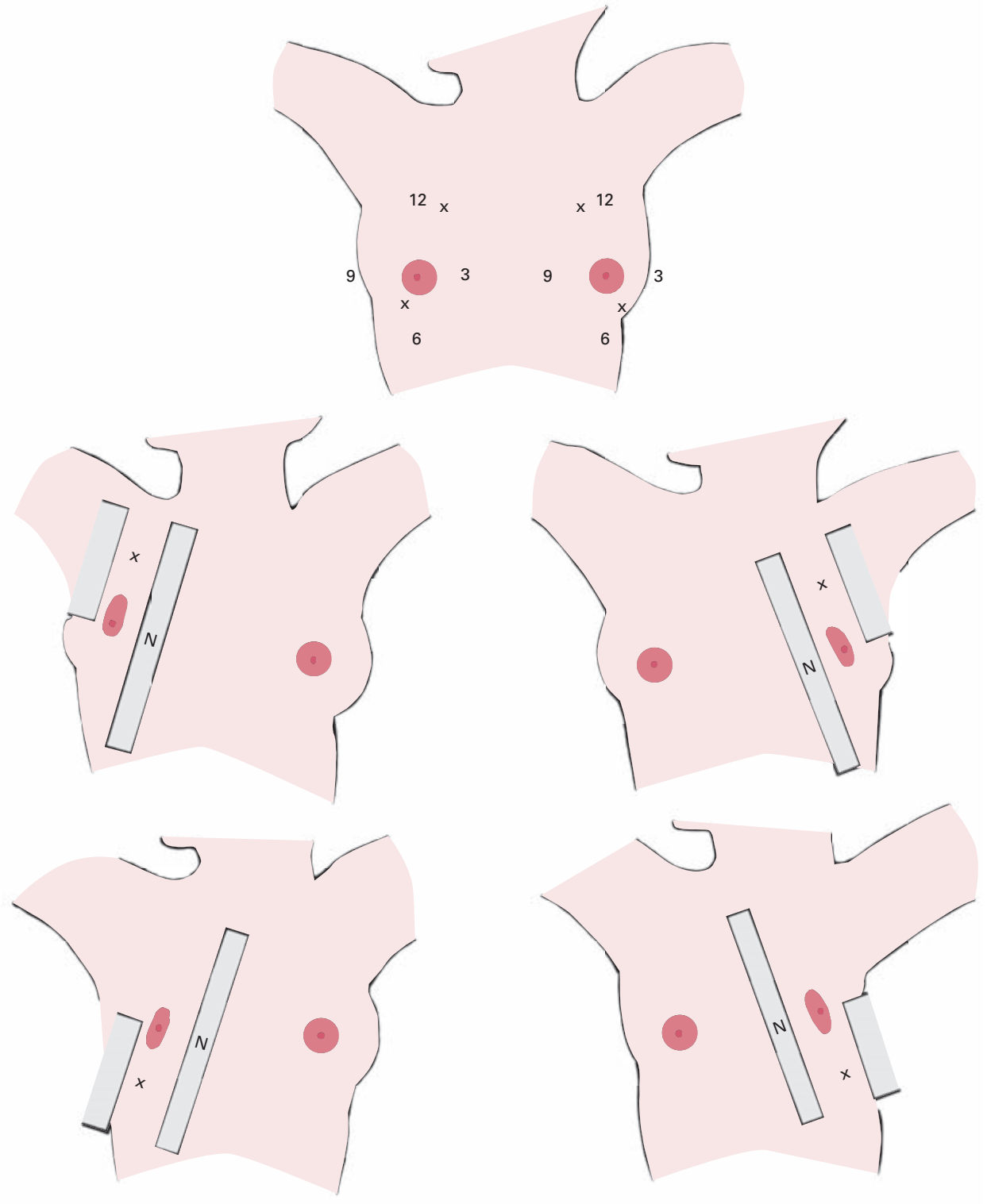
Performing the Study

Place the C-arm at a 0° angle, as for a cranial caudal-projection. Step the patient forward as for the CC view. Lift both breasts onto the imaging surface, bringing the patient's head in and around the face shield. Place a hand on the handrail for support. Rather than place the cleavage centrally on the image receptor, you may offset centering to one breast or the other to cover the AEC detector (enabling the use of AEC on an analog unit) (Figures 7-77 and 7-78). The area of interest should determine the height of the image receptor, allowing imaging of the abnormality. The size of the breast and body habitus of the patient should determine which compression paddle is used. Often a smaller "quad" paddle is useful in acquiring more posterior medial tissue on this view.



A

Figure 7-70
Tangential View. **(A)** If the lesion lies at 2:30 or 8:30 in the right breast or 9:30 or 3:30 in the left breast then a SIO projection of about 15° will demonstrate these areas tangentially. Again note that a certain C-arm angle illustrates both an upper quadrant and lower quadrant abnormality tangentially. (*continued*)



B

Figure 7-70 ***(continued)***
(B) If the lesion lies at 1:00 or 7:00 in the right breast or 11:00 or 5:00 in the left breast then a SIO projection of about 70° will demonstrate these areas tangentially.

