

Chapter 17 Mammography 2D imaging

Part 2: Practical mammography

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Introduction

Positioning a client for a mammogram takes a great deal of skill and expertise. Practitioners are required to master a high standard of reproducible positioning skills; incorporating effective compression together with excellent client communication skills. It is deemed essential that practitioners master the art of continual high quality imaging. For any screening and symptomatic service, mammogram images are compared for subtle changes and practitioners need to ensure their images are of high quality and consistent with their peers.

This section illustrates a step by step guide to the basic positioning techniques required to produce high quality mammogram images. A 'handy hints' section will provide key points throughout.

1. Prior to imaging

Aside the information gathered indicated within Part 1 of this chapter, the practitioner should:

- Explain the procedure to the client
- Ask the client to remove evidence of deodorants or talcum powder
- Ask the client to remove jewellery (large earrings, large necklaces) and spectacles

Remember, your client will feel vulnerable and putting them at ease is a priority; this will assist in achieving high quality images.

Your client should then be asked to undress from the waist up. Whilst doing so the appropriate paddle size should be selected. The following views, cranio caudal (CC) view and medio lateral (MLO) view, are then

performed. The practitioner should observe the breast to check for sores or rashes (see Chapter 13) and record these in the appropriate format following your service procedures (see Chapter 17, Part 1).

2. Compression force application

Breast compression during mammography is one of a number of necessary requirements to produce an image of optimal diagnostic value¹. Effective compression is said to spread out overlapping tissues to enable better visualisation of breast structures. The application of compression force reduces breast thickness, which would therefore minimise the amount of radiation required for imaging. However compression force has the potential to cause the client pain and discomfort which may ultimately deter them from attending for routine screening mammography (see Chapter 12)^{2,3}.

It is acknowledged that one of the most important factors in determining the success of a screening programme is screening uptake^{4,5}. The causes of any non-uptake are multifactorial (see Chapters 7 and 8). Following a systematic review it is evidenced that between 47,000 and 77,000 women in England do not re-attend for breast screening in a year due to pain directly related to a previous mammogram³.

In order to maximise the number of women attending screening mammography, pain and discomfort should be minimised. Therefore as practitioners your goal is to achieve optimum image quality with minimal radiation dose and minimal client discomfort. This can be achieved by adopting evidence based mammographic technique, which incorporates effective

but not excessive compression force with an equalised balance of force between the image receptor (IR) and the compression paddle⁶.

3. Compression force and pressure

At present there can be large variations between practitioners in the compression force they use^{7,8}. This can lead to a wide variation in applied pressure to the breast - *applied pressure is inversely proportional to breast size if the applied compression force is constant*⁹. Further information on the use of pressure to optimise breast compression can be found in Chapter 17, Part 4.

4. Achieving compression force balance

The position of the IR when performing the CC projection has a considerable effect on compression force balance between IR and paddle, and size of breast footprint on the IR⁶. It is important to balance compression forces from compression paddle and IR, such that not too much force is exerted from either direction; balancing is likely to minimise pain.

Using pressure mapping technology, left CC 'pressure' images have been created. Firstly, with the IR at the infra mammary fold (IMF) and compression force of 80N (Figure 4.1). Secondly (Figure 4.1), raising the IMF by 2cm has a demonstrable effect of equalising *compression force balance* together with an increase in *breast footprint* on the IR. The pressure image is represented in a linear colour scale where dark blue represents no pressure and red represents high pressure.

Insert:

Fig. 4.1 Left CC IR at IMF

Fig. 4.2 Left CC IMF plus 2cm

HANDY HINTS:

In order to achieve maximum breast footprint and optimum compression force balance between IR and paddle for the CC projection, you should aim to position the IR approximately 1-2cm above the level of the IMF.

