CHAPTER 1

INTRODUCTION

1.1 Background and rationale

Intensity modulated radiation therapy (IMRT) is well accepted that local tumor control and normal tissue complications have sigmoidally shaped dose response curves [1]. For normal tissue complications, radiation response also depends on the volume of tissue irradiated. The success of radiotherapy is therefore highly dependent on the radiosensitivity of the particular tumor being treated relative to that of the surrounding normal tissues. The goal in radiation therapy, therefore, is to sufficiently separate the dose response curves of local tumor control and normal tissue complications. Basically, the only physical or dosimetric method for achieving this involves configuring the radiation portals to reduce the dose delivered to the normal tissues, and also the total volume of normal tissue irradiated. During the past two decades, advances in radiological imaging and computer technology have significantly enhanced our ability to achieve this goal through the development of three dimensional image based conformal radiotherapy (3DCRT). Intensity modulated radiation therapy (IMRT) is an especially advanced method of 3DCRT that utilizes sophisticated computer controlled radiation beam delivery to improve the conformality of the dose distribution to the shape of the tumor. This is achieved by varying beam intensities within each beam portal, as opposed to uniform beam intensities as in conventional 3DCRT. IMRT is based on the use of optimized non uniform radiation beam intensities incident on the patient. IMRT treatment plans are often generated using inverse planning or automated optimization three dimensional radiation treatment planning 3D-RTP systems, which use computer optimization techniques to help determine the distribution of intensities across the target volume.

IMRT is a complex form of conformal therapy. Although IMRT can deliver extremely conformal dose distributions, it requires a reliance on the treatment planning system software, its data and algorithms, the information transfer process, and the linear accelerator calibration and operation that is unprecedented in radiation therapy. Error any where in the process can lead to catastrophic mistakes in dose delivery that may be detected first by their clinical consequences. IMRT is a relatively new delivery technology in which, for a given beam direction, many small fields are delivered, each potentially with differing monitor units (MU), to produce the required variations in intensity throughout the volume of interest [2]. A key element for a successful clinical implementation of IMRT is establishing a dosimetric verification process that can ensure the delivered doses are consistent with calculated doses for each patient. Accurate point-dose measurement can be conducted using ionization chambers and thermoluminescent dosimeters (TLDs), but for mapping IMRT dose distributions the use of these measurement devices can be unwieldy or impractical. Dose distribution mapping with TLDs requires significant processing of a large number of dosimeters placed in a custom phantom, while scanning ionization chamber systems are impractical to use with dynamic delivery of multileaf collimator (MLC) IMRT systems. For complete IMRT dose verification, multidimensional measurements are required to quantitatively measure the dose distribution in steep dose gradient regions. Unparalleled high spatial resolution, two-dimensional dose

distributions can be obtained using radiographic film by converting measured optical densities into values of absolute or relative dose [3]. Film based quality assurance (QA) is an important element of any verification for IMRT program. Film quality assurance provides a convenient method to acquire high spatial resolution two-dimensional dose distributions. X-OMAT V film (XV2 film) from Kodak is the most common radiographic film for relative dose distribution measurements for IMRT but the main limitation of XV2 film is it limited dose range for IMRT application [4].

A new commercially released ready-pack film has been introduced that has an extended dose range (EDR2), The composition of this film as reported by Kodak is different from XV2 film in that the EDR2 AgBr grains are 1/10 the size and more uniform in shape than the XV2 grains. In addition, the silver content of EDR2 is about one-half that of XV2, significantly lowering the sensitivity of the film [2]. The result is that the EDR2 film can be exposed in wide range of dose levels (0-600cGy) without becoming saturated. Due to the reduced silver content and smaller grain size, the energy dependent problem might be reduced as well. The main problem in using radiographic film as a dosimeter is the dependence of its sensitive, i.e., the ratio of optical density (OD) and delivered dose, on (a) photon beam energy; (b) film plan orientation with respect to beam direction; (c) emulsion differences amongst film of difference batches, film of the same film; (d) processing conditions; (e) type of densitometer. The most problematic and least avoidable variable is the photon energy spectrum, which, for a given beam quality, may change with both depth in phantom and field size due to the variation in beam hardening and phantom scatter. The variables (c), (d) and (e) can be minimized or eliminated entirely with appropriate calibration (e.g., specific to the film batch, processing conditions and densitometer [5]. Because the dependencies of film response to depth and field size have been suggested to increase with the amount of silver halide present in the film, it seems that, due to the decrease in the emulsion thickness of EDR2 films. If one characteristic curve measured under calibration conditions could be used to convert optical density to dose for EDR2 film over a wide range of energies, depths, and field sizes. Two dimensional absolute dose distributions verification could be performed accurately with the film [3].

The purpose of this study is to investigate the properties of EDR2 film and determine the optimal field size, depth that suitable for dosimetric verification of dynamic IMRT at the department of Radiology, King Chulalongkorn Memorial Hospital.

1.2 Research objectives

1.2.1 To study the characteristic of EDR2 film with respect to energy, field size of the beam and the measurement depth.

1.2.2 To measure the absolute isodose distribution of IMRT plan that can be compared with calculated isodose distribution.