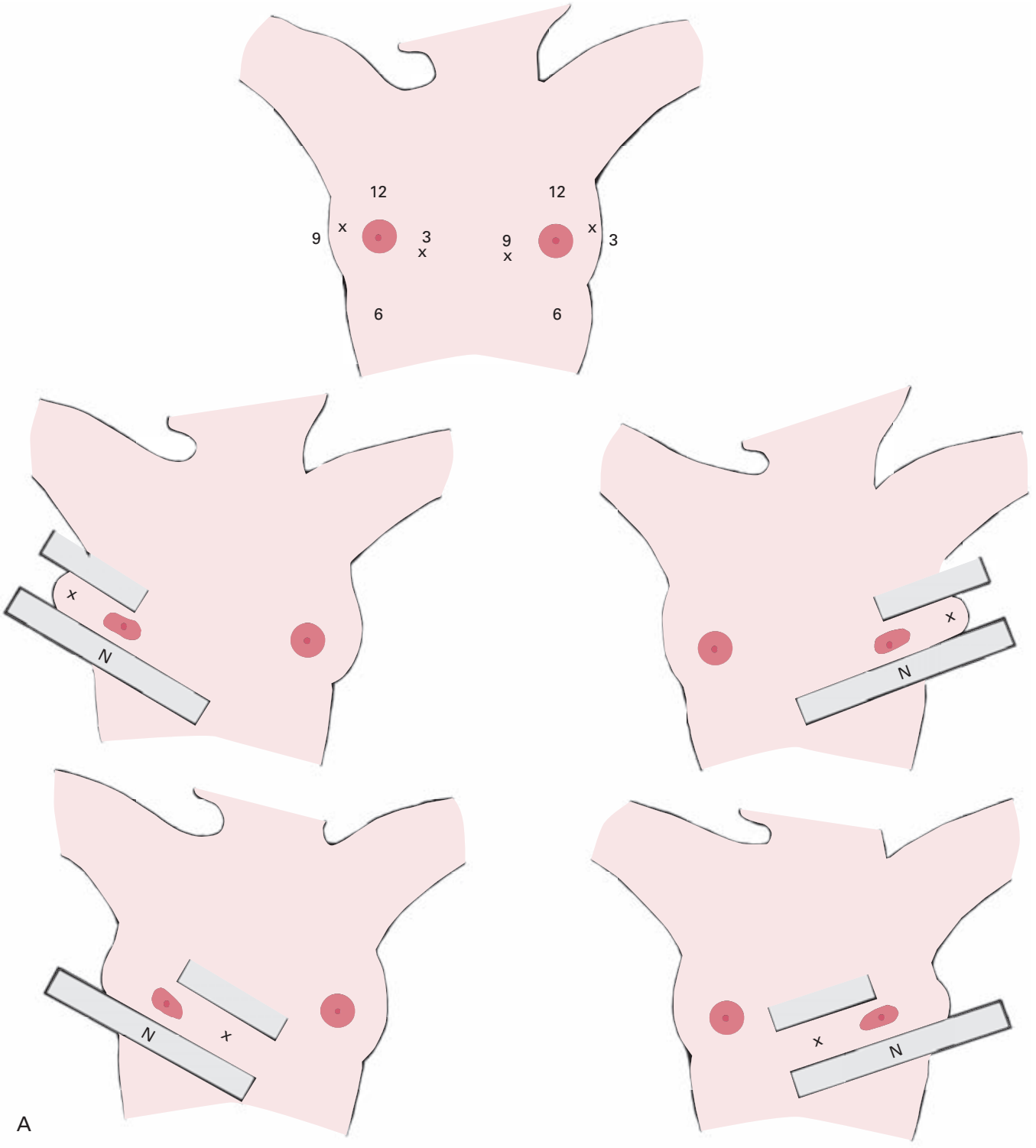
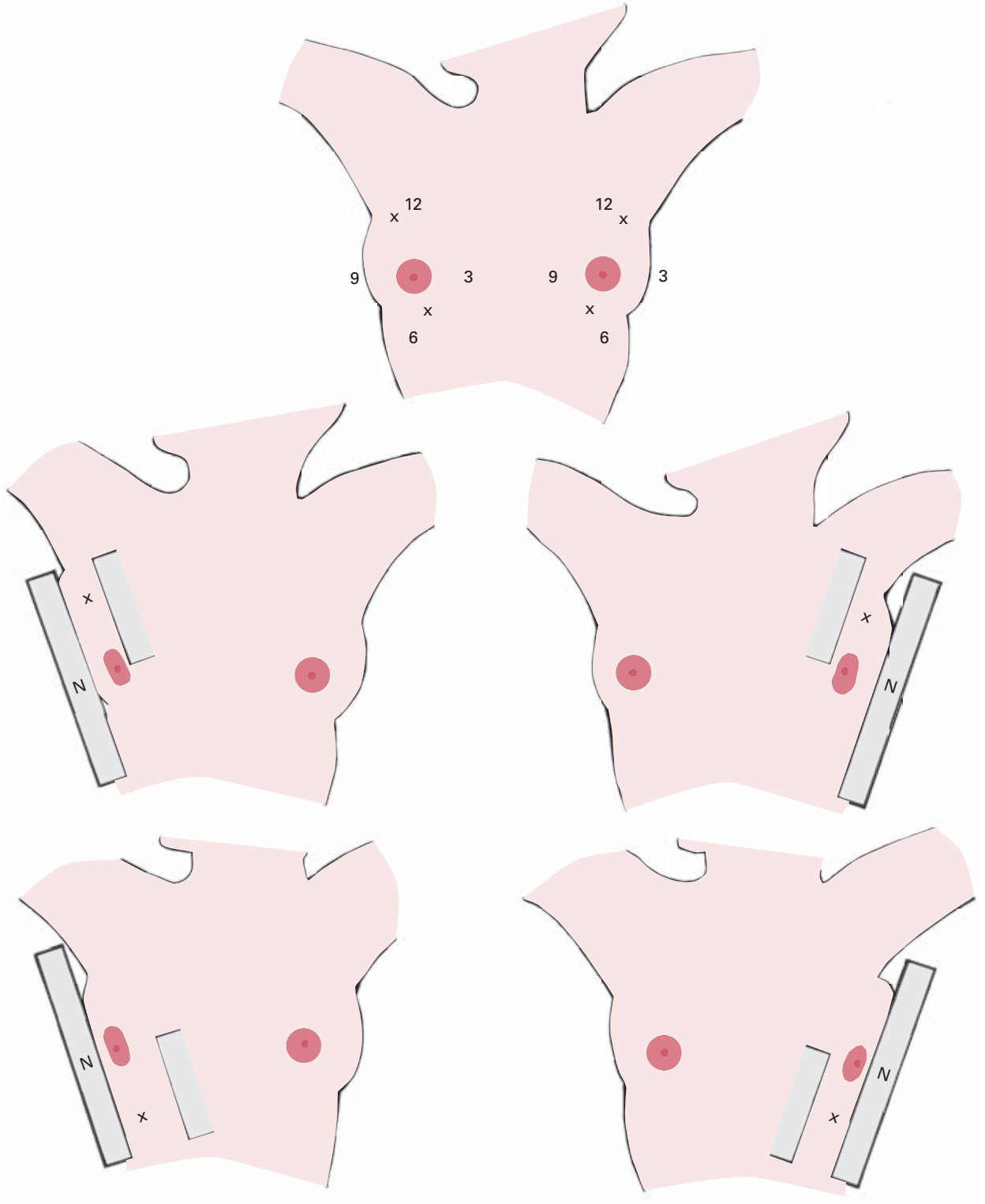
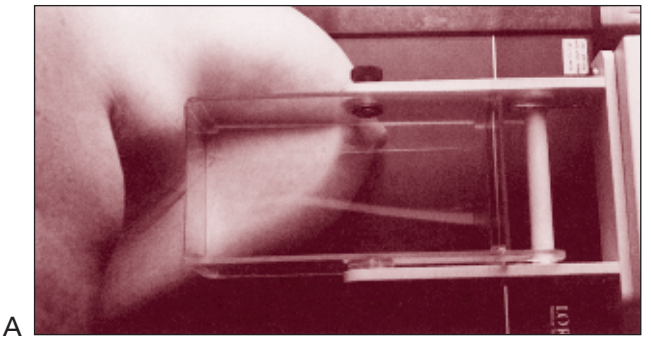