5. Cranio-Caudal (CC) view – a step by step guide

HANDY HINTS: The 5 P's

Proper **P**lanning and **P**reparation leads to **P**erfect **P**ositioning

- Practitioners should be aware of their postural techniques at all times during positioning to reduce any risk of repetitive strain injury (see chapter 17, Part 3).
- Stand the client facing the mammography unit about a hands width back from the IR. Ask the client to stand with their feet hips width apart for stability, with their hand of the side being imaged on their abdomen.
- Stand next to the client, at the contralateral side, and ask the client to turn their head to face you and rest their cheek against the face guard.
- Ask the client to keep their feet in the same position and bend forwards slightly, pushing their bottom back. Lift the breast being imaged, using its natural mobility (Figure 5.1).

Insert:

Fig. 5.1 (Picture Ref 6073 copy)

- With a positive hold, using the breasts natural mobility, lift and pull the breast forwards onto the image receptor at the medial and lateral breast sides (Figure 5.2), adjust so that the nipple is centrally placed. The nipple is a standard and reliable landmark to ensure accurate breast positioning.

Insert:

Fig. 5.2 (Picture Ref 6063)

- It has been demonstrated that following correct positioning the nipple will fall into profile in at least one view with almost all located along or close to the breast boundary^{10,11}.

5.1 Raising the breast

Figure 5.3 highlights the extent to which the breast should be raised prior to positioning for the CC view in the first instance.

Insert:

Fig. 5.3 (Picture Ref 6061)

Adjust the height of the IR to allow the breast to sit at a 90 degree angle at the chest wall in the first instance. It is of great importance now to raise the level of the infra mammary fold (IMF) to achieve maximum breast footprint and balance the compression force to the top and bottom of the breast. The amount of uplift will be client dependent; it has been evidenced that an increase in 1-2cm above the IMF significantly increases breast footprint⁶ (Figures 4.1 and 4.2) It is important to ensure that the IR is not raised too high as this could result in a loss of breast tissue on the image with the nipple inverted down, towards the underneath the breast.

- Check for creases and air gaps and smooth the breast tissue. Ensure the nipple is in profile (but not at the expense of breast tis-

HANDY HINTS: It may occasionally help to place the opposite breast onto the image receptor to encourage the medial breast border to be in the field of view – ensure that the opposite breast is not imaged though

sue) and central (Fig 5.4).

Insert:

Fig. 5.4 (Picture Ref 6070)

- Whilst holding the breast securely with one hand, place one arm around the clients' back and gently guide their shoulder down allowing relaxation of the lateral breast tissue.
- Place your hand positively on the clients back to encourage a 'leaning forwards motion' followed by compression force application.

HANDY HINTS:

If your client is unsteady, place their hand, opposite to the breast being imaged, onto the bar of the mammography unit

- Apply compression force slowly and evenly moving your hand towards the nipple as the compression takes over the hand (Figure 5.5).

Insert:

Fig. 5.5 (Picture Ref 6078)

- The breast should be compressed to ensure compression force balance between paddle and IR is achieved; the breast may feel taut and immobile. Client consistency between sequential at-

tendances is imperative¹² and the compression force could be standardised between 90 and 130 Newtons of force¹³. Apply smaller forces if the client experiences discomfort; larger forces if the breast is not immobile.

- Check the medial and lateral borders for skin folds, if present smooth out with fingers ensuring not to disturb any breast tissue (Fig 5.5). Perform a last check to ensure no artefacts are present on the image detector (ie: clients hair, chin)
- Perform the exposure. Following automatic compression release, lower the height of the column slightly prior to imaging the opposing side; this allows for correct breast uplift.

6. Medio Lateral (MLO) View – a step by step guide

- Initial set up: Reduce the height of the IR slightly from the CC view

HANDY HINTS: Remember the 5 P's:

Proper Planning and Preparation leads to Perfect Positioning

and angle the tube head to 50degrees.

- Adjust the IR in accordance with client's height. It is now of vital importance that the correct angle of the IR is selected. Suboptimal positioning and incorrect angle selection could result in excessive compression force being applied to the chest wall / axilla. This may cause unnecessary discomfort to the client and result in inadequate compression of the breast.

