*Acta Physica Hungarica 59 (1—2), pp. 111—114 (1986)*

# DOSIMETRY OF RADIATION DURING HOMOGENEOUS EXPERIMENTAL IRRADIATION OF ANIMALS

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The aim of the work was irradiation of experimental animals with homogeneous dose of high X-irradiation and adding of known dose to the experimental animal, for the purpose of investigating acute radiation syndrome. Under known dose we mean its constant rate, as well as its distribution. Irradiation was performed by use of a linear accelerator of maximal energy 4 MeV with two opposite fields.

For dosimetric control an ionization chamber with a Farmer dosimeter was used while distribution dose was measured with TLD. Dose distribution was calculated by use of a computer on the basis of known data about pencils of rays and measured contours of the body of the experimental animal on more characteristic levels. During the calculation, inhomogeneity of tissue was included so that the effects of lesser density of lungs and considerable density of bones could be visible on the representative levels.

The distribution of the dose on the level of the sternum, the middle of the abdomen and middle of the neck varied from 105-170 relative units and the total variation for the whole body amounted to ±24 % respectively.

## Introduction

In the course of investigating acute radiation syndrome carried out on large experimental animals it is important to select the type and the method of irradiation. At the stage of selection of the source several requirements occur which are partly and mutually contradictory. The radiation energy has to be sufficient so as to irradiate a relatively homogeneous experimental animal while it should simultaneously be low enough to irradiate sufficiently the surface layer [1-3]. Also important in this investigation is qualitative dosimetry for the reliability of the experiment. The basic criteria when selecting dosimeters are reliability and reproducibility and, in addition, insensitivity to the large or variable speed of dose which occurs in a linear accelerator. The dosimeter with an ionization chamber best satisfies these criteria by reason that it works as an integration dosimeter so that its reading is independent of the rate of the dose in a broader range, which is not the case with a dosimetric system which individually counts impulses [4-6].

## Material and methods

In the experiment 12 goats of autohtonous strain were used, aged 2-3 years and weighing 25-32 kg. A linear accelerator of maximum energy 4 MeV and a Co-60 source was used for irradiation. For dosimetric control a Farmer dosimeter was used with an ionization chamber and TLD. The distribution of dose was calculated by use of the system for planning of radiotherapy RAD 8 (General Electric). The pencils of the source of irradiation were prepared in the form of tables referring to the behaviour of the pencil according to depth and horizontal position. In the system there are the data for cobalt bombs, accelerators and rtg. Installation enables, by adding anatomic values and relations, the simulation and estimation of the distribution of doses for different regimes of irradiation

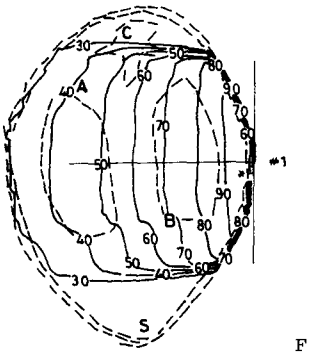


Fig. 1

RAD-8 VERSION B
B/21/81
MAGNIFICATION FACTOR = 50 %

OUTLINE * 27 HETEROGENEITIES
HOSP. NO * VET. FAK. OVCA A= 0.60
NAME * OVCA B= 0.60
CONSULTANT * BREYER C= 1.60
SITE * CIJELO TIJELO
SEQ. * 1

NORMALIZE DOSE = 100
PT. DOSE (AT *1,*2,*3,*4)= 94 , 95 , 94 , 89

BEAM *1 SSD THER 80/45 PHOTON
W.=200 MM SSD=800 MM
L.=200 MM ANG=270 DEG
WEDGE = 0
WEIGHT = 100

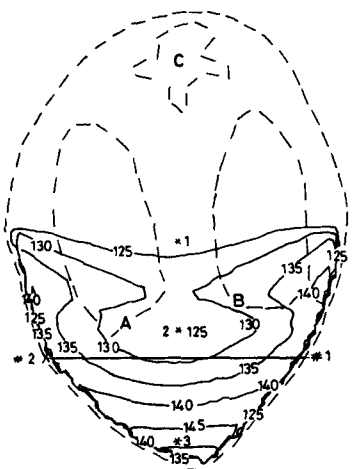


Fig. 2

RAD-8 VERSION B
B/21/81
MAGNIFICATION FACTOR = 100 %

OUTLINE * 28 HETEROGENEITIES
HOSP. NO * VET. FAK. OVCA 2 A = 0.60
NAME * OVCA 2 B = 0.60
CONSULTANT * BREYER C = 1.60
SITE * BEZ BOLUSA
SEQ. * 2

