Special Communication

Xeroradiophotography

Mojtaba Navabpoor, Massoud Alizadeh Azimi
Radiation Sciences Department, Paramedical Sciences College of Shahid Beheshti Medical University, Tehran, Iran.
Corresponding Author: Massoud Alizadeh Azimi. Email: maa_tech20@yahoo.com

Abstract

Sensitive emulsion of current radiographic film is constructed by silver halogen crystals, including millions of ions that form the image. The resolution of image is associated with the number of ions, but they cannot exceed a certain limit in terms of surface area unit. Besides, relevant accessories and stages of processing also mean longer time and higher cost. To reduce such barriers, the Xeroradiophotography system was designed and built on the basis of Xero Physical phenomenon in which the image is formed by taking advantage of both X-rays and visible light. Besides, different physical method for developing and fixing is used, replacing the conventional photochemical process with the electrostatic function. As a result, high-quality images are obtained while reducing radiation and other biological hazards, making radiography safer and quicker and less expensive. As this paper highlights, the device could be best used for soft-tissue procedures like mammography.

Keywords: Radiography, Xeroradiophotography, Mammography.

Introduction

Diagnostic imaging systems are very important in para-clinical practice because these systems have effectively been widely utilised in diagnosis. Consultants, as such, need to be encouraged to improve the efficiency of medical imaging systems through modification for a more accurate diagnosis.

Radiographic film sensitive emulsion is formed by silver halogen crystals. A crystal is a package of certain number of silver and bromine atoms - about one to ten millions - that will be readily susceptible to X-ray stimulus, bringing them on the way to becoming a radiographic image.[1]

In current radiography, latent image of an X-ray exposed object is produced when X-rays strike silver bromide crystals in the film emulsion; they can only absorb a very small amount of X-ray energy to convert them into a latent image. The crystals ionise into positively-charged silver ions and negatively-charged bromide ions, with the degree of ionisation depending on the amount of exposure received. When such a situation is created, a latent image is produced. The ionic equation can be written as: Ag Br + X-rays → Ag+ (silver ion) + Br - (Bromine ion).

The disadvantages of radio-chemical radiography are detailed below:

A) Unilateral Contrast:

Different densities constituting the visible processed silver image originate from the latent image of the crystals. But unexposed crystals or those which are exposed by lower-than-threshold of radiation stimulation do not get an opportunity to develop to any perceptible degree. Substantially, the unexposed silver bromide is unaffected by this treatment during the development period. Hence, the radio-chemical radiograph is formed only by reduced silver and possesses unilateral contrast.[2] The latent image in Xeroradiophotography, in contrast, comprise both negative and positive charges that attract opposite charges of fine-grain toner to make a more visible image.

The number of silver halogen crystals associated with image resolution is for lesser, per surface unit and the crystal size associated with image wedge sharpness is relatively big in current radiolgraphy. The fine-grain toner, which is the constituent unit of Xeroradiophotographic image, is considerably larger in number and smaller in size. The application of a crystallised intensifier sensitive screen is inevitable for current radiography protection because that allows lower radiation intensity on the patient.[3]

B) Accessories and Wet Processing Tools:

The current radiographic image is obtained via photochemical procedures, photo protector stroke resistance cassette, intensifier screen, special films, film processing tools, film processing agents and other accessories. These stages of radiographic image-making, particularly with regard to today's technology, are relatively expensive and time consuming.

Xeroradiophotography mechanism is similar to Xeroradiography, but in this system for the patient's dose reduction, a photo-intensifier screen is used. However, by doing so the image resolution and edge sharpness are relatively diminished. But a specific mechanism has been contrived to ensure optimal image resolution and sharpness. Image intensifying screen is a sheet of crystals of inorganic salts (called phosphors) which emit fluorescent light when excited by X-ray radiation .In this method, the selected intensifier sheet is characterised to emit proportionate visible light wavelength to conform to the photoconductor maximum function. However, the intensifier screen augments the emitting X-ray through the conversion of X-ray to light, but the divergence of light diminishes either resolution or sharpness. To compensate for such elements, an optical device has been improvised which consists of cylindrical lens, with narrow leaner focus in which the fluorescent light coming out of the intensifying screen is converged. The latent image is thus localised and then compressed to regain optimal resolution and sharpness. The compressed latent image is then transferred to cylindrical photoconductor surface known as drum. To process the latent image, fine-grained toner powder is used. The grains are 200 times smaller than those of radiology film emulsion crystals.

