CME Article

Artifacts in mammography: ways to identify and overcome them

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ABSTRACT

High-quality mammography images enhance a radiologist's ability to interpret mammograms because they have greater sensitivity and specificity. Artifacts may create pseudo-lesions or mask abnormalities leading to misinterpretation. Familiarity with the numerous artifacts encountered will enable radiologists to provide accurate diagnoses. We reviewed all the artifacts in mammography encountered at our centres and classified the causes of these artifacts into four categories. They are: 1. patient-related; 2. technologist-related; 3. related to the mammographic unit; and 4. related to processing and the processor. Implementation of a well-organised quality control programme will reduce the occurrence of artifacts. Recognition of artifacts in mammography is instructive and will help to improve the mammographic diagnostic quality.

Keywords: artifacts, mammography, pseudo-lesions, quality assurance

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INTRODUCTION

Image artifacts are a cause for rejected images. Artifacts degrade image quality[1]. They may be caused by the patient, the technologist, the mammographic equipment (including bucky, cassette tray, films, and intensifying screen), or the processing and the processor. Many artifacts are obvious and do not cause clinical confusion. However, some may obscure the lesion or create pseudo-lesions leading to misinterpretation[2]. Familiarity with the numerous artifacts encountered will enable radiologists to provide accurate diagnosis. Technologists also need to recognise the characteristics of the artifacts and their causes, to make corrections immediately. This pictorial essay illustrates the characteristics and the causes of artifacts, and how the occurrence of these artifacts can be minimised.

Fig. 1 Overlying organ. Right mediolateral oblique (MLO) mammogram shows a high density area (arrow) of underexposure due to overlying chin in the upper axilla.

PATIENT-RELATED ARTIFACTS

Patient-related artifacts may be caused by motion or superimposed objects or substances either on or within the body of the patient. Objects or substances, such as cloth, button, necklace, earring, long wet hair, body part, jewellery, medical device, and pharmaceutical patch, may superimpose on the breast. Therefore, when positioning the patient, technologists should switch on the light beam to check the X-ray beam, to avoid overlapping shadows of objects or substances (Fig. 1). Deodorant and talcum that contain zinc or magnesium may produce high densities that mimic calcifications. To prevent these artifacts technologists should inform the patients, in advance, not to wear powder, deodorant, and body cream or ointment prior to the mammographic examination.

Medical devices and pharmaceutical patches or substances on the skin may obscure the true abnormalities or create pseudo-masses[2]. Therefore, the technologist must examine the patient's skin

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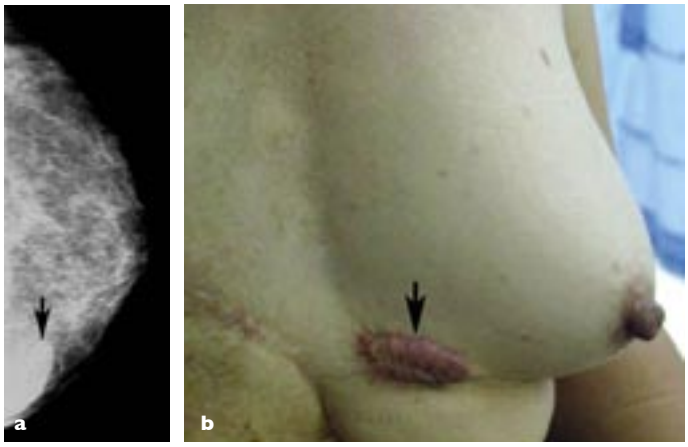

Fig. 2 Keloid. (a) Left craniocaudal (CC) mammogram shows a circumscribed mass (arrow) in the medial aspect. (b) Photograph of the patient shows keloid (arrow) from previous right mastectomy.

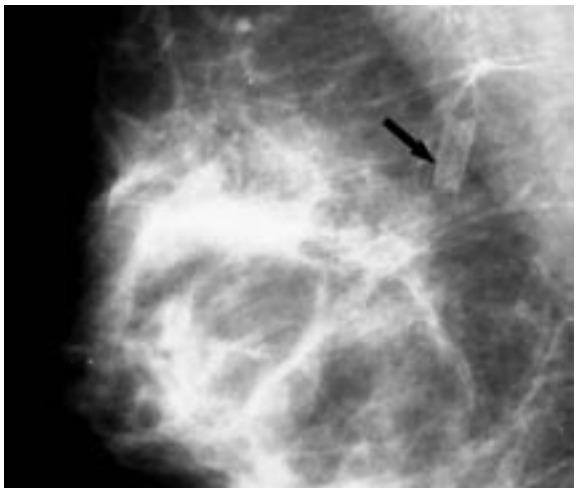

Fig. 3 Right MLO mammogram shows a retained Dacron Hickman catheter cuff (arrow).

