ONE CASE OF LEUKEMIA INDUCED BY ^{60}Co ACCIDENT

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ABSTRACT

The peripheral blood lymphocyte chromosomes in a case of ^{60}Co γ rays accident were examined at 2.5 h after exposure. The frequency of the dicentrics plus centric rings was 89% and exposure dose was estimated to be 4.78 (4.53~4.88) Gy. The examinations of lymphocyte chromosome aberration within follow-up 12 a showed that the incidence of Dic+R reduced with lg regression ($r = -0.9895$). While the number of cells with stable aberration remained unchanged and showed a tendency to increase. During the period of leukemia, bone marrow cell chromosome aberrations were studied by method of G-banding. Of 13 cells observed, 4 cells belonged to normal karyotypes. Among 9 aberration cells, 12 aberrations were detected. The majority of which were classified as translocation, deletion and inversion. Numeric aberrations were -9, -12, -20, -22, -y. This case suggested that acute lymphocytic leukemia was induced after radiation accident.

Keywords Chromosome aberration, Exposure accident, Acute lymphocytic leukemia, ^{60}Co

1 INTRODUCTION

Chromosome breaks can be induced by radiation. Some breaks which did not be or error-repaired form chromosome aberrations. The chromosome aberration remained in the body long after exposure and those stable aberrations stayed more longer. As many cancer patients showed chromosome aberrations, special attention was paid to the relationship between chromosome abnormalities and development of carcinoma.

A case of accidental ^{60}Co exposure was reported with chromosome analysis follow up respect to over the years. During the period of leukemia, bone marrow cell chromosome aberrations were studied by method of G-banding. The over exposure inducing leukemia is discussed.

2 MATERIALS AND METHOD

2.1 Accident general situation

The accident happened on 1 September 1980 in Shanghai. The activity of ^{60}Co source was 19.6×10^5 GBq. This worker stayed at a distance of 1 m away from the source for 30~40 s and was injured by over exposure. The lymphocyte chromosome analysis was carried out at 2.5 h after the exposure. The frequency of the dicentrics plus rings (Dic+R) was 89%. The results of Dic+R were calculated for estimation of biological

Manuscript received date: 1995-06-20

dose with the equation established in our laboratory. The average biological dose of this patient was 4.78 (4.53~4.86) Gy[1].

2.2 Course of acute lymphoblastic leukemia (ALL)

In Febrary 1992, patient complained of fever, tireness and chill. Physical examination showed enlargement of the spleen, liver and neck lymphnodes with sternodymia. white cells were 3.28×10^{11}/L in peripheral blood with immature cells of 97%. Periodic-acid Schiff (PAS) reaction was positive and peroxidase was negative in lymphocytes. Bone marrow examination showed ALL and belonged to L_2 morphology.

A multiple drugs of the chemotherapy regimen was started with release from symptoms. The patient died of recurrence with intracranial bleeding in July 1993.

2.3 Chromosome aberration analysis

Blood samples were taken at 2.5 h and approximately in 0.5, 2.5, 3, 4, 5, 6, 11 and 12 a after the accident. The well spread metaphase cells were selected to take photograph and karyotype analyses of the samples in 2.5, 3, 4, 5, 6 and 12 a were done. The losses of numbers of stable and unstable aberrations were compared.

2.4 Analysis of bone marrow chromosome by G-banding

Direct prepherations of bone marrow cells were preferred, chromosomal spreading achieved by hypotonic and the chromosome stained with G-banding technique.

3 RESULTS

3.1 The losses of aberrations over years after accident

The decrease in numbers of the unstable aberrations was found during each time of examination. The fraction of Dic+R was reduced from 0.89 to 0.19 half a year after exposure and fluctuated at low level later (see Table 1). The 12 a follow-up showed that the incidence of Dic+R reduced with logarithmic regression (relation coefficient $r = -0.9895$), while the well spread metaphase cells were selected to take photograph and to analyse. Only samples at 2.5 h and in half an year were not examined. The fraction of stable aberrations were 0.37, 0.41, 0.47, 0.48, 0.45, 0.47, respectively. They were higher than those examined by the conventional light microscopic analyses at the same time.

