實驗的 絕食에 있어서 血液細胞 및 造血機能의 變化에 關한 硏究

Ⅰ. 家兎의 絕食經過에 있어서 豫備的 血液學的 觀察

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ALTERATIONS OF BLOOD CELLS AND HEMATOPOIETIC FUNCTION DURING THE EXPERIMENTAL STARVATION

I. PRELIMINRY HEMATOLOGICAL OBSERVATION IN THE COURSE OF STARVATION ON RABBITS.

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Practioners are well aware of the need for routine hematological examination as an aid to establishing definite diagnoses of various diseases. Some of these conditions, however, are often manifested by anorexia. Although blood changes in the course of diseases are mainly attributable to specific etiology concerned, there is a possibility that changes in blood cells may be an effect of starvation or complete anorexia. The present studies were, therefore, undertaken in an effort to gaining more information as ts to the blood cell changes in the course of starvation, as measured by routine hematological examination.

Numerous observations on the pathological changes during the starvation of various animal species and human, especially of small animal have been reported.(1-9) Takizawa(1) concluded that the main causes of the pathological changes in undernutrition of dogs, known as chronic starvation, are unbalanced consumption of nutrients in body and resorption of its catabolic substances, and that it differs from complete starvation in that pathological changes may be attributable to the catabolic action of body constituents. He also showed hematological differences in both conditions: The decrement of total blood volume was more severe in starvation than in undernutritional condition. Increased blood sedimentation time, decrement of specific gravity in blood and plasma, low hematocrit value, low erythrocytic and leukocytic counts and low hemoglobin value, were usually seen in undernutritional condition, while almost normal ranges were retained in complete starvation.

On the other hand, the recent work of Chu(6) demonstrated the hemoconcentration with the increased hemoglobin volume and hematocrit value in experimental complete starvation on rats. This work was conducted with blood samples from the heart of rats.

In regard to the hemopoietic organ in experimental starvation, Iketa(7) reported slight hyperplastic condition of red marrow in early stage of starvation. Suzuki(4) also suggested active hyperplastic function of bone marrow in early stage and marked atrophy of lymphatic apparatus in the experimental starvation on small animal.

Sato(8) and Hashimoto(9) recently demonstrated the atrophy of fat marrow with the formation of gellatinous marrow in starved rabbits and according to Hashimoto these changes wers restored in one to three days after refeeding.

There were few studies reported on the starvation in large animal. Nakamura et al(10) observed on a horse with doubtful healthy condition and Miyamoto(11) dealt with 5 horses affected by infectious anemia.

Shinosaki et al(12) studied undernutrition of human and indicated the marked diminution of myeloid and lymphoid cell formation. Ueda(13) and Misao(14) suggested that reduced erythroietic and leukopoietic function may be particularly caused by disturbances in maturation of normoblasts and myelocytes respectively. In addition, they reported the disturbance of monocytic formation. Natsu(15) demonstrated decreased lymphocytes and fewer mitochondria in cytoplasm of lymphocytes and monocytes by means of supravital stain of leukocytes.

Many of the literatures cited above suggested a possibility of hemopoietic disturbances in starvation or undernutrition.

On the other hand, Ancel(16) described in his report on human starvation that increased erythropoiesis was found in the sternal marrow of anemic and starving persons.

The possibility that excessive peripheral destruction of the red blood cells may be involved was suggested by reports of hemosiderin deposits in tissue, particularly spleen and liver of starved human and animal (16,3, 19,20,21).

Extensive observation were made on hematological changes following starvation of human (16, 17, 18) and animals, and divergent results have been reported. In summarized view, apart from species, these divergences may be attributed to the length of period of starvation, degrees of starvation in quality and quantity of nutrients and other factors such as shifts in body hydration and concomitaut diseases, which in themselves may radically alter the composition of blood.

The paper herein reported concerns a preliminary observation made on starved rabbits by means of routine hematological examination. Particular emphasis was placed on the alteration of reticulocytes as a regenerative change in the course of complete starvation.

MATERIALS AND METHODS

1. Test Animal.

Animals employed in this experiment were 8 adult rabbits weighing 1.87 to 2.14 kilogram, 4 males and 4 females, 6 white and 2 grey in color.

They were fed usual diets in the laboratory animal cages. The animals were selected

after strict inspection of healthy condition. Rabbits in a state of undernutrition, or infested with parasites, or showing low erythrocytic count, low hemoglobin volume, or high leukocytic count were excluded from this experiment.

During the starvation, they were kept under well hygienic care and were restricted of all food intake with the exception of water until death.

The examination was carried out until death which included erythrocytic count, hemoglobin estimation, hematocrit measurement, reticulocytic count, total leukocytic count, differential count of leukocytes, microscopic observations of polychromatic erythrocytes, nucleated red cells and cell morphology, and measurement of body weight and rectal temperature.

2. Procuring Blood.

Blood samples were obtained by venipuncture using hypodermic needle from ear vein. Special care was taken to keep similar condition of venous distension at the time of venipuncture, since the condition of ear vein might alter their blood composition. Particularly, for the hematocrit measurement, 1 ml. of blood was obtained by 2 ml. of syringe from ear vein and poured into a sample bottle containg anticoagulant. Anticoagulant was composed of ammonium oxalate 1.2g and potassium oxalate 0.8g in 100 ml of water. One-tenth ml of this solution was measured and dried in a sample bottle. According to Wintrobe this anticoagulant is most satis ac tory if the shrinkage in volume of packed red cells is to be avoided.(23)

3. Erythrocytic(R.B.C) and Leukocytic(W.B.C) Counts.

For the R.B.C and W.B.C counts, Thoma pippetes and Türks hemocytometer with two sides of counting chambers, were used. The blood was diluted with Hayems and Türks solution respectively. Two cell counts were made on both sides of a hemocytometer and the values averaged.

If the difference between the two sides was greater than 10 percent, slide was recharged after removing the dilution in pippetes and another count was made until the total for each side were in better agreements in order to control any gross error due to inadequate mixing.

4. Hemoglobin(Hb) Estimation.

Hellige hemometer(made in Hellige Inc. U.S.A) was used for Hb estimation.

As acid hematin color altered with the time and temperature, the measuring tube containing the mixture of 0.1 N HCl and blood, were kept in water bath at 50 C for 15 minutes and then diluted with distilled water until the color was exactly that of standard.(22)

5. Estimation of haematocrit (Ht).

Ht was estimated by centrifugation (3000 r.p.m. for 30 minutes) in Wintrobe Ht tube of blood samples that had been treated with anticoagulant, and M.C.V. were calculated.

6. Reticulocytic count.

Blood smears were stained supravitally with brilliant cresyl blue and then counterstained with Giemsa stain by the following methods: A small drop of brilliant cresyl blue (C.I. No. 877) dissolved in absolute alcohol to give 0.5 per cent dye solution was placed at one end of a slide, and allowed to spread out on the slide. The stained area should not exceed about tow-thirds of an area of coverslip. The stain was then allowed to dry so as to yield thin film of the stain. A small drop of blood, obtained by venipuncture, was placed on a coverslip. The coverslip was then laid on the stained end of slide to make the blood coming into contact with the stain. Only about two-thirds of the coverslip was applied to the slide leaving one-third surface of the coverslip free from the edge of the slide. These were then allowed to stand in a moist chamber for 15 minutes so as to give a maximum penetration of dye into red cells. In the meantime, blood and dye were mixed once on the slide by elevating gently the free end of coverslip. This wet preparation was then taken out from the chamber and any moisture adhering on the slide was allowed to evaporate by warming slightly the slide on an alcohol lamp. The free end of coverslip was then obliquely lifted and the other end was slid on the slide so as to yield a stained blood smear in the usual manner. The smear was allowed to dry.

Decoloration and fixation were made with absolute methyl alcohol and counterstain with Giemsa stain. For the reticulocyte count usually 3,000 red cells were examined (6,000 cells or more when reticulocytes were less numerous.) Counting was facilitated by placing into the eyepiece of the microscope a piece of paper of adequate size.

7. Stained Blood Film for Differential Count of Leukocytes.

Two smear preparations were made, and one was stained with Giemsa and the other with peroxidase Giemsa stain.

For differential count of leukocytes, 200 of W.B.C. were examined by means of four-field meander method in each smear preparation and a total of 400 of W.B.C. in two preparations were calculated.

In addition, the nucleated red cells, Turks irritation cell and plasma cells, which may often appear normally in rabbits(24), were counted.

