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An Evaluation of Water Equivalent Phantoms in Photon Beams

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INTRODUCTION

Measurements of the absorbed dose have been extensively studied in radiation therapy and now adequate consideration for its accuracy is required[1] . To measure the absorbed dose of radiation at various calibration depths, tissue substitute that is similar in absorption and scattering property to muscle, is usually used as a phantom. The phantom consists chiefly of water equivalent, and various water equivalent solid phantoms are now available[2] . In this study two types of water equivalent phantoms used in radiation therapy were measured on tissue-maximum ratio (TMR), field factors using photon beams and so on and furthermore comparison of these results were performed[3] .

METHOD

For the study of water equivalent phantoms, Tough water phantom (Kyoto Kagaku Co., LTD) and Mix-DP phantom (Taisei Medical Co., LTD) were employed. Table 1 shows physical characteristics of water and water equivalent phantoms. TMR was measured in the regions of surface to depth of peak in the phantom using Shallow chamber, and peak to 20cm depth using JARP chamber. Both Shallow and JARP chamber were produced by APPLIED ENGINEER-ING INC. The former chamber type was C-134A; quantity of effective substance: 0.05cm^3,inside diameter: 14mm, and latter type was C-110; quantity of effective substance: 0.6cc, inside diameter: 7mm, size: 230Wx90Hx205Dmm. The field sizes were 5x5cm^2, 10x10cm^2, 15x15cm^2, 20x20cm^2, 25x25cm^2 . The influence of backscatter must be also taken consideration in the measurement of them, so the same 15cm thick material as phantom was put under the measuring point. Source-chamber distance (SCD) was fixed 80 centimeters. Ionized charge measured using photon beams including cobalt 60- γ ray.

	Density	Effective atomic number	Electron density x10^{26} e-/kg	Electron concentration x10^{26} e-/m^3	Elemental composition (Weight-ratio)
Water	1.00	7.42	3.34	3.34	H(0.112), O(0.888)
Tough Water	1.01	7.44	3.25	3.32	H(0.082), O(0.207), C(0.663), N(0.022), Cl(0.004), Ca(0.022)
Mix-DP	1.00	7.01	3.35	3.35	H(0.127), O(0.048), C(0.763), Mg(0.036), Ti(0.014)

Table. 1 Physical characteristics of water and water equivalent phantoms

RESULTS

Fig1 and Fug2 show TMR of tough water phantom and that of Mix-DP phantom respectively. The field factor in the reference point is represented in Fig3.

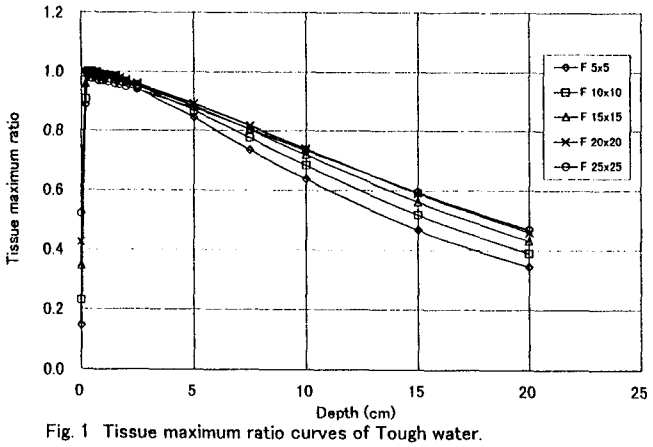

Fig. 1 Tissue maximum ratio curves of Tough water.

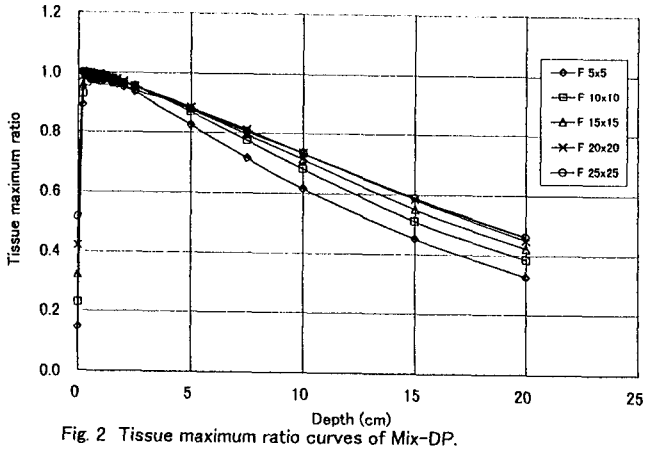

Fig. 2 Tissue maximum ratio curves of Mix-DP.

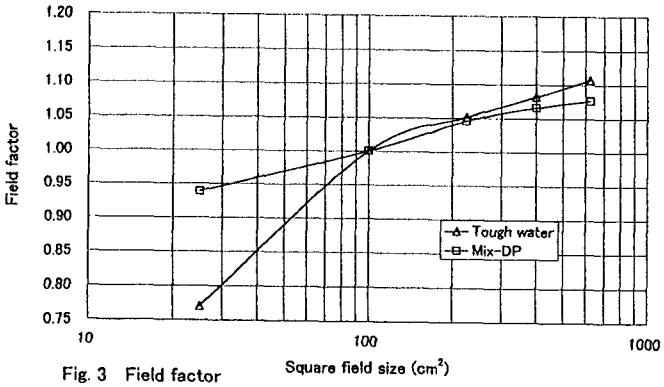

Fig. 3 Field factor

DISCUSSION

Tissue-maximum ratio curves of the water equivalent phantoms indicates that both of the water equivalent solid phantoms tend toward same linearity on the TMR curves. However, the larger the field size is, the less TMR decreases in both of the water equivalent solid phantoms and the shallower the peak position in TMR becomes. The result shows that TMR becomes rather susceptible to multiple scattering rays as the field size changes wider. In other words, multiple scattering rays have considerably effect on the change of peak position and increase of the TMR ratio. Therefore, it is necessary to consider the effect of scattering. There is a large gap of field factor in comparing Tough water with Mix-DP as the field size changes smaller.

CONCLUSION

In this study, we measured TMR of Tough water and that of Mix-DP under the same condition and found that there is a significant difference between them. These differences were caused by the characteristics of the phantoms. Therefore, the various characteristics of phantom must be considered.

REFERENCES

1) ICRU REPORT 24: Determination of absorbed dose in a patient irradiated by of X or gamma rays in radiotherapy. ICRU Washington, D.C., USA, (1976).
2) Toshimine Yabutani, Yoshihiro Ida, Takeshi Sawada: Evolution of Water Equivalent Phantoms. Japanese journal of Radiological Technology, 54(6), 747-753, (1998).
3) Koji Yamashita, Ikuo Ikeshita, Hiromi Ikezaki, others: The comparative study of measurements of high energy x-ray beams, using solid phantoms. Japanese journal of Radiological Technology, 52(10), 1451, (1996).