CHAPTER 5

DISCUSSION AND CONCLUSION

5.1 Discussion

The dosimetric verification of radiation therapy is a very important procedure, because successful radiation therapy requires an accurate delivery of dose to a cancerous volume of tissue. It is believed that a decrease of 10% to 15% in dose delivery will reduce the chance of a cure by a factor of two or three and that an increase in dose will similarly increase the chance of irreversible damage.

Film has been a popular dosimeter in situations that require a two-dimensional dose distribution and/or employ a complex from of radiation delivery. EDR2 film was used for IMRT verification, it is a very slow speed, fine grain film.

Film can be used for the determination of relative or absolute dose distributions if a suitable calibration curve is available. In principle absolute dose values are obtained if the film sensitivity is identical for all films. But in a real situation the film sensitivity is never identical due to the small difference of emulsion coating. The investigation of the response of film which also depends on the processor should be considered. However, the dependence of film sensitivity on energy, depth and field size would exist, then the conversion of dose is not a simple procedure. To determine a suitable calibration curve for changing optical density to absolute dose, the mentioned parameters needed to be studied sothat a calibration curve will give correct dose value in all patient of IMRT field.

5.1.1 Film reproducibility and accuracy

The difference in film optical density response to dose for repeated irradiation and developed at different time can be even larger if changes were made to the processor or its chemicals. The small magnitude of this variation would be obtained if the complete daily QA has been performed. Our result showed the accuracy of EDR2 film dosimetry which was within 1.95% for irradiation dose below 200 cGy for 6 MV x-ray beam but the accuracy was dropped to 4.9% for dose at 450 cGy. For accurate absolute dose distribution of IMRT QA, the dose given to the film should be in the order of 200 cGy so that it would be able to measure absolute dose with an accuracy within 2%.

5.1.2 Sensitometric curve

Due to the silver content in the film emulsion, radiographic film is known to over-respond relative to water (tissue) with increased field size and depth, causing an increase in low-energy scattered photons to the point of measurement [3]. These are the reason that the small field and small depth have less response to radiation than large field and large depth. However, using EDR2 film for the range of the depths, field sizes, and energies investigated here, our results indicated that for megavoltage photon beams, sensitometric curves are slightly independent of field size and depth of calibration. These were due to the reduced silver content and smaller grain size of EDR2 film which made the energy dependence problem reduced [2]. This confirms

with Yeo and Kim [12] who mention that EDR2 film is less sensitive to the scattered low energy photons.

5.1.3 Energy response

The sensitometric curves of 6 MV and 10 MV x-ray beams were nearly identical. This illustrated that EDR2 film was energy independent. The result is the same as Childress et al.[17], they compared the sensitometric curves between 6 MV and 18 MV x-ray beams and found the agreement between the two energies.

5.1.4 Percent depth dose

The percent depth dose measured by ionization chamber and EDR2 film for both 6 and 10 MV x-ray beams showed less discrepancy at shallow depth but more discrepancy at the deeper depth. There were no discrepancies between film and ionization chamber at shallow depth due to small amount of low energy scatter. Whereas, at the deeper depth the low energy scatter were pronounced made the greater film response.

5.1.5 Beam profile

The responses of EDR2 film in the penumbra region of our study were less than the response of ionization chamber which contradicted to the other published result. This may due to low optical density near penumbra, where nonlinearity of sensitometric curve of EDR2 film occurred and caused uncertainty in the dose.

5.1.6 Verification of IMRT plan

The optimal field size of 3x3 cm^2 and 5 cm depth over the range of 20 to 450 cGy for both 6 MV and 10 MV x-ray beams were chosen for film calibration to convert optical density to dose for IMRT verification. This technique could be performed in one film and easy to set. The absolute dose obtained was reliable. The parameters selected seem to be suitable for the IMRT plan. Verification of 2 IMRT plans for 6 MV and 2 plans for 10 MV x-ray beams, showed the good agreement between the measured dose and the calculated by Eclipse treatment planning. Caution should be aware for the high dose because when the dose was greater than 330 cGy, the non linearity between optical density and dose was occurred. The dose accuracy was also degraded at the higher dose. These made the discrepancy compared with the calculation. However, in this institute, the composite IMRT plan was used when doing the verification. The amount of the dose in IMRT plan need to be checked before performing the verification sothat the cause of discrepancy should be notified.

The limitations of EDR2 film dosimetry are the effect of processing condition and interbatch difference on dose response. Working with film is time consuming and quite difficult to determine absolute dose. However, film dosimetry provides a high resolution 2-dimensional dose distribution. From our study, EDR2 film is suitable for IMRT plan verification due to its near tissue equivalent response to low-energy photons, its linear response for large doses, and its better repeatability for high energy doses.

5.2 Conclusion

A Varian Clinac 23EX for 6 MV and Clinac 21EX for 10 MV x-ray beams were used for irradiated film in this studied. The densitometer calibration should be performed before reading the optical density. The film processor quality control should be undertaken before developing the irradiation film. The reproducibility and accuracy of film measurement over the period of this study was within 1.9% for the dose up to 200 cGy and went up to 4.9% for the dose of 450 cGy. The result was agreed with Zhu et al [4].

The dose responses of Kodak EDR2 films were evaluated for clinically relevant depths of 5 cm, 10 cm and 15 cm, and field size of 2x2 cm^2, 3x3 cm^2 10x10 cm^2 and 15x15 cm^2. All the sensitometric curves showed linearity when the optical density ranged from 0.5 to 2.0 and the dose range from 80 to 330 cGy. When the depth was fixed and the field size was varied, the maximum dose discrepancy between the field size of 2x2 cm^2 and 15x15 cm^2 occurred at 5 cm depth which were 4.2% for 6 MV and 2.85% for 10 MV x-ray beam, and greatest difference tend to occur at higher doses. When the field size was fixed and the depth was varied, the maximum dose discrepancy of sensitometric curve between 5 and 15 cm depth were within 1.6% for 6 MV and 3.4% for 10 MV x-ray beams at field size of 2x2 cm^2, small field size have more effect of depth than large field size. We can conclude that the response of film slightly depended on depth and field size, especially at the low dose. However, field size gives more effect than depth. EDR2 film has less energy dependence. The maximum dose discrepancy between 6 and 10 MV x-ray beams was only 0.3%.

The agreements of beam profile of EDR2 film compared with ionization chamber measurement were in the central region but the discrepancy occurred at the penumbra region. The discrepancy of beam profiles in the penumbra region were slightly less for 6 MV compared with 10 MV x-ray beam. The small field gave more discrepancy in the penumbra region than large field. The percent depth dose showed a good agreement at shallow depth, but more discrepancy at the deeper depth especially for small field size for both 6 MV and 10 MV x-ray beams.

Verification of all clinical IMRT plans showed the good agreement between the measured dose and the calculated by Eclipse treatment planning.

5.3 Recommendation

The effect of temperature of processor variation when varying temperature should be studied for good quality control of film processor.