The Radiation Effect on Peripheral Blood Cell

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To evaluate radiation effect on the hematopoietic system, we analyzed 44 patients who were treated with conventionally fractionated radiation therapy (RT) at Chonbuk National University Hospital.

According to the treatment sites, we classified them into three groups: group I as head and neck, group II as thorax, and group III as pelvis.

White blood cell, lymphocyte, platelet and hemoglobin were checked before and during RT

The results were as follows;

1. White blood cell (WBC) and lymphocyte count were declined from the first week of RT to the third week, and then slightly recovered after the third or fourth week. There was prominent decrease in lymphocyte counts than WBC.

2. Platelet counts were declined until the second week of the RT, showed slight recovery at fourth week in all groups. Hemoglobin values were slightly decreased in the first week and then recovered the level of pretreatment value, gradually.

3. Lymphocyte count were declined significantly on group III($p<0.05$), WBC and platelet counts were decreased on group II but statistically not significant.

Key Words: Hematopoietic system, Radiation therapy

INTRODUCTION

The hematopoietic system is the one of the radiosensitive organs in the body[1~3]. The changes in the circulation blood after total body irradiation by sublethal doses are chiefly a result of damage to the blood forming organs and are not a direct effect on the circulating blood[2].

The depletion of the bone marrow stem cell by radiation eventually manifested depression in the peripheral blood cell count[3].

Peripheral blood cells are affected in their number, morphology and functional activity during RT[4~7].

Lymphopenia may render the patients more susceptible to various kinds of infectious agents especially viral or fungal agents and possibly also impair their capacity to react immunologically against their own tumor[6].

Granulocytopenia may increase the chances of the opportunistic infection in cancer patients[8].

We observed the alteration of peripheral blood cell counts to show hematopoietic effect during the conventionally fractionated RT in according to the treatment sites.

MATERIALS AND METHODS

From July 1987 to Septmber 1988, we analyzed 44 patients received conventionaly fractionated RT for only curative aim and had no history of previous RT or chemotherapy within 1 month before treatment (Table 1).

We classified 44 patients into three groups, according to the treatment sites(Table 2).

All patients were treated with 6 MV linear accelerator.

Peripheral blood cell counts were checked before and during RT, counted by automatic cell counter Coulter S Plus®.

We observed WBC, lymphocyte, platelet and hemoglobin counts as parameters.

RESULTS

1. WBC

WBC counts were markedly declined in the first week, maintained decreased level until the fifth week in group I and II, where as progressively declined until the fourth week in group III.

Results among the groups were not statistically significant (Fig. 1).

2. Lymphocyte

Lymphocyte counts were markedly declined until the third week in all groups, especially group III.

The difference among the groups was statistically significant ($p<0.05$)(Fig. 2).

3. Platelet

Platelet counts were declined until the second week of RT, showed slight recovery at the fouth week in all groups.

Statistical difference among the groups was not found(Fig. 3).

4. Hemoglobin

Hemoglobin values were slightly declined in the first week and then gradually recovered the level of pretreatment value (Fig. 4).

DISCUSSION

There is normally a delicate balance between the circulating lives of blood cells, the rate of replacement of these cells, and the body's demand for them.

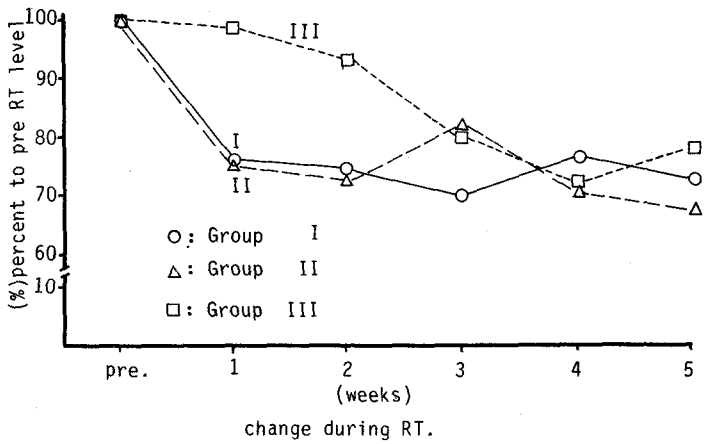
Radiation damage of the hematopoietic tissue upsets this balance by reducing or interrupting the supply of blood cells[2,3].