Figure 7-71
Tangential view. **(A)** If the lesion lies at 9:30 or 3:30 in the right breast or 8:30 or 2:30 in the left breast then a MLO projection of about 15° will demonstrate these areas tangentially. Again note that a certain C-arm angle illustrates both an upper quadrant and lower quadrant abnormality tangentially. (*continued*)

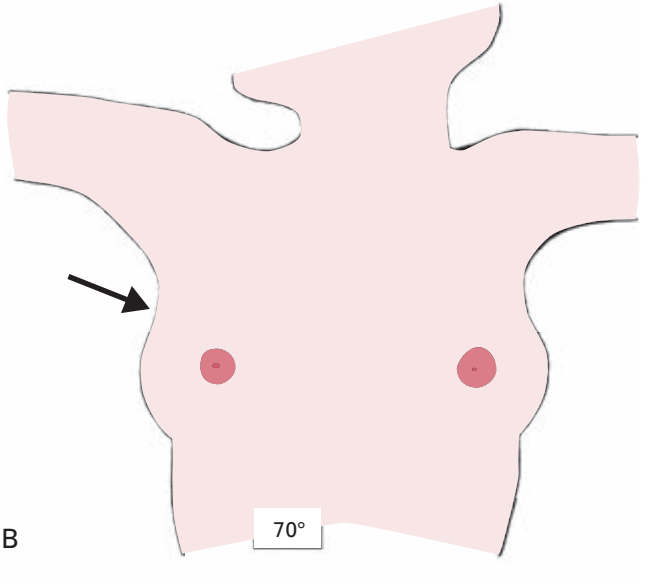


B

Figure 7-71 *(continued)*
(B) If the lesion lies at 11:00 or 5:00 in the right breast or 1:00 or 7:00 in the left breast then a MLO projection of about 70° will demonstrate these areas tangentially.



A

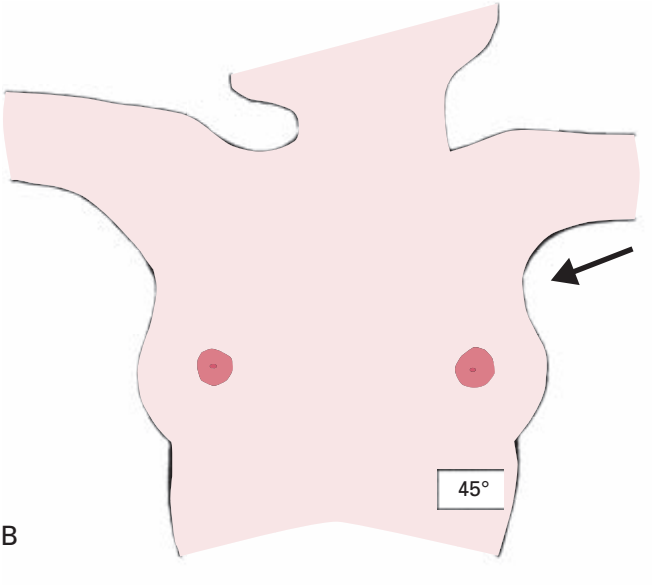


B

Figure 7-72
Tangential view. **(A)** Example of positioning for the tangential view. Schematic **(B)** demonstrates the 70° SIO is used to image the 5:00 area of the right breast.

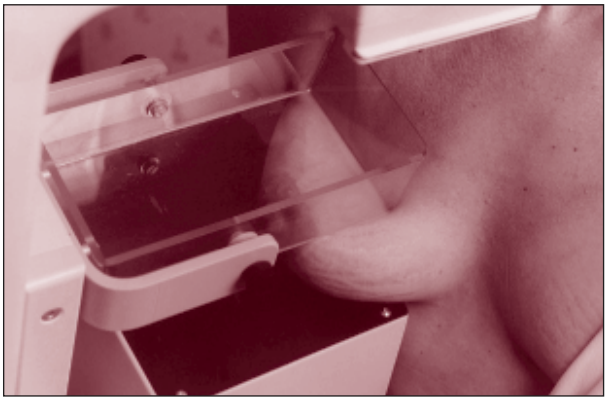


A

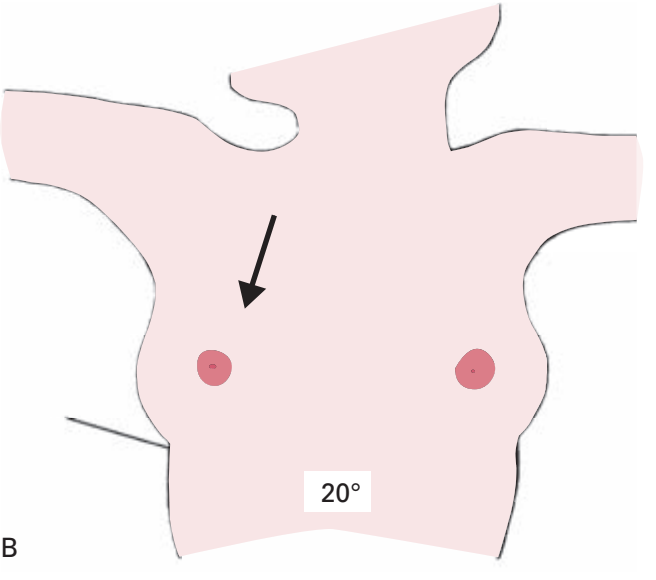


B

Figure 7-73
Tangential view. **(A)** Example of positioning for the tangential view. Schematic **(B)** demonstrates the 45° SIO is used to image the 10:30 area of the left breast.



A



B

Figure 7-74
Tangential view. **(A)** Example of positioning for the tangential view. Schematic **(B)** demonstrates the 20° MLO used to image the 9:30 area of the right breast.

