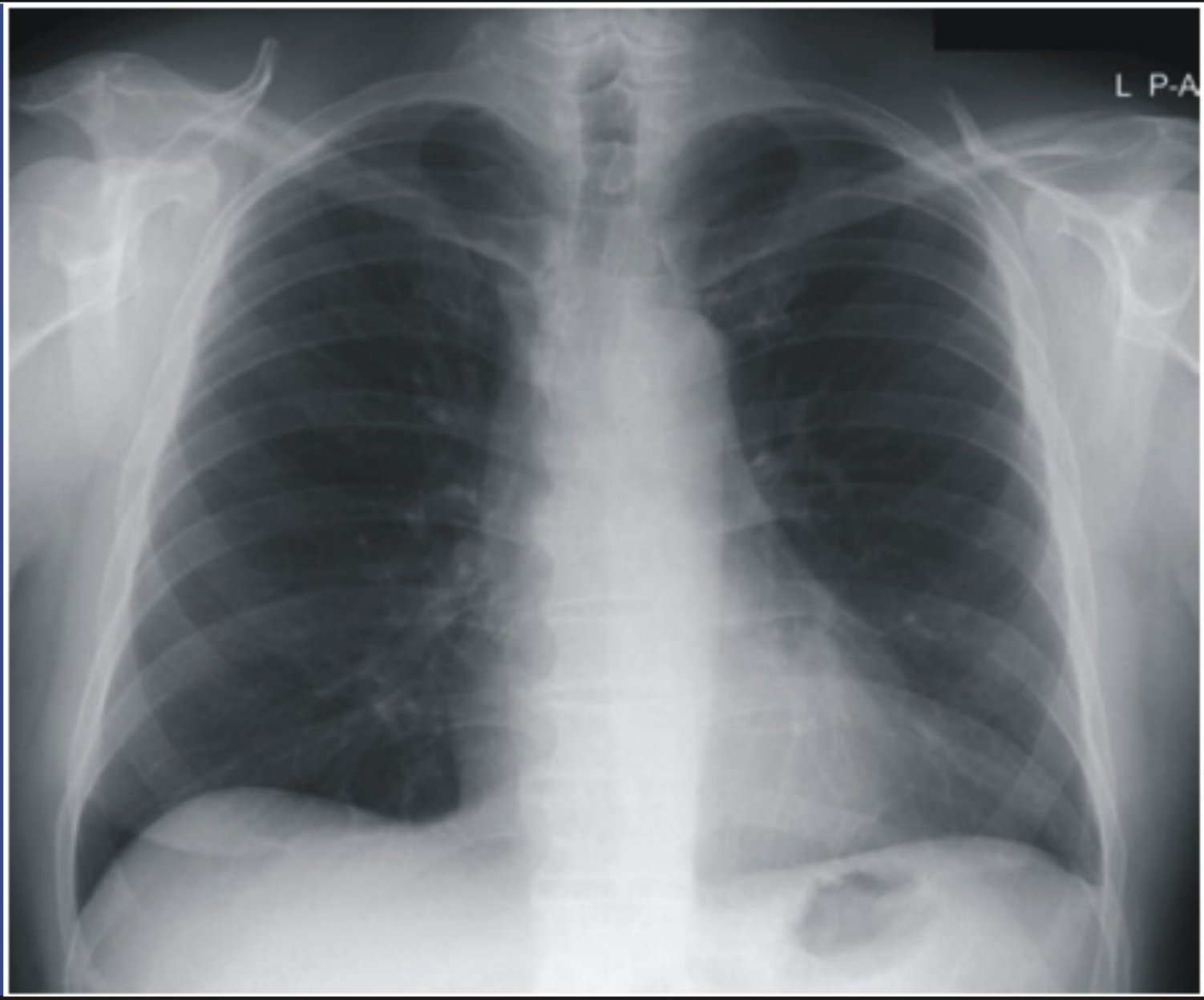
The Association Of Radiographers Of Nigeria
EYE OF MEDICINE

JOURNAL OF THE ASSOCIATION OF RADIOGRAPHERS OF NIGERIA

ISSN: 1115- 7976 Vol 28, Issue 1, December, 2014

The Official Journal of The Association of Radiographers of Nigeria

J A R N



Journal homepage: www.jarnxray.org

Artefactual Behaviour of Fluid in Radiographic Darkroom Practice

Adejoh Thomas*, [1]Moi Alhamdu Silas, [1]Nkubli Flavious Bobuin, [2]Chiegwu Hyacienth Uche

