Studies on Histological, Cytological and Cytochemical Changes in the Liver of Rabbits Caused by the Alteration of Atmospheric Temperature

I. Histological changes at 26–28°C

Isamu Ono

Department of Anatomy, School of Medicine, Keio-Gijuku University, Tokyo

Many investigators have noticed that atmospheric temperatures have effective influence upon body temperature of the animal’s water content of blood and liver function.

Abe (1951) and his collaborators studied extensively on the increase of water content of blood when rabbits are warmed and its relation to liver function.

I observed rabbit’s liver histologically, cytologically and cytochemically, when the animals are warmed. In this paper, histological changes are described.

Material and Method

As experimental animals I used apparently healthy adult rabbits about two kilograms in body weight. Body temperature of rabbit was measured every 30 minutes by means of thermometer inserting it 6 cm deep into anus.

Blood is taken from the capillay of the ear of rabbits, then the amount of hemoglobin is measured with the aid of Sahl’s method. I conjectured the increase of water content of blood when the amount of hemoglobin decreased, and the decrease of it when the amount of hemoglobin increased. A thermostat equipped with a thermometer and a hygrometer was employed for the warming of animals.

The control rabbits were killed after fasting for 24 hours.

The experiment was conducted on the rabbits which were fasted for 22 hours. Liver was excised and fixed instantly with 10% formalin solution, imbedded into paraffin and sectioned in the thickness of 4 µ,
and stained with hematoxylin-eosin.

The heating experiment was carried out as follows: Eleven rabbits were kept for two hours in a thermostat at the temperature of 26-28°C on average and in the relative humidity of 60-90% on average, when the room temperature was 10-20°C.

Observations

In the experimental cases the body temperature of rabbits does not rise and sometimes even drops, as seen in table I.

Sahl's count decreased in 10% or so, therefore the increase of water content of blood is inferred.

As seen in Fig. 3 and Fig. 4, central vein, hepatic sinusoid and blood vessels within interlobular connective tissue hold more erythro-

Table 1.
cytes than normal, as shown in Fig. 1 and Fig. 2, i.e. the phenomenon called as congestion exists.

A shrinkage of hepatic cells in the central portion of a lobule and a dilatation of hepatic sinusoid are observable. Such a shrinkage of hepatic cells is seen within the central region, whose radius is a third to a half of the distance between central vein and interlobular connective tissue, and in the peripheral region of a lobule such a picture is hardly observed. The central vein of a lobule, in which such a shrinkage is present, has a comparatively large diameter. On the other hand, there are some lobules, in which no shrinkage of hepatic cells nor dilatation of hepatic sinusoid are found and only congestion is present. In such a lobule the diameter of the central vein is comparatively small. There is no infiltration of round cells in the region around interlobular connective tissue and bile duct.

Discussion

Some physiological studies were focussed on this problem, Hosoya (1952) noticed that the atmospheric temperature, which is effective enough to raise the body temperature of a normal rabbit to a measurable extent, shall be approximately higher than 29°C within an individual deviation; According to Saito (1949), when he warmed normal rabbits at 26-28°C, he found that body temperature is kept constant by the stimulation of the parasympathetic body temperature regulating center in corpus striatum, and that a drop of body temperature is caused by a over regulation against heat, and at the same time the parasympathetic blood osmotic pressure regulation center is also excited and the water content of blood increases. On the other hand Barbour and Tolstoi (1923) observed, in their experiment keeping dogs in a bath at the temperatures of 40°C and 42°C, that body temperature rises with an increase of water content of blood without a rise of body temperature. Ochi (1940) and Suzuki (1950) reported an increasing of water content in blood within an environment of high temperature.

The water content of blood increased in my experiment. These results are the same as the ones of the above mentioned investigators.

Histological studies were published by several authors. Suzuki (1950) investigated liver of rabbits, which were kept in high temperatures (40–50°C) for from twenty to sixty minutes, and made it clear that hepatic cells shrink and a congestion occurs. Barbour and
Andelotte (1933), by heating or cooling the basal ganglia directly, found that the body temperature drops in parallel with the blood concentration when the basal ganglia are heated, and that the body temperature rises in parallel with the blood concentration when the ganglia are cooled, and they concluded from these results that the regulation of the body temperature can be conducted by the heating or cooling of the basal ganglia. Besides these, they examined histological picture of liver when the basal ganglia are heated and observed that it was difficult to differentiate the histological characteristics from those of the normal liver, but saw an edema of the liver when the basal ganglia are cooled directly. Hida (1946) divided his rabbits into two groups: one group was kept at 40°C (relative humidity 80%) for 5–60 minutes and another group was kept at the same temperature and in the same humidity for 110–590 minutes, and found, in both cases, in the histological examination of liver a congestion, a swelling of hepatic cells, which look round-shaped, and a round cell infiltration in the interlobular connective tissue especially around bile ducts. In my case, however, the infiltration of the cells of this kind was not identified. The congestion of liver and the shrinking or swelling of hepatic cells were denied by Hett (1924) in his experiment with the mouse which was kept at 37–39°C for 2–19 days, and also by Fukai (1935) in his observation using a dog, which was heated every day for 14 hours at 45–50°C.

Suzuki (1950) and Hida (1946) carried out similar experiments on rabbits, and the congestion was certified by both on the other hand, however the former investigator reported the shrinking of hepatic cells, and the latter the swelling of the cells. According to Kolski (1908), the tissue of a normal rabbit liver is oligemic, erythrocytes are extremely scarcely found, hepatic cell cords are winding around each other; when the sympathetic nerve is cut, erythrocytes are numerous in the central vein and hepatic sinusoid, hepatic sinusoid dilates, and hepatic cells are compressed mechanically by the dilatation of hepatic sinusoid.

In my control rabbits (after fasting for 24 hours) the histological picture of the liver is almost the same as that of Kolski. The disagreement of my findings with those of the other investigators may be based on the difference of the kinds of experimental animals, on the difference of atmospheric temperature and humidity, and on the difference of the method and the duration of experiments. The dilatation of hepatic sinusoid which I recognized is considered to be caused
partly by the shrinkage of hepatic cells and partly by the increase of water content of blood. The correlation between hepatic sinusoid and hepatic cells or the water content of blood suggests a similar relation between central vein and hepatic sinusoid. Therefore the dilatation of a central vein of a lobule is explained to be directly proportional to the dilatation of hepatic sinusoid.

Abe and his collaborators made it clear that the parasympathetic body temperature regulation is conducted in the liver through vagus nerve. The shrinking of hepatic cells and the congesting, which I noticed, are by all means in an inseparable relation to the regulation of body temperature and to the increase of water content of blood.

**Conclusion**

When animals are heated at 26-28°C for 2 hours the body temperature does not increase but often on the contrary decreases and the water content of blood increases, and a congestion in rabbit liver and a shrinking of hepatic cells are obviously seen.

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**References**


Explanation of figures

Fig. 1. The centre of the lobule of the control case.
Fig. 2. The periphery of the lobule of the control case.
Fig. 3. The centre of the lobule of the experimental case.
Fig. 4. The periphery of the lobule of the experimental case.

Fixed with 10% Formol, embedded in paraffin, sectioned 4 μ thick, stained with hematoxylin and eosin.

Magnification ca 300×