Review

Artefacts on Mammograms: Recognition, Causes and Prevention

Hrovat Polona[1], Knez Sabina[1], Kramer Maša[1], Nusdorfer Ela[1], Sember Tara[1], Gošnak Dahmane Raja[1,*]

1. University of Ljubljana, Faculty of Health Sciences, Ljubljana, Slovenia
* Correspondence: Raja Gošnak Dahmane: raja.dahmane@zf.uni-lj.si

Citation: Hrovat P, Knez S, Kramer M, Nusdorfer E, Sember T, Gošnak Dahmane R. Artefacts on Mammograms: Recognition, Causes and Prevention. Proceedings of Socratic Lectures. **2026**, 14, 18-23. https://doi.org/10.55295/PSL.14.2026.I3

Abstract:
Digital mammography represents the foundation of modern screening and diagnostic strategies for breast cancer detection, as it enables high resolution imaging, precise visualization of tissue structures, and early identification of pathological changes. This article aims to present artefacts on mammographic images, their origin, characteristics, and impact on diagnostic image quality, as well as to emphasize the importance of their recognition and prevention in clinical practice. A literature review was conducted drawing from peer-reviewed articles, textbooks, and guidelines published between 1995 and 2025, to examine recognition, causes and prevention of artefacts. Mammography is an imaging method that uses low-dose x-rays to create detailed pictures of the breast. Mammograms are performed in at least two standard views, the craniocaudal view (CC) and the mediolateral oblique (MLO). An artefact is any variation in mammographic density not caused by true attenuation differences of the breast. Radiographers are the first to encounter patients and perform the examination, so it is important that they know how to recognize artifacts in images, understand why they occur, and know how to reduce or prevent them if possible. The recognition and prevention of artefacts in mammography is a crucial role in ensuring accurate detection of breast pathology. Prevention of artefact occurring is more valuable than to recognize them after they have occurred. Artefacts can be divided into four main groups: patient related, detector based, equipment related and post-acquisition related. Patient related artefacts remain one of the most common causes of reduced image quality. Simple factors such as hair, antiperspirant or slight movement, can produce findings that resemble a pathology, most commonly microcalcifications. Maintaining high diagnostic accuracy, reducing unnecessary repeat examinations, and improving breast cancer detection outcomes critically depend on heightened awareness, preventive strategies, and careful artifact recognition.

Keywords: Mammography; Artefacts; Breast images; Prevention; Pathology

1. Introduction

Digital mammography represents the foundation of modern screening and diagnostic strategies for breast cancer detection, as it enables high-resolution imaging, precise visualization of tissue structures, and early identification of pathological changes. Technological advancements, including digital tomosynthesis and contrast-enhanced mammography (CEM), have significantly improved the sensitivity and specificity of imaging methods, while simultaneously raising new concerns regarding the impact of artefacts on diagnostic reliability. Artefacts arising from technical, anatomical-physiological, or procedural factors can markedly degrade image quality, obscure lesions, or mimic pathological findings, leading to misinterpretation and potential clinical harm (Nori et al., 2020). Contrast-enhanced mammography, which combines low-energy and high-energy acquisitions to depict vascularity and contrast uptake, is particularly susceptible to specific artefact types such as incomplete subtraction, patient motion, detector saturation, metallic objects, and reconstruction-related artefacts. These may result in false-positive or false-negative interpretations, necessitating a thorough understanding of their origin, prevalence, and clinical implications (Nori et al., 2020). Effective identification and management of artefacts are therefore essential for ensuring diagnostic accuracy, reducing the need for repeat imaging, and optimizing radiation exposure. Advances in artificial intelligence, particularly deep learning methods, have facilitated the development of algorithms for automated artefact detection and removal as well as improved contrast enhancement in mammographic images. Transfer learning, based on pre-trained neural networks, has proven to be highly effective in artefact classification and image quality improvement, even in settings with limited datasets (Oza et al., 2022). Such approaches not only support radiologists in image interpretation but also contribute to the standardization of imaging quality and reduction of subjective variability (Oza et al., 2022; Wong et al., 2025). A thorough understanding of breast anatomy, histological organization, and physiological variability is fundamental for accurate interpretation of mammographic images. Variations in glandular composition, vascularization, lymphatic drainage, and tissue density can significantly influence image appearance and may contribute to the formation or misinterpretation of artefacts. In digital and contrast-enhanced mammography, such artefacts can obscure normal anatomical structures or mimic enhancement patterns, thereby complicating image assessment. Systematic recognition of artefact-related image distortions, combined with knowledge of normal breast structure and imaging principles, is essential for maintaining image quality, improving diagnostic reliability, and supporting the development of standardized and intelligent imaging approaches (D'Orsi, 2006; Perčič & Breg, 2024).