Radiology Department, Nnamdi Azikiwe University Teaching Hospital, Nnewi, Nigeria;
*adtoms@yahoo.com; +234(0)8133301005

[1]Department of Medical Radiography, College of Medical Sciences, University of Maiduguri, Nigeria

[2]Department of Radiography and Radiological Sciences, Nnamdi Azikiwe University, Nnewi Campus, Nigeria

Received:11 July, 2013. Received in revised form: 30 August, 2013. Accepted:11 January, 2014

ABSTRACT

Background: Before the advent of computed and digital radiography, radiographs were processed in a light-tight darkroom. In spite of advancement in technology which enables film processing without the intermediary of the conventional darkroom, many radiographic centres worldwide, especially in developing countries like Nigeria, still carry out darkroom processing. Liquid chemicals are involved, and their misuse may result in artefacts on the processed radiographs.
Objective: To investigate the artefactual abilities of common darkroom fluids on x-ray films (unprocessed) and radiographs (processed) in a centre transiting from darkroom to computed radiography.
Methods: A total of five thousand, five hundred (5,500) radiographs produced between January to June 2013, and retrieved from the archive were scrutinized retrospectively, with the aid of a viewing box until those with fluid-induced artefacts were identified and isolated. The nature, grayscale appearance and origin of artefacts were arrived at by consensus of the researchers and documented. Divergence in opinion or ambiguous artefacts was resolved through darkroom simulations. Data was analyzed with a simple calculator.
Results: Sixty-one (1.1 %) radiographs with fluid-induced artefacts were noted. Developer caused black artefacts while fixer, water and grease all caused different hue of grey artefacts. Only grease caused artefacts after processing whereas other fluids were inert on them. Water-induced artefacts, as a result of stuck films in the automatic processor had the highest frequency (n = 21; 34.4 %) while water-bed artefact was rare (n = 1; 2 %). The stages at which artefacts were introduced were noted as pre-processing, processing and post-processing, respectively.
Conclusion: All four investigated darkroom fluids are potential artefactual agents. A knowledge of their distinct characteristics on films and radiographs may help to reduce distractions during reporting, as well as serve as guide to effective remedial actions during subsequent darkroom processing.
Keywords: Artefacts, radiographer, darkroom, processing, fluid

Introduction

Radiologists may make mistakes when interpreting radiographic images due to the presence of radiographic artefacts [1], which are structures not naturally present in living tissue but of which an authentic image appears on a radiograph [2]. Artefacts mask or mimic clinical features (3) and are distracting, and compromise accurate diagnoses [4], with extreme cases leading to gross misdiagnoses [5]. The radiographic appearances of artefacts range from opaque to grey and, depending on its origin, may have a constant or different position on follow-up or repeat radiographs [3].

Artefacts also lead to film repeat [6] which invariably leads to a repeat visit to the hospital as well as additional radiation dose to patients [7].

Although most artefacts that occur in conventional radiography have become familiar [4], others still present a true diagnostic challenge [8], especially in developing countries where film-screen radiography is still widely used. It was assumed that digital systems which supplanted film-screen systems will eliminate artefacts but that was not to be as they have only managed to reduce artefacts rather than eliminate them [9].

Film-screen radiographic films are processed with the manual processors in light-tight darkrooms. An improvement in technology on the manual processor led to the automatic processor where the process of film transport, agitation, fluid replenishment and drying are automated. While the automatic processor produces neat radiographs with reduced tendency for causing artefacts, just like the unfulfilled expectations from the digital system, artefacts should be expected from there if optimum practice is breached. A review of literature however, while establishing that the darkroom was responsible for most artefacts in practice [1, 2], implicated the manual much more than the automatic processor [1,3]. As at the time of this work, automatic processor was used in the centre in focus.

