APPLICATION OF RADIATION SOURCES IN ONCOLOGY

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ABSTRACT

Medical Physics is one of only a few professions in the physical science whwre we can exert a direct influence on the health and welling of mankind. We play a key role in the detection, diagnosis and treatment of diseases.We devise new technologies sources and then maintain improve them. In no subfield of medical physics this more true than in radiation oncology,especially within the past decade to improve control of the disease and as the same time, minimize the risk of complications. Many new treatment technologies have been directly, are being currently,developed where by patients can be treated more effectively with reduced side effects. these include several types of conformal radiotherapy such as stereatactic radiosurgery(SRS) and radiotherapy(SRT), intensity modulated radiation therapy(BNCT), heavy ion therapy and several forms of branchy therapy, such as high-dose rate(HDR), pulsed branchy therapy(PB) and 252Cf branchytherapy. A brief review of each new technologies is discussed.

Keyword: - *Onchology, Radiotheraphy, X-ray, Gamma-ray, Teletheraphy….*

1.Radiotherapy

Radiotherapy is the treatment of diseases with X- rays or other forms of radiation. Nowadays the disease concerned is mainly, but not exclusive, cancer,the basic value of radiotherapy in the treatment of that disease being the fact that ionizing radiation. A doseof radiation sufficient for cancer cells will produce considerable, but not irreparable damage to normal tissue. Safe and efficient treatments can only be carried out when at least approximate optimem dosage levels have been established and these can only be know after considerable clinical observation of the effects know dose of radiation. Not only accurate, but also constant dosemetry is essential to good radiotherapy. Radiotherapy can convinently be divided into three sections.

1.1 Teletherapy

Teletherapy is the general term appired to treatments when the external source of radiation is many centimeters from the part being treated. Beams of X and gamma rays, high energy electrons, and neutrons have all been used in this way. Usilng X- or gamma rays, it is tha most widely used of the three therapeutic methods. Dependent upon the debth of the tumour in the body, it calls for beams of various penetrating power, and for the various tumour shape and sizes, beams of different shape and sizes which are produced by suitable beam collimation by applicators.

1.2 Plesiotherapy

Plesio is usually applied to indicate those forms of radiotherapy where the radiation source is close to the tissue being treated. Plesio therapy can include X-ray treatments in which theS.S.D is only a few centimeters, but it is usually reserved for treatments where small beta or gamma-ray sources are placed within a centimeter. Most attention will be given to gamma-ray plesiotherapy. It was came out exclusively with radium or radon in suitable tubes or needles. However, a number of other gamma-ray sources are available, for example Cobalt 60,Caesium 137,Iridium 192, and Gold 198. For the start distance between the sources and the tissues being treated, it is usually assumed that radiation attenuation is negligible and that doses can be calculated by means of the inverse square law and know gamma-ray dose rate of the isotope.

1.3 Internaltherapy

This form of treatment is entirely by means of radioactive isotopes which in some form or another are incorporated into body tissues. The radiations involved are beta particles, gamma raysm or both. Radioactive isotopes have not fulfilled the early hopes that were placed in them, but a few either because they are selectively absorbed in specific organs or because they are widely distributed throughout the bodym are used as interrnal irradiators.

Absorbed dose at any point=EXRxfxt

where : E is the Exposure rate at the reference point for the operating conditions in the question, i.e it is the output.

: R is the Exposure rate at the point of interest expressed relative to E.

: f is the roentgens to rads convension factor appropriate to the operating conditions.

: t is the radiation time.

2. Radioactive Isotopes in Clinical Medicine

Table-1

Radioactive isotopes	Symbol	Half-life	Radiation emitted	Principal gamma-ray energies in MeV
Hydrogen 3	$^{3}_{1}H$	12.3yr	β^-	None
Fluorine 18	$^{18}_{9}F$	1.9hr	β^+	0.505
Sodium 24	$^{24}_{11}Na$	15hr	$\beta^-\gamma$	1.37 and 2.75
Phosphorous 32	$^{32}_{15}P$	14.3dy	β^-	None
Chromium 51	$^{51}_{24}Cr$	27.8dy	γ^*	0.323
Iron 55	$^{55}_{26}Fe$	2.7yr	γ^*	0.066
Iron 59	$^{59}_{26}Fe$	45dy	$\beta^{-\gamma}$	Mainly 1.01 and 1.29
Cobalt 57	$^{57}_{27}Co$	270dy	γ^*	Mainly 0.122 and