NORMALIZE DOSE = 100
HOT SPOT DOSE (AT*H) = 153
PT. DOSE (AT * 1,*2,*3 4) = 120 , 125 , 148 , 96

BEAM *1 SSD THER 80/45 PHOTON
W. = 200 MM SSD=800 MM
L. = 200 MM ANG=270 DEG
WEDGE = 0
WEIGHT = 100

BEAM * 2 SSD THER 80/45 PHOTON
W.=200 MM SSD = 800 MM
L.=200 MM ANG= 80 DEG
WEDGE = 0
WEIGHT = 100

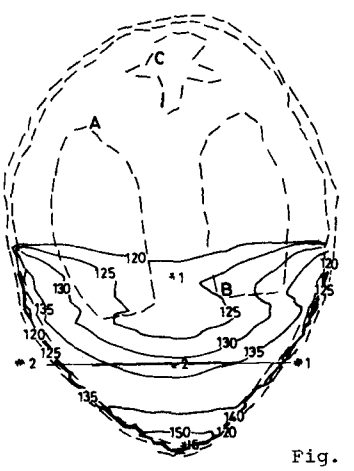


Fig. 3

RAD-8 VERSION B
B/21/81
MAGNIFICATION FACTOR = 100 %

OUTLINE * 27 HETEROGENEITIES
HOSP. NO * VET. FAK. OVCA A=0.60
NAME * OVCA B=0.60
CONSULTANT * BREYER C=1.60
SITE * CIJELO TIJELO
SEQ. * 1

