

EXPERIMENTAL STUDIES ON THE FAT METABOLISM OF THE LUNG AS THE INDEX OF THE SOLITARY COMPLEMENT FIXATION TESTS (TORIKATA)

by

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INTRODUCTION

In our laboratory, it was reported that the immuno-serum had more mighty ability to fix a complement independently than the normal serum in both men and animals, and that in this immuno-serum clearer increase of the lipid in blood was recognized than in the normal serum.

ISHIMOTO, KAWAI and HIDAKA stated that with the increase of the lipid in blood, the phagocytosis also grew powerful.

On the other hand, KIPP, CHAUFFARD and LARCHE reported that, in the case of infectious diseases, the lipid in blood decreased at their height, and at the convalescence it reached the normal, or more than normal. INOUE observed that there was a constant relation between lipid and antibody. But all the above investigators injected the fat subcutaneously or into the abdominal cavity, and infused the lecithin or fatty acid intravenously, until the series of experiments of our clinic were established.

In regard to the immunological studies on the fat emulsion injected intravenously, there is almost no information at present.

Now, turning to the results of studies in our clinic, in 1949, Dr. HIKASA of our clinic succeeded in producing a stable fine fat emulsion which could be given intravenously. Already, ASADA, NAKATA, TSUKADA, NISHINO and CHEN of our clinic studied on metabolic process in vivo histochemically and biochemically when the fat emulsion was infused intravenously.

Particularly, the opsoninproduct in blood has been examined by CHEN, and it is emphasized that the opsoninproduct is related closely to the fat metabolism of the lung which phagocitizes neutral fat globules and changes them into phospholipid.

I investigated the differences of ability concerning the solitary complement fixation between normal and pneumothorax rabbits-serum when the fat emulsion was infused intravenously, and so the examination was performed in order to study this problem more distinctly by way of volumetric complement fixation tests.

Further more it is conceivable that when the function of lungs is limited by some procedure, the fat metabolism may be affected by the disturbed lungs.

In this paper, therefore, using this fat emulsion, I studied to determine the two

main subjects; i. e. when one side of lungs is collapsed artificially, how will its ability of fat metabolism change? And then, how is it related to the ability of the complement fixation?

EXPERIMENTAL MATERIALS AND METHODS

1) Fat Emulsion and Used Drugs.

Fat Emulsion.....In the present investigation, 20 per cent sesame oil emulsion was used as a rule. This fat emulsion contained 20 per cent sesame oil, 7 per cent glucose and small quantities of stabilizers. The standard dosage of the intravenous administration of fat emulsion was defined as 1.5 cc of 20 per cent fat emulsion, which was equal to 0.5 g of fat, per kg of body weight.

Used Drugs.....In the present investigation, methionine as *l*-methionine, riboflavin as riboflavin-5'-phosphate, vitamin C as *l*-ascorbic acid and nicotinic acid as niacin amide, were used in the formation of the solution.

2) Experimental Animals

Healthy adult male rabbits, each weighing approximately 2 kg, were used. They were used after being fed with fatless standard diets for two weeks.

3) Volumetric Complement Fixation Tests by Prof. Dr. R. TORIKATA

i) TORIKATA's precipitometers

Before the experiments, TORIKATA's precipitometers were chosen, that the capacity of the hemocyte volume in 0.1 cc of plenty washed-goat-erythrocyte suspension might be kept always at 3.6–3.8 graduations. (1 graduation = 0.0007 cc)

ii) Serum

Serum used in the present investigation was taken from the blood of hungry rabbits early in the morning. After it was separated from the blood, it was made inactive, and warmed in 56°C water for half an hour.

iii) Erythrocyte Suspension

5% goat erythrocyte suspension was used. But 1.0 cc of 5% goat-erythrocyte-suspension is not always constant, so that such erythrocyte suspension was only used, so that such erythrocyte-volume in 1.0 cc of 5% erythrocyte suspension might be kept at 30 graduations.

iv) Hemolysin

Hemolysin was made according to the hemolysin-tests originated from our laboratory methods.

v) Complement.

Fresh serum obtained by heart-punction of a healthy marmot was used, and the serum was diluted by ten times with physiological salt-solution.

EXPERIMENT 1

Solitary Complement-Binding Reaction by infusing fat emulsion once for all.

Experimental Results and Investigations.

In the experiments of normal rabbits, the RR, that is the action of complement

Fig. 1 Curves Showing the SRR of Right-Side Pneumothorax Rabbit Serum without Infusion of Fat Emulsion.