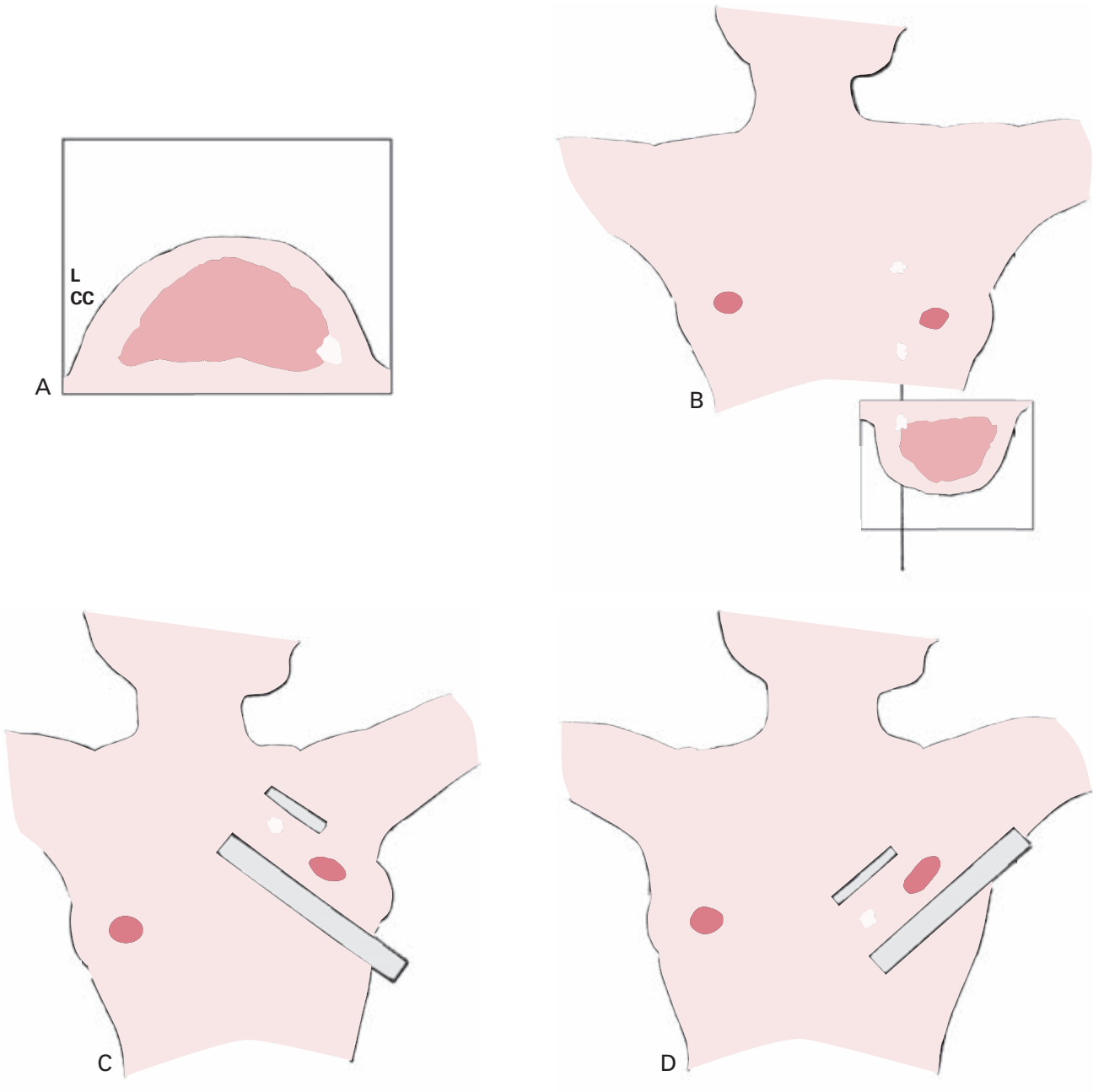


Figure 7-75
Proving skin calcium evident on only one view. A tangential view can prove skin calcium. **(A)** Calcium evident on only one view. The calcium is either superior or inferior **(B)**. Two tangential views **(C,D)** are necessary to rule out skin calcium.

Captured Lesion (CL) (Coat Hanger View)

Application

The coat hanger view will image palpable masses that escape compression with normal techniques. Either a corner of a standard household wire coat-hanger (or other "tool") can be effective in capturing a slippery mass for imaging (Figure 7-79). Reversing the spot compression paddle is another tool useful for this purpose (Figure 7-80). The following are possible scenarios for use:

1. Palpable abnormalities high on the chest wall
2. Palpable abnormalities posterolateral next to the chest wall
3. To separate a palpable abnormality from an implant (where the modified compression technique is not possible).