Polychromatic R.B.C. were also counted in appearanes per field (approximately 200 red cells in a field) with the examination of 20 fields at the least.

Red cell morphology was also observed in the blood smear examination.

RESULTS

Summarized data in the experiment were shown in Tables 1 to 8 and and Figures 1 to 8.

BODY WEIGHT AND RECTAL TEMPERATURE.

As is shown in Table 9, the average decrement ratio of body weight on the terminal day of starvation was 34.3 ± 7.5 per cent, the range widely varying from 24.5 to 46.3 per cent in 8 rabbits.

The average duration of life until death was 10.25 ± 2.6 days, the range being from 6 to 14 days. The data in Table 9 shows that the decrement ratio of body weight varies and is not always proportional to the duration of life.

The rectal temperature dropped to obviously subnormal temperature in 2-3 days before

death with a tendency to fall gradually from the middle stage of starvation in all of 8 starved rabbits.

Table 9. Decrement ratio of body weigh in the starvation of rabbits.

Case No. of rabbits.	1	2	3	4	5	6	7	8	average
Body weight(kg before starvation.	1.95	1.91	2.00	1.87	2.01	2.00	2.14	2.05	1.99±0.08
Body weight(kg) on the terminal day of starvation	1.22	1.41	1.51	1.23	1.33	1.16	1.15	1.43	1.31±0.14
Decrement ratio(%)	37.4	26.2	24.5	34.2	33.8	24.0	46.3	30.2	34.3 ±7.5
Days of duration until death.	14	8	6	12	18	11	11	12	10.25±2.6

ERYTHROCYTES(R.B.C), HAEMOGLOBIN(Hb), and HAEMATOCRIT(Ht)

As is shown in Tables 1-8 and on Figures 1-8, R.B.C. counts per c.mm. of blood on the day before starvation in 8 rabbits showed the range from 5.00 to 6.02 million and tended to rise gradually in the course of starvation with the exception of case No.6 and 8, in which no appreciable changes were observed.

R.B.C. counts on the terminal day of starvation in 6 cases that showed a tendency to rise, showed the range from 6.26 to 7.14 million, the rise being approximately 10 to 30 per cent.

Hb volume per 100 ml of blood during the starvation showed a moderate rise coinciding with the rise of R.B.C. in 6 cases, while in case No.8 there was no significant change in Hb. or R.B.C. counts and No.6 showed a moderate rise in Hb, although R.B.C. count remained unchanged.

Ht. value during starvation showed a slight rise in case No.1,2,5 and 7 and no changes in No.3 and No.4 while a slight fall was shown in case No.6 and No.8.

M.C.H.C. was slightly increased and M.C.V. was slightly diminished except in case No. 4.

For reference, averages and standard deviations of these in 8 rabbits on the day before starvation and on the terminal day of starvation are given inTable 10.

As shown in the table, the data before starvation were in approximate agreemet with those on normal blood of rabbits reported by Kobayawa, Wintrobe et al, Casey et al, and Sabin et al.(24,25,26,27.)

Table 10. Means and Standard Deviation on 8 Rabbits.

	R.B.C.(mill)	Hb.(g)	Ht.(%)	M.C.H.C.(%)	M.C.V.(cu)
Before starvation	5.6±0.53	11.6±0.82	39.0±1.9	29.0±1.9	70±3.9
Terminal day of starvation	6.44±0.55	13.0±1.50	40.7±3.7	32.1±2.9	64±2.9

RETICULOYTES(Retics), POLYCHROMATIC ERYTHROCYES AND MORPHOLOGY OF ERYTHROCYTES.

As shown in Fig. 1-8, the reticulocytes were persent in circulatory blood in 6 cases (No.1-6), the range varying from 35 to 76 cells per thousand R.B.C. on the day before starvation, fell abruptly on 3rd to 4th day of starvation, and gradually decreased in later stage In the other 2 cases, No.7 and 8, the reticulocytes were less numerous, the number being less than 30 cells, and were gradually reduced in number in the course of starvation. In all of 8 cases, these were decreased to the extent of more or less 10 cells per thousand R.B.C. on 5th day of starvation and less than 10 cells on the 7th day of starvation.

As shown in Table 11 and Fig. 9, the average percentage of reticulocytes was abruptly lowered on the 3rd to 4th day of starvation to the extent of less than 30 per cent of the normal level on the 4th day and gradually of approximately 10 per cent of the normal on the 7th day of starvation,

Table 11. The Average Number and Percentage of Reticulocytes in the Course of Starvaton on 8 Rabbits. (from data in Table 1-8)

Days of starvation	Before	1	2	3	4	5	7	9	11
Average No. of Retics	45.3	41.0	35.4	24.5	12.3	10.7	4.9	4.9	2.1
per thousand R.B.C.	±17.0	±14.4	±7.8	±7.2	±3.1	±2.9	±2.9	±2.1	±1.5
Average percentage.	100	90.5	78.1	54.1	27.2	22.6	10.8	10.8	4.6
Number of rabbits examined.	8	8	8	8	5	8	7	5	5

The appearance of polychromatic R.B.C. in the course of starvation was almost coincided with the fall in the number of reticulocytes.

In 6 cases, No.1-6, which showed numerous reticulocytes, 3 to 5 polychromatic R.B.C. per field were observed, compared to 1 or 2 cells in the other 2 cases, No.1 and 8.

During the starvation, the number of polychromatic R.B.C. was decreased abruptly on the 3rd to 4th day of starvation and almost disappeared as early as on the 5th day in case No.3, and on 7th day in other 6 cases, and none was found on the 8th day of starvation in all of 8 cases.

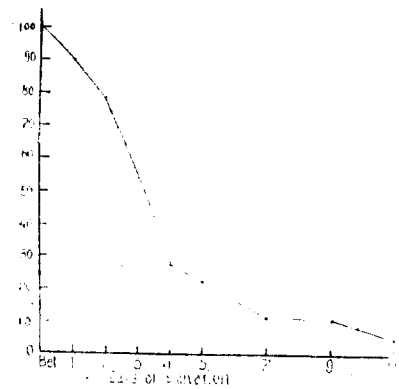

Fig 9 The Variation in Average Percentage of Reticulocytes in the Course of Starvation (from data in Table 11)

The variation of polychromatic R.B.C. and reticulocytes during starvation in rabbits seems to suggest that the erythropoieic function is markedly

restricted on 3rd or 4th day of starvation and suspended almost completely in about a week of starvation.

The nucleated R.B.C. in circulating blood was considered insignificant as it was only encountered in No.4 rabbit with only 1 cell in the course of starvation.

Anisocytosis, poikilocytosis and alteration of stain in R.B.C. were not observad in the course of starvation.

Diameter of R.B.C. examined in 4 cases, No.1-4, after measuring 200 R.B.C. in each count of smear preparation showed no significant shifts in Mean Corpuscular Diameter (M.C.D.) and Price-Jones curve, although there was a tendency that the number of macrocytes was limited during the starvation. The results are shown in Table 12.

Table 12. The Shifts in Diameter of of R.B.C. in Starvation.

Case No. of rabbits	1		2		3		4	
	M.C.D.	Range	M.C.D.	Range	M.C.D.	Range	M.C.D.	Range
Before starvation(u)	5.97	4.5-7.0	6.13	4.5-7.5	5.93	4.5-7.5	6.15	4.5-7.5
Terminal day of starvation(u)	5.91	4.5-7.0	6.11	4.5-7.0	5.91	4.5-7.0	6.91	4.5-7.0

LEUKOCYTES (W.B.C.)

As shown on Figures 1-8, the number of W.B.C. in the course of starvation gradually fell in all of 8 cases though there were irregular and transient fluctuations in the curve.

On the day before starvation, the average in 8 rabbits was 7600 per cubic millimeter of blood, the range being from 6500 to 8400. On the terminal day examined the average in 8 rabbits was 5100, the range being from 2700 to 6800.

Its decrement ratio on the terminal day in each rabbit widely varied from 13 per cent to 64 per cent, the average in 8 cases being 34± 18.2 per cent.

The decrement of total number of W.B.C. in each rabbit was given in Table 13.

Table 13. The Decrement of Number of Leukocytes in Starvation.