Fig. 4 Radiopaque ventriculoperitoneal shunt. Bilateral CC mammograms show a tubular density in the right side.

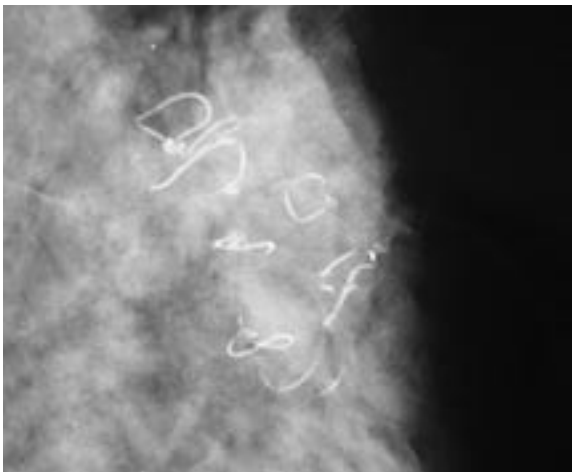

Fig. 5 Retained suture materials. Left MLO mammogram shows multiple calcified suture materials from previous surgery. (Courtesy of Dr Cholatip Wiratkapun, Ramathibodi Hospital, Mahidol University)

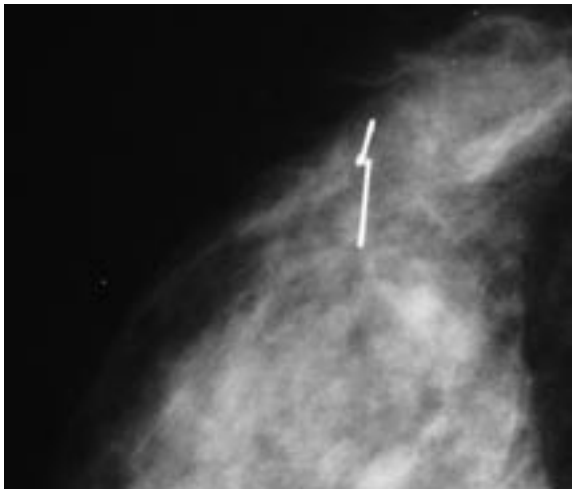

Fig. 6 Right CC view shows transected wire on the outer part of the breast from previous needle localisation. (Courtesy of Dr Cholatip Wiratkapun, Ramathibodi Hospital, Mahidol University)

and notify the radiologist about any keloid (Fig. 2), scar, or nevus. Implanted medical devices, for example, Dacron Hickman catheter cuff (Fig. 3), ventriculoperitoneal shunt (Fig. 4), surgical clips, retained suture materials (Fig. 5), and transected wire (Fig. 6) from previous needle localisation procedure, are easy to identify, but may obscure the true lesions. Foreign bodies, such as bullets (Fig. 7), may create densities similar to microcalcifications.

Patient's movement can lead to blurred image if the compression plate is not properly compressed (Fig. 8). The compression force should be regularly checked and the weight should be adequate to compress the breast tissue in the proper position. The compression plate should also be of the same size as the film[3,4]. Repeated mammograms must be performed with motion artifact because masses and calcifications will be obscured.

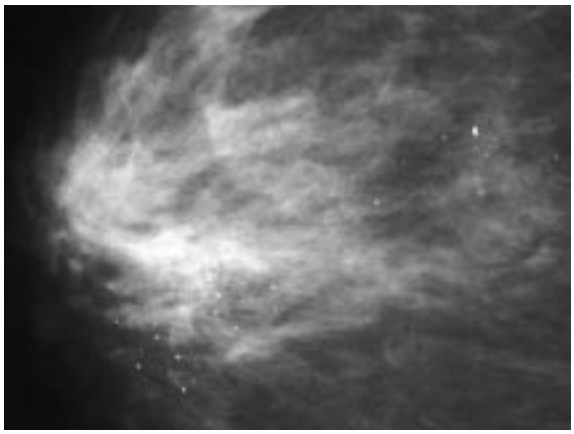

Fig. 7 Spot magnification view shows scattered shotgun bullet fragments simulating microcalcifications.