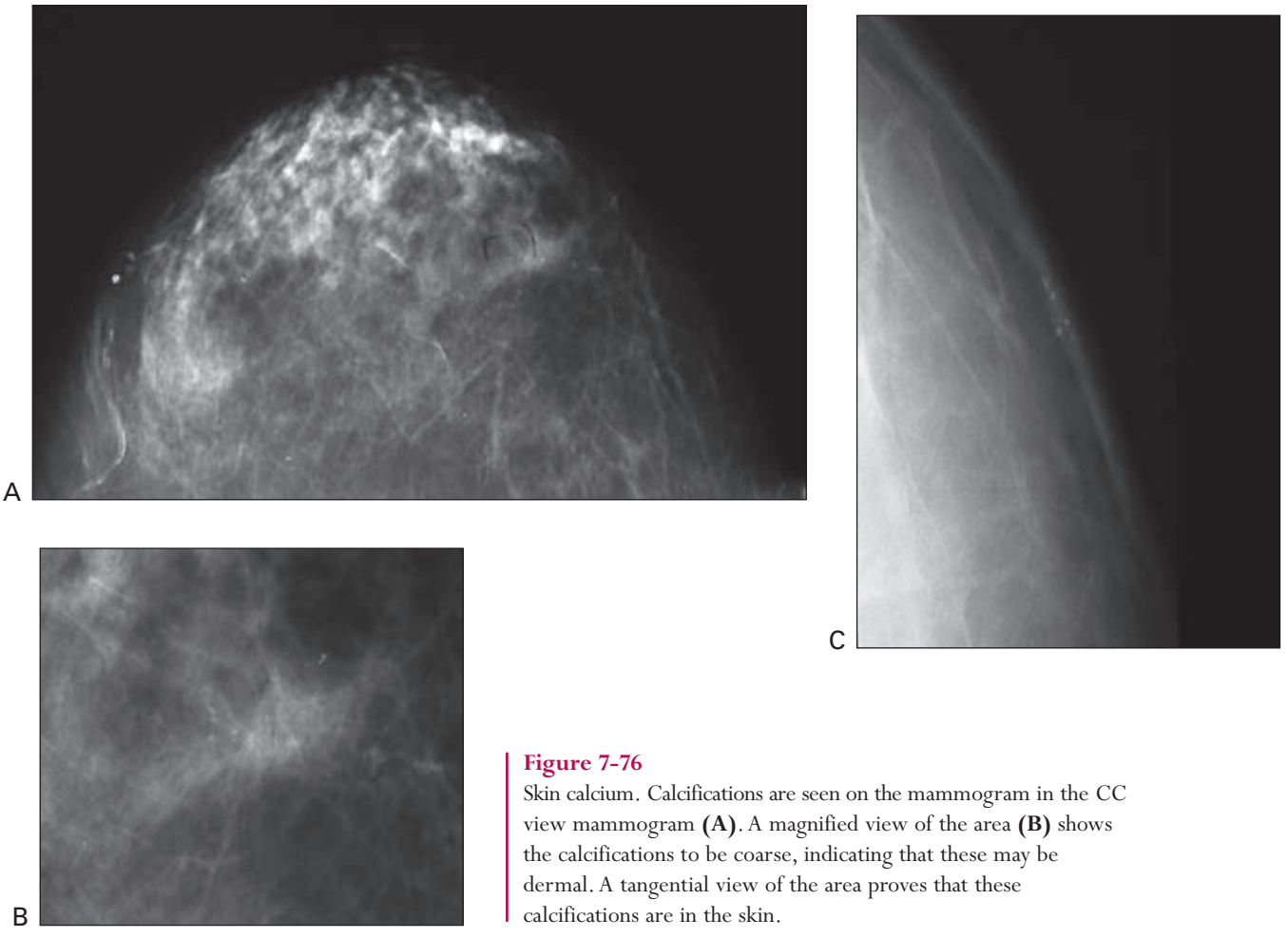


Figure 7-76
Skin calcium. Calcifications are seen on the mammogram in the CC view mammogram **(A)**. A magnified view of the area **(B)** shows the calcifications to be coarse, indicating that these may be dermal. A tangential view of the area proves that these calcifications are in the skin.

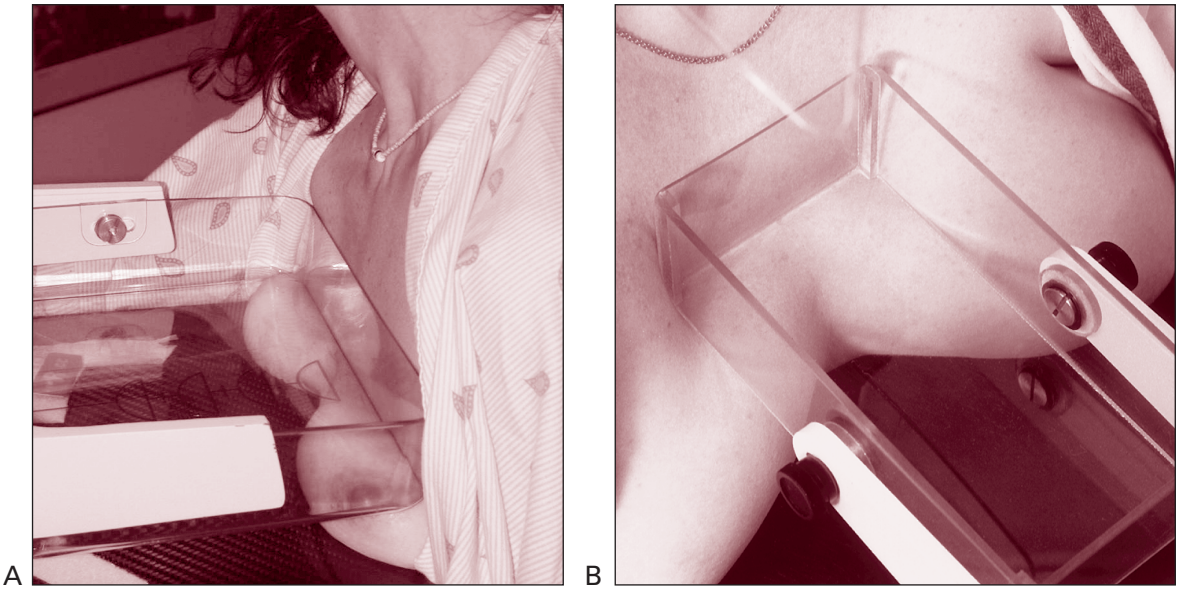


Figure 7-77
Cleavage view. The cleavage view (CV) can be accomplished using the full compression paddle **(A)** or a quadrant paddle **(B)**, depending on the physiology of the patient.