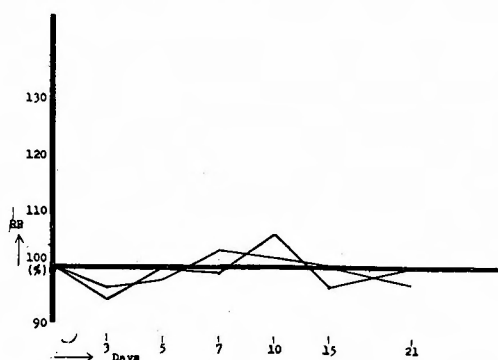
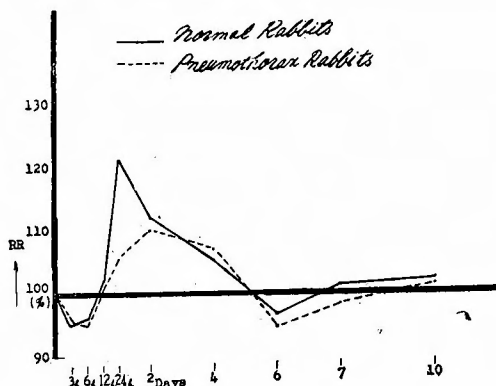


Fig. 2 Curves Showing the SRR by Infusing Fat Emulsion once for all.



fixing, began to increase gradually with the lapse of time after infusing fat emulsion, and reached the maximum titre, showing the increase at about 21 per cent after 24 hours.

Afterwards it gradually began to decrease and decreased to the point of 12 per cent 48 hours after the first infusion.

In the experiments of pneumothorax rabbits, such remarkable changes could not be observed; in this case the RR reached the maximum titre at the 48th hour since the first infusion, and showed lower titre than in the case of normal ones after 4 days, and no conspicuous differences could be observed between them.

The facts above mentioned agreed to the experimental results by ASADA that the neutral fat infused once for all burnt through the steps of phospholipid and was perceptible from the histochemical point of view, and also agreed to those obtained by CHEN that the production of opsonin in the blood advanced most extremely in 24-48 hours in the case of infusion of fat emulsion once for all.

So it is considered that the extreme ability of complement fixing in such cases as infusing fat emulsion was the secondary phenomenon based on the results that the infused fat was changed smoothly into phospholipid.

From this point of view, the lower ability of complement fixing in the case of pneumothorax rabbits would be well understood as a phenomenon caused by the loss of the ability to change the neutral fat in the lung into phospholipid.

EXPERIMENT 2

SRR by the repeated infusions of fat emulsion for three weeks.

According to the results of Experiment 1 that SRR showed the maximum titre at the 24th hour after the infusion of fat emulsion, the blood was always taken out punctually at the 24th hour after the last infusion, and the pneumothorax was carried out at intervals of more than six hours, so as to avoid as much as possible the direct effect by the artificial pneumothorax operations.

Experimental Results and Investigation.

In the experiments of normal rabbits, the RR continued to increase by the

repeated infusions and showed the maximum titre pointing to the increase of 21 per cent on the 7th day. Afterwards, the RR did not keep increasing in spite of more new infusions and began to decrease gradually.

Still even in the case of stopping them, so remarkable a change did not appear, gradually decreasing to the normal value.

In the experiments of the pneumothorax-side, the RR continued to increase slowly after the first infusion and reached the maximum titre on the 7th day as in the case of normal rabbits, pointing to the increase of about 16 per cent.

Comparing with each other, the RR of pneumothorax-side was observed to be much less in the ability of complement fixing and more rapid in returning to the normal value, than that of normal rabbits.

These facts could be understood in similarity with CHEN's experimental results that by infusions of fat emulsion intravenously into pneumothorax rabbits, fat globules were phagocytized by alveolen, KUPFFER's cells, spleen and reticuloendothelial cells as evidently as in the case of normal rabbits, and that the accumulation of fat globules in the collapse-side-lung was much more perceptible than in the normal-side-lung, and further that the lipid-reaction of the fat globules observed on the part of the collapsed lung was very feeble, even when the fat globules were phagocytized in alveolen.

But the smooth curve-line of the RR without any rapid change should be supposed to be due to the fact that the sesame oil emulsion was used alone in this experiment, while the cod-liver oil was tried in CHEN's experiments.

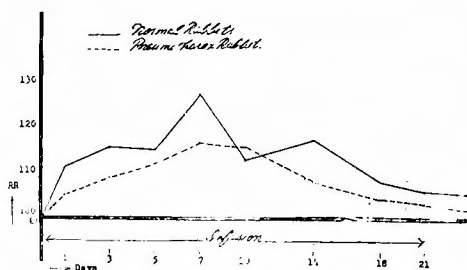
In other words, it has been pointed out by ASADA that the accumulation of the infused fat was observed histologically in the 3rd week, and the infused fat was not well phagocytized, in case that the cod liver oil was infused repeatedly; and ZAIRSU's biochemical experiments made it clear that histological fat of the lung and liver increased more and more in its amount from the 3rd week, when cod liver oil emulsion was repeatedly infused.

