Loosing or damaging occur in x-ray films and Its effects on patient health

Abstract

Radiography is the use of X-rays to view a non-uniformly composed material such as the human body. By using the physical properties of the x-ray an image can be developed which displays areas of different density and composition. This retrospective descriptive study aimed to assess the ratio and the reasons why damaged X-ray films had been detected by the staff of the x-ray department of the Azadi Hospital in Kirkuk city. The present study was carried on 1651 patients who attended radiological department, for period from 1-7-2012 to 30-9-2012. The result showed percentage of x-ray film damaging or losing (25.13%), these losing caused by errors occurred during radiology process, the most x-ray films damaging comes from Technical errors (exposure dose and film processing errors) would be 253 (60.9%) of x-ray film. These errors increase the risk of radiation effects on patients health due to retake x-ray film, patient exposed another dose of radiation increased X-ray film losing.

Key word: x-ray film damaging, staff, radiology department.

Introduction

X-rays are electromagnetic radiation that is capable to causing ionization in matter due to its to allow high energy content, it can penetrate the body non invasive visualization of the internal anatomy and can causes damage in tissues of the body. (Committee. College Park, Md:2008). X-rays have wavelengths between about 10 nanometers (10 x 10^-9 meters) and 10 picometers (10 x 10^-12 meters). X-ray radiation oscillates at rates between about 30 petahertz (PHz or 10^15 hertz) and 30 exahertz (EHz or 10^18 hertz). X-rays are subdivided into hard X-rays and soft X-rays. The lower energy soft X-rays have longer wavelengths, while the higher energy hard X-rays have shorter wavelengths. The cut off between the two types of X-rays is around a wavelength of 100 pico meters or an energy level around 10 keV per photon. X-rays with energies between 10 keV and a few while X-rays are the result of accelerating electrons. (Robinson PJ,2007).

Biological effects of radiation:
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Biological effects of radiation are typically divided into two categories. The first category consists of exposure to high doses of radiation over short periods of time producing acute or short term effects.( Ling C C,2010)
The second category represents exposure to low doses of radiation over an extended period of time producing chronic or long term effects. High doses tend to kill cells, while low doses tend to damage or change them. High doses can kill so many cells that tissues and organs are damaged.(Varma& Zaider 2006).

High doses can effect on the skin include erythema (reddening like sunburn), dry desquamation (peeling), and moist desquamation (blistering). Skin effects are more likely to occur with exposure to low X-ray radiation. Most of the energy of the radiation is deposited in the skin surface.
The dose required for erythema to occur is relatively high, in excess of 300 rad. Blistering requires a dose in excess of 1,200 rad.

Hair loss is similar to skin effects and can occur after acute doses of about 500 rad. Sterility can be temporary or permanent in males, depending upon the dose. In females, it is usually permanent, but it requires a higher dose. To produce permanent sterility, a dose in excess of 400 rad is required to the reproductive organs. Cataracts (a clouding of the lens of the eye) appear to have a threshold of about 200 rad.

Low doses spread out over long periods of time don’t cause an immediate problem to any body organ. The effects of low doses of radiation occur at the level of the cell, and the results may not be observed for many years.

There are three general categories of effects resulting from exposure to low doses of radiation.(Spadinger and Palcic, 2009)

Genetic - The effect is suffered by the offspring of the individual exposed.

Somatic - The effect is primarily suffered by the individual exposed.

Since cancer is the primary result, it is sometimes called the Carcinogenic Effect.

In-Utero - Some mistakenly consider this to be a genetic consequence of radiation exposure, because the effect, suffered by a developing embryo/fetus, is seen after birth. (Wlodek and Hittelman , 2008).

Radiography:

is the use of X-rays to view a non-uniformly composed material such as the human body. By using the physical properties of the ray an image can be developed which displays areas of different density and composition( Filler& Aaron,2010). A heterogeneous beam of X-rays is produced by an X-ray generator and is projected toward an object.

According to the density and composition of the different areas of the object a proportion of X-rays are absorbed by the object. The X-rays that pass through are then captured behind the object by a detector (film sensitive to X-rays or a digital detector) which gives a 2D representation of all the structures.
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superimposed on each other. (Herman, G. T., 2009).