Case No. of rabbits.	1	2	3	4	5	6	7	8	Average
No. of W.B.C.(10) before starvation	8.0	7.8	7.7	8.4	7.5	7.5	7.7	6.5	7.6±0.55
Terminal counts(10) of W.B.C. in starvation.	6.3	6.8	6.2	6.5	4.2	2.7	3.5	4.3	5.1±1.6
Decrement ratio.(%)	21	13	20	23	44	64	55	34	34±18.2

For the differential count of leukocytes, six of the types, namely, the lymphocytes, neutrophilic (pseudoeosinophilic) leukocytes, eosinophilic leukocytes, basophilic leukocytes, monocytes, and the proplasmacytes and plasmacytes were differentiated and their

relative percentage were listed in Tables 1-8; the lymphocytes and neutrophiles were plotted only in absolute number.

The lymphocytes were diminished gradually from the onset and markedly at the later stage in 6 of 8 rabbits, while in the other 2 cases, No. 3 and 8, there was irregular and transient rise in the number of lymphocytes.

On the other hand, the neutrophilic leukocytes in the 6 cases, in which there were gradual fall of lymphocytes, showed a tendency to fall with irregular curve in early stage, and rise in contrast to marked fall of lymphocytes in later or terminal stage; while in the 2 cases, No.3 and 8, which showed transient rise in the number of lymphocytes, neutrophylic leukocytes were decreased during starvation.

It was, therefore, obvious that the gradual falls of total number or of W.B.C. during starvation were mainly attributable to the decrease of lymphocytes in 6 cases of 8 rabbits and to that of neutrophilic leukocytes in other 2 cases.

According to Kobanawa (24), the band cells, as the only form of young neutrophilic leukocytes in cirulating blood in normal adult rabbit, were as low as 0.4 per cent of total W.B.C., the metamyelocytes and the myelocytes being almost absent.

The range of band cells on the day before starvation in 8 rabbits was from 0.25 to 1.75 per cent and the metamyelocytes were very rarely present, only to the extent of 1 cell per 400 cells of W.B.C. in No.4 and 6.

No appreciable shifts in nuclear index were observed.

The eosinophilic leukocytes on the day before starvation in 8 rabbits ranged from 1.25 to 3.25 per cent.

During the starvion, the level of eosinophilic leukocytes in 5 cases, No.1, 4, 5, 6, and 8 was low, the range being from 0.5 to 0.75 per cent on the terminal day, and in cases No.2, 3, 7 there was no appreciable fall of relative percentage, but absolute number was slightly decreased.

As had been suggested in his report on the normal blood of rabbits by Kobanawa(24), the basophilic leukocytes were so rarely encountered as to be of any significance.

Monocytes varying on the day before starvation from 1.5 to 3.25 per cent in 8 rabbits were little altered during starvation. It may be pointed out that the differentiation between the monocytes and large lymphocytes in rabbits was not intended and the data on monocytes may be subject to modification.

According to Kobanawa(24), proplasmacytes or plasmacytes appeared frequently in small number as low as less than 0.6 per cent of W.B.C in circulating blood of normal rabbits.

In the experiment, these cells were present in 3 cases, No.1, 2, and 4, the range being from 0.25 to 1.00 per cent on the day before starvation.

During starvation, a relatively greater number of plasmacytes than normal were seen in 7 cases of 8 rabbits particularly in later stage of starvation and in another case, No.3, which died within 6 days, the shortest course of all, no plasmacytes were found throughout the course.

It seemed apparent that correct interpretation on the eosinophiles, the monocytes and the Turks irrition cells and plasma cells in starvation must await further study, as these cells were so few as to warrant any conclusion.

DISCUSSION

The most striking in erythrocytic series in peripheral blood in this study was restricted regeneration of R.B.C., as suggested by marked fall in the number of reticulocytes and polychromatic R.B.C., while R.B.C. count, Hb. content and Ht value maintained normal range or showed a slight hemoconcentration.

As the concentration of R.B.C. in circulating blood was thought to be dependent mainly upon the degree of regeneration and destruction of R.B.C., the variation in volume of blood plasma and partially upon the distribution of R.B.C. in body organ, it may be considered that the maintenance of normal level or an evidence of slight hemoconcentration of R.B.C. in starvation, in spite of markedly restricted regeneration, was mainly resulted from a proportionate loss of blood plasma.

The decrement in total blood volume and in volume of blood plasma in starvation had been described by Takizawa(1), Ancel Key and many other workers (16, 17.).

The possiblility of decreased erythropoietic function in starvation had been also suggested.

Sato(8) and Hashimoto(9) recently reported atrophy of fat marrow with the formation of gelatinous marrow in starved rabbits. On the other hand Iketa(7) and Suzuki(4). reported slight or active hyperplastic function of bone marrow in early stage of starvation.

No work on the reticulocytes in circulasing blood in starvation has been reported in the literature.

In this study, the average percentage of reticulocytes in 8 starved rabbits abruptly fell on the 3rd to 4th day of starvation, with the corresponding disappearance of polychromatic R.B.C., an evidence of inadequate response of the bone marrow.

Slight increase in M.C.H.C. and slight decrease in M.C.V. in the starvation were observed, although the erythrocytes were not of the normochromic normocytic type.

In M.C.D. and Price—Jones curve in diameter of R.B.C. no appreciable shifts were shown, although macrocytes were preset in small numbers.

Slight changes in M.C.H.C. and M.C.V. and fewer macrocytes may have resulted from disappearance of Retics. or polychromatic R.B.C..

The possibilty of excessive perpheral destruction of R.B.C. in starvation of human and animal as evidenced by hemosiderin deposits in tissue, were suggested by many workers. In this study, poikilocytoses, which frequently appears in anemia caused by the excessive destruction of R.B.C., was not observed.

The gradual decrease in total number of W.B.C. in all of starved rabbits was striking.

Numerous observaions on the leukocytes in circulaiong blood in the starvation of man and animal had been made with conflicting results, although the diminutions of myeloid and lymphoid cell formation were suggested.

In this study, the decrease in total number of W.B.C. was due mainly to the diminution in the absolute number of lymphocytes in 6 rabbits, and in other 2 cases due to the decrease in the number of neutrophiles.

The eosinophiles were markedly diminished in relative and absolute numer in 5 cases, but only slightly decreased in absolute number in the other 3 cases.

Rud(1947), Suzuki(1954), Wilhelmj et al (1954) and Pertoff(1954) demonstrated the decrease in eosinophiles in the experimental starvation on small animils and it was attributed to the stress arising from feeling of hunger and from metabolic derangement(28).

As reported by Kohanawa(24), the basophile was so rarely present as to arouse little interest.

On the monocytes, no constant variation was observed in this study, while Ueda(13) and Misao(14) suggested diminution of monocytic formation.

As was described already, differentiation between monocytes and lymphocytes in circulating blood of rabbit was not intended with the staining methods used and the criticism on it would not be available in this study.

The nature of proplasma cells is not definitely knowr and at present no diagnostic importance could be ascribed to them.

In man(29, 30.), Türk cells appear in the blood in considerable numbers in conditions associated with irritation of bone marrow, notably in primary and secondary anemia, leukemia, malaria and in the leukocytosis of pneumonia, and plasma cells are seldom seen in circulating blood but atypical plasma cells are of diagnostic significance in multiple myeloma.

Therefore it was considered that the tendency of increase in the number of these cells at later stage of starvation is problably due to unusual irritation of bone marrow in response to catabolic consumption of body constituents.

SUMMARY

A routine hematological observation in the course of starvation was carried out on eight experimentelly starved rabbits. They were strictly selected and restricted all of food intake with the exception of optional water intake until death.

The body weight of each rabbit on the day before starvation was about 2 kilograms.

The results are summarized as follows.

1. The average decrememt ratio of body weight on the terminal day before death was 34.3 ± 7.5 per cent with the range from 24.5 to 46.3 per cent.
   The average life duration until death was 10.25 ± 2.6 days, the range being from 6 to 14 days.
2. The decrease in number of reticulocytes with a parallel disappearance of polychromatic erythrocytes in peripheral blood in the course of starvation was the most

remarkable change in erythrocytic series, an evidence suggesting marked restriction of the erythropoietic function on 3rd to 4th day and almost complete suspension in about a week of starvation.

3. Erythrocyte count, hemoglobin content and haematocrit value of peripheral blood, were normal or indicative of slight hemoconcentration.
4. Mean Corpuscular Hemogloin Concentration was slightly higher than normal and Mean Corpuscular Volume tended to be low and no appreciable shifts were observed in Mean Corpuscular Diameter and Price-Jones curve of erythrocytes, while fewer macrocytes than normal were seen.