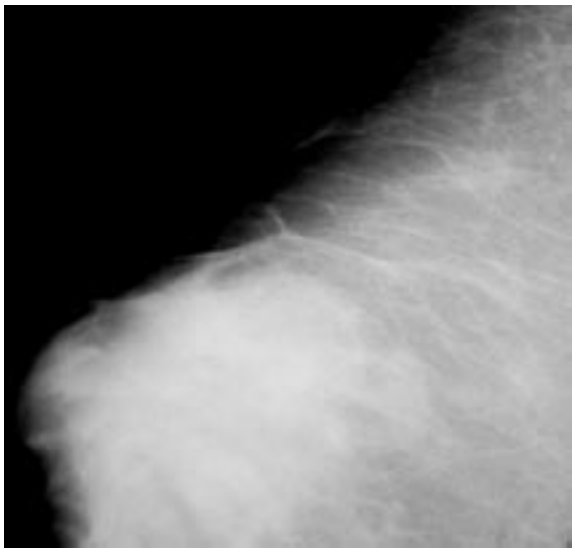

Fig. 8 Right MLO mammogram shows blurring of the film due to the patient's movement.

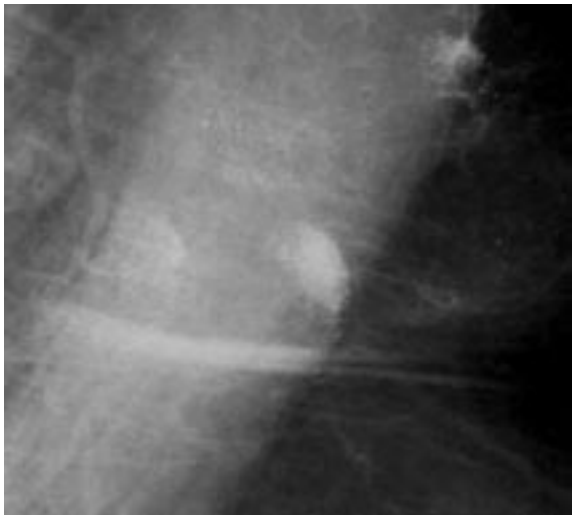

Fig. 9 Left MLO mammogram shows fingerprint artifacts.

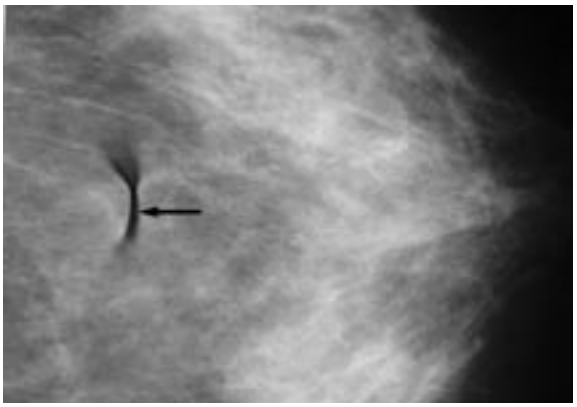

Fig. 10 Pressure mark or crimp mark due to excessive pressure on film appears as increased optical density (arrow).

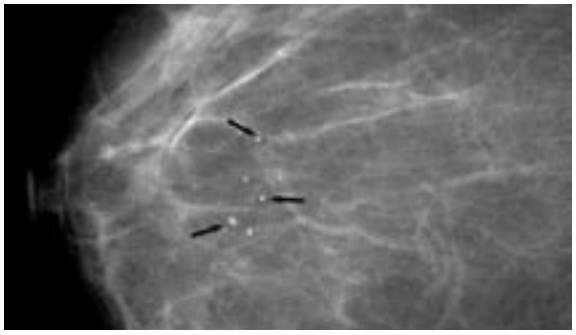

Fig. 11 Artifacts caused by dust and dirt on the intensifying screen to create white spots simulating calcifications (arrows).