The researchers had a minimum of 5 years experience working with both manual and automatic processors. The automatic processor machine has three compartments which are occupied by the developer and fixer which are liquid chemicals, as well as ordinary water. The water occupies the second and fourth tanks of the manual processor but only the third compartment of the automatic processor and it is basically used for rinsing. An absence of any or all of these fluids make the use of the automatic processor impracticable. Grease from body lotion as well as from sweat is the 'foreign body' amongst these fluids, and it is transferred onto films and radiographs from the fingertips of the darkroom assistants and radiographers, respectively.

In order to avoid misinterpretation of radiographs, recognizing artefacts and understanding their physico-technical background are of great importance in imaging [9]. This work sets out to investigate the artefactual capabilities of everyday darkroom fluid on x-ray films and radiographs in the course of our work in the Radiology department of a teaching hospital. This will increase the body of knowledge on the subject matter, and give clues to minimizing them.

Material and methods

A total of five thousand, five hundred (5,500) radiographs produced between January to June 2013, and retrieved from the archive were scrutinized retrospectively, with the aid of a viewing box until those with fluid-induced artefacts were identified and isolated. The nature, grayscale appearance and origin of artefacts were arrived at by consensus of the researchers and documented. Divergence in opinion or ambiguous artefacts was resolved through darkroom simulations. To achieve simulations, both radiation sensitized and non-sensitized films were stained with different fluids before and after processing and the reactions and or, interactions with films/ radiographs were noted. Data was analyzed with a simple calculator.

Results

Sixty-one (61) fluid-induced artefacts were isolated (1.1 %). Black artefacts were peculiar to developer while different shades of grey emanated from fixer, water and grease. Only grease had the capability to induce artefacts on radiographs, but this is easily erasable and with no consequence to the image (Table 1). Water marks as a result of stuck films in the processor was the most common form of fluid artefacts (n = 21; 34.4 %) while waterbed artefact was the least (n = 1; 2 %). Also, artefacts were introduced in all three stages of processing. These findings are summarized in Table 2. Shown in Figure 1 is developer artefacts from roller marks. In the event of power failure films may be trapped between the rollers of the automatic processor.

In the postero-anterior (PA) skull radiograph shown in Figure 1, (A) is evidence of completion of development. (B) represents region of film in contact with developer-wet exit rollers in developer compartment. (C) represents film in contact with developer-wet cross-over roller. White arrow shows film movement through the automatic processor. Figure 2 is evidence of contact of fixer solution with (i) a radiation-sensitized but not-yet-processed film which results irredeemably in a white smooth-edge mark on the radiograph; (ii) a processed film does not discolor or affect the image; (iii) a non radiation sensitized film has the same effect as (i) but such films should not be used anymore due to the risk of screen stains and developer neutralization during processing. The white patch is evidence of silver halide erosion. This image was simulated in the darkroom.

Figure 3 gives an insight of the artefacts caused by water on radiographs. The image represents an attempt to perform a lateral chest x-ray on a quadriplegic patient brought to the department on a waterbed made of multiple 60cl cellophane sachets of drinking water converted to bed to avoid bedsores. The inferiorly-located (below curved lines) greyish homogenous opacity represents the waterbags. It is almost iso-dense with the diaphragm located superiorly to it. This water artefact could be a source of confusion to the reporting radiologist oblivious of its origin.

Discussion

Our findings reveal that black artefacts are only induced by developer while fixer, water and grease produced different hues of grey artefacts. The high density areas (blackness) caused by developer are evidence of prolonged contact with the fluid which led to latent image formation through metallic silver atom deposition. Both radiation-sensitized and non-sensitized films are susceptible to developer interaction (Figure 1). As revealed by previous work, abnormally high density areas, aside being artefactual, often mask anatomical markers and may lead to reject and subsequently, repeat with the attendant radiation dose and risks [1].

It was observed in this work also, that developer-stained feedtray was a salient cause of artefacts. This particular artefact exhibited an aesthetic tattooing with interspersed black and grey areas like a chess board. This occurs when a film being fed into the automatic processor, and which has made some contact with developer fluid, is withdrawn. Developer subsequently stains the feedtray. Unless quickly detected and cleaned from the tray, these chessboard artefacts should be expected. Fixer artefacts are difficult to come by because the chemical is sandwiched between developer and water and its effects is cushioned by this 'accident' of location.However, fixer should be suspected as the likely cause of an artefact when greyish-white areas of reduced density are noted on radiographs.