Table 1
Incidences of chromosome aberration of peripheral lymphocytes in 12 a follow-up after exposure

Time after exposure/a	2.5(h)	0.5	2.5	3	4	5	6	11	12
No of cells scored	82	100	100	100	100	100	100	100	100
Dic+R fraction	0.89	0.19	0.10	0.05	0.10	0.05	0.01	0.03	0.04
Fragments fraction	0.64	0.13	0.08	0.01	0.16	0.02	0.09	0.01	0.03
Fraction of stable aberration cells	0.024	—	0.015	0.01	0.05	0.11	0.23	0.02	0.06

3.2 Chromosome analysis of bone marrow cells by G-banding method

During the period of leukemia, patient's bone marrow cell chromosome aberrations were studied by method of G-banding. Of the 13 cells observed, 4 cells belonged to normal karyotypes. Among 9 aberration cells 12 aberrations were detected.

The most common changes were translocations, deletions and inversions. The chromosomes were mainly involved in number #3, #5, #6, #7, #8, #9 and #11. Numeric aberrations were observed in –9, –12, –20, –22, –y.

4 DISCUSSION

Regarding difference for the frequency of structural chromosomal in ALL exists among laboratories. The patient has fraction of bone marrow cells chromosomal abnormalities at the time of diagnosis to be approximately 0.5. In this patient 13 cells were examined, 4 belonged to normal karyotypes, 9 presented chromosome structural rearrangement. Fraction of translocations in structural abnormalities is 0.63. This finding corresponded to observation by other authors.

Table 2
Chromosome structural rearrangements of bone marrow cells by G-banding method

Cells order	Karyotypes	Chromosome structural rearrangements
1	46, xy	del(9)(p21)
2	43, xy, –9, –12, –y	t(3;11)(p11;q23) t(5;8)(q35;q22)
3	46, xy	t(3;11)(q21;q23) t(5;10)(q35;p11)
4	45, xy, –22	t(6;15)(p23;q22) t(7;18)(q22;q23)
5	46, xy	del(8)(p21)
6	46, xy	inv(5)(q14;p12)
7	45, xy	dic(0)(6—11)
8	46, xy	t(6;11)(p11;p15)
9	45, xy, –20	t(3;8)(q27;q24)

The primary abnormalities are considered to be essential in the development of leukemia. Secondary ones may occur mainly in the late phase of disease. In this patient except the presence of 11q; 8q24; del/t(9p) basic break points of ALL, more aberrations were secondary rearrangements. The chromosome aberrations mainly involved No. #3, #5~#9 and #11. Among them No.#3, #5, #6 chromosomes were more obvious. Seven translocations were present in above three and another chromosomes. Other changes as inversion and the dicentric were also observed in No.#5 and #6 chromosomes.

Kowalczyk[2] reported that chromosomes #5, #6, #7, #9, #14, #17 and #21 were involved in different types of changes and most frequently in childhood ALL. Heim[3] considered that chromosomes #6, #7, #14, #21 were most frequently involved. We have not found any rearrangement involved in chromosomes #14, #17, #21. This results suggested that secondary cytogenetic abnormalities were not distributed at random in ALL[4].

The cell transformation has direct relation to the chromosome aberrations. The chromosome abnormalities lead to the changes of one or more cancer relevant genes. It may be induced by deletions or loss of entire chromosomes (monosome). Such carcinogenic changes could be the result of loss of tumor suppresson genes[5].

This patient had a large quantity of chromosome aberrations especially the stable aberrations kept at high level. It might be that these abnormal genetic material proliferated into clones and gave the carcinogenic effect.

Takana[6] reported the chromosome G-banding analyses of 22 cases of atomic bomb survivors who were within 1 km of the hypocenters. The regions involving the high incidence of break points found in atomic bomb survivors well consisted with those of leukemia cell in lymphocytic leukemias and in myelocytic leukemias. Masao[7] reported that 766 cases of leukemia occurring among atomic bomb survivors who were within 9 km of the hypocenters. Incidence rates of all leukemia types in creased with increasing exposure level. The effects of radiation were more obvious on the incidence of ALL and chronic myeloid leukemia (CML).

As this case was injured by over dose exposure and presented a great quantity of chromosome aberrations and the stable aberration remained unchanged. The diagnosis of ALL also agreed with the high incidence of ALL in atomic bomb survivors. This leukemia took place 12 a after radiation accident, it accorded with the later period of radiation induction leukemia is at least 5 a as well.

So it was suggested that the acute lymphocytic leukemia in this case was induced by radiation accident.

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