Table 1. Patients Characteristics

Characteristics	No. of patienst (%)
Total	44 (100)
Age (year)	
Range	21–70
Median	53
Sex	
Male	21 (48)
Female	23 (52)
Classificstion	
Group I (Head & Neck)	13 (30)
Group II (Thorax)	14 (32)
Group III (Pelvis)	17 (38)
Eligibility	
No previous RT	
No CT within 1 m.	

Table 2. Primary Site at Each Group

Group	Site	Number
I	Larynx	5
	Nasopharynx	3
	Oral cavity	3
	Thyroid	2
II	Breast	7
	Esophagus	4
	Lung	3
III	Cervix	11
	Rectum	5
	Bladder	1
Total		44



change during RT.

Fig. 1. WBC change during RT.

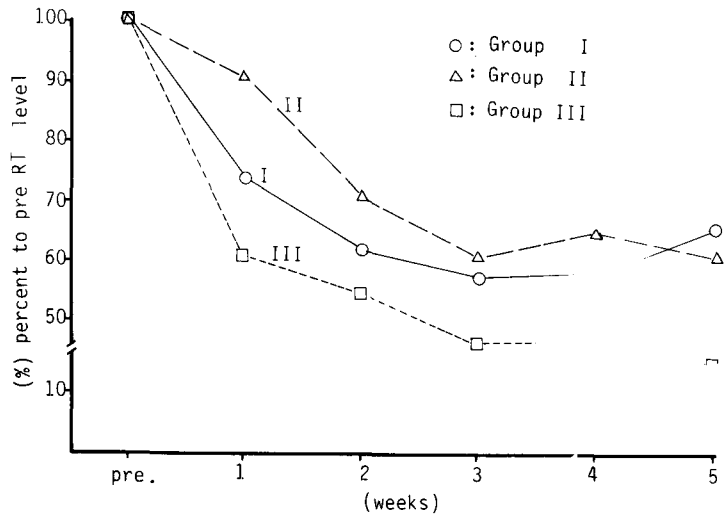


Fig. 2. Lymphocyte change during RT.

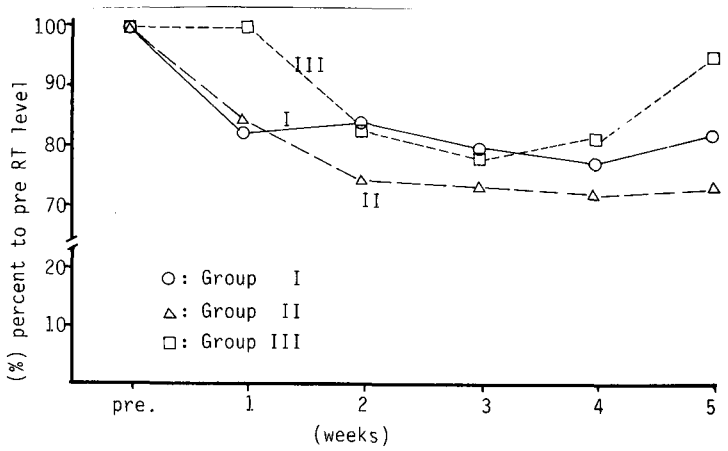


Fig. 3. *Platelet change during RT.*

Sacks et al. reported that important factors that influence local marrow regeneration after RT were the radiation volume, tumor dose and age[4].

The critical radiation dose that may sufficiently damage the red marrow ranged from 3000 to 4000 cGy[9~11].

After single total body irradiation in rat, the earliest drop of lymphocyte count and the least reduction in RBC were remarkable[2,3].

Unlike the other circulating formed elements, the circulating lymphocyte is sufficiently sensitive to be seriously demaged by total body irradiation.

The most prominent aspect of acute radiation effect is a reduction in number of circulating lymphocyte, together with appearance of abnormal lymphocyte forms[4~7,20,21].

Irradiation significantly reduce the "barrier function" of nodes. Following total nodal irradiation in Hodgkin's disease, there is significantly decrease in lymphocyte function.

The effect in lymphocyte function is gradually reversed so that by 5 years following irradiation, the lymphocytes of such patients function normally[14].