				0.27
Cobalt 58	$^{58}_{27}Co$	71dy	$\beta^+\gamma^*$	0.51 and 0.08
Cobalt 60	$^{60}_{27}Co$	5.26yr	$\beta^-\gamma$*	1.17 and 1.33
Selenium 75	$^{75}_{34}Se$	121dy	γ^*	Mainly 0.14 and 0.27
Strontium 85	$^{85}_{38}Sr$	65dy	γ^*	0.531
Strontium 87m	$^{87}_{38}Sr$	2.8hr	γ	0.388
Technetium 99m	$^{99}_{43}Tc$	6hr	γ	0.140
Indium 113m	$^{113}_{49}In$	1.7hr	γ^*	0.390
Iodine 125	$^{125}_{53}I$	60dy	γ^*	0.035 and 0.027
Iodine 131	$^{131}_{53}I$	8dy	$\beta^-\gamma$	Mainly 0.36
Iodine 132	$^{132}_{53}I$	2.3hr	$\beta^-\gamma$	0.38 to 1.39
Xenon 133	$^{133}_{54}Xc$	5.3dy	$\beta^-\gamma$	0.081 and 0.16
Mecury 197	$^{197}_{80}Hg$	65hr	γ^*	0.0169 and 0.077
Gold 198	$^{198}_{79}Au$	2.7dy	$\beta^-\gamma$	Mainly 0.412β

2.1 Example

A patient who weights is 64 kg, and whose thyroid gland is estimated to weight 34 g,is given 16mCi of 131I for the treatment f cancer of thyroid. It is estimated that 51 percent of the adminstered iodine is taken up by thyroid, and that effective half-life is 5.5 days.What will be the total absorbed dose delivered to the thyroid for the complete decay of the isotope?

For 131I , the value of K is 2.3 Rper hour and Eβ is 0.187 MeV.

Assuming that the thyroid gland is spherical, its diameter would be approximately 4cm and therefore the average value of G will be 1.5πD=6π=18.9.

Isotope connection in the thyroid gland= $\frac{16x1000}{34} x \frac{51}{100} = 240\mu Ci\ per\ gramme$

Rβ=73.8x0.187x5.5x240=18217rad

Rγ=33.1x10-3x2.3x18.9x5.5x240=1890rad

Giving a total absorbed dose of 20107 rad. It will be noted that the gamma-ray contriution to the thyroid dose is relatively small, and infact, it is often ignored.

Not without interest, of course is the dose to the rest of the body from the iodine there in and also from the iodine in the thyroid itself. Tocalculate this accurately is very difficult, but a rough idea csn be obtained as follows. First consider the absorbed dose d ue to the 49 percent of the adminstered iodine not taken up by the thorid, and which it must be assumed is uniformly distributed through the rest of the body.

The concentration will be

$$\frac{16000x0.49}{64000} = 0.1225\mu Ci\ per\ gramme$$

Hence the Beta-ray dose will be

73.8x0.187x5.5x0.1225=9.3rad

The gamma-ray dose will depend upon the shape of the patient, because of the geometric factor in the formula. If it is assumed that he is 160 cm tall then the geometric factor(G) from the tables of Hine and Brownell, is about 122. Therefore the gamma-ray dose is

33.1x10-3x2.3x122x5.5x0.1255=6.3rad

3.Therapy using of different sources

3.1 Stereotactic Radio Surgery(SRS) and Radiotherapy(SRT)

Stereotactic Radio Surgery(SRS) and Radiotherapy(SRT) are two p hysical similar technologies. The major difference is fraction:SRS refers to single fraction treatments, wherwas SRT implies multiple fractions. Another differeence is the type and location of the disease treatedm and the amount of normal tissue that has to be irradiated. In general, SRS is confined to the treatment of small lesions in the brain. SRT is most often employed for the treatment of large primary or secondary cancers in the brain and lesions close to sensitive normal structures,where significant regions of normal tissue have to be treated is achieved by one, or a combination of several, imaging techniques suchas CT, MRT. An alternative deliverytechnique is with the gamma mators that crate spherical high-dose regions of diameters 4,8,14,or 18mm at isocenter. Multiple isocenters are used for irregularly shaped targets.