   These changes were considered to have resulted from a marked decrease in young erythrocytes in peripheral blood in the course of starvation.
5. Neither poikilocytoses or anisosytosis was observed.
6. Leukopenia was observed in all of 8 starved rabbits. The decrement ratio on the terminal day of starvation was between 13 to 64 per cent. The leukopenia was mainly due to fall of lymphocytes in 6 cases and to fall of neutrophilic leukocytes in the other 2 cases. In many cases, irregular fluctuation of neutrophilic leukocytes in its biological curve were seen in contrast to the relatively smooth changes of lymphocytes.

   Eosinophilic leukocytes tended to decrease in absolute number especially in later stage of starvation.

   Little significance in regard to monocytes and basophilic leukocytes in this study was discussed.
7. Proplasma cells, rarely plasma cells, appeared with a tendency to increase in number at later stage of starvation.
8. The most characteristic changes on circulating blood cells in complete starvation of rabbits were the leukoponia and failure of regeneration of erythrocytes.

   These changes were considered as adaptive phenomena in response to the catabolic consumption of body constituents.

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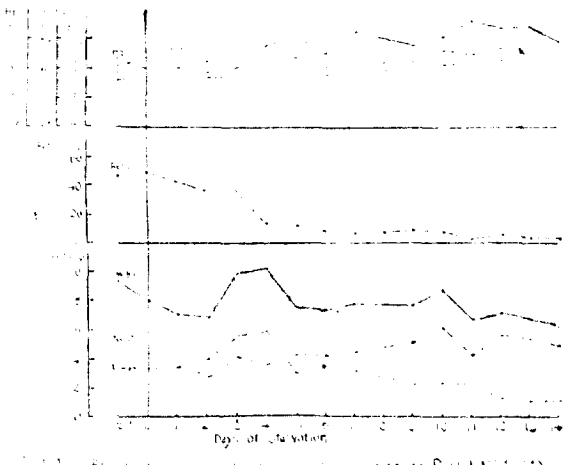

Fig. 1 Blood changes in the course of starvation of Rabbit No. 1 (♀)

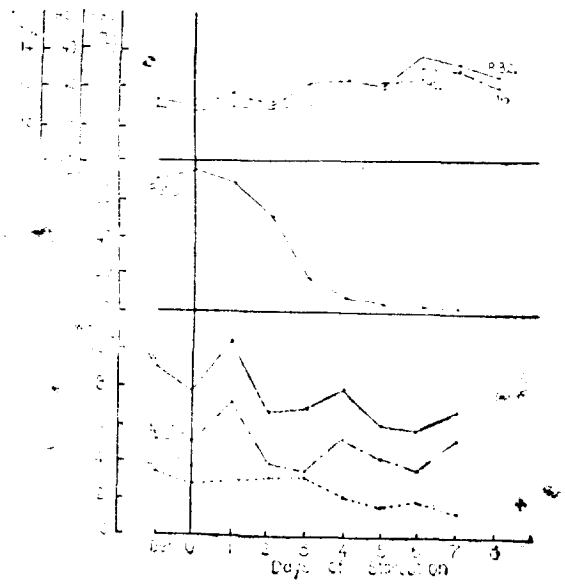

Fig. 2 Blood changes in the course of starvation of Rabbit No. 2 (♀)

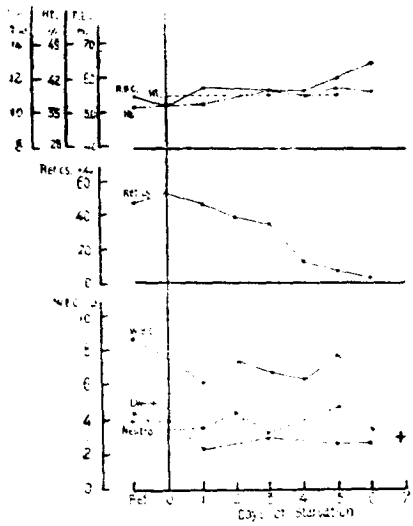

Fig 3 Blood changes in the course of starvation on Rabbit No 3 (♂)

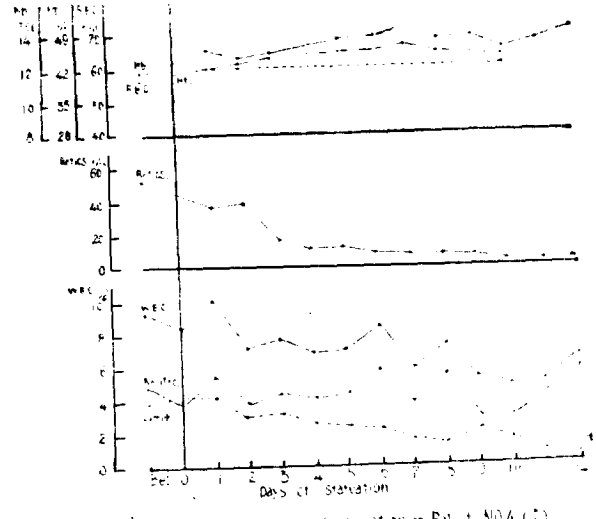

Fig 4 Blood changes in the course of starvation on Rabbit No 4 (♂)

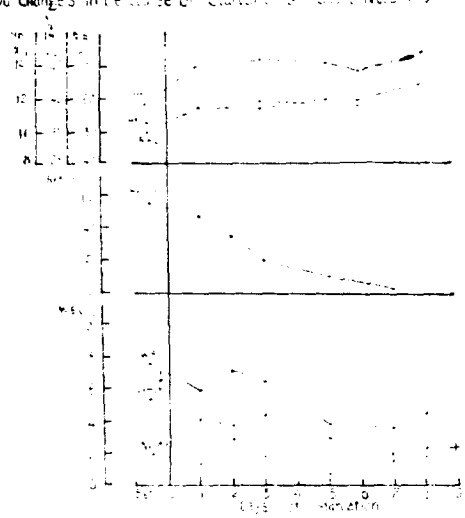

Fig 5 Blood changes in the course of starvation on Rabbit No 5 (♂)

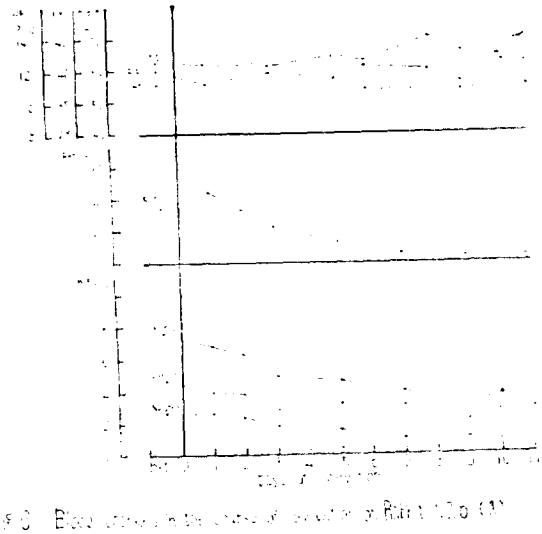

Fig 6 Blood changes in the course of starvation on Rabbit No 6 (♂)

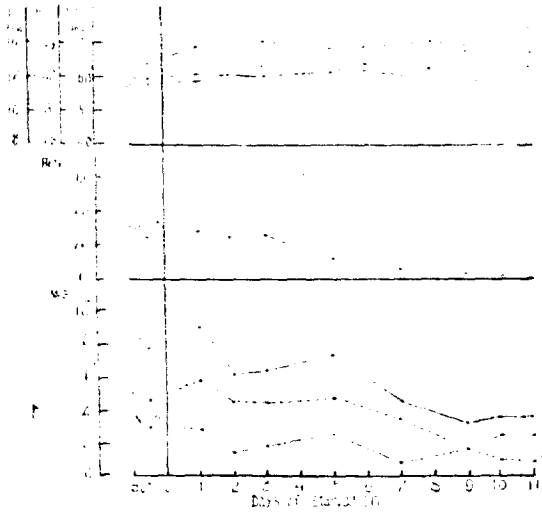

Fig 7 Blood changes in the course of starvation on Rabbit No 7 (♂)

