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A Study of Effects on Dose Distribution Characteristics by Changing Beam Tuning Parameter of Radiation Accelerator in Medicine

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INTRODUCTION

Particle acceleration devices in medicine are constituted of the state of the art devices including ion source part, microwave part, acceleration tube part, radiation measurement part, and computer controlling part. The quality assurance of these parts has a close relation in health care progress. For the quality assurance on radiation therapy devices that require optimal accuracy and precession, we must have interrelationships between the technique to understand the properties of accelerators themselves and the technique of external dose measurements. There are a lot of researches about the characteristic of radiation dose distribution out of an accelerator output, but seldom is performed the researches which find the effects on output difference by changing design properties of a radiation accelerator itself and by aging. Therefore, through investigating the variances on dose distribution by changing beam design properties of a radiation accelerator, our hospital members are able to achieve the know-how about the quality assurance on radiation therapy device, perform more accurate radiation therapy, repair the device when it broken, and maintain the optimal condition of the therapeutic devices.

METHOD

We investigated the effects on dose distribution characteristics by changing beam design properties of a radiation accelerator after we understood the basic properties of ion source, microwave, acceleration tube, and therapy device parts, which constitute a linear accelerator. After injection current (INJ-I), injection voltage (INJ-E), pulse forming network (PFN), bending magnet current (BMI), and pulse repetition frequency (PRF) were selected among the beam tuning parameters which maintain uniform output dose rate, we investigated the permitted range which the linear accelerator automatically maintained and measured the variations of the dose rate, symmetry and flatness by changing current and voltage within the range. We used a linear accelerator(Mevatron MD, Siemens) as a radiation acceleration device. An RFA 300 plus(Scanditronix, Sweden), a 0.6ml ion chamber(Farmer type), an electrometer and an oscilloscope (Tektronix) were employed as measurement devices.

RESULTS

When the currents and the voltages of INJ-I, INJ-E, PFN, BMI, and PRF were modified, we were able to observe the variations (0.9 - 20%) on the dose rate by examining the change of the output pulse using the oscilloscope and by measuring them using the ion chamber. However, when we surveyed the graphs of percent depth dose, symmetry, and flatness from RFA 300 plus, there were 0.00 - 0.02% differences in D10/D20, 0.1 - 0.2 % differences in symmetry, and 0.1 - 0.4% differences in flatness. Here, the D10/D20 is a ratio of the percent depth dose, which indirectly refers the energy of a certain radiation, at 10cm depth and 20cm depth.

DISCUSSION

The difference in dose rate appeared large when the beam controlling parameters are changed however we found that the machine controlled itself automatically in case of the beam energy and the dose distribution. We also found that the default values of the beam tuning parameters were set almost near the optimal value. The machine automatically stopped its operation when it was overloaded beyond the permitted tuning ranges.

CONCLUSION

The fundamental data for quality assurance on medical accelerators were achieved by analyzing the changes of radiation beam tuning parameters which were design properties of accelerator in medicine and the co-relations of dose distribution characteristics. By obtaining the techniques about the quality assurance on linear accelerators in medicine, we could perform more accurate radiation therapy, repair the device when it broken, and maintain the optimal condition of the therapeutic devices.