NORMALIZE DOSE = 100
HOT SPOT DOSE (AT * H) = 154
PT. DOSE (AT * 1,* 2,* 3,* 4) = 122 , 131

BEAM *1 SSD THER 80/45 PHOTON
W. =200 MM SSD=800 MM
L. =200 MM ANG=270 DEG
WEDGE = 0
WEIGHT = 100

BEAM *2 SSD THER 80/45 PHOTON
W = 200 MM SSD = 800 MM
L = 200 MM ANG = 90 DEG
WEDGE = 0
WEIGHT = 100

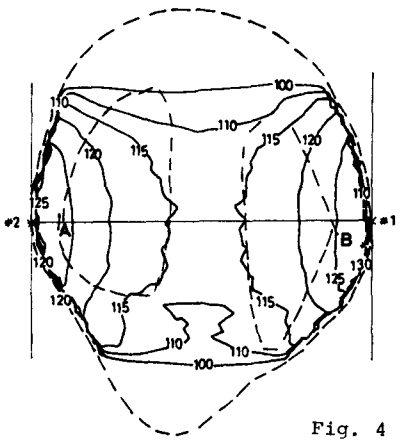


Fig. 4

RAD-8 VERSION B
8/21/81
MAGNIFICATION FACTOR = 100 %

OUTLINE # 26
HOSP. NO. * VET. FAK. OVCA
NAME * OVCA
CONSULTANT * BREYER
SITE * CIJELO TIJELO
SEQ. # 1

HETEROGENEITIES
A = 0.60
B = 0.60

NORMALIZE DOSE = 100
HOT SPOT DOSE (AT *H) = 129

BEAM #1 SSD THER 80/45 PHOTON
W. = 200 MM SSD = 800 MM
L. = 200 MM ANG = 270 DEG
WEDGE = 0
WEIGHT = 100

BEAM # 2 SSD THER 80/45 PHOTON
W. = 200 MM SSD = 800 MM
L. = 200 MM ANG = 90 DEG
WEDGE = 0
WEIGHT = 100

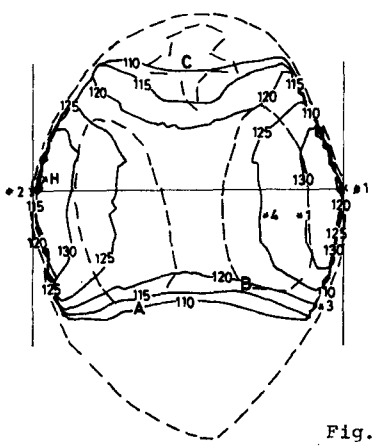


Fig. 5

RAD-8 VERSION B
8/21/81
MAGNIFICATION FACTOR = 100 %

OUTLINE # 28
HOSP. NO. * VET. FAK. OVCA 2
NAME * OVCA 2
CONSULTANT * BREYER
SITE * BEZ BOLUSA
SEQ. # 2

HETEROGENEITIES
A = 0.60
B = 0.60
C = 1.60

NORMALIZE DOSE = 100
HOT SPOT DOSE (AT *H) = 134
PT. DOSE (AT *1, *2, *3, *4) = 128, 132, 62, 124

BEAM #1 SSD THER 80/45 PHOTON
W. = 200 MM SSD = 800 MM
L. = 200 MM ANG = 270 DEG
WEDGE = 0
WEIGHT = 100

BEAM #2 SSD THER 80/45 PHOTON
W. = 200 MM SSD = 800 MM
L. = 200 MM ANG = 90 DEG
WEDGE = 0
WEIGHT = 100

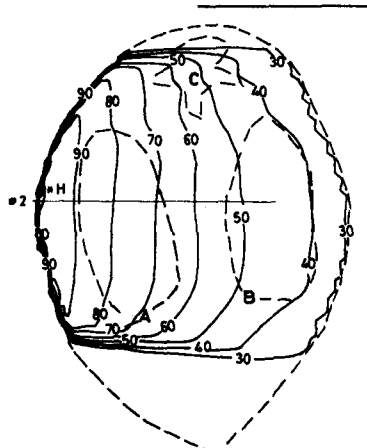


Fig. 6

RAD-8 VERSION B
8/21/81
MAGNIFICATION FACTOR 100 %

OUTLINE # 28
HOSP. NO * VET. FAK. OVCA 2
NAME * OVCA 2
CONSULTANT * BREYER
SITE * BEZ BOLUSA
SEQ. # 2

HETEROGENEITIES
A = 0.60
B = 0.60
C = 1.60

NORMALIZE DOSE = 100
HOT SPOT DOSE (AT *H) = 99

BEAM # 2 SSD THER 80/45 PHOTON
W. = 200 MM SSD = 800 MM
L. = 200 MM ANG = 90 DEG
WEDGE = 0
WEIGHT = 100

and different sources.

## Dosimetry considerations

Although not unusual in animal experiments, it is insufficient to define exposure dose and measure the given dose at a few points within the animal's body to properly define the received dose in a large animal. In order to assess the dose distribution on our experimental animals we used a radiotherapy planning computer system (RAD-8) and calculated the dose distribution for Co-60 photons for different irradiation plans. After consideration of these we accepted the two opposed fields plan as the best trade off between homogeneity and irradiation complexity. The treatment planning system is not designed for calculation of fields as large as is necessary for goat whole body irradiation so we calculated the distribution sequentially for different sections (Figs 1-6). As a result we obtained a distribution with an overall dose varying less than ±24%. The different densities of lungs and bones have been taken into account. While the dose variation may sound large, there is no way to obtain a better homogeneity with two opposed fields. It seems to us that this has not always been realized and that some of the variations of experimental results are not surprising. The actual delivered dose was additionally controlled using a Farmer dosimeter, and a set of TLDs. The advantage of the Farmer dosimeter is its stability and accuracy, however it can measure only one point at a time. The TLDs suffer from quite a bit of dispersion and time variation but are easy to distribute at positions of interest. A combination of the two dosimetry methods and distribution calculation guarantees a good definition of the delivered dose.

It is interesting to note that the skin dose is relatively low with high energy radiation and while this is a fairly realistic assumption for an accidental situation, real homogenization would require that layers be built up in the way they are used in total body irradiation treatments in human medicine.

## Conclusion

Irradiation of experimental animals from two opposite fields in order to attain homogeneity from ±24% may satisfy all demands of radiobiological investigation of acute radiation syndrome. Computer systems are necessary for the estimation of the distribution of dose and degree of homogeneity.

## References

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