2. Design of the Review

To prepare the review, a systematic analysis of scientific literature published between 1995 and 2025 was conducted, with emphasis on studies addressing artefacts in digital mammography, contrast-enhanced mammography, and methods for their detection, classification, and clinical management. Included were articles describing the technical mechanisms underlying artefact formation, their impact on diagnostic image quality, and contemporary approaches to artefact reduction, including artificial intelligence algorithms and transfer learning techniques and what we can do to prevent them. The selection process involved three stages: initial screening of titles and abstracts, full-text evaluation for relevance, and exclusion of duplicate or methodologically inadequate studies. Only articles written in English or Slovene and directly related to artefacts, diagnostic performance, or image-processing methodologies were retained. Extracted data were synthesized narratively, with attention to recurring artefact types, diagnostic challenges, and emerging computational strategies for improving mammographic image quality.

3. Mammography

Among the female population worldwide, breast cancer is the most commonly diagnosed cancer. Every year, breast cancer kills more than 500.000 women around the world. Roughly half of all breast cancers occur in women with no specific risk factors other than sex and age. Most people will not have any symptoms when the cancer is still in its early stages which is why early detection is so important (WHO, 2014). Out of all, mammography is the most traditional and successful imaging modality (Oza et al., 2022). Mammography is an imaging method that uses low-dose x-rays to create detailed pictures of the breast. It is used to detect cancer and other breast conditions. During the exam, the breasts are positioned one at a time between an x-ray plate and a plastic compression plate. Each breast is gently pressed between the plates to spread the breast tissue for a clearer image (National Cancer Institute, 2025). Mammography can be used to evaluate the breast based on the differential attenuation characteristics of the tissues. Specifically, fat attenuates fewer x-rays than fibroglandular tissue and stromal elements and appears grey on mammography. Dense mineral deposits can be easily identified and appear bright white, such as skin calcifications or calcifications within a lesion. Superimposition poses a challenge in mammography, as tissue structures that overlap one another may obscure a small mass. To try and combat this, screening mammograms are performed in at least two standard views, which include the craniocaudal view (CC) and the mediolateral oblique (MLO).

By comparing these two different viewpoints, structures that are superimposed upon one another in one view may be separated in the other. In cases of uncertainty, additional diagnostic views with spot compression or variant angles may be obtained. A typical mammogram can depict the skin surface, the nipple, the main breast ducts, fibroglandular tissue, veins, adipose tissue, muscle and occasionally lymph nodes (Reeves & Kaufman, 2023).