There were controversy that which cell was the most radioresistant. Some insisted that the megakaryocyte was the most radioresistant[2,15], the

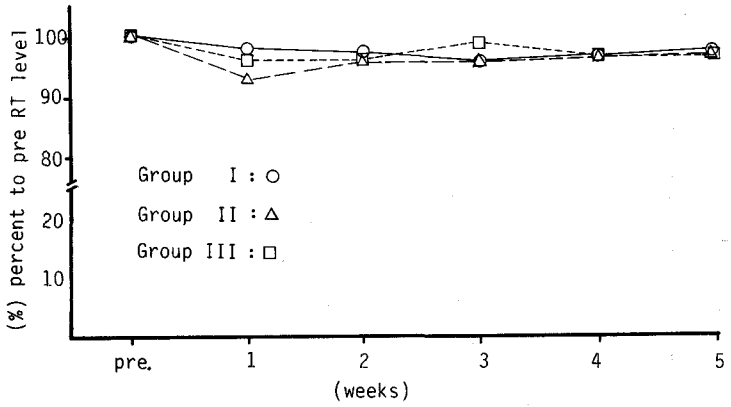


Fig. 4. Hemoglobin change during RT.

others reported that RBC was[16,17].

In our reports, hemoglobin value that reflect RBC level was more resistant than platelet.

Such apparant discrepancy is probably due to physiologic life span of each cell. The life time of RBC is 120 day whereas that of platelet is 7 to 10 day. The radiation damage must be manifested earlier and definitely in the platelet in vivo[3].

With doses of radiation employed clinically, the red cell counts decrease slowly. Several weeks of poorly functining bone marrow are required to produce a clinically noticeable decrease in the total red cell count[2].

In laboratory animals, high dose of radiation much above clinical levels increase the permeability of capillaries, permitting an exit of erythrocyte from the circulation[18].

However, in clinical radiotherapy this is probably not an important factor of anemia.

The precusor of the erythrocyte, the reticulocyte, disappear from the circulating blood almost as quickly as the lymphocyte.

There was another explanation that anemia in cancer patients may be caused by the factors such as alteration of serum folate clearence rate, serum iron and ESR that may influence hemoglobin synthesis[19].

Megakaryocyte is the least radiosensitive cell of myeloid elements[2,15]. Circulating platelets are resistant to high dose of radiation.

Approximately 40% of the active adult marrow is in the pelvis, 25% is in thoracic and lumbar vertebrae[22].

The amount of bone marrow in the RT portal was more greater in the pelvis than other sites. In our results, lymphocyte counts were declined significantly on pelvis, WBC and platelet counts were more decreased on thorax than other sites.

CONCLUSION

From July 1987 to September 1988, we analyzed 44 patients who were received conventionally fractionated RT at Chonbuk National University Hospital and obtained following results.

1. The lymphocyte was the most radiosensitive, especially in group III.
2. The radiation effect upon the platelet counts was intermediate, the difference among the groups was statistically not significant.
3. The hemoglobin was the most radioresistant.

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=국문초록=

방사선치료에 따른 암환자의 말초 혈액상의 변화

전북대학교 의과대학 치료방사선과

이태준 · 권형철 · 김정수 · 임선균 · 최기철

방사선치료가 조혈 기관에 미치는 영향을 평가하고자, 87년 7월부터 88년 9월까지 전북대학병원 치료방사선과에서 관례적인 분활요법(Conventionally fractionated) 방사선치료를 받은 환자중 치료 전, 중, 종료시에 말초 혈액소견이 전부 갖추어진 44명의 환자를 두경부암, 흉곽 소재암, 골반 부위암등 종양부위에 따라서 3군으로 나누어 이들의 백혈구 총수, 임파구수, 혈소판치 및 혈액소치의 변화를 분석한 결과 다음과 같은 성적을 얻었다.

1. 말초 혈액내의 백혈구 총수 및 임파구의 수는 치료개시 1주부터 현저하게 감소되기 시작하여 3주까지 계속 하강하고, 3~4주째 이후에는 약간 회복을 보였는데, 백혈구 총수에 비하여 임파구 수가 더욱 감소되었다.

2. 혈소판치는 치료개시 2주까지 감소하다가 제 4주째부터는 전군에서 약간의 회복을 보였고 혈색소치는 치료개시 1주에 약간 감소되어 그후 점차적으로 회복되었다.

3. 임파구 수는 골반 부위암에서, 백혈구 총수와 혈소판 치는 흉곽 소재암군에서 저명한 변화을 보였다.