Moreover it was proved by CHEN that the opsoninproduction was reduced in the blood from the 3rd week. According to the experimental results made by OTANI and IZUKURA afterwards, when the sesame oil emulsion was used instead of the cod liver oil emulsion, no accumulation could be observed at all and the sesame oil could be utilized much better and more smoothly.

In the present experiment, however, the smoother curve line of the RR could be observed in contrast with CHEN's experiment, but still it showed gradual decreasing from the 7th day in spite of the more new repeated infusions into both normal rabbits and pneumothorax ones.

This fact should be understood not only as the accumulation of the infused fat

Fig. 3. Curves Showing the SRR by the Repeated Infusions of Fat Emulsion for Three Weeks.



emulsion, but as a toxic-phenomenon of the acidosis caused by the abnormal increase of such intermediates as keton and others because of the insufficiency of various kinds of enzyme systems that were necessary through the process in which the infused neutral fat resolved itself into carbonic acid gas and water passing through the form of lipid-body by the infusions of fat emulsion alone, as HASHINO reported. Now, as mentioned above, the ability of solitary complement fixing was as remarkable in pneumothorax rabbits as in normal ones, and the infused fat was observed to be changed into the lipid and phagocytized smoothly in the early stage of the experiment owing to the advancement of compensation-action in the normal lung, liver and spleen.

The reflection should be made here that, when artificial pneumothorax was tried, the available area of the lung became smaller and the lipid-reaction of the infused fat emulsion was apt to be rough and late, and so the ability of solitary complement fixing showed far lower titre and returned the sooner to the normal value in the pneumothorax side.

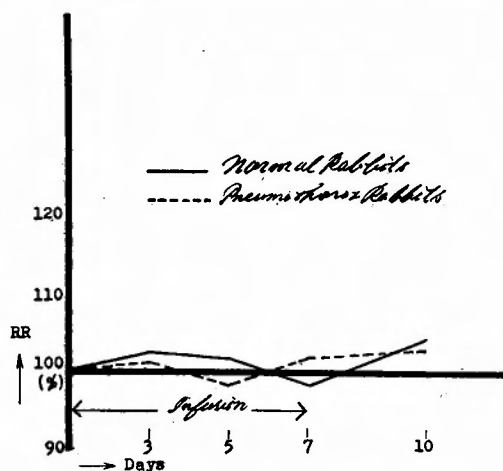
EXPERIMENT 3

SRR by the repeated infusions of fat emulsion together with methionine for three weeks.

Methionine has been recognized to have the noticable ability of antifatliver. According to the reports by ASADA, NAKADA, SENO, NISHINO, CHEN, IZUKURA and HASHINO, methionine was observed to hasten the oxidizaiton of contained fat acid almost in various tissues and to be indispensable to such animals as rabbits having not so much ability to phagocytize the infused fat emulsion.

Yet the whole smooth compensation-process of fat would be expected not only by using methionine together with fat emulsion. In the present experiment here methionine was used at the rate of 5 mg to 1 kg jointly with fat emulsion.

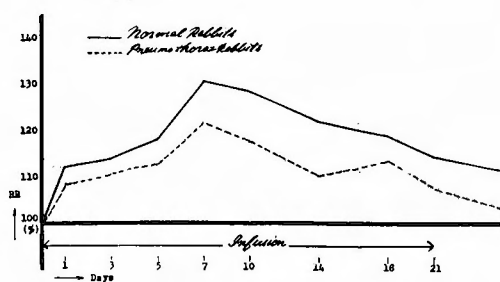
Fig. 4. Curves Showing the SRR by the Repeated Infusions of Methionine alone.



Experimental Results and Investigation.

According to the report the methionine was effective to antifatliver, basal metabolism and liver-function.

Fig. 5. Curves Showing the SRR by the Repeated Infusions of Fat Emulsion together with Methionine for Three Weeks.



In the present investigation, methionine alone was applied repeatedly intravenously to normal rabbits for a week as in the first stage.

But no noticable results could be gained from this stage; the curve line of the RR recorded for ten days showed no new fact as shown in Fig. 5. Then as the second stage, methionine was tried together with fat emulsion.

In this case, the SRR was observed to continue to increase with the passage of time and reached the maximum titre (the increase being 30 per cent) on the 7th day, as shown in Fig. 4.