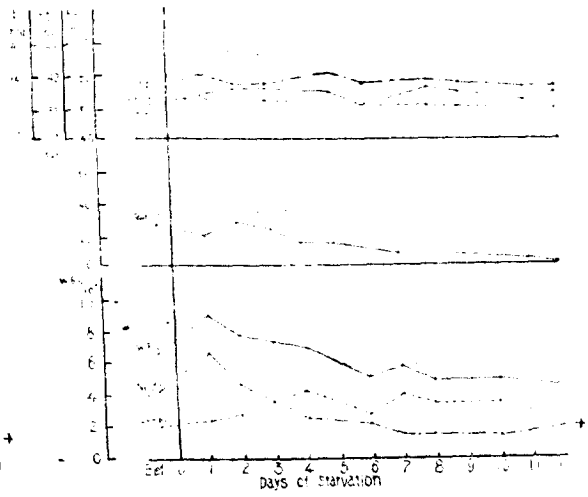

Fig 8 Blood changes in the course of starvation on Rabbit No 8 (♂)

TABLE I. BOOD CELLS IN THE COURSE

Date of experiment (1958)	Before		After starvation				
Course of starvation (days)	Mar.19 1	20 0	21 1	22 2	23 3	24 4	25 5
Body weight (Kg)	1.97	1.95	1.85	—	1.82	—	1.60
Rectal temperature (F)	103.1	102.6	103.5	—	102.2	—	102.4
R.B.C. count(10^6/c.mm.)	5.92	6.30	6.34	6.20	6.02	6.82	7.11
Haemoglobin(g/dl)	12.0	11.7	12.0	11.5	12.0	12.5	12.8
Haematocrit(%)	—	41.0	—	40.0	—	—	—
M.C.H.C.(%)	—	28.5	—	28.8	—	—	—
M.C.V. (c.u.)	—	65.1	—	64.5	—	—	—
Reticulocytes (%)	47.0	49.0	42.0	36.0	36.0	14.0	13.0
W.B.C.count(10^3/c.mm.)	9.3	8.0	7.0	6.8	9.9	10.1	7.5
Differential counts of Leukocytes (Percentage and absolute count) Neutrophiles	52.5 (4883)	42.5 (3400)	47.5 (3325)	56.0 (3808)	55.5 (5490)	58.5 (5909)	39.0 (2925)
Non-Lobulated Myelocytes	0	0	0	0	0	0	0
Non-Lobulated Metamyelocyte	0	0	0	0	0	0	0
Non-Lobulated Band cell	0.25	0	0.25	0.75	0.5	1.00	0.75
Non-Lobulated Degenerative band cell	2.25	2.25	1.25	3.0	3.5	3.25	0.75
2—7 lobes	50.0	40.25	46.0	52.25	51.0	54.25	37.50
Eosinophiles	1.75	1.00	0.50	1.50	0.25	2.00	1.50
Basophiles	0.25	0	0.25	0	0	0.25	0
Lymphocyte	43.25 (4022)	53.5 (4280)	49.25 (3448)	40.5 (2754)	42.0 (4158)	35.0 (3535)	56.0 (4200)
Monocyte	2.0	2.5	2.5	1.75	2.25	3.5	2.25
Türks irritation cell or Plasma cell	0.25	0.5	0	0.25	0	0.75	1.25
Nucleated R.B.C.	0	0.5	0	0	0	0	0
Polychromatic R.B.C (per field)	4-5	4-5	4-5	3-2	3-2	2-1	1.0
Sequelae							

OF STARVATION RABBIT NO.1 (8)

26 6	27 7	29 9	30 10	31 11	Apr. 1 12	2 13	3 14
—	1.49	—	1.40	—	1.27	—	1.22
—	101.8	—	101.3	—	100.2	98.6	98.8
6.45	7.26	6.81	7.05	7.68	7.42	7.47	6.90
12.0	—	12.4	13.2	13.0	13.5	—	12.5
40.5	—	—	43.0	—	44.0	—	—
29.6	—	—	30.7	—	30.7	—	—
63.0	—	—	61.0	—	59.4	—	—
9.0	7.0	9.0	9.0	3.0	5.0	4.0	3.0
7.4	7.8	7.7	8.7	6.6	7.2	6.8	6.3
37.25 (2756) 0	57.5 (4480) 0	66.0 (5140) 0	71.0 (6177) 0	63.5 (4191) 0	80.0 (5760) 0	81.0 (5508) 0	79.5 (5009) 0
0	0	0	0	0	0	0	0
0.25	1.00	1.25	1.00	1.50	0	0.5	0
1.75	2.75	4.00	3.25	2.75	2.25	2.5	3.0
35.25	53.75	61.50	66.75	59.25	77.75	78.0	76.5
0.75	1.00	0.75	0	0	0.5	1.0	0.5
0	0	0	0	0	0	0	0
58.5 (4329) 3.0	40.0 (3120) 1.5	28.50 (2195) 3.25	26.25 (2284) 1.75	32.75 (2161) 3.0	16.75 (1206) 2.5	17.0 (1156) 1.0	18.5 (1165) 1.0
0.5	0	0.75	1.0	0.75	0.25	0	0.50
0	0	0	0	0	0	0	0
0.3	0.05	0	0	0	0	0	0

Died on Apr. 4

TABLE II. BLOOD CELLS IN THE COURSE

Date of experiment (1958)	Before Apr.19	20	21	22
Course of starvation (days)	1	0	1	2
Body weight (Kg)	1.90	1.91	1.80	—
Rectal temperature (F)	103.3	102.2	102.2	—
R.B.C. count(10^6/c.mm.)	5.6	5.41	5.80	5.51
Haemoglobin(g/dl)	11.0	10.8	11.0	11.0
Haematocrit(%)	—	39.0	—	39.0
M.C.H.C.(%)	—	27.7	—	28.2
M.C.V. (cu.)	—	72.0	—	71.0
Reticulocytes(%)	71.0	76.0	68.0	49.0
W.B.C. count(10^3/c.mm.)	9.0	7.8	10.4	6.7
Differential counts of leucocytes (percentage and absolute count) — Neutrophiles	56.0 (5040)	62.5 (4875)	69.0 (7176)	40.5 (3714)
Non-lobulated — Myelocytes	0	0	0	0
Non-lobulated — Metamyelocytes	0	0	0	0
Non-lobulated — Band cell	1.25	1.75	2.50	0.75
Lobulated — Degenerative band cell	2.75	8.25	6.25	2.25
Lobulated — 2—7 lobes	52.0	57.50	60.60	37.50
Eosinophiles	3.25	2.25	1.25	2.0
Basophiles	0	0	0	0
Lymphocytes	37.50 (3375)	34.0 (2652)	27.5 (2860)	54.75 (3065)
Monocytes	2.25	1.25	1.75	2.0
Türks irritation cell or plasma cell	1.00	0	0.50	0.75
Nucleated R.B.C.	0	0	0	0
Polychromatic R.B.C. (per fiedid)	4-5	4-5	3-4	3-4
Complication				

OF STARVATION ON RABBIT NO.2 (♀)

After starvation					
23 3	24 4	25 5	26 6	27 7	28 8
1.70	—	1.57	—	1.46	1.41
102.0	—	101.5	—	100.4	100.4
6.09	6.20	6.06	6.80	6.57	6.26
11.0	12.5	12.0	13.0	13.0	12.0
—	—	—	44.0	—	—
—	—	—	29.6	—	—
—	—	—	65.0	—	—
18.0	7.5	5.0	3.5	1.0	—
6.8	8.0	6.0	5.8	6.8	—
48.0 (3264) 0	68.5 (5480) 0	70.5 (4230) 0	61.5 (3567) 0	77.0 (5236) 0	— — —
0	0	0	0	0.25	—
1.25	1.75	0.75	1.25	1.75	—
2.00	4.25	2.25	2.00	4.25	—
44.75	62.50	67.50	58.25	70.75	—
2.5	2.0	1.75	2.00	1.25	—
0.25	0	0	0	0	—
46.25 (3145) 2.5	26.25 (2100) 1.25	26.50 (1590) 0.25	34.0 (1972) 0.75	20.75 (1411) 0.50	— — —
0.5	1.50	1.00	1.75	0.50	—
0	0	0	0	0	—
0.5-1	0.5	0	0	0	—