Correct IR angle selection

Angle selection for the MLO view is a skill and refinement of the angle selected will be required through positioning. In the first instance a quick observation of the clients' body habitus (Fig. 6.1) will provide a rough indication and enable you to select an appropriate angle to commence.

Insert:

Fig. 6.1

- The aim on the MLO position is to get the sternal angle and the IR parallel to each other to enable effective compression force balance between IR and paddle with maximum breast footprint on the IR. Figure 6.2 – 6.4 illustrate angle positioning for varying

body habitus; the parallel lines illustrating correct IR angle selection.

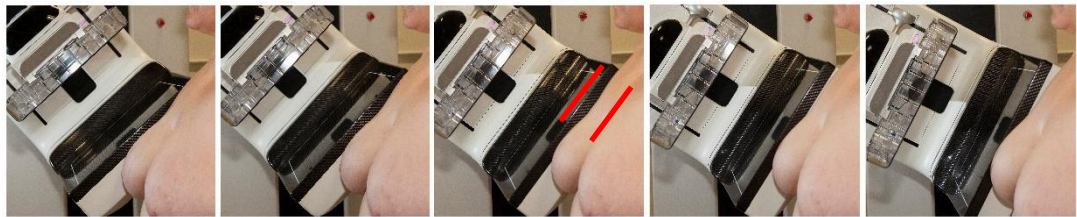
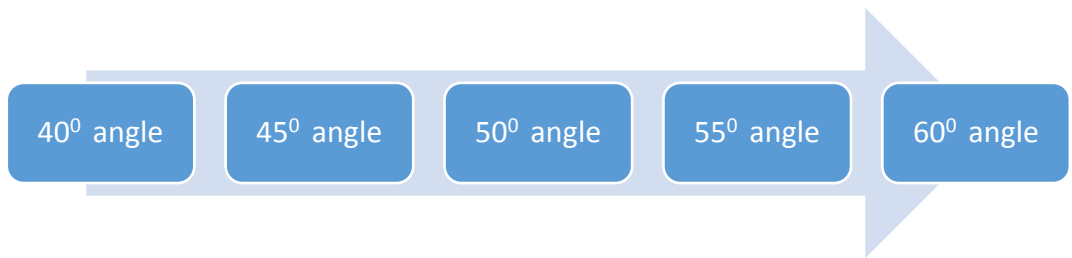


Fig. 6.2. 45 degree angle of the IR.



Fig. 6.3. 50 degree angle of the IR. (Image Ref 6113-17)

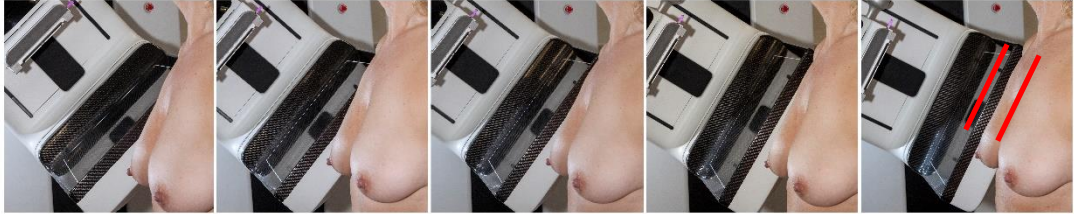


Fig. 6.4. 55 degree angle of the IR (Image Ref 6118-6122)

- Incorrect angle selection for the MLO will lead to uneven compression force balance which could increase the levels of pain for the client due to higher pressure points. Figure 6.5 illustrates a right sided MLO with the client positioned at an incorrect 45 degrees angle selection and a correctly selected 55 degree angle (Figure 6.6) which highlights correct compression force balance

Insert:

Fig. 6.5 MLO at 45 degrees

Fig. 6.6 MLO at 55 degrees

- Following on from correct angle selection, for stability ask the client to face the machine with feet hips width apart. Standing behind the client place your hand at the bottom of the rib cage of the side being imaged. Move the client forwards until your fingertips are just touching the front and bottom aspect of the IR; the client will be about a hands width back from the IR (Figure 6.7).