Moreover, as compared with that by methionine alone, the curve line of the RR was smoother and never showed any rapid curve of decrease in this case, as long as the repeated infusions were continued anew. It was considered that the infused fat emulsion was phagocytized rapidly and smoothly in vivo and the tendency of fat-accumulation could be observed less in this case than in the first case. And as the next stage of this experiment, SRR was investigated in case of the repeated infusion of methionine and riboflavin together for three weeks.

EXPERIMENT 4

SRR by the repeated infusions of fat emulsion with methionine and riboflavin for three weeks.

It has been lately reported that riboflavin plays an important part in oxidizing action, especially in the process of fat metabolism as flavoprotein-ferment, combining with special albumens in vivo.

So in using riboflavin together with methionine the phagocytizing action of the infused fat, as our predecessors already proved, was hastened and carried out much more smoothly owing to the rapid oxidizing action of fatty acids, contained in the infused fat emulsion in vivo.

Now in this stage of the experiment, these facts were investigated anew from the point of view of complement fixing.

In this stage, methionine was used at the similar rate of 5 mg to 1 kg as tried in the last time and riboflavin as riboflavin-5'-phosphate sodium solution... at the rate of 2.5 mg to 1 kg jointly with fat emulsion.

As the preliminary stage of the experiment, methionine and riboflavin were infused repeatedly intravenously into normal rabbits for a week, and the SRR was observed for ten days. But no effect upon the complement fixing could be observed. (Fig. 7)

EXPERIMENTAL RESULTS AND INVESTIGATIONS.

In this stage, the RR were observed more obviously than in the last stage in both normal and pneumothorax rabbits; each RR reached the maximum titre on the 7th day, showing the increase at 39 per cent in normal ones and at 26 per cent in pneumothorax ones, and besides kept its good high titre as before after the 7th day as long as the infusion was continued; moreover the increasing was more remar-

kable all over the period than in the case when methionine was used alone.

The conclusion was that the ability of complement fixing was more remarkable in the case when methionine and riboflavin were used together than in the case when methionine was used alone.

Fig. 6. Curves Showing the SRR by the Repeated Infusions of Methionine together with Riboflavin.

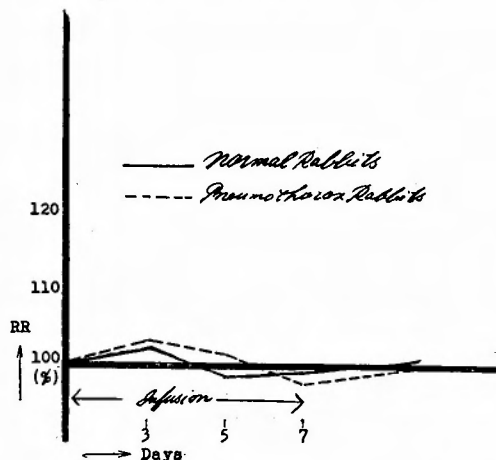
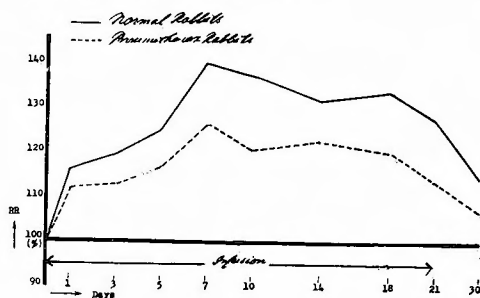


Fig. 7. Curves Showing the SRR by the Repeated Infusions of Fat Emulsion together with Methionine and Riboflavin for Three Weeks.



The similar fact was observed, too, in the case of pneumothorax rabbits; the curve line of the RR was so smooth with neither rapid increasing nor decreasing, keeping almost parallel lines with that of normal rabbits from the 7th day to the third week.

Such experimental results mentioned above agreed to the predecessor results that no accumulation of infused fat could be observed histochemically as far as methionine and riboflavin were used jointly with fat emulsion, and that the lipoid reaction of neutral fat was hastened as it was proved in the study of fat metabolism in the isolated perfused liver and lung and the oxidization of acetyl CoA was performed smoothly and the accumulation of keton was extremely reduced, and that the protein-metabolism was carried out considerably well from the viewpoint of the nitrogen balance and electrophoresis and the noticeable effect was observed on the curve line of the opsonin-production in the blood.

EXPERIMENT 5

SRR by the repeated infusions of fat emulsion with riboflavin, vitamin C and nicotinic acid for three weeks.

It has been already concluded in Experiment 4 that the ability of complement fixing was very remarkable when methionine and riboflavin was used together with fat emulsion.

Next, in the present stage, the SRR was investigated, riboflavin, nicotinic acid being used jointly with fat emulsion.