Therefore, there is considerable promotion of image quality in Xeroradiophotography that could be a step forward towards a new imaging diagnosis system.

Methods and Results

Digital Radiography:

Other methods used for the purpose currently included the following: In this method the X-rays latent image is first converted to visible light, and then to video signals (via specific camera). Recorded images in the memory are printed on a special thermal paper. Comparing these images with the usual radiographs suggest that the digital images have no preference over ordinary radiographic images in all aspects such as resolution, contrast, image, edge sharpness and expenses. The shorter processing time is the only mentionable value of digital radiography.

Xeroradiography:

This method is based on the mechanism in which a charged surface of photoconductor (amorphous selenium) partially dissipates the charge by exposure of X-ray to form an electrostatic latent image that becomes visible by xerographic processing. The development of Xeroradiographic image is defined as the selective deposition of imaging material onto a surface in response to electrostatic forces. Development consists of attracting small charged dust particles, called toner, to the electrostatic latent image on the selenium surface of the plate. The exposed Xeroradiographic plate is placed on the top of a dark box into which an aerosol of charged toner particles is sprayed through a nozzle. The electric charge on the toner particle is produced by friction between the toner and the wall of the nozzle. The basic problem of Xeroradiography method is

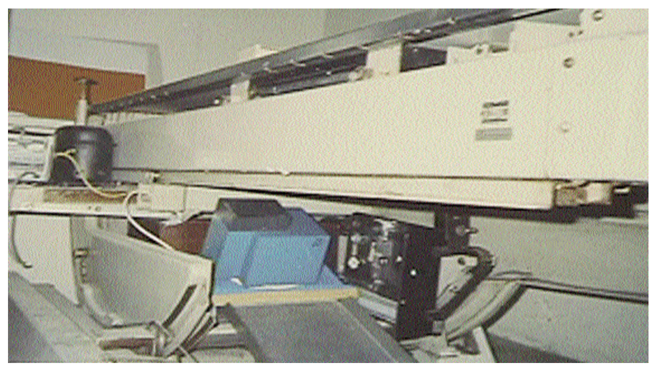

Figure-1: The first picture of Xeroradiophotography system prototype: With dimension of W 55cm, L 80cm, H40cm.

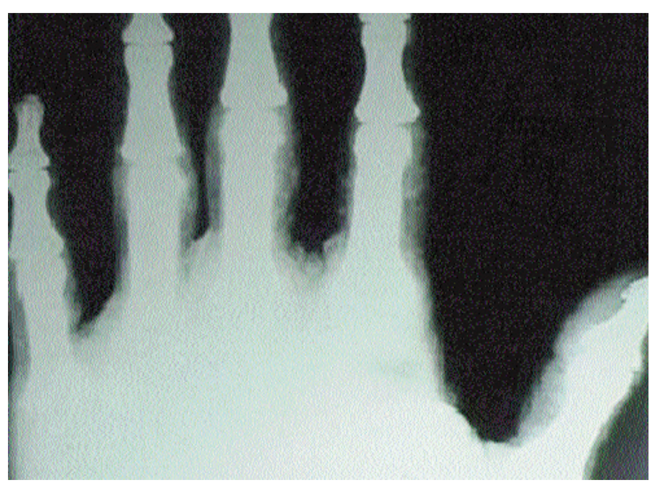

Figure-2: The digits soft tissue Xeroradiophotography that demonstrates soft tissue with appropriate clarity to compare with current radiography.