TECHNOLOGIST-RELATED ARTIFACTS

Technologists cause artifacts by improper handling or loading of film, poor cleaning of screen, improper use of mammography unit and equipment, and darkroom errors. Technologists must be careful while handling and loading films. Contaminated hands, fingerprints (Fig. 9), and pressure on the films or improper loading of films will cause artifacts[2,5]. Crimp mark is caused by bending of the film (Fig. 10), which can be avoided by storing films vertically[5]. The pressure on the film will break the bond between the silver and the halide ion, resulting in black metallic silver after processing. Dust and dirt on the intensifying screen are the most common artifacts seen on mammograms[1,2]. They block the path of light from the intensifying screen to the film during the exposure and create white densities similar to calcifications (Fig. 11). Stain on the intensifying screen produces minus density on the image (Fig. 12). It will appear with the same characteristic and position on the mammogram whenever this cassette is used. Intensifying screens and cassettes should be cleaned at least weekly, but more frequent cleaning may be required, depending on the environment and the volume. A soft lint-free cloth dampened with a screen-cleaning agent, is suggested for use in cleaning. The screens and the cassettes should be completely air dried before loading the film, by standing the cassettes on the edge[5]. A cassette with a wet screen may damage the film and appears on the mammogram as a plus density artifact (Fig. 13).

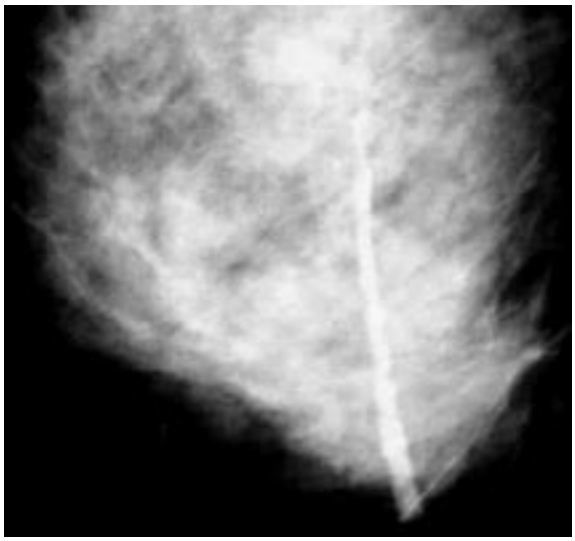

Fig. 12 A long streak of stain on the intensifying screen appears as minus density on the mammogram.

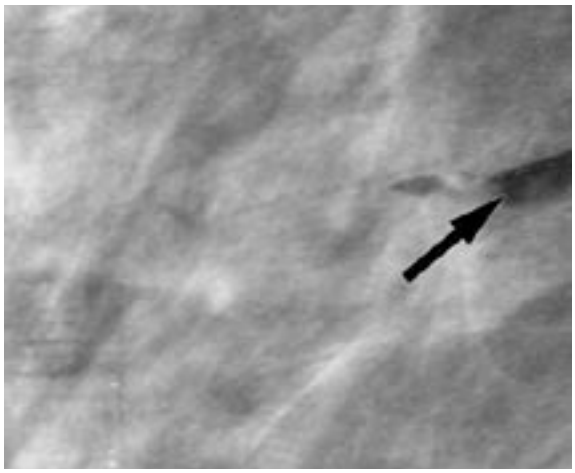

Fig. 13 Wet or damp screen causes the plus density artifact (arrow) on the mammogram.

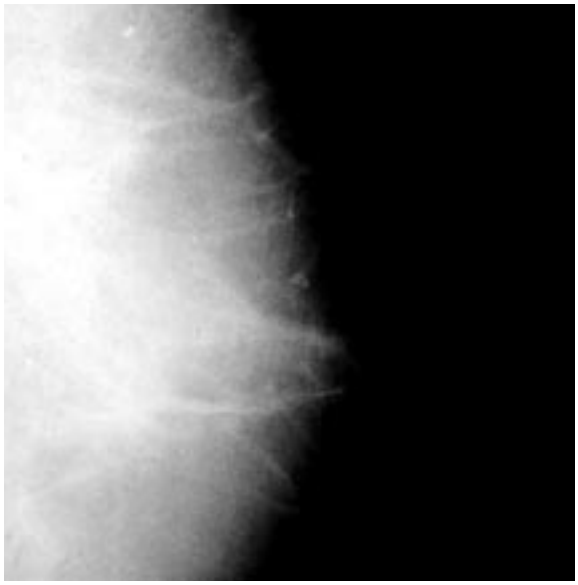

Fig. 14 Left MLO mammogram shows underexposure of film caused by upside-down loading of film.