3.2 Proton Therapy

Protontherapy provides another, although much more expensive method of producing comformal radiotherapy. With protontherapy is the unique depth dose characteristics of high energy protons is used to deliver high dose to the tumor, while minimizing doses to tissues infront of and behind the target volume.

3.3 Neutron Therapy

Radiotherapy with fast neutrons has been available for several decades. The major rationale for neutron therapy is improved biogical effectiveness when compared with therapy using protons, electrons, and high energy protons. The results have been equivocal, however, because of the severse radiation injuries observed at the some facilities primilarily due to inadequate beam shaping with neutron beams need to be properly shaped in order for the high-dose region to conform to the size and shape of the target volume and need to have energies of at lest about 50Mev so as to be significantly penerating and skin sparing such that superficial tissues are not overirradiated.

3.4 Boron Neutron Capture Therapy

The clinical application of the very high thermal neutron capture cross-section in 10B as means to deliver high-LET radiation dose to tumors is by no mens new, having been first attempted about 40 years ago, but with poor results. As with fast neutrons, the major problem was excessive normal-tissue damage. However, also with fast neutrons recent technological advances look promising. Major problem that doomed carlier sudies to failure induded insufficient 10B containing drug concentrations in the tumor with sufficient exclusion from surrounding normal tissue and indequate penetrationof the neutron beams.

3.5 Heavy Ion Therapy

The use of heavy ions to treat cancer is just becoming a reality with the development of a facility dedicated to this in Japan. Heavy ions are attractive for radiotherapy because they exhibits both the physical advantages of protons and the radiobioiogical benefits of neutrons.

3.6 High-Dose Rate Branch Therapy

The advantage of High-Dose Rate Branch Therapy over LDR aremainly physical, most patients are treated as outpatients, so occupancy of hospital beds is greatly reduced, and far more patients can be treated with a given HDR source.

3.7 252Cf Brachy Theraphy

Another type of neutron therapy that has been around for many years without achieving wide acceptance is 252Cf branchy therapy. 252Cf sources are neutron emitters. They thought to exhibit radiobiological advantages similar to fast neutrons, with the added dose distribution benefits of branchy theraphy. 252Cf branchy theraphy has not been successful for several reasons:(i) the hazards to staff of exposure to neutrons has been a radiation safety nightmare neutrons are relatively difficult to shield against and the biological effectivness(RBE) for enviromental level of neutrons can be very high, and (ii) the available 252Cf sources have been large compared to 137Cs sources used for traditional branchy theraphy.

3.8 Liver

The safe dose in adult patients for whole liver irradiation, 3Gy per fraction is in the order of 21 to 24 Gy given in 11/2to weeks. At 1.5 to 1.8 Gy per fraction the safe dose increase to about 30 Gy when given over 31/2 to 4 weeks.

3.9 Eye

The lens of the ees is a higly radiosessitive structure and its radiation can lead to cataract with consequent impacirment or loss of visual acuity. Small opacities have been observed after single dose of 0.5 to 2Gy, with 5Gy or more serious progressive catarats may occur. The vision can be restored by excision of the lens. The function of the lens can be replaced by plastic prosthesis or by on extrinsic corrective lens and vision restored as long as the radiation has not damaged the retina. Damage to the retina or conjunctiva may occur at dose in excess of 46 Gy/27 fractions/38 days.

3.10 Brain

A dose of 55Gy in 51/2 weeks to the whole brain or 65 Gy in 61/2weeks to a small part, approaches the threshold for radinecrosis in man**.**

4. Conclusion

Radiation sources are used in medical, industrial, agricultural, educational training , research purpose and of course the generation of energy by nuclear power. Cancerous conditions may be treated through radidotheraphy, in which beams of high energy X-rays or gamma-rays. Gamma sources are often used in radio therapy, because their greater penetrating powermake, them able to penetrate deeply into the body where tumor might be growing. Also photon source, neutron source are used in radiation theraphy the same as gamma source.For sources of radiation treatment of cancers and related diseases. Patient can be treated more effectivelywith reduce side effects andimprove the quality of life for the living by these new technologies.

5. REFERENCES

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