**X-RAY FILM:**

The major recording medium used in radiology is X-ray film. The film can be exposed by the direct action of X-rays, but more commonly the X-ray energy is converted into light by intensifying screens and this light is used to expose the film, as described above.

The basic structure of the film is outlined in Figure (1).

![Figure 1: Cross-section through a double emulsion film](image)

The film base provides the structural strength for the film. However, the base must be flexible for ease of processing, essentially be transparent to light and be dimensionally stable over time. Early base materials were glass and cellulose nitrate, but more recently cellulose triacetate and polyester have been adopted. A thin layer of adhesive is then applied to the base and this binds the emulsion layer. Covering the emulsion is a thin supercoat that serves to protect the emulsion from mechanical damage. (Dunne E, 2008)

The two most important ingredients of a photographic emulsion are **gelatin** and **silver halide**. With most X-ray film the emulsion is coated on both sides of the film but its thickness varies with the nature and type of the film, but is usually no thicker than 10 mm. Photographic gelatin is made from bone and is ideal as a suspension medium in that it prevents clumping of grains. In addition, processing chemicals can penetrate gelatin rapidly without destroying its strength or permanence. Silver halide is the light sensitive material in the emulsion. In X-ray film, sensitivity is increased by having a mixture of between 1% and 10% silver iodide and 90 to 99% silver bromide. In photographic emulsion the silver halide is suspended in the gelatin as small crystals (called **grains**). Grain size might average one to 2.3 mm in diameter with up to a billion silver ions per grain and billions of grains per ml of emulsion. In its pure form the silver halide crystal has low photographic sensitivity. The emulsion is sensitised by heating it...
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under controlled conditions with a reducing agent containing sulphur. This results in the production of silver sulphide at a site on the surface of the crystal referred to as a sensitivity speck. It is the sensitivity speck that traps electrons to begin formation of the latent image centres. (Department of Radiology and Medical Imaging 2012). Silver bromide is cream coloured and absorbs ultraviolet and blue light, but reflects green and red light. Historically, this was fine since the principle emission from calcium tungstate screens is blue light. Films for photography of image intensifier images and films for use with rare earth screens need to have their spectral sensitivity broadened to encompass the longer wavelengths associated with the emissions from these screens. This is accomplished by the addition of suitable dyes. Thus, we have green sensitive orthochromatic film and red sensitive panchromatic film.

Film processing:

Film processing is a multi-stage process involving development, fixing, washing and replenishment (Figure 2). In development, the exposed grains are preferentially reduced to black metallic silver. In fixing the remaining unexposed grains are dissolved so that they can be removed from the emulsion by washing. Replenishment ensures that chemical balance is maintained with usage of the processing solutions. (Rothenberg 2010).

Figure 2: Schematic of an automatic film processor, showing the pathway followed by film as it is guided by roller mechanisms through the processing solutions.

Photographic characteristics of x-ray film:

When the X-ray beam passes through body tissues, variable fractions of the beam will be absorbed, depending on the composition and thickness of the tissues and the quality (kVp & filtration) of the beam. The

magnitude of this variation in intensity is the mechanism by which the X-ray beam emanating from the patient produces diagnostic information. The information content of this X-ray image must be transformed into a visible image on the X-ray film with minimal information loss.
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In general radiography, the X-ray image is first converted to a light image using intensifying screens, which in turn produce a visible pattern of metallic black silver on the X-ray film. Ultimately, the degree of blackening is related to the intensity of the radiation reaching the intensifying screen. The amount of blackness on the film is called the **optical density**, \( D \), which is defined in Figure 3. For example, if 100 light photons are incident on a film and only one is transmitted the film density would be \( \log_{10}(100) \) or 2. Useful densities in diagnostic radiology range from about 0.2 to about 2.5. High density means black films. If the relationship between the logarithm of the radiation exposure and the optical density is plotted we obtain a curve known as the **Characteristic Curve**. For film exposed with an intensifying screen, this curve is essentially sigmoidal in shape (Figure 4). It is characterized by:

![Diagram](image)

**Figure 3:** The definition of optical density, \( D \).

A toe or region of low gradient at low exposures, a region of relatively steep increase in density for minimal exposure increases, and a third relatively flat region called the shoulder at high exposures. The important part of the curve diagnostically is the approximately linear region between the toe and the shoulder where the density is proportional to the logarithm of the exposure.
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The information content resulting from the radiograph arises from differences in the film density, which we can define as **radiographic contrast.** Radiographic contrast depends on **subject contrast** and **film contrast.** For the moment you should recall that subject contrast depends on the differential attenuation of the X-ray flux as it passes through the patient and is affected by thickness, density and atomic number of the irradiated parts of the subject, the kVp, the presence of contrast medium and scattered radiation. For example, relatively few X-ray photons pass through bone compared with soft tissue but care must be taken in selecting the correct kVp in order to produce an X-ray image of high information content for the screen-film to record. That is, the kVp influences the magnitude of the subject contrast.