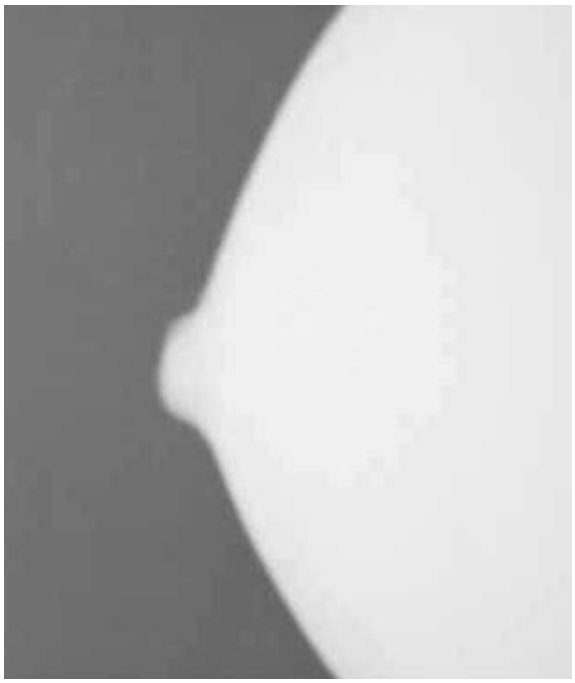

Fig. 15 Right CC mammogram shows underexposure of film caused by the loading of two films in the same cassette.

Fig. 16 Artifact caused by front-back reverse loading of the cassette into the bucky tray. The breast parenchyma is superimposed by the identification flash (arrow).

Cleaning the darkroom every morning is the best way to minimise dust and dirt artifacts.

Upside-down loading of mammographic films will result in underexposure because the emulsion side does not come into contact with the intensifying screen (Fig. 14). Loading of two films into the same cassette will also result in underexposure because the light from the emitting phosphor cannot transmit through the second film (Fig. 15). Wrong side loading (front-back reversed) of the cassette into

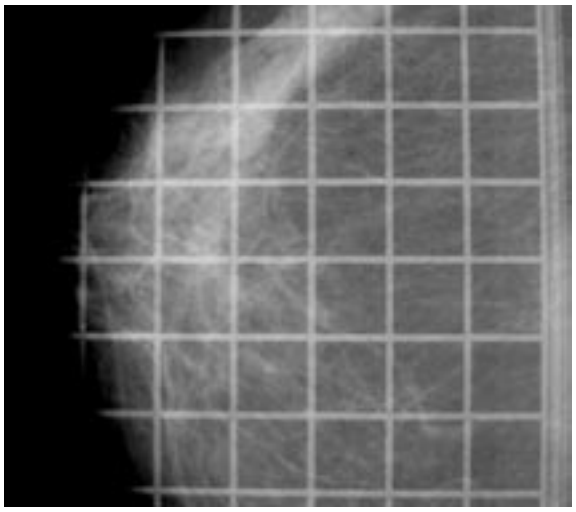

Fig. 17 Artifact caused by upside-down loading of the cassette into the bucky tray, showing the internal structure of the cassette on the image.

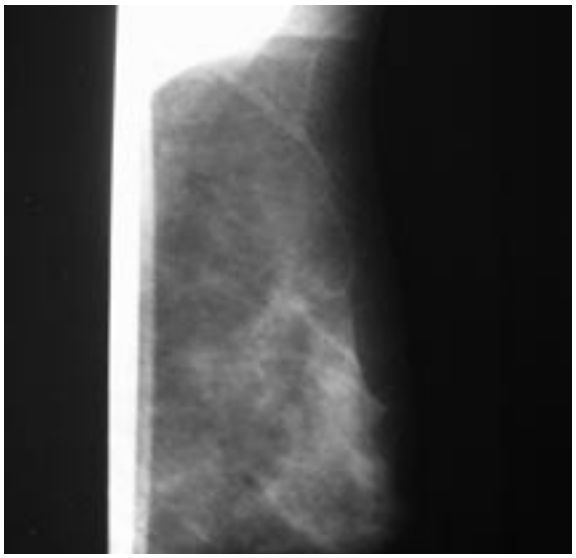

Fig. 18 Artifact caused by double exposure film of two positions (CC and MLO views on the same film).

