ANIMAL EXPERIMENTS FOR RADIATION THERAPY AND RADIOGRAPHY FROM 52 MeV PROTON BEAM FROM THE FM CYCLOTRON

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Abstract

Developments of accelerator techniques such as betatron,linear accelerator and medical cyclotron have brought great clinical effects in radiation therapy field. Clinical efficacy of radiation therapy using gamma-rays and electrons from betatron and linear accelerator may be said to be evaluated in some limits. Many radiotherapists having difficulties to treat with the patients with low radiosensitive or advanced cancer have great expectance to be able to use heavy particle with high LET. As a kind of such a parcle, proton beam has many excellent properties as follows ; they are charged particles with sharp Bragg's peak in matter, dose distribution in objects has nolateral scattered radiation, and beam flux is relatively pure with a few induced gamma-rays and thermal or fast neutrons from the reactions of proton with the elements of objects. Owing to the above advantages, proton beam from the FM cyclotron has been examined for the applications to radiologic fields such as clinical radiation therapy and proton radiography.

Experiments for preparation of radiation therapy

Some problems of physical and technological conditions for the application of proton beam to clinical radiology are reported in this proceedings by one of our colleagues.

A) Measurement of the RBE value of 52 MeV proton(beam size of 3x7 cm) with whole body irradiation. LD 50/30(50 % lethal dose of mice in 30 days after irradiation) of ddN mice is computed as 0.72. This value may represent that of bone marrow death. Owing to max. range of protons,dose distribution in mice may be not easy to be accurately estimated.(Fig.1).

B).Skin reaction of rabbit's ears after proton irradiation(beam size of 3x3 cm). Some ears are irradiated by plateau and Bragg's portion of protons.

1.Tissue tolerance dose is a little above about 8000 rads(60 n-c). Peripheral part of ear skin is more sensitive than that of center.

2. Little biological effect difference between plateau and Bragg's portion is observed. The RBE appears less than one(Fig.2a & 2b).

C) Proton radiography has two characteristics of marginal range and multiple scattering. The first one is to use a great energy loss near the end of proton range. Subtle change of depth and atomic components in matter shows steep energy loss transformed into film density. The second one is to use edge effects by multiple scattering of incident protons. Proton radiography will be useful for monitoring of proton therapy and proton computed tomography (Fig.3)

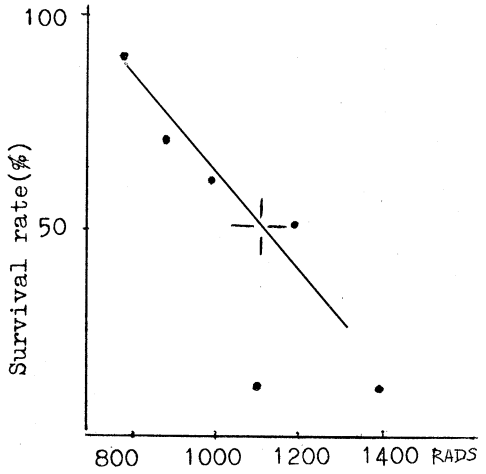
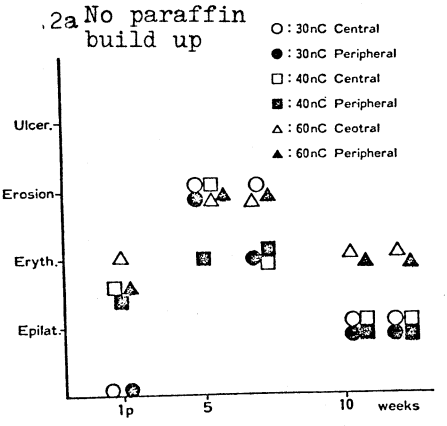
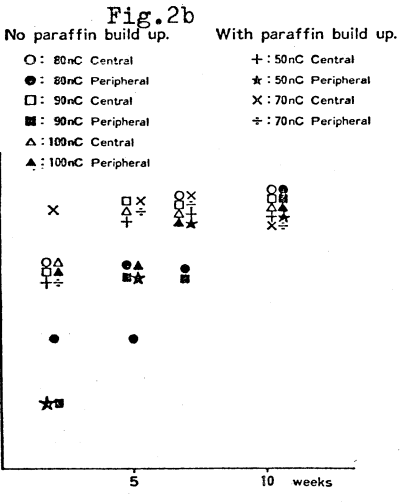


Fig.1 Survival rate of mice for various irradiation. The LD 50/30 is estimated 1150 rads from the figure.

Fig.2 Skin reaction of rabbit's ears after proton irradiation.





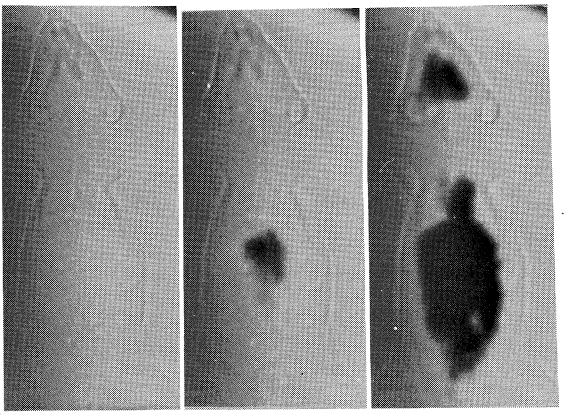


Fig.3 Proton radiographs of mouse obtained by special x-ray film sandwiched by each 1 mm aluminium plate. The dark areas are caused by no irradiation beyond the range of 52 MeV protons. Contours of mouse are sharpend by multiple scattering.