- Height adjustment of the mammography unit can now commence; adjust to the level of the axilla in the first instance. Rest the clients arm along the top of the IR (Figure 6.7).

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Fig. 6.7 Client Position for MLO (Figure Ref 6082)

- Standing at 90 degrees to the client place your hand to the lateral aspect of the breast and place your other arm, in a supportive position, around her back (Figure 6.8).

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Fig. 6.8 (Figure Ref 6087)

- Using the natural mobility of the breast, lift the breast with one hand and guide the client into the machine with your other hand. Concurrently, ask the client to bend from their waist and lean towards the side of the IR.
- Move around to the back of the client and position her arm; lifting it upwards, gently reaching the shoulder over the IR. Adjust the height of the machine; the corner of the IR should be seated into the axilla (mid axillary line between the latissimus dorsi muscle and pectoral muscle), or in the space if the axilla is hollow.

Insert:

Fig. 6.9 (Figure Ref 6093)

- The client can drape her arm over the IR (Figure 6.9) and rest her hand on the handle of the equipment; but not grasp too tightly as this will cause the pectoral muscle to tense. Ensure the clients' arm is not higher than their shoulder and check that the pectoral muscle is flat and not over stretched.
- Following on, return to the front of the client and sit on an appropriate stool for correct ergonomic positioning (Figure 6.10).

Insert:

Fig. 6.10 Client Position for MLO (Figure Ref 6101)

- Now ask the client to relax down onto the IR and gently ease the shoulder backwards and with both hands carefully pull the breast through onto the IR. The breast should be centrally placed in the IR with the corner of the compression paddle to be seated just below the head of humerus – adjust the column height accordingly if required.
- Sweep your hand down the back of the breast from the axilla to the infra mammary angle checking for creases and ensuring all breast tissue is pulled on. Ensure the clients hips are back and smooth the infra mammary angle. Ask the client to push her hips back slightly if the abdomen is protruding.
- Using your hand lift the breast up and away from the chest wall; the breast is to be imaged at 90degrees to the chest

wall. The nipple should be in profile with no air gaps between the breast and the IR.

- Slowly apply compression force (slowly and evenly) moving your hand towards the nipple as the compression paddle takes over the hand.

HANDY HINTS: When supporting the breast tissue under compression to ensure effective positioning, different hand positions can be used which may reduce your risk of possible repetitive strain injuries (see Part 3 of this Chapter). Two examples are illustrated in Figures 6.11 & 6.12.

Insert: Fig 6.11 (Picture ref 6107)

Insert: Fig 6.12 (Picture ref 6109)

- The top of the compression paddle should sit just below the clavicle, head of humerus and the inner edge alongside the sternum (Figure 6.13).

HANDY HINTS:

Ask the client to hold her other breast away from the field of view if required and raise her chin slightly

Insert:

Figure 6.13 (picture ref 6110 copy)

- The breast should be compressed until equal compression force balance between paddle and IR is achieved; the breast may feel taut and immobile. Client consistency between sequential attendances is imperative¹² and the compression force could be standardised between 90 and 130 Newtons of force¹³. Apply smaller forces if the client experiences discomfort; larger forces if the breast is not immobile.
- Ensure the infra mammary angle is open and free from skin folds (Figure 6.13) and perform a last check to ensure no artefacts are present on the image (ie: clients hair, chin, knuckles).
- Perform the exposure. Following automatic compression release, lower the height of the column slightly prior to imaging the opposing side; this allows for effective breast and shoulder placement.

HANDY HINTS:

Mammogram images are compared for subtle changes and practitioners need to ensure their images are of high quality and consistent with their peers.

7. Check list and problem solving

7.1 Rapid check list

Chapter 21 discusses human observer studies in mammography, including image quality and criteria. Table One provides an aid to an overview image quality check only.