Cysticercosis (mesenteria) on postmortem exam.
Died on Mar. 29

TABLE IV. BLOOD CELLS IN THE COURSE

Date of experiment (1958)	Before		After starvation			
	Apr. 25	30	May 1	2	3	4
Course of starvation (days)	5	0	1	2	3	4
Body weight (Kg)	1.85	1.87	1.80	1.75	1.70	1.60
Rectal temperature (F)	101.7	101.8	101.8	101.7	101.8	102.0
R.B.C. count (10^6/c.mm.)	5.66	6.21	6.49	6.32	6.45	—
Haematocrit (g/dl)	11.7	12.0	12.0	12.2	12.7	—
Haematocrit (%)	—	41.0	—	42.5	—	—
M.C.H.C. (%)	—	29.3	—	29.0	—	—
M.C.V. (cu.)	—	66.1	—	67.5	—	—
Reticulocyte (%)	52.0	44.0	36.0	40.0	17.0	12.0
W.B.C. count (10^3/c.mm.)	9.3	8.4	10.1	7.1	7.8	6.8
Differential counts of leucocytes (percentage and absolute counts) — Neutrophiles	53.50 (4976)	46.50 (3864)	54.50 (5505)	53.75 (3816)	56.00 (4368)	60.25 (4114)
None lobulated — Myelocytes	0	0	0	0	0	0
None lobulated — Metamyelocytes	0	0	0.25	0.25	0	0
None lobulated — Band cell	0.75	1.25	2.25	2.00	1.25	1.25
None lobulated — Degenerative band cell	2.25	1.75	2.00	2.75	1.75	2.00
2—7 lobes	50.50	43.00	50.00	48.75	53.00	37.00
Eosinophiles	2.50	1.75	0.50	2.25	1.25	0.75
Basophiles	0	0	0	0	0	0
Lymphocytes	40.75 (3790)	49.50 (4158)	41.75 (4217)	41.75 (2964)	41.25 (3218)	37.50 (2550)
Monocytes	3.25	2.50	3.25	1.75	1.50	1.25
Türks irritation cell or plasma cell	0	0.25	0	0.50	0	0.25
Nucleated R.B.C.	0.25	0	0	0	0	0
Polychromatic R.B.C. (Per field)	3-4	3-4	3-4	2-3	2-3	2
Sequelae						

OF STARVATION ON RABBIT NO.4 (1)

5 5	6 6	7 7	8 8	9 9	10 10	11 11	12 12
—	1.52	—	1.42	1.37	—	1.28	1.23
—	100.8	—	100.4	100.4	—	96.6	95.5
6.91	7.00	7.21	6.85	6.90	6.49	6.80	7.14
12.9	13.0	13.4	13.0	—	12.7	—	—
—	—	—	—	—	42.5	—	—
—	—	—	—	—	30.0	—	—
—	—	—	—	—	65.4	—	—
12.0	9.0	8.0	7.0	7.0	4.0	4.0	5.0
7.0	8.4	5.7	7.2	5.2	4.8	5.1	6.5
62.5 (4375) 0	70.5 (5922) 0	69.25 (3947) 0	76.00 (5472) 0	55.00 (2860) 0	61.50 (2952) 0	83.50 (4259) 0	89.00 (5785) 0
0	0	0	0	0	0	0	0
0.50	1.75	0.75	0.50	0	0	0.25	2.25
2.50	2.75	1.25	2.25	2.00	1.25	2.25	3.00
59.50	66.00	67.25	73.25	53.00	60.25	81.00	83.50
1.00	1.25	0.75	1.75	0.25	0.50	0.75	0.50
0	0	0.25	0	0	0	0.25	0
33.75 (2363) 2.75	26.50 (2226) 1.75	27.75 (1581) 1.75	19.00 (1368) 2.00	41.75 (2171) 2.25	34.50 (1656) 2.00	14.50 (739) 0.75	8.75 (569) 1.00
0	0	0.25	1.25	0.75	1.50	0.25	0.75
0	0	0	0	0	0	0	0
0.5	0.2	0	0	0	0	0	0

Died on May 13

TABLE III. BLOOD CELLS IN THE COURSE OF STARVATION ON RABBIT NO.3(♀)

Date of experiment (1958)		Before		After starvation					
		Apr.3	24	5	6	7	8	9	10
Course of starvation		1	0	1	2	3	4	5	6
Body weight (Kg)		2.00	2.00	1.90	1.80	1.70	1.63	1.55	1.51
Rectal temperature (F)		102.6	102.7	102.6	102.0	102.6	102.3	101.7	100.2
R.B.C. count(10^6/c.mm.)		5.45	5.17	5.60	—	5.54	5.60	6.00	6.41
Haemoglobin(g/dl)		10.3	10.4	10.6	—	11.2	11.0	11.4	11.3
Haematocrit(%)		—	38.0	—	—	39.0	—	39.0	—
M.C.H.C.(%)		—	27.4	—	—	28.7	—	29.2	—
M.C.V. (cu.)		—	73.0	—	—	71.0	—	65.0	—
Reticulocytes (%)		48.0	53.0	46.0	39.0	35.0	12.0	8.0	3.0
W.B.C.count(10^3/c.mm.)		8.8	7.7	6.1	7.4	6.7	6.4	7.8	6.2
Differential counts of Leucocytes (percentage and absolute count)	Neutrophiles	35.5 (4004)	50.0 (3850)	36.5 (2226)	35.0 (2580)	45.25 (3031)	—	33.5 (2613)	41.25 (2558)
	Non-lobulated: Myelocytes	0	0	0	0	0	—	0	0
	Non-lobulated: Metamyelocytes	0	0	0	0	0	—	0	0
	Non-lobulated: Band cell	0.5	0.25	0	0	2.00	—	0.50	0.75
	Lobulated: Degenerative band cell	3.0	3.75	3.25	3.00	2.00	—	0.75	1.50
	Lobulated: 2—7 lobes	42.0	46.00	33.25	32.00	42.50	—	32.25	39.00
	Eosinophiles	3.25	2.25	3.00	4.50	2.50	—	2.00	1.25
	Basophiles	0	0	0	0	0	—	0	0
	Lymphocytes	48.25 (4246)	45.00 (3465)	58.00 (3538)	58.00 (4292)	49.50 (3317)	—	62.00 (4836)	55.50 (3441)
	Monocytes	3.0	2.75	2.5	2.5	2.75	—	2.5	2.0
	Türpks irritation cell or plasma cell	0	0	0	0	0	—	0	0
Nucleated R.B.C		0	0	0	0	0	—	0	0
Polychromatic R.B.C (per field)		—	4-5	4-5	4.0	1-2	—	0.05	0
Complication				Cysticercosis (mesenteria) Died on Apr. 11					

TABLE V. BLOOD CELLS IN THE COURES OF STARVATION ON RABBIT NO.5 (+)

Date of experiment (1958)	Before	After starvation						
	May 18	19	20	21	23	24	25	26
Course of starvation	0	1	2	3	5	6	7	8
Body weight (Kg)	2.01	1.71	1.64	1.56	1.45	—	—	1.33
Rectal temperature (F)	103.3	102.2	102.1	101.7	101.3	—	—	100.0
R.B.C. count(10^6/c.mm.)	5.00	5.70	—	5.68	5.97	6.03	—	6.53
Haemoglobin (g/dl)	12.0	14.0	—	14.4	14.2	13.8	—	14.8
Haematocrit (%)	37.0	39.0	—	41.0	—	40.5	—	—
M.C.H.C.(%)	32.5	35.9	—	35.1	—	34.1	—	—
M.C.V. (cu.)	74.0	68.4	—	72.0	—	67.5	—	—
Reticulocytes(%)	54.0	47.0	35.0	20.0	10.3	—	2.3	—
W.B.C.count(10^3/c.mm.)	7.5	5.8	7.1	6.4	3.8	—	3.6	4.2
Differential counts of leucocytes (percentage and absolutecount) Neutrophiles	26.0 (1950)	26.0 (1248)	41.5 (1947)	28.5 (1824)	19.25 (732)	— —	44.25 (1593)	52.5 (2205)
Non-lobulated Myelocytes	0	0	0	0	0	—	0	0
Non-lobulated Metamyelocytes	0	0	0	0	0	—	0	0
Non-lobulated Band cell	1.25	0	1.25	1.00	0	—	0.75	1.25
Lobulated Degenerative band cell	1.50	1.50	2.75	1.50	0.50	—	4.00	3.50
Lobulated 2—7 lobes	23.25	24.50	37.50	26.0	18.75	—	39.50	47.75
Eosinophiles	2.25	4.00	4.25	2.50	0.75	—	0.50	0.75
Basophiles	0	0.25	0	0	0	—	0	0
Lymphocytes	70.00 (5250)	68.25 (3959)	51.75 (3674)	68.25 (4368)	77.25 (2936)	— —	52.50 (1890)	44.75 (1880)
Monocytes	1.75	1.50	2.50	0.75	1.50	—	1.0	1.25
Türks irritation cell or plasma cell	0	0	0	0	1.25	—	1.75	0.75
Nucleated R.B.C.	0	0	0	0	0	—	0	0
Polychromatic R.B.C. (per field)	3.0	3.0	2.0	1.0	1.0	—	0	0
Sequelae		Died on May 27						