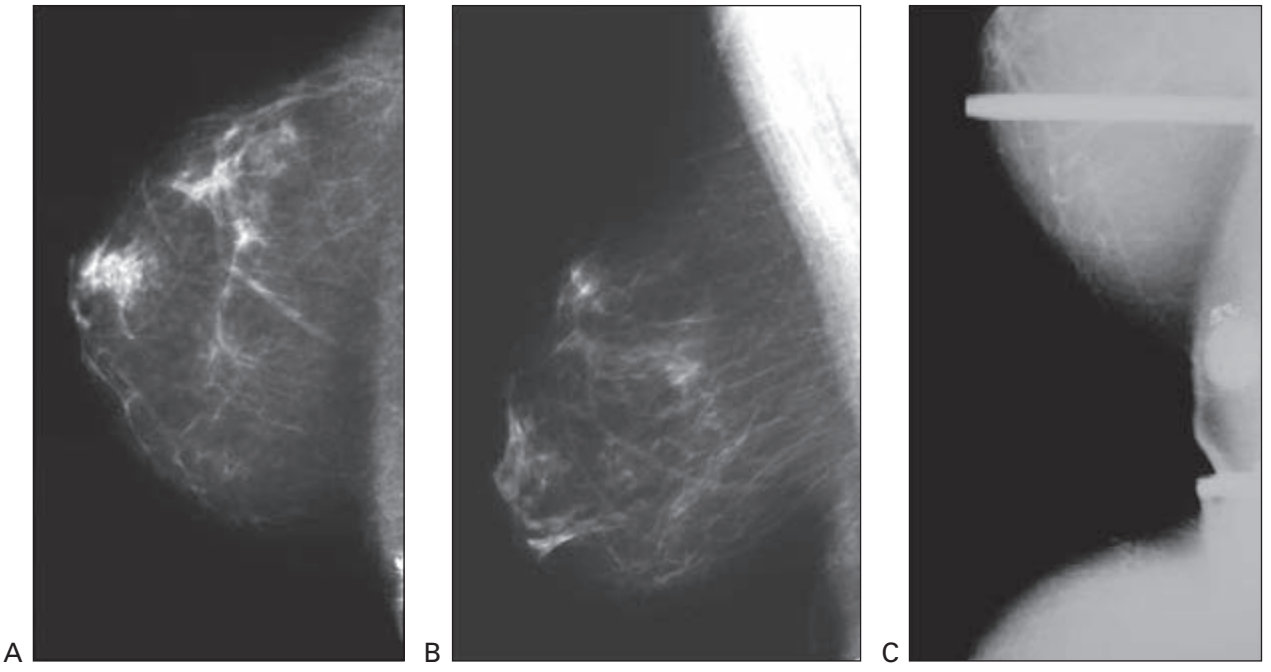


Figure 7-78
This patient's screening mammogram revealed a medial area of calcification that was not well seen on either the CC **(A)** or the MLO **(B)** view. The CV view images the tissue between the breasts **(C)** showing a calcified sebaceous cyst.

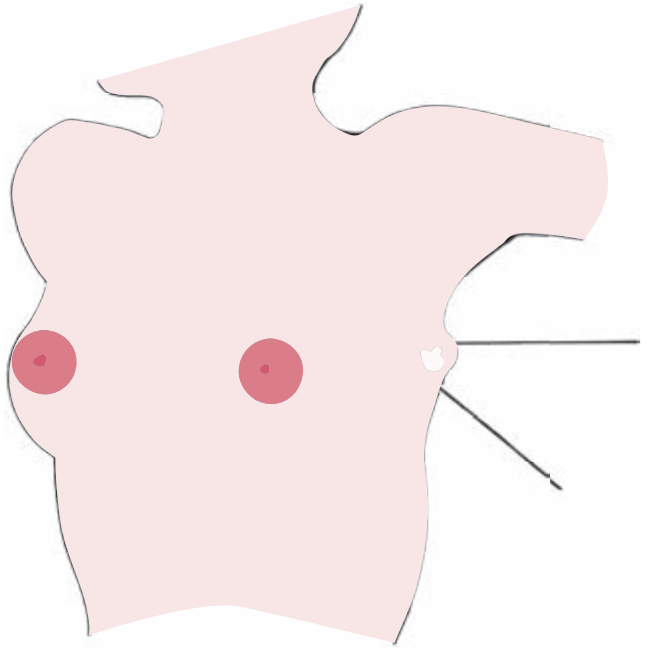


Figure 7-79
The captured lesion (CL) or "coat hanger" view. A schematic demonstrating the CL position to image those posterior abnormalities that slip out from under compression.

Performing the Study

This position requires two people, one person (with lead apron and glove) to hold the "tool" in place and the technologist, to position and take the exposure. In some cases, the patient can hold the coat hanger herself. Abide by all radiation health laws when holding the "tool."

The angle of the C-arm depends on the location of the abnormality. Remove the compression paddle; use magnification. Bring the patient to the image receptor. Set the edge of the rib cage (or implant) against the edge of the image receptor. Impose the tool between the rib cage and the abnormality, or the implant and the abnormality, catch the palpable mass and hold in place for imaging. Minimal pressure should be used and compression is not necessary because the area caught by the coat hanger will be thin and small (Figure 7-81).

MAMMOGRAPHIC POSITIONING FOR INVESTIGATING "MASS EFFECT" (PSEUDOCARCINOMA)

Application

The following three projections are useful in determining if a "mass" that is visible mammographically is a true abnormality or is a result of structural overlap. Also, noting the direction of movement in relation to the nipple, the slight oblique and rolled positions are useful to determine approximate location. For application of these positions, refer to Chapter 10. When an abnormality is suspicious for pseudomass, it is best to include the entire breast on the image to allow direct referencing between views.

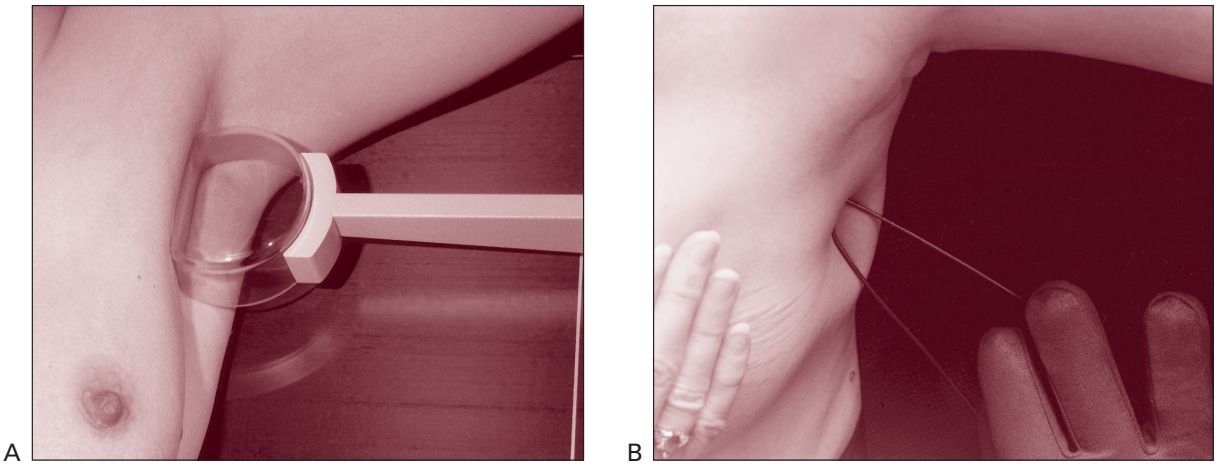


Figure 7-80
The captured lesion (CL) or "coat hanger" view. **(A)** Inverting the spot compression paddle will provide another tool to capture slippery abnormalities. **(B)** Completed positioning for the coat hanger view to "catch" very slippery abnormalities.