Film stasis in fixer-wet rollers lead to excessive fixing and the formation of uniform straight line areas of reduced density across the film. If drops of fixer interact with the film however, smooth-edged, minus density areas should be expected (Figure 2). When films are stuck in the automatic processor, the efficiency of the squeegee action of rollers is compromised and subsequently, even drying is not so perfect anymore. When stuck radiographs are separated manually the area of adhesion show distinct, zigzag greyish water mark artefacts.

A serendipitous encounter in this work was the behaviour of water(bag) as a foreign body. It presented as greyish homogenous opacity that was almost iso-dense with the diaphragm. This water artefact could be a source of confusion to the reporting radiologist oblivious of its origin (Figure 3). Grease has adhesive and cohesive properties [10]. This is detrimental to the archival longevity of radiographs as multiple radiographs in a film jacket may stick together thereby accelerating deterioration of the images. The probability of culturing bacteria is also there. However, in this present study, grease was noted to stain the radiographs with a dirty, conspicuous and constantly expanding hue. It equally diminished the aesthetics of the radiographs.

Although the final output remained diagnostically useful, it was aesthetically unsatisfactory.

The authors introduced three mnemonic stages at which artefacts are introduced, to aid memory recall.

This division is fairly in tandem with several previous works [1, 8]. Although different researchers may come up with different closely-related stages, the mnemonic classification of this work gives some edge due to ease of recall [1].

Table 1: Fluid reaction and colour of fluid-induced artefacts

Characteristics	Developer	Fixer	Water	Grease
Pre-processing	Black	Greyish-white	Nil	Nil
Processing	Black	Grey	Grey	Nil
Post-processing	Nil	Nil	Nil	Grey

Table 2: Characteristics of artefacts

Processing stage	Cause of artefacts	Appearance	Description	Specific cause(s)	Frequency
Pre-processing	Water	Grey	Grey areas with same isodencity as diaphragm	Water bed	1 (2%)
Pre-processing	Fixer	Greyish-white	Smooth-edge, greyish-white marks	Fixer contact with film before processing (simulated)	2 (3%)
Processing	Fixer	Grey	Straight grayish lines on films	Film stasis between fixer-wet rollers	5 (8.1%)
Processing	Water	Grey	Minus density, irregular thick tattoos	Stuck films	21 (34.4%)
Processing	Water	Grey	Noticeable irremovable dirt on films	Dust and dirt particles floating atop rinse which was not removed or agitated	12 (20%)
Processing	Developer	Black	Straight black lines on films	Film stasis between developer-wet rollers	2 (3%)
Processing	Developer	Greyish-black	Greyscale , regular tattoos	Developer-stained feed tray	7 (11.5%)
Post-processing	Grease	Grey	Erasable, greasy finger prints	Poor handling during sorting	11 (18%)