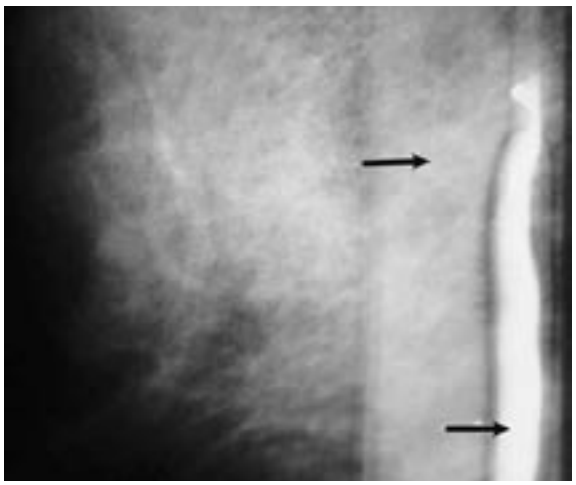

Fig. 19 Right CC mammogram shows an underdeveloped area (arrows) caused by running films too close together, through the processor.

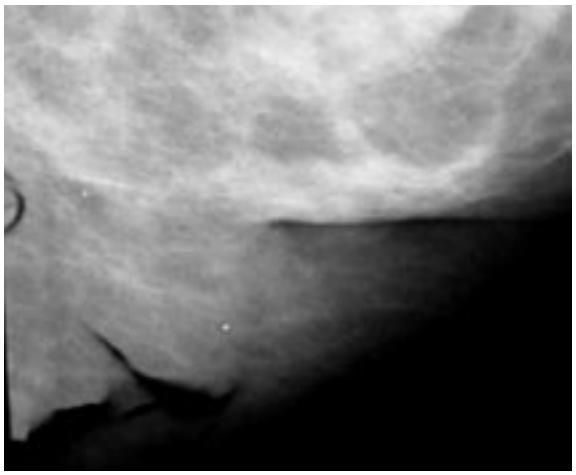

Fig. 20 Artifact caused by the light leak from cracked cassette or incompletely latched.

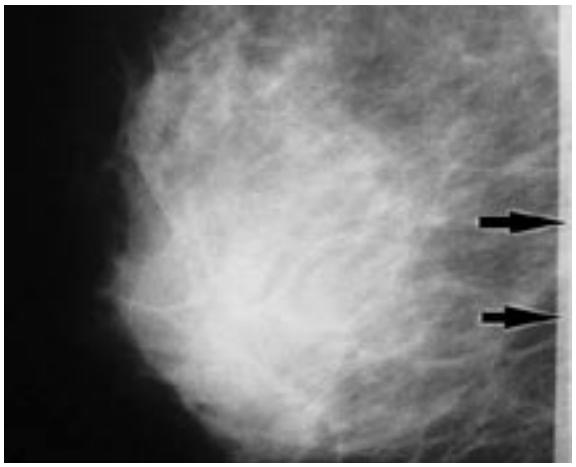

Fig. 21 Artifact caused by unexposed area (arrows) in the inner aspect of the breast due to defect of the anterior lip of the compression plate.

the bucky tray will cause the identification flash to be superimposed over the breast tissue (Fig. 16). Upside-down loading of the cassette into the bucky tray will show the internal structure of the cassette on the mammogram (Fig. 17).

Improper use of the mammographic unit and equipment are also common causes of unacceptable mammograms[6,7]. Double exposure results from the failure to change the cassette between two positions, causing superimposition of the two images (Fig. 18). Feeding films too fast through the processor will cause them to overlap and stick together (Fig. 19). The technologist should wait until the exposed film passes completely into the processor, before feeding the new film.

Light fog is another common cause of artifacts. Light leaks may occur from cracked or broken cassettes (Fig. 20), mobile phone, and fluorescent objects. Technologists should not carry mobile phones that cause light in the darkroom and should not wear fluorescent T-shirts, bandages, fingernail

Fig. 22 Right mammogram shows a lightning-like density from a static artifact.