It has been considered indispensable to use vitamins together with fat emulsion.

Especially vitamin C has been reported to play an important part in the process of fat metabolism.

HIKASA and ISHIGAMI observed that simultaneous infusion of ascorbic acid with the fat emulsion was effective in aiding metabolism of the infused fat emulsion as a result of intensification of activity of lipase in serum and the liver.

Fig. 8. Curves Showing the SRR by the Repeated Infusions of Vitamin C together with Riboflavin and Nicotinic Acid.

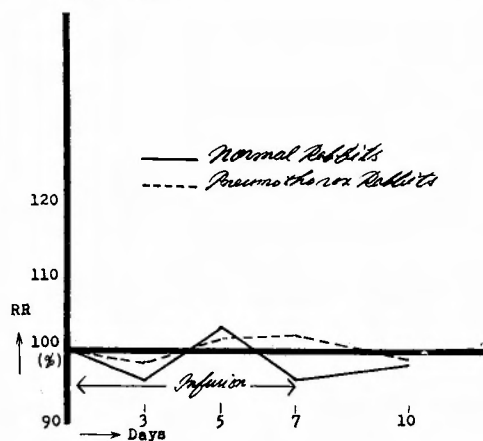


Fig. 9. Curves Showing the SRR by the Repeated Infusions of Fat Emulsion with Riboflavin, Vitamin C and Nicotinic Acid.



ment in vivo with fat metabolism from the viewpoint of ketone body formation, it was not proper to use methionine and riboflavin with fat emulsion, but necessary to try vitamin with them. Moreover nicotinic acid and pantothenic acid had to be tried in addition to them so as to perform the fat metabolism most smoothly.

Therefore we measured the SRR by using riboflavin at the rate of 3 mg (to 1 kg), vitamin C 10 mg, and nicotinic acid 6 mg with fat emulsion.

As the preliminary stage, each SRR of serum was measured with repeated infusions, "riboflavin + vitamin C + nicotinic acid" and "riboflavin + vitamin C + nicotinic acid + rutin" being used.

But no noticeable result could be gained from them in both normal rabbits and pneumothorax ones.

Experimental Results and Investigation.

In the present stage of experiment, the SRR of both normal rabbits and pneumothorax ones reached the maximum titre of the RR on the 7th day and showed almost the similar course of curve line as in Experiment 4, and the infused fat emulsion seemed to be sufficiently phagocytized under the good conditions, no accumulation of it being observed at all. But in the same stage, there appeared no efficacious result by vitamin C and nicotinic acid on the ability of complement fixing.

And the increasing of the ability of complement fixing could never be understood merely as a phenomenon by physical stimulus, from the fact that the ability increased when methionine and riboflavin were used together with fat emulsion.

The increasing ability of complement fixing would have been impossible if allergy had existed in the infused fat emulsion, though it was denied in OTANI's

Fig. 10. Curves Showing the SRR by the Repeated Infusions of Vitamin C together with Riboflavin, Nicotinic Acid and Rutin for Seven Days.

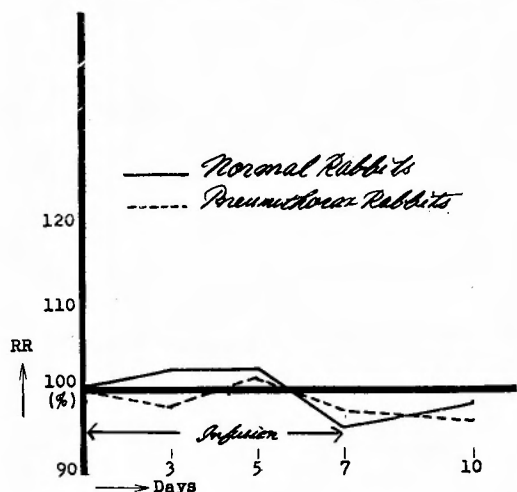
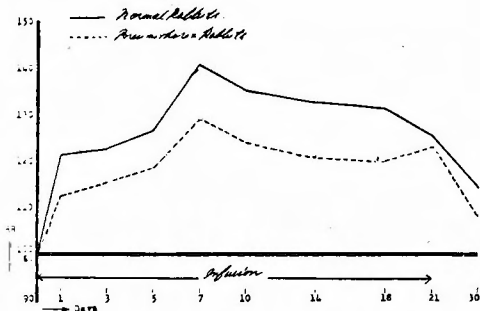


Fig. 11. Curves Showing the SRR by the Repeated Infusions of Fat Emulsion together with Riboflavin, Vitamin C, Nicotinic Acid and Rutin for Three Weeks.



report.

