CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)
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Project Number
J1511

Project Title
Predicting the R50 of High Energy Electrons

Abstract

Objectives/Goals
The goal of this experiment is to see if I can accurately predict the R50 of high energy electron beams produced by a medical linear accelerator. The R50 is the thickness of water or tissue that an electron beam must travel through in order to reduce the dose of radiation to 50% of the maximum dose. The R50 is used to determine how far an electron beam will travel inside a cancer patient being treated with a linear accelerator. This information is used to make sure that an adequate dose of radiation will be delivered to a tumor and that only a safe dose will be given to the normal tissues. My hypothesis is that after I measure the R50 for three different energies of electron beams I will be able to predict the R50 for other electron beams.

Methods/Materials
I used a Varian linear accelerator to produce five energies of electrons. A parallel plate ion chamber was used to calculate the dose of radiation that had traveled through different thicknesses of solid water. Solid water is a material with the same density as water and tissue. Every reading was repeated three times and averaged. After ion chamber readings were obtained for 6 MeV, 9 MeV, and 12 MeV, I created depth-dose curves for each energy of electrons. These curves allowed me to find the maximum dose of radiation for each electron beam (Dmax). From these curves I then determined the thickness of solid water that was needed to cut the dose of radiation in half. This is the R50 and it is measured in cm. I then plotted the energy of electrons in units of MeV vs. the measured R50s in units of cm. I extrapolated a linear best-fit-line and predicted the R50s for 16 MeV and 20 MeV. I repeated the experiment and found the actual R50s for 16 MeV and 20 MeV.

Results
From my data I predicted the R50s for 16 MeV and 20 MeV to be 6.4 cm and 8.2 cm. After I repeated the experiment, I determined the measured R50s to be 6.5 cm and 8.0 cm for 16 MeV and 20 MeV respectively. These results show that I can accurately predict the depth of tissue where the dose of radiation is reduced to 50% of the maximum dose.

Conclusions/Discussion
The data supports my hypothesis. The predicted and measured R50s are very close. This experiment has real world applications. Being able to predict the range of high energy electrons through tissue will allow for safer and more effective use of ionizing radiation in the treatment of cancer.

Summary Statement
I studied high energy electron beams produced by a medical linear accelerator and was able to accurately predict the dose of radiation in a tissue equivalent material.

Help Received
Jason Durant operated the equipment for my experiment and my dad helped me do research and answered many of my questions.