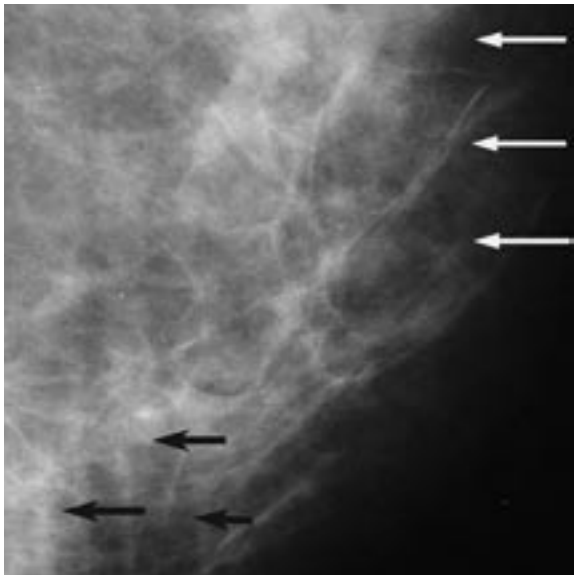

Fig. 23 Processor artifacts. Left CC mammogram shows plus density stub lines (black arrows) perpendicular to the direction of the film travel caused by pressure from developer rollers or moisture on the entrance rollers. White arrows indicate the direction of the film travel.

polishes, or tattoos. Proper training of the personnel and careful handling of the films with clean and dry hands, are important to avoid artifacts.

ARTIFACTS RELATED TO THE MAMMOGRAPHIC EQUIPMENT

Equipment-related artifacts include grid lines, equipment parts superimposed on the image[7], defective compression plate (Fig. 21), and compression failure. Regular checking of the mammographic unit will minimise these artifacts.

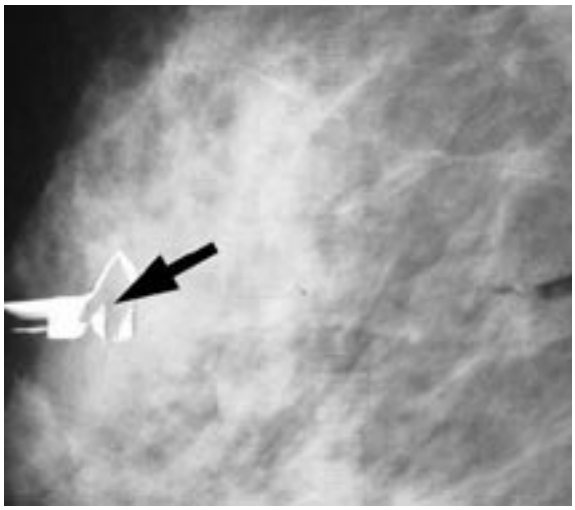

Fig. 24 Right MLO mammogram shows pick-off artifacts (arrow) due to pulling off stuck films.

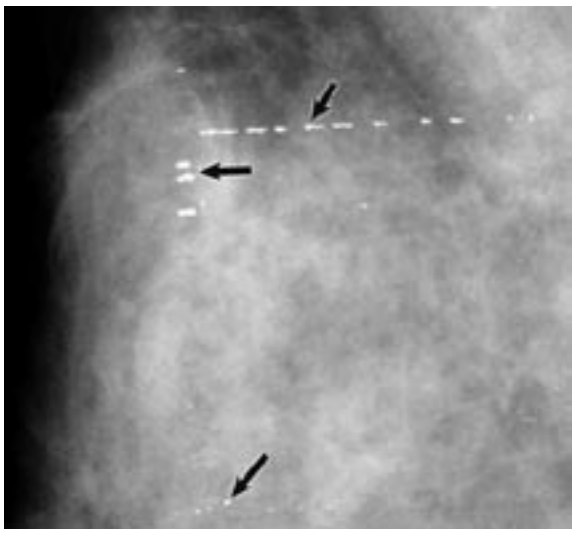

Fig. 25 Right MLO mammogram shows the small minus densities (arrows) caused by dirty rollers in a poorly-maintained processor or by dust in the darkroom. They are seen as pick-off, white spots where the emulsion has been removed.

PROCESSOR-RELATED ARTIFACTS

Artifacts that occur during processing include static artifacts, water marks, scratches, roller marks, contaminated developer, chemical residual, and incomplete fixing. Static mark artifacts appear on the mammogram as random plus-density marks that resemble ladybug, tree branches, lightning (Fig. 22), or a dark area[1,2,8].