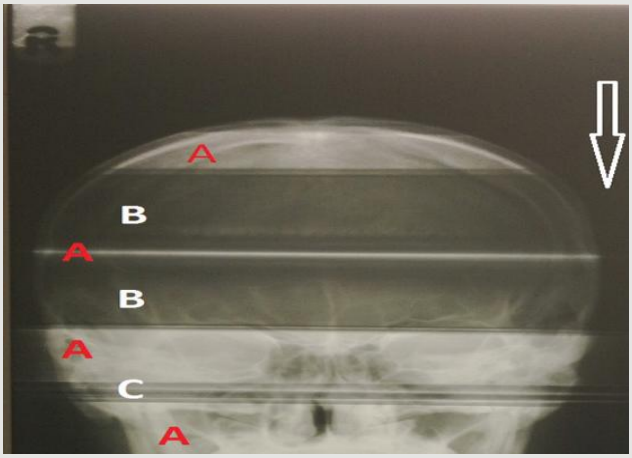


Figure 1: Developer artefacts from roller marks

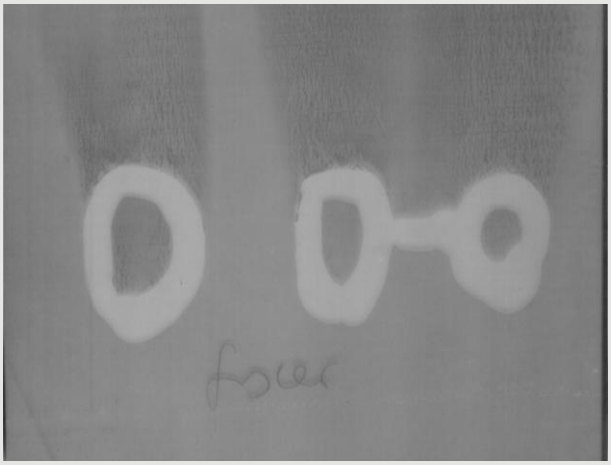


Figure 2: Fixer stain artefacts

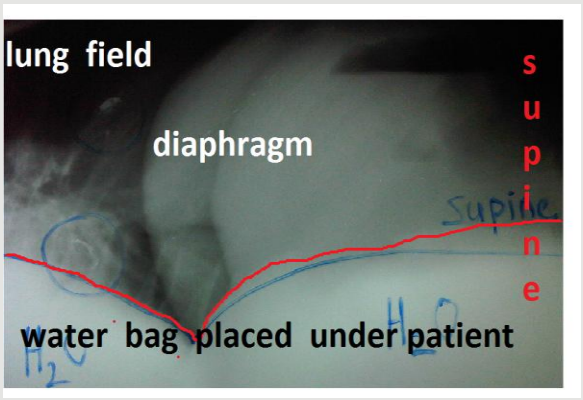


Figure 3: Water as an artefact

Conclusion

The appearance of fluid artefacts in radiograph is greyscale. Developer and fixer are highly sensitive on films but inert on radiographs. Only grease introduced artefacts on radiographs. Most radiographic artefacts can be prevented by proper storage and handling of films and by optimal practice of darkroom techniques [3]. We recommend regular quality control and trouble-shooting attitude amongst darkroom assistants and radiographers to minimize the occurrence of artefacts.

Reference

[1]. Adejoh T, Onwuzu S. W. I., Nkubli F. B. and Ikegwuonu N.C., 2014. Film-Screen Radiographic Artefacts: A Paradigm Shift in Classification. Open Journal of Medical Imaging; 4(4):108-111

[2]. Akinola R, Oluwarotimi A, Jinadu F, Akintomide T, Soeze P, Asuquo O, 2008. Artefacts in Mammography: A three year Experience in a New Teaching Hospital. The Internet Journal of Radiology; 8 (1)

[3]. Kirberger RM, Roos CJ., 1995. Radiographic artifacts. Journal of South African Veterinary Association, 66(2): 85 – 94

[**4].** Caesar,LJ; Schueler BA;Zink FE; Daly TR; Taubel JP; Jorgenson LL; 2001. Artefacts Found in Computed Radiography. British Journal of Radiology; 74:195-202

[5]. Karen M. Horton, Pamela T. Johnson and Elliot K. Fishman, 2010. MDCT of the Abdomen: Common Misdiagnoses at a Busy Academic Center. American Journal of Roentgenology; 194(3): 660-667

[6]. Charloeykitti L, Muttarak M, et al 2006. Artefacts in Mammography: Ways to Identify and Overcome them. Singapore Medical Journal; 47(7):634-641.

[7]. Eze KC, Omodia N, Okegbunam B, Adewonyi T, Nzotta CC ,2008 . An audit of rejected repeated xray films as a quality assurance element in a radiology department. Nigerian Journal of Clinical Practice;11(4):355-8.

[8]. Jacquelyn P.Hogge, Carolyn H. Palmer, Caroline C. Muller, Sherrill T. Little, Deborah C. Smith, Panos P. Fatouros, Ellen Shaw de Paredes,1999.Quality Assurance in Mammography: Artifact Analysis. RadioGraphics, 19 :503-522.

[9]. Waaler, D and Hoffman, 2010.ImageRejects/ Retakes -Radiographic Challenges. Radiation Protection Dosimetry;139(1-3)375- 379.

[10]. Achanta S., Jungk M. and Drees D., 2011. Characterisation of cohesion, adhesion, and tackiness of lubricating greases using approach–retraction experiments. Tribology International ; 44(10):1127- 1133

How to cite: Adejoh T, Moi AS, Nkubli FB, Chiegwu HU. Artefactual Behaviour of Fluids in Radiographic Darkroom Practice. J Assoc Rad Niger, 2014; 28 (1): 1 – 5