CHAPTER 1

INTRODUCTION

1.1 Background and rationale

In the last few decades, numerous technological advancements have shown in the field of radiology such as sonography, color doppler, computed tomography (CT), magnetic resonance imaging (MRI) and digital subtraction angiography (DSA). In fact this has prompted the change of the nomenclature of this specialty from radiology to medical imaging. Conventional radiology as known as plain films has been benefited significantly as technological advancement on computer technologies. As the hardware and software revolution has progressed globally in all fields, this has naturally benefited these modalities but not conventional radiology. The key to advanced conventional radiology is in digitizing the images so they can be manipulated in an electronic format and thus enhanced.

At present day, computed radiography (CR) is based on the use of photostimulable phosphors, which are also known as storage phosphors. The phosphor used mostly is barium fluorohalide family in powder form and deposited onto a substrate as an imaging plate or screen. X-ray absorption mechanisms are identical to those of conventional phosphor screens used with film. They differ in that the useful optical signal is not derived from the light emitted in prompt response to the incident radiation. But rather from subsequent emission when the latent image, consisting of trapped charge, is optically stimulated and released from metastable traps. This triggers a process called photostimulated luminescence (PSL) resulting in the emission of shorter wavelength (blue) light in an amount proportional to the original x-ray irradiation. In CR, an imaging plate (IP) containing the storage phosphor is positioned in a light-tight enclosure, exposed to the x-ray image and then read out by raster scanning with a laser to release the PSL. The blue PSL light is collected with a light guide and detected with a photomultiplier tube (PMT). The PMT signal is digitized to form the image on a point-by-point basis.

The advantages are its large dynamic range, digital format, portability, and post-processing capability. The technology of CR continues to improve in concomitant with the development of digital technology.

Computed Radiography (CR) has become a major digital imaging modality at Department of Radiology, King Chulalongkorn Memorial Hospital, Thai Red Cross Society since 2003. CR system changes workflow from the conventional way of using film/screen by employing photostimulable phosphor plate technology. This results in the changing perspectives of technical, artefacts and quality control issues in. Guidelines for better image quality in computed radiography include guidelines for users and the quality control programme specifically designed to serve the best quality of clinical images [1]. Radiographers need understanding technological shift of the CR from conventional method to employ optimization of CR images. Proper anatomic collimation and exposure techniques for each radiographic projection are crucial steps in producing quality in digital images. Matching image processing with specific anatomy is also an important factor that radiographers should realize. Successful shift from conventional to fully digitised radiology department requires skillful radiographers who utilize the technology and a successful quality control program from teamwork in the department.

Chest radiography is the most common examination performed in radiology departments worldwide. The main problem in producing chest radiograph is the large difference in the x-ray transmission between the lung and mediastinum [2]. It is difficult to achieve optimum density and contrast of the lung and mediastinum on the same radiograph. Occasionally, two exposures are needed to show these two areas. With advancing technology, the use of computed and digital radiography has increased rapidly worldwide. It is intended to widen diagnostic capabilities, decrease patient dose, facilitate the radiologists' work and reduce cost. With the introduction of computed and digital radiography, the dose to the patient has to be considered without neglecting the image quality [3, 4, 5].

Image Quality in Chest Radiography [6]

Image quality in chest radiography is usually considered in terms of the portrayal of normal anatomy or the depiction of potential pathology. Radiographic display of normal anatomy provides examples of the compromises that arise when image quality is considered. As one example, technical factors that might improve the visibility of unobscured lung may tend to diminish the visibility of lung projecting behind the heart or mediastinum. Consideration of such compromises often dominates careful investigations of image quality for the examination. Although thoracic anatomy is predictable in a given patient, potential abnormal findings are much less and it is not advisable to discuss image quality without reference to a target abnormality of interest. Lesions of clinical importance in chest radiography that might typically escape detection due to poor image quality include small, faint, opacities resulting from an early neoplasm or faint linear opacities caused by early interstitial disease. Technical approaches that might increase the likelihood that one type of target is detected can often decrease the likelihood of the detection of another. Discussions of image quality in chest radiography are most frequently framed in the context of detection of early neoplastic manifestations.

The concepts of image contrast, image sharpness and image noise are the mainstays in the quantification of image quality in medical radiographic science. These are used throughout the report as the basis for discussions of technical image quality in chest radiography.

Chest radiographic technique

The radiographic depiction of thoracic anatomy poses many technical challenges. The early development of radiographic technology for the chest examination first focused on generation of sufficiently intense x-ray beams to allow visualisation of basic anatomy with short exposure times and favorable geometry. Later developments allowed issues related to the wide range of x-ray attenuation resulting from normal thoracic structures to be addressed.

Chest radiography is currently performed with high kilovoltage (120–150 kVp) that is sometimes combined with added filtration of 0.1–0.2-mm copper. This technique is primarily used because of the inherent properties of conventional screen-film radiography. High kilovoltage settings in screen-film radiography improve the penetration of the rib cage and the mediastinal structures and reduce the entrance surface dose. Given the limited dynamic range of conventional screen-film radiography, it is also advantageous that high kilovoltage settings compress the image latitude and therefore result in improved visualization of the large absorption differences within the chest. Finally, high kilovoltage allows for short exposure times that result in fewer motion artifacts.

Moreover, the estimation of radiation burden to the patient should be based on effective dose rather than incident or skin exposure because effective dose describes best the probability of stochastic radiation damage, which is the only type of radiation effect of importance at dose levels typical for chest radiography. Because the relationship between skin exposure and effective dose changes with radiation quality (kilovoltage), an accurate estimation of effective dose is necessary for each kilovoltage considered. This study will lead to the optimization of the exposure technique. With the introduction of computed and digital radiography, the dose to the patient has to be considered without neglecting the image quality.

1.2 Objective

1.2.1 To establish the high kVp technique for chest radiography to the computed radiography in the Department of Radiology, King Chulalongkorn Memorial Hospital, Thai Red Cross Society.
1.2.2 To obtain the optimal image quality of chest radiography when using high kVp technique in CR system.
1.2.3 To compare estimated skin dose on chest radiography to dose reference level (DRL).