TABLE VI. BLOOD CELLS IN THE COURSE

Date of experiment (1958)	Before	After starvation		
Course of starvation	May 18 0	19 1	20 2	21 3
Body weight (Kg)	2.00	1.80	1.72	1.66
Rectal temperature (F)	103.4	102.8	102.1	101.4
R.B.C.count(10^6/c.mm.)	6.02	5.61	—	5.92
Haemoglobin (g/dl)	12.4	12.4	—	12.2
Haematocrit(%)	39.0	42.0	—	41.0
M.C.H.C.(%)	31.8	29.5	—	30.0
M.C.V. (cu.)	65.0	75.0	—	70.0
Reticulocytes(%)	35.0	43.0	33.0	22.0
W.B.C.count(10^3c.mm.)	7.5	6.6	6.2	4.7
Differential counts of leucocytes (percentage and absolute count) — Neutrophiles	35.50 (2663)	37.25 (2459)	36.75 (2279)	39.00 (1833)
Non-lobulated — Myelocytes	0	0	0	0
Non-lobulated — Metamyelocytes	0	0.25	0	0
Non-lobulated — Band cell	0.5	0.25	0.75	0.5
Lobulated — Degenerative band cell	1.50	1.25	1.00	1.75
Lobulated — 2—7 lobes	33.50	35.50	35.00	36.75
Eosinophiles	2.25	2.50	2.00	1.25
Basophiles	0	0	0	0
Lymphocytes	60.50 (4538)	59.00 (3894)	59.00 (3658)	58.25 (2738)
Monocytes	1.75	1.25	2.00	1.50
Türk's irritation cell or plasma cell	0	0	0.25	0
Nucleated R.B.C.	0	0.25	0	0
Polychromatic R.B.C. (per field)	3.0	3.0	3.0	2.0
Sequelae				

OF STARVATION ON RABBIT NO.6 (♀)

23 5	24 6	25 7	26 8	27 9	28 10	29 11
1.57	—	1.45	—	1.34	1.26	1.16
101.0	—	100.8	—	100.4	100.2	98.4
5.67	6.23	—	5.88	5.55	—	6.28
12.8	12.50	—	14.0	13.0	—	13.8
—	38.0	—	—	37.0	—	37.5
—	32.9	—	—	35.1	—	36.8
—	61.0	—	—	67.0	—	60.0
12.0	—	4.3	—	2.0	—	1.6
4.5	—	3.9	—	3.0	3.6	2.7
68.00 (3060) 0	— — —	78.00 (3042) 0	— — —	67.00 (2010) 0	77.00 (2772) 0	— — —
0	—	0	—	0	0	—
3.25	—	2.50	—	0.50	0.5	—
3.75	—	3.50	—	2.00	2.00	—
61.00	—	73.00	—	64.50	74.50	—
0	—	0	—	0.5	0	—
0	—	0	—	0	0	—
30.50 (1523) 0.50	— — —	21.00 (819) 0.75	— — —	30.25 (908) 0.50	21.25 (765) 1.00	— — —
1.00	—	0.25	—	1.75	0.75	—
0	—	0	—	0	0	—
0.1	—	0.05	—	0	0	—

Died on May 30

TABLE VII. BLOOD CELLS IN THE COURSE

Date of experiment (1958)	Before	After starvation		
Course of starvation	May 18 0	19 1	20 2	21 3
Bady weight (Kg)	2.14	1.81	1.73	1.68
Rectal temperature (F)	106.6	102.5	102.5	102.6
R.B.C count(10^6/c.mm.)	5.83	6.00	—	6.2
Haemoglobin (g/dl)	12.7	13.7	—	14.0
Haematocrit(%)	41.0	41.0	—	44.0
M.C.H.C. (%)	31.0	33.4	—	31.8
M.C.V. (cu.)	71.0	68.0	—	73.0
Reticulocytes(%)	24.0	27.0	24.0	25.0
W.B.C. count(10^3c.mm.)	7.7	9.1	6.2	6.4
Differential counts of leucocytes (percentage and absolute count) — Neutrophiles	36.75 (2830)	31.00 (2821)	24.5 (1519)	29.00 (1856)
Non-lobulated — Myelocytes	0	0	0	0
Non-lobulated — Metamyelocytes	0	0	0	0
Non-lobulated — Band cell	0.75	0.25	0.50	0
Lobulated — Degenerative band cell	2.00	1.25	3.25	1.50
Lobulated — 2--7 lobes	34.00	29.50	20.75	27.50
Eosinophiles	1.5	2.00	2.00	1.50
Basophiles	0	0	0	0
Lymphocytes	59.50 (4582)	64.50 (5870)	72.00 (4464)	68.00 (4352)
Monocytes	2.25	2.50	1.50	1.50
Türk irritation cell or plasma cell	0	0	0	0
Nucleated R.B.C.	0	0	0	0
Polychromatic R.B.C.	2.0	2.5	2.0	1.0
Sequelae				

OF STARVATION ON RABBIT NO.7 (♀)

23 5	24 6	25 7	26 8	27 9	28 10	29 11
1.57	—	1.47	—	1.31	1.22	1.15
102.7	—	102.8	—	100.5	99.6	99.2
6.12	6.28	—	6.16	6.65	—	6.70
13.6	13.7	—	14.0	13.8	—	14.9
—	43.0	—	—	40.0	—	44.0
—	32.8	—	—	34.5	—	33.9
—	68.0	—	—	60.0	—	66.0
11.0	—	4.7	—	2.0	—	0
7.4	—	4.5	—	3.2	3.6	3.5
34.75 (2572) 0	— — —	18.75 (844) 0	— — —	48.0 (1536) 0	71.75 (2584) 0	71.00 (2450) 0
0	—	0	—	0	0	0
0	—	0.50	—	1.25	1.25	0
0.75	—	1.00	—	1.50	1.50	3.50
34.00	—	17.25	—	45.25	69.00	57.50
0.50	—	1.00	—	0	1.50	1.25
0	—	0.25	—	0	0	0
63.50 (4699) 1.25	— — —	78.25 (3521) 1.00	— — —	50.00 (1600) 0.50	25.00 (900) 1.00	25.50 (880) 0.5
0	—	0.75	—	1.50	0.75	1.75
0	—	0	—	0	0	0
0.2	—	0	—	0	0	0

Died on May 30

TABLE VIII. BLOOD CELLS IN THE COURSE

Date of experiment (1958)	Before	After starvation			
	May 21	22	23	24	25
Course of starvation	0	1	2	3	4
Body weight (Kg)	2.05	2.04	1.97	—	1.83
Rectal temperature.(F)	102.8	102.6	103.0	—	102.4
R.B.C count(10^6/c.mm.)	5.07	5.32	5.48	5.52	—
Haemoglobin.(g/dl)	10.8	12.0	11.3	11.3	—
Haematocrit(%)	37.0	—	—	36.5	—
M.C.H.C. (%)	29.2	—	—	31.0	—
M.C.V. (cu.)	72.0	—	—	66.0	—
Reticulocytes(%)	27.0	20.0	27.0	23.0	16.0
W.B.C. count(10^3/c.mm.)	6.5	9.0	7.7	—	6.9
Differential counts of Leucocytes (percentage and absolute count.) Neutrophiles.	63.75 (4150)	72.25 (6503)	57.5 (4428)	— —	36.0 (2484)
Non-Lobulated: Myelocytes	0	0	0	—	0
Non-Lobulated: Metamyelocytes	0	0	0	—	0
Non-Lobulated: Band cell.	0.75	2.0	0	—	0
Non-Lobulated: Degenerative band cell.	0.50	3.0	1.0	—	1.50
Lobulated: 2—7 lobes	63.00	67.25	56.50	—	34.50
Eosinophiles.	2.25	2.00	3.00	—	2.50
Basophiles.	—	—	—	—	—
Lymphocytes.	32.50 (2112)	25.00 (2250)	39.00 (3003)	— —	59.00 (4071)
Monocytes.	1.50	0.75	1.00	—	2.5
Türks irritation cell or plasma cell.	—	—	—	—	—
Nucleated R.B.C.	—	—	—	—	—
Polychromatic R.B.C. (per field)	1.0	1.0	1.0	—	0.5
Sequelae					

