XA9745644 IAEA-CN-67/121

The distribution of chromosome aberrations among chromosomes of karyotipe in exposed human lymphocyte

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Abstract

Induced chromosome aberrations (ch. ab.) in exposed Human peripheral blood lymphocyte have been used to assay radio.bio.doses, because of their characters such as: the maitaining Go phase in cell cycle in body,the distribution of cell in blood system and the distribution of ch. ab. in exposed cells of body and among chromosomes of karyotype.The frequency of ch. ab. reflected the quantity of radiation dose,dose rate and radiation energy. The dependence between radiation dose and frequency of ch. ab. was illustrated by the mathematic equations.The distribution of induced ch. ab. among the cells exposed to uniform radiation fields was Poisson's,but the distribution of ch. ab. among chromosomes in karyotype depended on radiation field and mononucleotid sequence of DNAmolecular of each chromosome. The minimum influence of mononucleotid sequence of DNA molecular in inform ch. ab. will be advantageous state for dose-assessments.

The location of induced ch. ab. in exposed Human lymphocyte had been determined by karyotype analyse . The data of statistic analyse had improved that the number of ch. ab. depended on the size of chromosomes in karyotype. The equal distribution of ch. ab.among chromosomes in karyotype provided the ojectiveness and the accuracy of using the chromosomal aberrant analysis technique on bio.dosimetry.

Introduction

Chromosome aberrations in peripheral bloob lymphocytes have been used as a measure of radiation dose in man for many years ,and evidence has meet certain criteria ,aberrations provide a usefull estimate of absobed dose (3).The studies on distribution of ch. ab. in karyotype will supplemented the role of this bio.evidence for radio. bio. dosimetric assessments.

Karyotype of a specices is particularized with the number and the figure of chromosomes. There are 46 chromosomes in human cell. Structure of chromosome is a DNA double helix ,histon moleculars and other proteins. The induced breaks in DNA molecular of the cell exposed to radiation are double strand break (DSB),single strand break (SSB) and base damage (BD). Ch. ab. are induced directly from DSB . DSB can be created directly by radiation action or undirectly by unrepaire or misrepaire mechanizm of SSB,BD. The distribution of DNA strand breaks depended on two principal regulations:

First: the probability of radiation actions. Second:the unprobability of bio.mechanizm such as " hot point mechanizm" ,'hot point'- the location of DNA strand ,which the DNA breaks were induced with the highest frequency.The " hot point " theory have been used to demonstrate the radio.sensitive character of DNA molecular .The difference in chromosomal aberrant ditribution among chromosomes is satisfactory for bio.dosimetric assessment, but the remaining of "hot point" is unsatisfactory for this purpose. If there is not "hot point", induced ch. ab. in lymphocyte have depended on the size of chromosome in cell,but it is not true if radiation induced DNA strand breaks in the cells depended directly on the 'hot point' mechanism.The "hot point" created the unlikeness of radiation effects on this or that chromosome ,therefore it will aspect on determined radiation doses. The study of distribution of induced ch. ab. in exposed human lymphocyte improved the possibility of using the ch. ab. and the role of them on radio.bio.dosimetric assessments

Subject and method :

The photographs of chromosomal sets consisted of induced ch. ab. of exposed Human lymphocytes was used to studies.The photographs were product of bio.dosimetric calibrations for gamma rays, thermal neutron and the mixture of other neutrons.

Protocol of cell culture in IAEA technical report no:260,1986 was used for lymphocyte culture. Karyotype was classified in the following steps: classification of firgure of chromosome paire in order, measuring of the size of chromosome and puting them in order of length. The origin of ch. ab. was determined by eliminable method of chromosome which had paire or length enough. The equal distributed theory was used to controle the investigated data. The verifiable formular of distribution theory $\chi^2 = \Sigma^k_i [(mi - npi)^2 / npi]$ (k=investigation units =23; mi= the number of detected ch. ab. in paire i; n= total of detected ch. ab.; pi= relative lengh of chromosome i).