4. Artefacts on mammograms

An artefact is any variation in mammographic density not caused by true attenuation differences of the breast (Bassett, 1995). High quality mammography images enhance a radiologist's ability to interpret mammograms because they have greater sensitivity and specificity. On the other hand, artifacts reduce quality of mammograms and can create pseudolesions or mask abnormalities leading to misinterpretation. Radiographers are the first to encounter patients and perform the examination, so it is important that they know how to recognize artifacts in images, understand why they occur, and know how to reduce or prevent them if possible. This will also enable for radiologists to provide accurate diagnoses (Chaloeykitti et al., 2006). Artifacts can be patient related (patient motion, superimposition of objects or other parts of the body over the breast), detector based (dead pixels, dead or unread lines, ghosting), equipment related (other components on the gantry) or post acquisition related (failure to properly reconstruct the image at the review station or inability of the processing algorithm to compensate for differences in exposure across the detector). Implementation of a well-organised quality control programme is crucial to reduce the occurrence of artifacts (Geiser et al., 2011). In a study data from one digital mammograph were collected over a 1-year period time in order to evaluate retakes, rates, causes and the possible measures to reduce their occurrence. Among them 7.1 % of the images were marked as repetitions and in 16 % of the studies, at least one image was repeated. When evaluating causes of retakes, the primary cause was incorrect positioning (49 %), closely followed by additional retakes in cases of large breasts (44 %). When dealing with large breasts and using a small flat panel, additional images were necessary to fully visualise the breast. They found that to try and reduce the retake rate, it is important to plan training sessions based on images selected from the retake analysis (Prieto et al., 2015). In a similar study they investigated the incidence of full-field digital mammographic artifacts with three systems at two institutions and compared the artifacts between two detector types and two grid types. A total of 4440 direct and 4142 indirect images were reviewed by two radiologists and artifacts were classified as patient related, hardware related, and software processing. The overall incidence of artifacts was 3.4 %. Patient related artifacts (motion artifacts and skin line artifacts) were the most commonly detected types (1.7 %). The most common mammographic artifacts were patient related (1.7 %).

Underexposure and high-density artifacts were more common with direct detector and crossed air type of grid (Choi et al., 2014).

5. Artefact recognition

Since artefacts are non-anatomical features that can mimic or obscure breast pathology and can give us false-positive or false-negative results, it is of great importance that we know how to regonize them. Different artefacts show in different ways, but they do have one thing in common and that is, that they remain stable with repeated imaging. In comparisson with lesions, artefacts often change with breast compression, positioning, breath-holding and repeated exposures (Tekcan Sanli & Sanli, 2025). We can recognize arefacts either manually or with automatic detection, which uses artificial inteligence (Schueppert et al., 2025).

6. Causes of artefacts

Artefacts on mammogram can be caused by various factors. Patient-related artefacts arise from physical factors external to the imaging system. They can be caused due to motion or superimposed objects (external or internal), such as hair, antiperspirant, clips, breast implants. Motion artefacts can be seen as blurred images. Antiperspirants can mimic microcalsification and breast implants can obscure part of breast tissue and therefore may hide lesions (Tekcan Sanli & Sanli, 2025).

Equipment-related factors result from problems with detector, such as x-ray tube malfunction, which can cause incorrect exposure parameters, that result in bad contrast. Artefacts that are caused because of dead pixels also fall into theis category. They can be seen as as a white line (Singla et al., 2025). When/if using film the stain blockes the path of light from the intensifying screen to the film during the exposures, which creates white mass similar to calcification (Chaloeykitti et al., 2006).

Another artefacts that are worth mentoining are technique-dependent. These are caused due to dual-energy acquisition timing, poor contrast injection technique and positioning technique errors (Singla et al., 2025). When using contrast-enhanced spectral mammography (CESM), which uses iodine based contrast it is important to know what can causes artefacts. Most commonly seen is the rim artefact which occures due to increased and faster contrast uptake in the peripheral breast tissue, due to lower compression in comparisson to the more compressed central tissue of the breast (Yagil et al., 2016).