OF STARVATION ON RABBIT NO.8 (♂)

26 5	27 6	28 7	29 8	30 9	31 10	Jun. 1 11	2 12
—	1.72	1.67	1.63	1.59	1.54	1.49	1.43
—	102.1	102.1	102.5	101.7	101.0	100.9	—
5.39	4.98	—	5.51	5.27	—	5.00	5.28
12.0	11.3	—	11.5	11.3	—	11.0	11.0
—	35.0	—	—	34.5	—	—	34.0
—	32.3	—	—	32.7	—	—	32.4
—	70.0	—	—	65.0	—	—	64.0
14.0	—	7.0	—	4.5	—	2.0	0
—	4.9	5.6	4.8	—	4.9	—	4.3
—	42.25	24.0	27.5	—	27.25	—	45.25
—	(2070)	(1334)	(1320)	—	(1335)	—	(1946)
—	0	0	0	—	0	—	0
—	0	0	0	—	0	—	0
—	0.25	0	0	—	0.25	—	0
—	1.50	0.50	0	—	0.75	—	0.50
—	40.50	23.50	27.50	—	26.25	—	44.75
—	2.00	3.50	0.4	—	0.25	—	0.5
—	—	—	—	—	—	—	—
—	53.00	70.00	69.00	—	68.50	—	50.00
—	(2597)	(3920)	(3312)	—	(3356)	—	(2150)
—	2.0	1.25	2.50	—	2.0	—	3.0
—	0.75	1.25	0.50	—	2.0	—	1.25
—	—	—	—	—	—	—	—
—	0.5	0	0	—	0	—	0

Died on June 3

實驗的絕食에 있어서 血液細胞 및 造血機能의 變化에 關한 硏究

Ⅰ. 家兎의 絕食經過에 있어서 血液學的豫備觀察

李 芳 煥

全北大學校農科大學 獸醫學科獸醫內科學敎室

血液學的診斷이 要請되는 臨床病例에 있어서 食慾絕廢의 症勢가 隨伴되는例를 흔히볼수있다. 이러한 病例에있어서의 血液所見은 그疾病의 特異한 病因的要素에 起因된 血液像일뿐만 아니라 一部는 絕食(食慾絕廢)에 依해서 二次的으로 誘起된 變化가 合併되었을것으로 생각된다. 이와같은 見地에서 絕食에起因된 血液細胞의 變化에關한 基本的인 見解를 얻기爲한 豫備實驗으로서 體重2kg前後의 8頭의家兎를 完全絕食(飮水는 任意攝取케함)시켜 斃死에 이루기까지의 經過中에 이러나는 末梢循環血液細胞의 變化를 例別로 觀察하여 다음과같은 結果를 얻었다.

1. 絕食最終日의 體重減少率은 平均34.3±7.5%(最低24.5% 最高46.3%)이며 斃死까지의 耐過日數는 平均10.25±2.6日(最短6日 最長14日)로서 個體에따라 큰差異가있으며 個體別로 比較했을때 體重의 減少率은 반듯이 耐過日數에 比例되지 않았다.

2. 絕食經過中에 있어서의 末梢血液의 赤血球系의 가장큰 變化는 網狀赤血球의 出現의 顯著한 減少이었다. 絕食家兎8頭에 對한 網狀赤血球數의 平均減少率을보면 絕食第3日乃至第4日에 顯著하게 減少되며 第4日에는 約 70%以上의 減少率을 表示하고 그以後부터 漸減하여 絕食第7日에는 約 90%의 減少率을 表示하였다.

多染性赤血球도 이와 거의 一致한 出現率의 變化를 表示하였다. 이와같은 所見으로 미루어보아 絕食經過中의 造赤血球機能의 變化는 絕食第3日乃至第4日에 顯著하게 減退되고 約1週日後에는 거의 停止된것으로 생각되었다.

3. 絕食經過中의 赤血球數, 血色素量및 Hematocrit値는 評價될만한 變化가 없거나 또는 若干의 增加傾向을 表示하였다.

絕食經過中에 있어서 造赤血球機能이 顯著하게 減退됨에도 不拘하고 赤血球濃度에 큰變化가 나타나지 않음은 絕食에 있어서 體重減少에 隨伴되는 體液減少에 起因된것으로 생각되었다.

4. 平均赤血球血色素濃度는 若干의 增加傾向이며 平均赤血球容積은 若干의 減少傾向을 보였다. 平均赤血球直經및 Price-Jones曲線은 大赤血球의 出現率의 若干의 減少傾向을 表示하였을뿐 큰變化는 없었다. 이들變化는 循環血液中의 幼若型赤血球 즉 網狀赤血球 또는 多染性赤血球의 減少에 起因된것으로 생각되었다.

5. 異形赤血球症 또는 赤血球大小不等症은 볼수없었다.

6. 絕食經過에 있어서 白血球總數는 全8例에 있어서 減少되었으며 絕食最終檢査日의 例別

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減少率을 보며 13%에서 64의 큰差異를 表示하였다.

이와같은 白血球總數의 減少는 8例中 6例에있어서 主로 淋巴球의 絶對數 減少에 起因되었고 남어지 2例에 있어서는 骨髓性白血球(主로 好中球)의 絶對數의 減少에 起因되었다.

많은 例에있어서 絶食經過中의 好中球의 絶對數의 變化曲線은 不規則한 波動이 보이나 淋巴球의 絶對數의 變化는 이에比하여 比較的 平旦한 變化를 보이고 있다. 好酸球는 그絶對數에 있어서 特히 絶食後期에 減少傾向을 보였다.

7. Türk氏 刺戟細胞(또는 드물게 Plasma cell과 類似한細胞)가 絶食後期에 있어서 少數이기는하나 더욱 頻繁하게 出現하는 傾向이 보였다.

이들所見을 綜合하였을때 家兎絶食에 있어서의 重要한 血液細胞의 變化는 白血球總數가 減少되는點, 그리고 赤血球再生이 顯著하게 抑制됨에도 不拘하고 赤血球計算 血色素定量및 Hematocrit測定에 있어서는 貧血像이 나타나지 않는點이며 이와같은 變化는 絶食에있어서의 體成分의 一方的分解消耗에 順應하는 適應反應으로 생각되었다.

(抄錄)

動物의 Salmonella屬菌 分布에 關한 硏究

第一報 大邱地域의 犬에 있어서의 Salmonella屬菌의 分布

趙 漢 喆

Studies on the Distribution of Salmonella Group Organisms in Animals

(1st. Report)

Distribution of Salmonella Group Organisms in Dogs of Taegu Area

動物의 Paratyphoid의 原因菌으로서 各種動物에서 여러學者들에 依하여 많은 Salmonella屬菌이 分離報告되고 있으나 우리나라에서는 아직 動物에 있어서 Salmonella屬菌에 對한 關心이 極히 稀薄하여 豚의 Paratyphoid와 雛白痢를 除外한 그外의 家畜의 Salmonella症은 거이 看過되고 있는 狀態에 있으며 人間의 Paratyphoid 및 食中毒等에 密接한 關係가 있음을 생각할때 家畜의 Salmonelle症은 단지 獸醫學 뿐만 아니라 公衆衛生上 輕視못할 問題이다. 特히 犬은 愛玩用, 狩獵用, 또는 家庭 警備用等으로 人間生活에 있어 接觸하는 機會가 가장 많은 動物이므로 이로 因한 人間의 被害를 생각하지 않을수 없다.

筆者는 犬에 있어서의 Salmonella屬菌의 分布狀態를 調査할 目的으로 1958年 夏季 大邱市內 狂犬病 豫防接種時 家庭飼養犬 100頭의 糞便을 檢査하여 6頭에서 Salmonella屬菌 各 一株씩을 分離하였으며 다음과같이 菌型을 決定하였다.

Sal. typhi-murium	1株
Sal. cholerae-suis	1株
Sal. paratyphi A	1株
Sal. hartford	1株
菌型未決定	2株

(慶北大學校 論文集 第三輯에 發表하였음)