Result and discussion

The statistic value of investigative parameters have related to the studies of karyotype of vietnamese ppulation and bio.dosimetric calibrations. Karyotype of Human lymphocytes of Dalat population(a city of Vietnam) was investigated and illustrated in table 1:

Table 1: The size of Human lymphocyte chromosome (%) (the rate of a chomosome per total of chromosome).

ch.	rate	ch.	rate	ch.	rate	ch.	rate	ch.	rate	ch.	rate
1	8.37	5	5.92	9	4.75	13	3.71	17	2.75	21	1.87
2	7.76	6	5.61	10	4.43	14	3.39	18	2.56	22	1.68
3	6.73	7	5.42	11	4.31	15	3.07	19	2.34	X	2.52
4	6.26	8	4.90	12	4.11	16	2.99	20	2.11	Y	0.94

(Ch.= Chromosome).

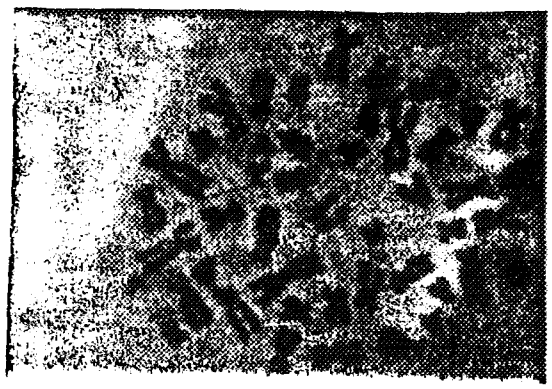
Standard error of the measuremental data were satisfactory. The investigation corresponded to Paris standard (1,2,3) .

The chromosomes were distinguished this paire from that paire with the size and fig , except some case such as : some time the third paire had the longer chromosome than other, the size of 12 th paire was shorter than the size of 13th... These evidences can be explained by helix processing of some chromosome happened ealier than other chromosome .

The blood samples were exposed to uniform radiation field such as: gamma rays, thermal neutron and mixture of other neutron. The evidence of uniform radiation field was also improved by the results of dosimetric calibrations such as : the distribution of ch. ab. per cell in a dose and the standard curves. The distribution of induced ch. ab. in any dose was poisson (12,13,14). The results of radio.bio.dosimetric calibration were the response dose effect curves with popular equation form: $Y = \alpha D + \beta D^2 + C$ (12,13,14).

The ch.ab. were detected by microscope and photograph. The location of ch.ab. was determined by measure chromosomes, compare them together on size and figure and put them in corect paire . The ch.ab. were located in the chromosomes which were absent one in any paire or in the chromosomes which were absent all two in a paire.Example:the following photograph consisted of 46 chromosome units limited by 1 dicentric, 1 fragment and 44 normal chromosomes.

There were 21 whole paire and 2 absent paire .



Thewholepairewere:1;2;3;5;6;7;8;9;10;11;13;14 ;15;16;17;18;19;20;21;22;and xx.The absent paire were : 4 and 12. The size of dicentric was:1.24 cm ,fragment: 0.81 cm , di. + fra. = 2.05 cm ,the size of di. + fra. Was corresponding to the size of absent chromosome : ch.4: 1.29 cm and ch. 12: 0.77 cm, ch.4 + ch.12=2.06 cm. Now therefore di. and fra. aberrations induced from ch. 4 and ch. 12.

The data of located investigations of ch. ab.was showed in table 2.

Table 2 : The distributions of ch. ab. among chromosomes in karyotype of exposed human lymphocyte.