Water marks occur when the guide soft rubber rollers are wet (Fig. 23). The guided-plate may scratch the emulsion off because of improperly-seated transport racks or rollers. Scratches or pick-off artifacts will mask the lesions on mammograms. Racks and crossover assemblies should be checked after the processor chemicals change or are cleaned off the processor. Pulling off stuck films due to power failure during processing, may cause emulsion pick-off artifacts (Fig. 24).

Fig. 26 Left MLO mammogram shows excessive optical density and chemical fog caused by over-development.

Processor-related linear artifacts may be caused by excessive roller pressure, dirt on the rollers (Fig. 25), inadequate washing of processor chemical from the film, and entrance roller marks. These artifacts may be plus or minus density and must be differentiated from grid line artifacts, by exposing two films with similar techniques and then running them perpendicular to each other in the processor. Artifacts caused by the processor will be parallel to each other on the two films, while grid line artifacts will be perpendicular to each other.

Overdevelopment of films may happen due to power failure. A dark area artifact is produced on the film by prolonged contact between the film and the developer chemicals (Fig. 26). To minimise all processor-related artifacts, quality control should be performed on the processor at the beginning of each workday[2,8].

CONCLUSION

High-quality mammographic images are important for accurate diagnosis. Artifacts may obscure the true abnormalities or create pseudo-lesions. Both radiologists and technologists should be familiar with the characteristics and the causes of artifacts to eliminate them. Careful attention to detail during patient positioning and performing the mammography, careful handling or loading of film, and strict adherence to all steps in quality control will help to minimise or avoid the artifacts.

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SINGAPORE MEDICAL COUNCIL CATEGORY 3B CME PROGRAMME
Multiple Choice Questions (Code SMJ 200607A)

	True	False
Question 1: Regarding patient-related mammogram artifacts:		
(a) Artifacts on the patient's skin may obscure the true abnormalities or create pseudo-masses.	❑	❑
(b) The technologist should notify the radiologist about any keloid, scar or nevus on the patient's skin.	❑	❑
(c) Motion artifacts will not obscure masses and calcifications.	❑	❑
(d) Small fragments of bullets may create the density similar to microcalcifications.	❑	❑
Question 2: Regarding technologist-related mammogram artifacts:		
(a) The crimp mark artifact is caused by bending of the film.	❑	❑
(b) Stains on the intensifying screen should be different on each mammogram.	❑	❑
(c) Upside-down loading of the mammogram film will cause underexposure of the image.	❑	❑
(d) Clean and dry hands are important for performing mammography.	❑	❑
Question 3: Regarding processor-related mammogram artifacts:		
(a) Static artifact appears as a lightning-like density.	❑	❑
(b) Processor cleaning is unnecessary unless artifacts appear.	❑	❑
(c) Daily quality assurance activity is the best way to prevent processor-related artifacts.	❑	❑
(d) Artifacts caused by wet rollers show plus density stub lines parallel to the direction of the film travel.	❑	❑
Question 4: Concerning artifacts in mammography:		
(a) Defects in mammographic equipment may cause artifacts.	❑	❑
(b) Dust and dirt can create a density similar to calcification.	❑	❑
(c) Artifacts can be seen as plus or minus density.	❑	❑
(d) Overdevelopment can reduce chemical fog.	❑	❑
Question 5: Ways to prevent mammogram artifacts are:		
(a) Artifacts cannot be controlled but can be corrected.	❑	❑
(b) Film storage should be kept in a place with warmth and high humidity.	❑	❑
(c) Familiarity with artifacts will enable radiologists to provide accurate diagnosis.	❑	❑
(d) Technologists need to recognise the characteristics and causes of the artifacts.	❑	❑

Doctor's particulars:

Name in full:_____

MCR number:_____ Specialty:_____

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Submission instructions:

A. Using this answer form

1. Photocopy this answer form.
2. Indicate your responses by marking the "True" or "False" box ☑
3. Fill in your professional particulars.
4. Post the answer form to the SMJ at 2 College Road, Singapore 169850.

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1. Log on at the SMJ website: URL <http://www.sma.org.sg/cme/smj> and select the appropriate set of questions.
2. Select your answers and provide your name, email address and MCR number. Click on "Submit answers" to submit.

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Results:

1. Answers will be published in the SMJ September 2006 issue.
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3. All online submissions will receive an automatic email acknowledgment.
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