Film contrast depends on four factors:

- the characteristic curve of the film,
- the film density,
- use of intensifying screens or direct exposure and
- the film processing.

The slope of the straight line portion of the characteristic curve tells us how much change in film density will occur as exposure changes. The slope or gradient of the curve may be measured and the maximum gradient is called the film **gamma**, which tells us how well the film will amplify the subject contrast. (Royal College of Radiologists 2006).

**Radiation safety:**

1. Protection of the physician should never be in the...
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primary beam, Patients should not be held during an exposure unless it is clinically necessary, i.e. sedation or general anaesthesia is required in many cases

o All physician participating in the examination should wear appropriate protective clothing (lead rubber aprons, gloves/sleeves)

o physician not involved in the radiographic examination should be excluded from the room

o The room should be large and have protective screens for use during exposure

o Appropriate dosemeters should be worn to identify if unacceptable exposure to X-Rays is occurring

2. Protection of the patient

o Use the fastest film/screen combination possible to obtain diagnostic pictures

o Collimate the primary beam to include only the area of interest

o Use a reasonable film-focal distance

o Avoid repeat radiographs by ensuring proper exposure and development

3. Protection of the public

o Doors and walls should be treated as required to prevent escape of radiation

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o Warning lights should be placed outside the radiography room to signal tube preparation and exposure

o Radiation warning signs should be present on the doors

o People under the age of 16 and pregnant women should not be allowed to assist in radiographic procedures. (Marchese., et al, 2009)

Material and Method

The present study was carried on 1651 patients who attended radiological department in Azadi General Hospital in Kirkuk city, for period from 1-7-2012 to 30-9-2012. The number of x-ray film used in radiology process and the number of x-ray film losing due to retake x-ray film will be recorded.

Result and Discussion

This retrospective descriptive study aimed to assess the ratio and the reasons why damaged X-ray films had been detected by the staff of the x ray department of the azadi Hospital in Kirkuk city. Under investigations were all sorts of films used to x-ray patients The total number of films the radiology
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department was dealing with over the three month were 1651 films
table(1). The data was collected using record forms and for analyzes
descriptive statistics were used in calculating percentage, the result
showed percentage of films damaging or losing by repeating x-ray, table (1) 415(25.13%).
About 122(29%) of x-ray films repeating due to patient movement or breathing inspiration expiration
during Radiology process, these types of errors coming from not enough information giving to the patient about the bases of the imaging process and what to do during this process (Berlin 2007)(Murphy 2008). Technical errors (exposure dose and film processing errors) would be 253(60.9%) of x-ray film damaging causes, technical errors coming from technicians number in
department will be few in compared with patients attending the radiology department and also variation of degree, some them have degree of radiology Diploma, radiology Bachelor and others have nursing Diploma and Bachelor of Science in Physic so we have limited expertise and limited scientific background on the process of Radiology (Krupinski,. etal, 2010).
Results found that about 40(9.6%) damaged in radiographic films was caused by error in coming report from emergency physician to technicians for determining the exact location of the injury (Southgate, 2008) (Jolly,. etal, 2011). These errors increase the risk of radiation effects on patients health due to retake x-ray film, patient exposed another dose of radiation and increase x-ray film loosing .(Goddard,. et al, 2011).

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<thead>
<tr>
<th>Total number of x-ray film</th>
<th>Number of x-ray film damaging</th>
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<tr>
<td>1651</td>
<td>415</td>
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<tr>
<th>Patient movement</th>
<th>Technical error</th>
<th>Error in report coming from Dr to technicians</th>
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<tr>
<td>122(29%)</td>
<td>253(60.9%)</td>
<td>40(9.6%)</td>
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