Σch.ab. (174)	Distribution of ch.ab. among chromosomes																						
Ch.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21+Y	22	X
Obs	18	17	13	8	10	6	14	8	6	8	9	10	7	6	7	8	4	7	3	1	7	3	2
Exp	15	14	12	11	10	10	9	9	8	8	8	7	6	6	6	5	5	5	4	4	5	3	4
Obs-exp	+3	+3	+1	-3	0	+4	+5	-1	-2	0	+1	+3	-1	0	+1	+3	-1	+3	-1	-3	+2	0	-2

ch. : chromosome; obs.: observed; exp.: expected.

The number of induced ch. ab. was direct proportion to the size of chromosome in karyotype,inverse proportion to the chromosomal order from first paire to 22th paire . There were difference in the rate of ch. ab. to the size of each chromosome between this and that chromosome in table 2 and between our result and Buckton's result . The classification 21th chromosome and Y chromosome in the size and firgue was uneasy ,therefore the data was added in 21th +Y group. The high ch. ab. in this group can be caused by the radiosensitive mechanism of 21th,the semilar result also detected by Buckton (3) . These results have given a question: What was distributive regulation of ch. ab. among chromosome in karyotype of exposed Human lymphocytes . The controlling of the result with equal distributive theory showed that the value of statistic parameters were determined $\chi^2 = 19{,}21$ with $k = 23$; χ_{k-1}^2 (0,05) = 33.90 . The equal distributive theory of the number of ch.ab. per the length unit of the chromosome was verified.

The distribution of induced ch. ab. in any case was also aspected to the accuracy of dose-calibrations and dose-assessments. The distribution of induced ch. ab. among the cells (karyotype) exposed to uniform radiation fields was Poisson (3,5,8,9,10,11). The equal distribution of induced ch. ab. among chromosome in karyotipe will be satisfactory.The distrbution of radiation actions on materials was probability's , but the distribution of induced bio.effects depended on bio.responsive mechanism.The bio.responsive mechanism depended on bio.structure and bio.actions of cells and body. In this case ,it was the links of mononucleotids of DNA sequence and repaire mechanizms created miss repaire or unrepaire of DNA straind breaks (3,10) . The radiation sensivity of DNA double helix depended on the links of mononucleotids in DNA straind and DNA double helix. Some links were more sensitive than anothers,and the concentrated location of them will create more changes than anothers, and it was called the 'hot point'. The 'hot point' was detected in some chromosome of isect cells. The outnumber of ch. ab. detected in some chromosome in our and buckton's result showed that there were presentation of 'hot point' mechanism in inform ch. ab. ,but this evidence pressed in the chromosomes: 1,2,6,7,12,16,21 in our result instead of 7,10,13,16,17,18,19,21 in Buckton's result improved that the 'hot point' presented not so popular and the probability's distribution had better. The existance of the ' hot point' locations of DNA strand was presented clearly, but the distrbution of them among chromosomes was popular . The difference of ch. ab. friquencies happened only when the mononucleotid's order was high difference between this chromosome and that. The density of sensitive sites were different among them. The results of equal distribution of ch. ab. among the chromosomes in karyotype of exposed human lymphocytes showed that popular structure of mononucleotid's sequence of DNA sequence was so big that none of chromosome have a special structure which presented so' hot' or so' cold point'.

The presentation of 'hot point' aspected to naturily's distribution of radiation effects and accuracy of radio. bio. dosimetric calibration also bio. dosimetry. The result of equal distribution of ch. ab. pressed the important role of this effect on bio. dosimetry.

Conclusion

Chromosome aberrations were induced by DNA strand breaks , therefore the dependence between radiation effects in inform DNA strand breaks and presentable frequency

of ch. ab. was natural. The distribution of ch. ab. depended on two basic factors, there are the probability's of radiation actions and the difference of radiation responsive effects of bio.structures, which among them were sensitive sites of DNA molecular.The result showed that the distribution of ch. ab. among chromosomes of karyotype had dependence on the size of chromosomes, and confirmed in equal distribution regulation. This conclution pressed the important role of ch. ab. effect on bio.dosimetry.

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