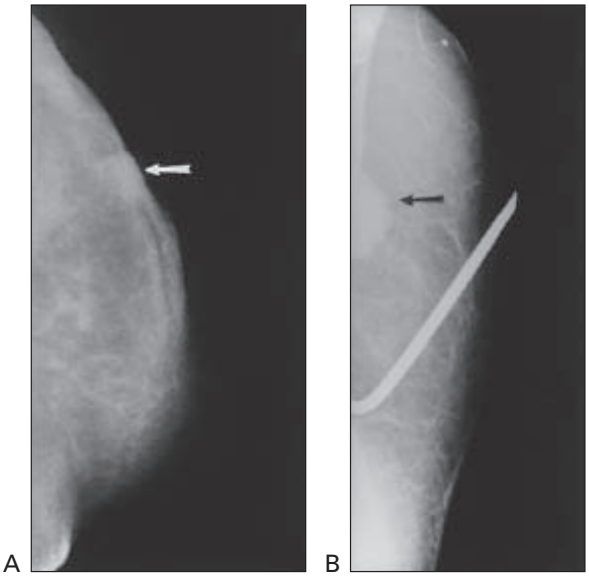


Figure 7-81
The captured lesion (CL) or "coat hanger" view. **(A)** A postero-lateral palpable mass is not evident with the MLO projection of the left breast after quadrectomy *(arrow indicates nipple)*. Other conventional extra views fail to image this abnormality. **(B)** A "coat hanger view" was successful in imaging this abnormality *(arrow)*, which was recurrent carcinoma on biopsy.

Slight Oblique Position

Performing the Study

An angle of 5° to 20° in an SIO or MLO (or sometimes both) projection (Figure 7-82) from the CC will open up overlapped structures. Apply these same principles when there is a question of a pseudomass on the MLO. Position the patient as for the CC or MLO projection. Rotate the C-arm 5° to 20° from the starting position. Compress as normal.

"Spot Compression" Position

Performing the Study

A repeat of the incriminating view using a spot compression paddle will increase compression over the area of interest allowing the tissue to spread more evenly and effectively, eliminating the pseudomass. If the abnormality is evident on both views, then image in both projections. One caveat with spot compression is that without rotation of the breast, either by rolling the breast or rotating the C-arm, the risk of demonstrating the same overlap of tissue might occur even with the better compression (Figures 7-83 and 7-84).

"Rolled" View (RL, RM)

The "rolled" view[4] as described by the ACR addresses the question of superimposition of tissue in the CC projection. However, this technique will also work when applied from the MLO position. Place the breast in the craniocaudad (or MLO) position. Rotate the top half of the breast in one direction while rolling the bottom half in the other. The direction of roll by the top hand is the indicated marking. For example, if the top hand is rolling the tissue toward the medial aspect, this is a medial roll (RM); if the top hand is bringing the tissue toward the lateral aspect, this is a lateral roll (RL). This maneuver separates the glandular structures to determine pseudomass (Figures 7-85 and 7-86). The caveat to performing this view is that it is difficult to replicate, as exact degree of roll is unknown and may vary from one technologist to another. Performing the slightly angled MLO or SIO will be more easily replicated and will give a point of reference to the mass if it is determined to be real.

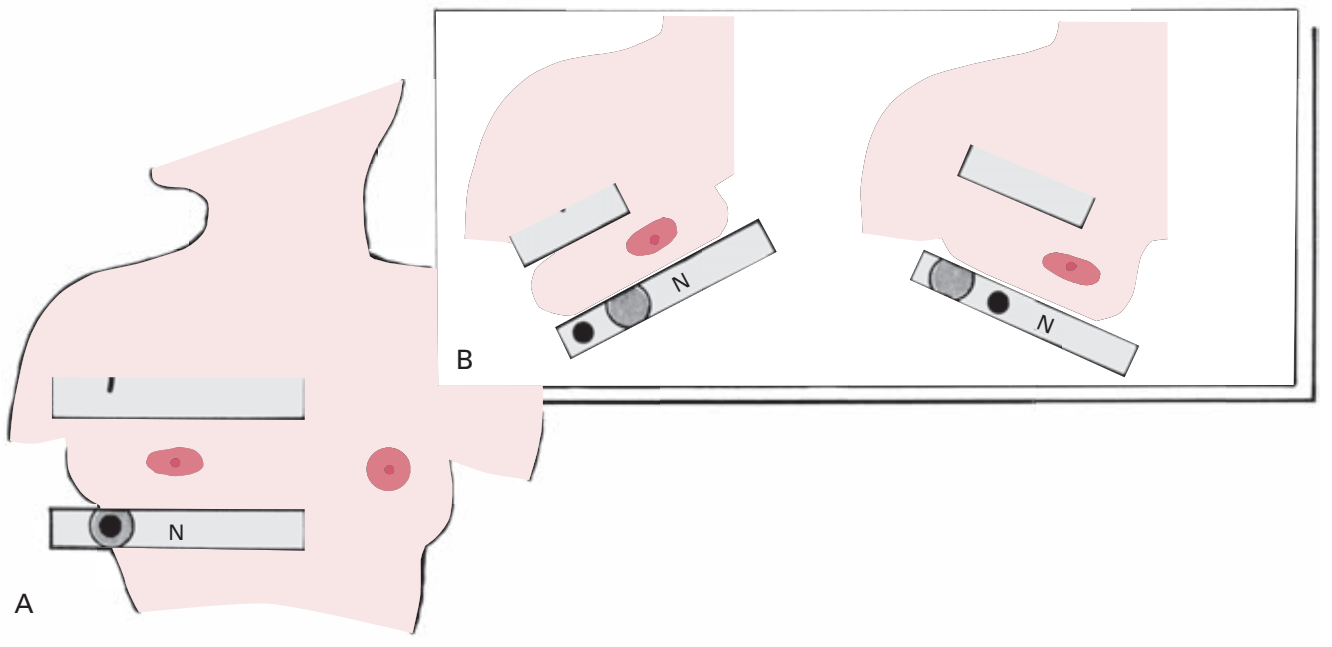


Figure 7-82
Slight oblique. The slight oblique projection can resolve areas of superimposition. Superimposed areas will "spread" apart **(A)** whereas a true abnormality will hold its shape **(B)**.