View	Checklist
Both	<ul style="list-style-type: none"> • Nipple in profile • All breast tissue imaged • Skin fold artefact free • Symmetrical • Free from blurring • Correct exposure parameters used
CC's	<ul style="list-style-type: none"> • Back of breast imaged, within 1cm of the MLO
MLO's	<ul style="list-style-type: none"> • Pectoral muscle to nipple level and appropriate width (correct height and angle of IR) • Infra mammary angle demonstrated

Table One: Overview check list

7.2 Problem Solving: The CC View

Proper Planning and Preparation leads to Perfect Positioning

The following information will assist the practitioner to define a solution to a 'problem' before the image has been acquired. If the image has been acquired and the resultant diagnostic image requires a technical repeat or recall, the information below may also assist to define the initial fault and assist the practitioner to identify a solution.

It is important that a decision to repeat an image is only performed following careful consideration and that it will have perceived diagnostic improvements. You should never repeat an image for un-diagnostic reasons.

PROBLEM	SOLUTION
Artefacts on the image	<p>Ensure clients':</p> <ul style="list-style-type: none"> • Hair is behind ears • Earrings are removed • Shoulders are relaxed • Chin is slightly raised • Other breast is being held back
Posterior aspect of breast tissue missing	<ul style="list-style-type: none"> • Check height of image receptor (IR); too high (Figure 7.1) or too low (Figure 7.2) the back of the breast will not be imaged. Figure 7.3 illustrates the correct position. • <p>Insert figures 7.1, 7.2 and 7.3)</p> <ul style="list-style-type: none"> • Ensure clients' head is facing you and rest it on the face guard; this will ensure that more breast tissue from the back of the breast is imaged. • Clients' shoulders should be level and relaxed with chin in a

	<p>neutral position</p> <ul style="list-style-type: none"> • Position client slightly away from the IR to enable client to bend in from the waist; this action moves the ribs and abdomen away and will ensure the back of the breast is imaged • Use both hands, one on the medial and one on the lateral side, lift the breast off the IR as you move the breast forward. As compression force is applied keep a firm hand on the breast to prevent any breast tissue slipping out
Creases and air gaps	<ul style="list-style-type: none"> • Check for breast creases medially and laterally before applying compression force • If there is an air gap on the medial side gently smooth it out from underneath the IR • Check the height of the IR – it may be too low or too high • Ensure the client is not reaching up on tiptoes / bent at the knees
Nipples not in profile	<p>It has been demonstrated that following correct positioning the nipple will fall into profile in at least one view with almost all located along or close to the breast boundary^{10, 11}. If not:</p> <ul style="list-style-type: none"> • Check height of the IR – it may be too low or too high (Figures 7.1-7.3) • Ensure the client is not reaching up on tiptoes / bent at the knees • Is all the breast tissue pulled through from underneath? • Are there any creases on the inferior aspect of the breast?
Symmetry	<ul style="list-style-type: none"> • Is the breast centrally placed on the IR? You can check this by ensuring there is an equal amount of light from the light beam visible on either side of breast (Figure 5.4)

8. Problem Solving: The MLO View

Proper Planning and Preparation leads to Perfect Positioning

The following information will assist the practitioner to define a solution to a 'problem' before the image has been acquired. If the image has been acquired and the resultant diagnostic image requires a technical repeat or recall, the information below may also assist to define the initial fault and assist the practitioner to identify a solution.

It is important that a decision to repeat an image is only performed following careful consideration and that it will have perceived diagnostic improvements. You should never repeat an image for un-diagnostic reasons.