From such point of view, in the next stage rutin was tried in addition to vita-

mins with fat emulsion and investigated as to its effect on the ability of SRR, because rutin has been proved to possess an antianaphylaxis by RAIMOA, LATER, MASS and BEILER in later years, and because the restraining ability of rutin has been experienced at the time of blood-transfusion.

For all these facts, when rutin was tried together with fat emulsion, riboflavin, vitamin C, nicotinic acid, the titre of the RR increased more rapidly than when rutin, was tried alone, and reached the maximum titre (the increase being 40.5 per cent, 29 per cent) in all courses of the experiments here.

From this result we came to the conclusion that the property of allergy of the infused fat emulsion did not bring about such an increase of the RR.

Besides, the conspicuous differences could be observed between the normal-side and the pneumothorax-side through the courses of all the experiments, 1, 2, 3, 4.

In comparison with the normal-side, the ability of complement fixing was far poorer in the pneumothorax-side.

The reason was concluded as follows:

When methionine, riboflavin, vitamin C and nicotinic acid were tried together with fat emulsion, the metabolic process of the infused fat was surely hastened in pneumothorax-side, too, but it is hard to deny that the reduction of the available area of the lung was caused by pneumothorax, as a result that the functions of the lung, above all, the fat metabolism of the lung, that is, the secondary function, decreased remarkably, while the fat metabolism of the non treated lung, the liver and the spleen concerning the primary fat metabolism reparatively increased; as an inevitable consequence, metabolic function of the infused fat emulsion became apt to delay and its utilization in the bodies could not be carried so smoothly as in the normal side.

From such a point of view, it can be said that the ability of fat metabolic

function of the lung has an important significance.

CONCLUSION

The conclusion of the results of all the experiments above is as follows:

When our fat emulsion was alone infused intravenously into rabbits, the RR showed an increase of 21 per cent in 24 hours and its curve line gradually rose and pointed to the increase of 27 per cent at the maximum titre on the 7th day after infusion.

The increase of the RR could not be observed in spite of more continuous injections and it gradually showed a tendency of decrease.

This phenomenon can be explained like this; when fat emulsion was alone intravenously infused for a long time into rabbits with the weak power of fat assimilation, even if sesame oil emulsion was tried at the same time the process of assimilation in bodies was not performed regularly, and the shortage of the ferment needful to the fat combustion seemed to bring about the accumulation of the intermediate products in ketone.

By using methionine together with riboflavin, the increase of the RR was very remarkable and showed an increase of 38 per cent at the maximum point on the 7th day; afterwards as long as the injections were continued, the curve line of the RR showed a smooth curve without any sudden descent and gradually restored to normal conditions for the first time after suspending the injections.

This phenomenon, different from the cases where fat emulsion was infused alone as above mentioned, was the result of better combustion of the infused fat emulsion by using methionine together with riboflavin, and the result of its being utilized without showing any accumulation. And the increase of ability of complement fixing by infusions of fat emulsion was based on that of lipid produced in living bodies; but at the same time, lipid produced in these living bodidies underwent both the Fatty Acid Cycles and Acetyl CoA, and it was necessary that after it was led to T. C. A. Cycle, it was perfectly burned; and in this process the existence of the F. A. D., which made a contribution to this process of metabolism by

Fig. 12. Comparison of the SRR of Normal Rabbit Serum (Fig. 3, Fig. 4, Fig. 6, Fig. 8, Fig. 10)

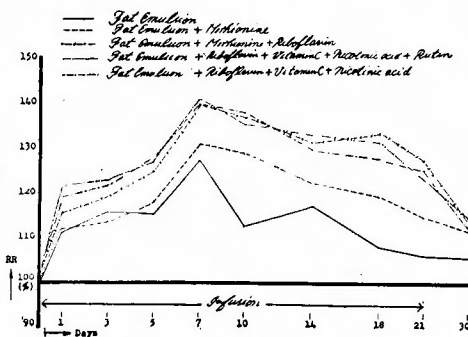
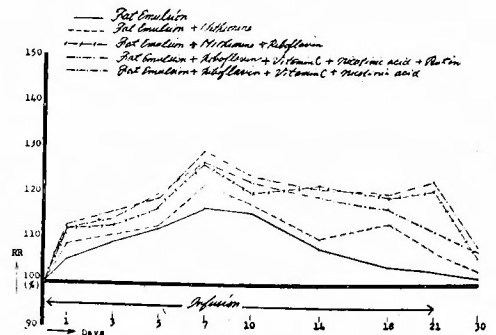


Fig. 13. Comparison of the SRR of Right-Side Pneumothorax Rabbit Serum (Fig. 3, Fig. 4, Fig. 6, Fig. 8, Fig. 10)



infusing fat emulsion, was also necessary.