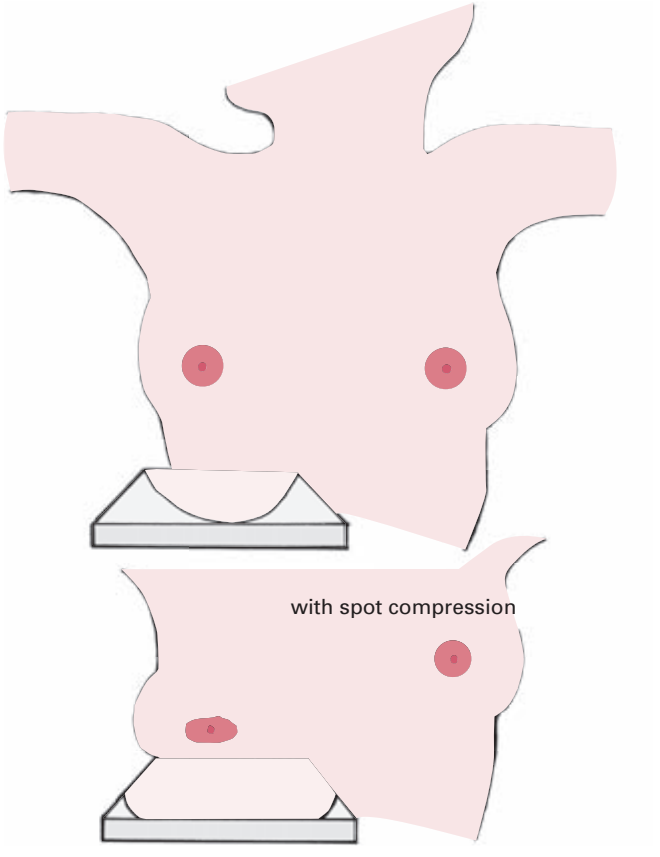


Figure 7-83
Spot compression. A "spot compression" view can resolve overlapped tissue. Localized compression over the area of interest spreads overlapped structures.

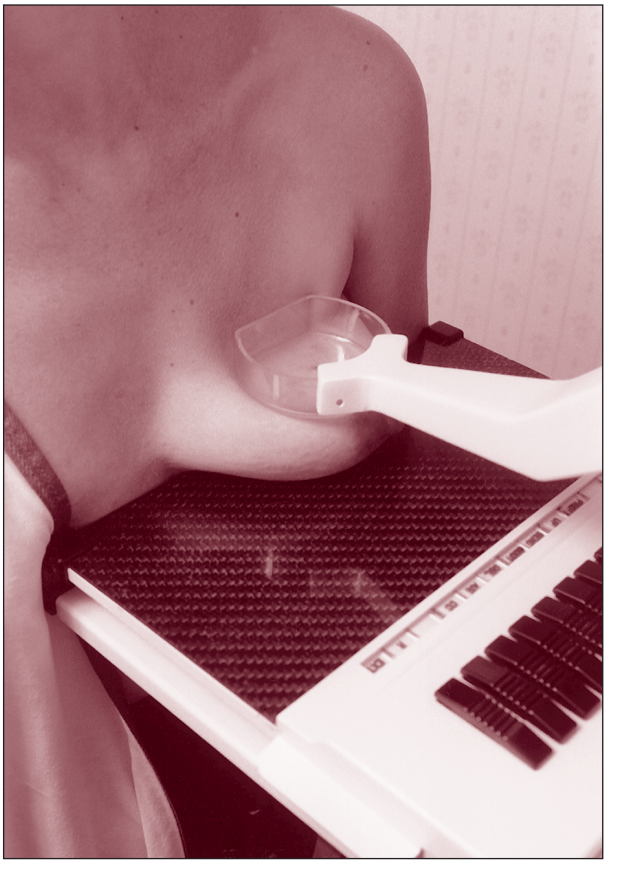


Figure 7-84
Spot compression. Completed spot compression position demonstrating localized compression over a specific area.

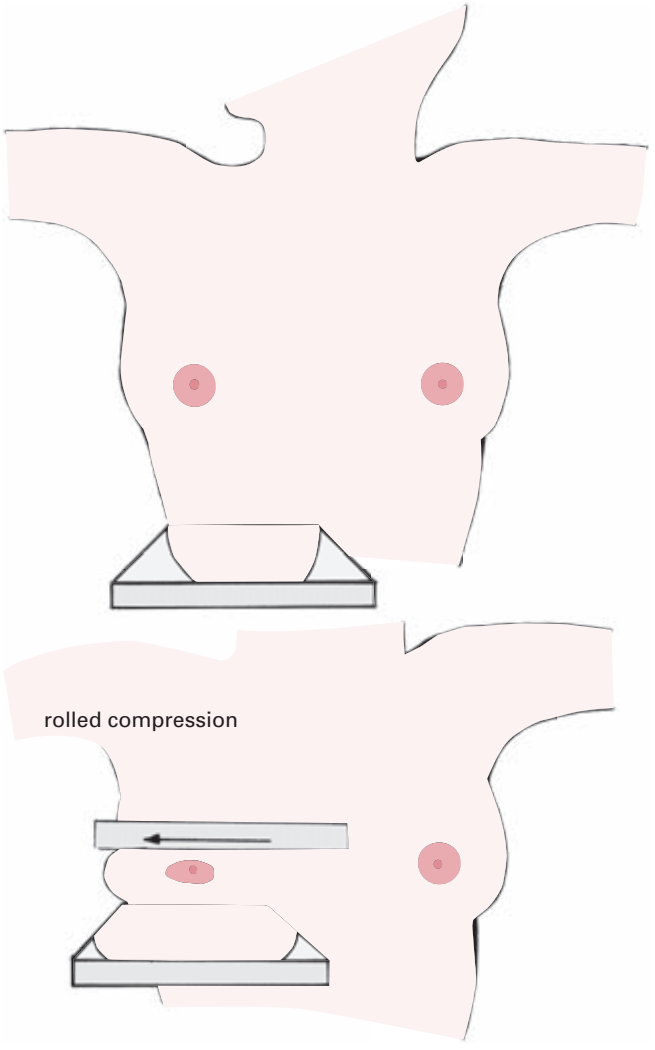


Figure 7-85
Rolled view. A "rolled" view can solve the dilemma of overlapped structures. Rolling the top half of the breast in one direction and the bottom half in the other moves the structures away from one another.

REVIEW QUESTIONS

1. Describe positioning of the craniocaudal view. What subtle nuances are performed within the positioning to maximize the amount of glandular tissue seen?
2. Describe positioning of the mediolateral oblique view. What subtle nuances are performed within the positioning to maximize the amount of glandular tissue seen?
3. Image receptor height is critical when positioning the breast. Describe how the image is affected when the image receptor is placed too high for both the CC and MLO view. Describe how the image is affected when the image receptor is placed too low for both the CC and MLO view.
4. Describe the positioning used to obtain a tangential view for a lump found in the right breast at 2:00.



Figure 7-86
Rolled view. Rolling the superior and inferior aspects of the breast in opposite directions for the "rolled" view, to resolve areas of superimposition.

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