7. Prevention on artefacts

Prevention of artefact occuring is more valuable than to recognize them after they have occured (Geiser, 2012). Artefacts are not that hard to prevent if we take the correct protocols. Patient-related artefacts are prevented by removing clothing and hair, careful positioning and good compression, as it disables motion. Patients should not use antiperspirant on exam day and should clean axilla prior to imaging to prevent antiperspirant artefacts. When imaging patients with breast implants Eklund's technique ought to be used and magnetic resonance imaging (MRI) is preferred (Singla et al., 2025). Equipment-related aretfacts that occure due to x-ray tube malfunction may be prevented with daily check-ups and weekly gain calibrations, since the issue can be spotted during the quality control tests. Aretefact caused by dir tor dust can be avoided with visual inspection of detector/film surface and regular cleaning. Dual-energy artefact, which belongs to the technique-dependant artefacts can be averted with the proper timing between low-energy and high-energy image captures and correct exposition parameters. Rim artefact in CESM are trickier to prevent as it needs update software and good post-processing (Yagil et al., 2016).

8. Discussion

The recognition and prevention of artefacts in mammography play a crucial role in ensuring accurate breast pathology detection. This is particularly problematic in breast imaging, where even subtle diagnostic errors can significantly impact patient outcomes. Therefore, understanding both the appearance and cause of artefacts is correct diagnosis (Schueppert et al, 2025). Patient-related artefacts remain one of the most frequent sources of lower image quality. Simple factors such as hair, antiperspirant or slight movement, can produce findings that resemble a pathology, most commonly microcalcifications. Breast implants present a unique challenge, as they not only obscure tissue but also reduce image quality due to increased attenuation. Although many of these artefacts are preventable through proper patient preparation and positioning, their continued prevalence suggests that additional emphasis on patient education is of importance (Tekcan Sanli & Sanli, 2025). Equipment-related artefacts, while are less frequent, can significantly compromise image quality when they occur. Issues such as dead pixels, dust, dirt, or X-ray tube malfunction have distinct radiographic appearances but may go unnoticed without regular quality control measures (Singla et al., 2025). This shows the importance of routine system checks, detector cleaning and calibration. Technique-dependent artefacts, especially in advanced modalities such as CESM, introduce additional complexity. Dual-energy acquisition requires precise timing, and deviations can result in misleading images (Singla et al., 2025). The rim artefact illustrates how even optimal technique cannot always eliminate artefacts. This highlights the need for improved post-processing algorithms (Yagil et al., 2016). Overall, the evidence suggests that artefact recognition is not solely a technical skill but a combination of knowledge, experience, and attention to detail. While artificial intelligence has shown promising potential in automating the detection of certain artefacts, current systems still rely on high-quality input and expert oversight (Geiser,2012).

9. Conclusions

Artifacts in mammography represent a significant challenge in breast imaging, as they can obscure pathology or produce false results, potentially leading to diagnostic errors. Artifacts can arise from patient-related factors, equipment issues, and technique-dependent processes, with each contributing in its own way to reduced image quality and diagnostic reliability. Among these, patient-related artifacts are the most common and are generally preventable through proper patient preparation, correct positioning, and adequate breast compression. Effective recognition of artifacts requires a combination of clinical experience, technical knowledge, and attention to detail from both radiographers and radiologists. The implementation of quality control programs, regular equipment maintenance, and professional training plays a crucial role in reducing the occurrence of artifacts. Accurate acquisition protocols and optimized post-processing are key to minimizing technically dependent artifacts. Emerging computational approaches, including artificial intelligence and transfer learning, show promising potential for automated detection and classification of mammographic artifacts. However, these tools should be regarded as complementary rather than a replacement for professional human oversight. Overall, maintaining high diagnostic accuracy, reducing unnecessary repeat examinations, and improving breast cancer detection outcomes critically depend on heightened awareness, preventive strategies, and careful artifact recognition.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Bassett LW. Clinical image evaluation. Radiologic clinics of North America. 1995; 33:1027–1039.
2. Chaloeykitti L, Muttarak M, Ng KH. Artifacts in mammography: ways to identify and overcome them. Singapore Med J. 2006; 47:634-641.
3. Choi JJ, Kim SH, Kang BJ, Choi BG, Song B, Jung H. Mammographic artifacts on full-field digital mammography. J Digit Imaging. 2014; 27:231-236. DOI:10.1007/s10278-013-9641-4
4. D'Orsi C. DMISTifying digital mammography in the USA. Breast Cancer Res. 2006; 8:P4. DOI:10.1186/bcr1419
5. Geiser WR, Haygood TM, Santiago L, Stephens T, Thames D, Whitman GJ. Challenges in mammography: part 1, artifacts in digital mammography. AJR Am J Roentgenol. 2011; 197:W1023-1030. DOI: 10.2214/AJR.10.7246
6. Geiser WR. Artifacts in digital mammography. In: Whitman GJ, Haygood TM, eds. Digital Mammography: A Practical Approach. Cambridge University Press; 2012; 71-84. Available at: https://www.aapm.org/meetings/amos2/pdf/41-10046-70873-266.pdf

