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# Study of Tissue Maximum Ratio of Small Field using Different Types of Detectors in Stereotactic Irradiation

Yoshikazu Tsunashima[1), Toraji Irifune[2), Tsuguhisa Katoh[2), Hiroki Ohtani[2),

1) Science University of Tokyo
2) Tokyo Metropolitan University of Health Sciences

## INTRODUCTION

Stereotactic irradiation uses a small radiation field and needs dosimetry of narrow beams. Accurate dosimetry of the absorbed dose is difficult. Because of the lateral component of secondary electrons which are not in equilibrium. The tissue maximum ratio (TMR) was measured using different types of detectors in several phantoms for 6 MV x-ray beams. The difference of TMR was discussed in terms of detector type, phantom material, phantom thickness and field size. We studied the physical characteristics and the dose evaluation of small field in stereotactic irradiation.

## MATERIAL AND METHOD

### Detectors

There are many detectors used for dosimetry of small field. For measurements, the ionization chamber is mainly used from protocol of absolute dose measurement. In this report, some characteristics measured with several types of detectors were studied. The detectors [ name and nominal ionizing volume or size in parentheses ] used in this experiment are as follows.

(1) ionizing chamber : micro ( thimble-type ; 0.009 ml, Fujitec ),
shallow ( plane parallel ; 0.33 ml, Fujitec )
(2) diode detector : EDD-2 ( p-Si ; 1.5 mm $\phi$ , Scanditronix )
EDD-5 ( p-Si ; $2 \times 2$ $mm^2$, Scanditronix )
999-700 ( p-Si ; 2.5 mm $\phi$ , Scanditronix )
(3) film : Kodak XV2

### Measurement of TMR

The TMR is indispensable for depth dose calculation for stereotactic irradiation with high-energy x-ray beams. The detectors were placed at the isocenter in the phantoms of the MixDP, the Tough Water and Water, in certain position of a reference point to 30 cm depth, respectively. Irradiation was performed for field size of 1×1, 2 ×2, 5×5, 10×10 $cm^2$. The measurements in water phantom were performed using the shallow chamber and the 999-700 detector, which are waterproof detectors.

## RESULTS

These TMR curves were agreed with those measured by each detectors for the field size 10×10 $cm^2$. However, a few difference in TMR curves were observed between each detectors for field size 1×1 $cm^2$. That difference increases with increase of the phantom thickness. This result was more obvious the TMR measured micro chamber compared with other detectors.

## DISCUSSION

It was found that the TMR measured micro-chamber differed the value from other detectors depend on the field size and the thickness of phantom. This is due to the difference of geometric structure of detectors. The sensitivities of the shallow chamber, the EDD-2 detector and the EDD-5 detector are below for lateral component of secondary electrons. However the micro chamber had constant sensitivity to almost $4\pi$ (sr) direction. The value used micro chamber is larger than the other detectors, because the micro chamber can be measured the share of lateral component of secondary electrons. In the small field size, the lateral component of secondary electrons decreases. Therefore, the difference of geometric structure between the micro chamber and the other detectors was affected less on small field size than on large field size. It is suggested that the characteristic of detector was an important factor for the measurement of the TMR for various field sizes.

## CONCLUSION

The TMR for small field size in stereotactic irradiation were measured by several detectors and were discussed in terms of the characteristics of detectors. For the measurement of the TMR, the detector should be carefully choose, where these characteristics and field size are taken into account. We conclude that characteristic of the detector should be studied to overcome the problem of unstable lateral electron equilibrium and to establish a dosimetry for small field in srereotactic irradiation.