By using vitamin C, nicotinic acid necessary to this metabolism, the experiments were tried in the same way, but no same differences as in those tried by using methionine together with riboflavin as above mentioned were not observed and the use of vitamin C together with nicotinic acid could not be proved to be necessary in these experiments.

The RR of this experiment tried here by using rutin together with vitamins showed the maximum titre on the 7th day through all the experiments and its increase was based not simply on physical stimulation and property of allergy of infused fat emulsion, but on an increase of lipoid caused by the infused neutral fat emulsion.

On the contrary, in the experiments of the pneumothorax rabbits in comparison with the normal ones the increase of the RR showed the maximum titre after 48 hours, but it was only 10 per cent increase. By infusing the fat emulsion for several days, it showed the maximum titre at the end of 7 days as in the experiments of the normal rabbits. But it was only 16.5 per cent increase in comparison with 27 per cent increase of the normal rabbits. And the curve of the RR showed gradually the descending trend after 10 days. But when we used methionine and riboflavin in the experiments of pneumothorax rabbits, the increase of the RR was very remarkable and showed 21 per cent after 3 weeks. In other words, in the experiments of the pneumothorax rabbits, by the infusion of the fat emulsion the increase of the RR was much weaker than in the experiments of the normal rabbits, and these facts were thought to be the influence of the pneumothorax itself, and based on the results that, seen from the results of our experiments, the fat treating abilities of the lungs in the pneumothorax side were remarkably on the decline by the reductions of available areas of the pneumothorax lungs, and even when normal lungs, normal liver and normal spleen compensated these abilities, the utilization of the infused fat was apt to be rough and late in comparison with that in the experiments of the normal rabbits.

Accordingly the fact of the increase of the RR in the infused fat should be understood as a phenomena that, as soon as the infused fat was treated utilized and the lipoid of living bodies was newly produced, oxidization and combustion of the fatty acid with lipoid were regularly carried on, and the function of the cell organization in the whole body was promoted.

Therefore we can understand well that the lungs play a very important part in the process of the fat metabolism.

SUMMARY

Infusing our fat emulsion intravenously into rabbits, we have studied the ability of complement fixation in the serum of both normal (non treated) rabbits and pneumothorax ones, and arrived at the following conclusions.

- 1) Through all the present investigations, the ability of complement fixation of the antiserum was stronger than that of normal serum.
- 2) After the infusion of fat emulsion alone, the RR showed an increase.

This phenomena, however, was not so distinct in the latter rabbits as in the former.

3) When fat emulsion alone was given daily for three weeks running, the RR showed a tendency of gradual increase, reaching its maximum titre at the end of 7 days.

But from the third week on, both normal and pneumothorax rabbits revealed no more increase of the RR.

4) The phenomena above mentioned was improved more notably by the simultaneous administration of methionine or methionine mixed with riboflavin than when fat emulsion alone was used.

In the light of the above mentioned results, in infusing of fat emulsion, we have proved the necessity of simultaneous administration of methionine or riboflavin.

5) In both cases, the difference of the RR between the normal and the pneumothorax rabbits was always quite distinguished.

6) Again from the viewpoint of the ability of complement fixation, with regard to fat metabolism, it was clearly demonstrated that the lung played an important part in changing neutral fat into phospholipid.

7) From the results of these present experiments, an increase of ability of complement fixation in the serum stands parallel with the production of the lipoid-body, but simultaneously fatty acid oxidation must be carried out smoothly, thus the increase of the RR after the infusion seems to be one of the resultant phenomenon, and neither due to the stimulative action of the reticuloendothelial cells nor to the allergy action of the infused fat, but this increase ensues from hypertension of the cells organizing the whole body.

8) In the light of the above mentioned result, it is very reasonable to assume that in practice fat emulsion should be administered intravenously with methionine, riboflavin, vitamin C and nicotinic acid.

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BIBLIOGRAPHY

1) Hikasa, Y., Asada, S., Zaitzu, A., Tsukada, A. and Nakata, K., 1952: Studies on the intravenous administration of fat emulsions. *Arch. Jap. Chir.* 21, 1; 1951, 1952, 1953: *J. Jap. Surg. Soc.* 52; 298, 53; 415, 54; 250. 2) Torikata, R., Die volumetrische Komplementbindungsreaktion. Jena, 1928. 3) Fujiwara, M.: Studies on the riboflavin in the blood of normal adult. *Vitamin*, 7; 191 1954. 4) Ikeda, H.: unpublished 5) Izukura, T.: unpublished 6) Chen, F.: Experimental study on the fat metabolism of the lung in the light of the production of the opsonin in the blood. *Arch. Jap. Chir.* 24; 1, 1955.