7. National Cancer Institute. (2025). Mammography. In NCI Dictionary of Cancer Terms. Available at: https://www.cancer.gov/publications/dictionaries/cancer-terms/def/mammography Access on 30.04.2026.
8. Nori J, Gill MK, Vignoli C, Bicchierai G, De Benedetto D, et al. Artefacts in contrast enhanced digital mammography: how can they affect diagnostic image quality and confuse clinical diagnosis? Insights Imaging. 2020; 11:16. DOI:10.1186/s13244-019-0811-x
9. Oza PR, Sharma P, Patel S. Transfer learning assisted classification of artefacts removed and contrast improved digital mammograms. Scalable Computing: Practice and Experience. 2022; 23:115-127. DOI:10.12694/scpe.v23i3.1992
10. Perčič D, Breg ER. Univerza v ljubljani zdravstvena fakulteta radiološka tehnologija, 1. Stopnja the impact of cardiovascular implantable electronic devices on the execution and quality of mammographic images-literature review. Diploma work. 2024. Available at: https://repozitorij.uni-lj.si/Dokument.php?id=189363&lang=slv. Access on 30.04.2026
11. Prieto C, Ten JI, Montes M, et al. Experience in retake analysis for digital mammography at a university hospital. Radiat Prot Dosimetry. 2015; 165:354-358. DOI:10.1093/rpd/ncv082
12. Reeves RA, Kaufman T. Mammography. In: StatPearls. Treasure Island (FL): StatPearls Publishing; 2023. https://www.ncbi.nlm.nih.gov/books/NBK559310/
13. Schueppert A, Glocker B, Roschewitz M. Radio-Opaque Artefacts in Digital Mammography: Automatic Detection and Analysis of Downstream Effects. 2025 IEEE 22nd International Symposium of Biomedical Imaging (ISBI). Houston, TX, USA. 2025, pp. 1-5. DOI: 10.1109/ISBI60581.2025.10981259.
14. Singla V, Garg D, Bhavith NP. Optimizing contrast enhanced mammography: A comprehensive review of artefacts, causes, and remedies. Current Problems in Diagnostic Radiology. 2025. DOI: https://doi.org/10.1067/j.cpradiol.2025.05.001
15. Tekcan Sanli DE, Sanli AN. Artefacts in contrast-enhanced mammography and their clinical management. Clin Radiol. 2025; 91:107084. DOI:10.1016/j.crad.2025.107084
16. Wong YT, Yang S, Leong PW, et al. Artefacts and diagnostic pitfalls in contrast-enhanced mammography: a pictorial review. Clin Radiol. 2025; 81:106763. DOI:10.1016/j.crad.2024.106763
17. World Health Organization. (2014). WHO position paper on mammography screening. Available at:https://www.ncbi.nlm.nih.gov/books/NBK269545/
18. Yagil Y, Shalmon A, Rundstein A, et al. Challenges in contrast-enhanced spectral mammography interpretation: artefacts lexicon. Clin Radiol. 2016; 71:450-457. DOI:10.1016/j.crad.2016.01.012