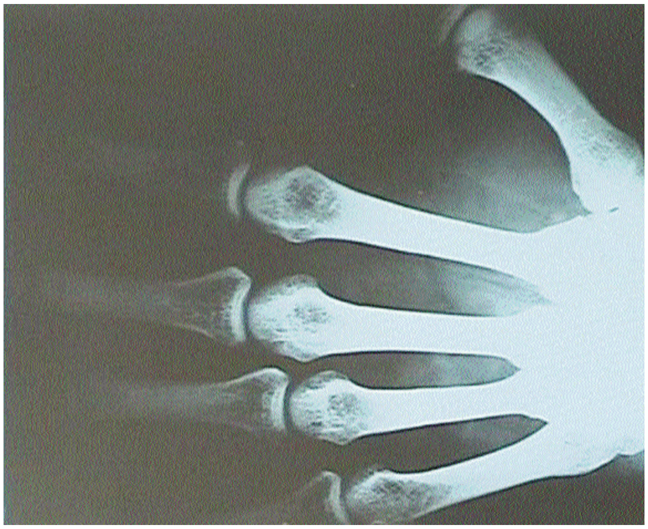

Figure-3: The first Xeroradiophotography of the inventor's hand has shown the more proper bone structure and edge sharpness, specifically around the carpo-metacarpal joints to compare with current radiograph of the same hand.

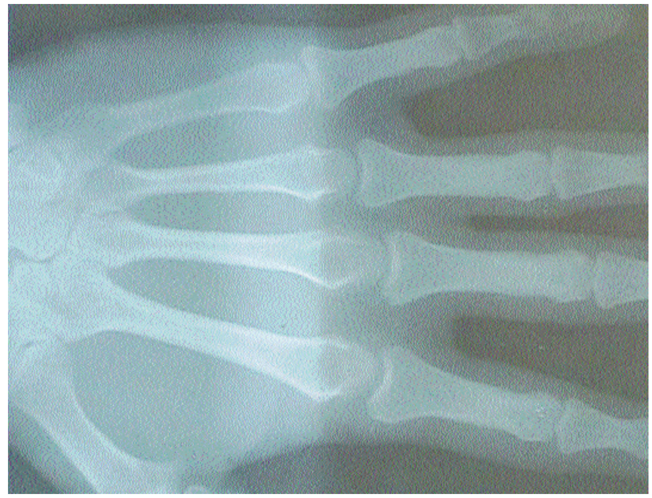

Figure-4: The current radiography of the same hand.

the requirement of high-dose radiation exposure onto the patients for image making.[4] Despite its considerable benefits, the utilisation of this method is, therefore, confined, and seldom practically used. The cause of high-dose exposure in Xeroradiography is the lack of intensifier screen and photo-image formation, on the basis of X-rays alone. In contrast, in the photochemical method, the role of X-ray is about 5% for image-making, while 95% of the image is constituted through photo-image intensifier.

Xeroradiophotography has all the positive attributes of Xeroradiography. The patient dose is even less than conventional radiography, and all the image preparation stages are done quickly. This system could be installed beneath the radiographic table. In 3 to 8 seconds after exposure, printed images on paper or a transparent sheet come out from the system.

The system gives a better image with edge sharpness being at least one hundred times better than the photochemical procedure. Besides, it is quick - about 3 to 8 seconds - and less expensive because it does not need film, cassette, intensifier screen, film-processing, processing agents and other accessories. There is also a possibility for the system to utilize electrostatic digital technology (Figures 1-4).

Conclusion

Trials conducted after the creation of a system prototype. produced images that had resolution relatively higher than conventional radiographs. Specifically, soft tissue xeroradiophotographs showed an acceptable quality for using this technique in mammography. The main disadvantage of the current mammography is high-dose procedure that also causes high patient's dose, but in Xeroradiophotography, such a dose is 200 percent lower than that in current mammography.

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