PROBLEM	SOLUTION
Artefacts	Ensure client's: <ul style="list-style-type: none"> • Hair is behind ears • Earrings are removed • Shoulders are relaxed back • Chin is slightly raised • Other breast is being held back
Creases	<ul style="list-style-type: none"> • Ensure client is not standing too close to the IR, bending in from the waist will alter the position of the ribs, smooth out the infra mammary angle and this will eliminate creases behind the breast • Perform a 'sweep' of breast tissue, in a downwards motion, behind the breast, starting in the axilla and coming out at the bottom of the breast, keep your hand flat against the IR and

	<p>your little finger against the rib cage</p> <ul style="list-style-type: none"> For slimmer clients, ensure the corner of the IR is placed into the axilla at a steeper angle eg. 55-60°, this will allow the pectoral muscle to lie flat on the IR
Folds across the axilla (Rings of Saturn)	<ul style="list-style-type: none"> Smooth breast in upwards motion as compression force is applied Before compression force is applied ask client to lift their elbow only on side being imaged, bring down the compression and allow the client's to relax their arm
Height of IR	<ul style="list-style-type: none"> Ensure that the breast is not too high or too low on the IR The breast tissue should be centrally placed on the IR to obtain maximum comfort for the client and allow optimum pressure distribution over the breast tissue. Correct height placement of the IR will allow the client to relax and flatten the pectoral muscle
Infra mammary creases	<ul style="list-style-type: none"> Ensure that skin folds are removed from behind the ribs prior to compression force application (ask the client to push her hips back whilst you smooth out any creases and then return back in again before the breast is lifted and compressed) Ensure the entire breast is in contact with the IR to avoid any air gaps. It may help to ask the client to bend their knee on the side being imaged Whilst applying compression force, keep the breast uplifted with one hand and smooth the infra mammary with the other When positioning the client ask her to bend forward from the waist and clear the infra mammary area prior to placing the breast on the IR and positioning the arm. This alters the position of the ribs
Missing infra mammary and back of breast	<ul style="list-style-type: none"> Ensure the client is standing in front of the IR (check position of feet) and that the correct angle is being used for that particular body habitus. Has all the breast tissue been pulled on? Use your hand to run down behind the breast, once in position, and pull through all breast tissue

Missing top of breast	<ul style="list-style-type: none"> If you cannot image the top of the breast and raising the tube does not help, lower the angle of the tube to at least 45
Nipples not in profile	<p>The direction of the nipple will alert you to what portion of the breast would not be demonstrated :</p> <ul style="list-style-type: none"> If the nipple is facing you it is likely that the client is positioned at the incorrect angle and is facing too far forwards, medially rotate the client towards the IR slightly If the nipple facing inwards towards the IR then probably not enough breast tissue has been pulled through.
Position of feet	<ul style="list-style-type: none"> Ensure the client is standing in the correct place with the feet and ribs in front of the IR With your hand check that the bottom of the ribs are in front and about a palms width away from the IR Slimmer clients can be stood closer to the IR It is useful to ask the client to slightly bend their knee on the side being imaged; the hip will drop which will bring more of the body into contact with the IR
Too wide or too narrow pectoral muscles	<p><u>Too narrow:</u></p> <ul style="list-style-type: none"> Check the height of the IR; too high and the muscle will be stretched, tense and not wide enough Always ensure that the corner of the IR is placed to the back of the axilla and the arm stretched across, otherwise the pectoral muscle will be too narrow Ensure the breast is pulled through and the pectoral muscle is flat on the IR with no gaps. Creases will occur if the IR is too far back in the axilla <p><u>Too wide:</u></p>

	<ul style="list-style-type: none"> • Check the height of the IR, too low and too much breast tissue will be included around the axilla • The IR will be too far back in the axilla, this results in too much breast tissue at the top and insufficient pressure on the main part of the breast
<p>Pectoral muscle not seen to level of nipple:</p> <p>Tube Angle</p>	<ul style="list-style-type: none"> • Alter the angle of the tube to suit the body shape going steeper when necessary (55 – 60 degrees) for prominent sternums, hollow axilla's, slimmer clients • Use a lower angle 45° or even 40° for clients with short pectoral muscles or 'barrel shapes', 'larger breasts'. HOWEVER: If too much pectoral angle is demonstrated on a client with wide, short pectoral muscles consider increasing your tube angle 50° to reduce the width of the muscle.

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