7) Kurokawa, M.: Fundamental studies on closed circuit anesthesia. *Jap. J. Anesthesiol.*, 4; 57, 1955. 8) Merii, S., et al; The function of the lung in the fat metabolism, *Trans. Soc. Path. Jap.* 42, 1953. 9) Jankovich L.; Ein Beitrag zur Fettspeicherung in der Lunge. *Ziegler's Beitr.* 92; 357, 1933. 10) Jeckeln; E. Über die Rolle der Lungen beim Fettstoffwechsel. *Ziegler's Beitr.* 92; 357, 1933. 11) Nakata, K.: Experimental studies on fat metabolism in the lung. *Arch. Jap. Chir.*, 23; 445, 1954. 12) Nishino, T.; Laboratory studies on the intravenous administration of the fat emulsion in the light of tissue metabolism. *Arch. Jap. Chir.*, 23; 607, 1954. 13) Seno, A.: A study of the

fat metabolism in the isolated perfused liver. Arch. Jap. Chir., 24; 179, 1955. 14) Tsukada, A.: Studies on the intravenous administration of the fat emulsion in the light of protein metabolism. Arch. Jap. Chir., 23; 215, 1954. 15) Beumer: Zur Kenntniss der Schützwirkung des Cholesterins. Zeitschr. F. Kindheilkunde, 35; 298, 1923. 16) Takeda, S.: Experimental studies on the effect of riboflavin following the intravenous administration of fat emulsion. Arch. Jap. Chir. 25; 221, 1956. 17) Kimura: Histologische Untersuchung über das Schicksal intravenös infundierten Fetts. Tohoku J. Exp. Med, 30; 315, 1937. 18) Kipp: Variation in der Cholesteringehalt des blutserums bei Krankheiten. München med. Wochenshr, 65; 781, 1918. 19) Leupold u. Bogendürfer: Über Einfluss des Cholesterins auf den Infektionskrankheitsverlauf. Deutsch Arch f. klin. Med. 1940; 28, 1922. 20) Murray, Freeman: The morphologic distribution of intravenously in-

jected fatty chyl and artificial fat emulsion in rats and dogs. j. Lab. & Clin. Med, 38; 56, 1951. 21) Much und Schmidt: Fettstudie. Zeitschr. f. Immunitätf., 31; 169, 1921. 22) Okamoto: Studien über die Lungenfunktion. Mitt. med. Akad. Kioto, 18; 1236. 23) Strauss: Über den Wirkungskomplex der Phrenicoexhairese. Zeitschr. f. exp. Med, 95; 397, 1935. 24) Suranyi: Immunkörperbildung lipoidgefütterter Tiere. Zeitschr. f. Immunitätsf., 57; 184, 1928. 25) Suranyi und Jarno: Über den Einfluss der Lipoid auf die Toxinwirkung. Zeitschr. f. Immunitätf., 57; 199, 1928. 26) Tamura: Über den Einfluss der Fettdiät auf die Parese als Folge von Diphterietoxin The J. of Biochemisry, 31; 443, 1940. 27) Tokuyama: Das immunbiologische Studium der Fette. Tohoku J. of exp. Med., 22; 252, 1933. 28) Walbum; Die Einwirkung verschiedener Alkohole auf Antigene und ähnliche Körper. Zeitschr. f. Immunitätf., 7; 544, 1910.

和 文 抄 録

単独補体結合反応（鳥瀉）を指標とした肺臓の 脂質代謝機能に関する実験的研究

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教室創製の脂肪乳剤を家兎静脈内注入した際の正常竝に気胸家兎血清の単独補体結合性を検討し、次の結論に到達した。

1) 脂肪乳剤のみを静脈内に注入すると(RR)の増大を認めるが、気胸倒ではこの現象が遙かに軽度であつた。

2) 脂肪乳剤のみを連続注入すると(RR)は漸次増大し、7日目に至つて最大とするが正常竝に気胸家兎とも3週目頃より脂肪乳剤の連続注入にもかかわらず単独補体結合性は弱まる傾向を示した。

3) 前項の事実はメチオニンの併用により更には又メチオニン、リボフラビンの併用により脂肪乳剤単独注入後に比著しく改善される。而して斯る観点からみて本脂肪乳剤の注入に当り如何にメチオニン、リボフラビンの併用が必用であるかよく理解し得たものとする。

4) 以上何れの場合に於ても(RR)の増加程度は正

常倒と気胸倒との間に著明な差が認められ前者の方が後者よりも著明であつた。

5) 而して血清単独補体結合性の上からみても如何に肺臓が脂肪代謝過程上重要な役割を有するかがよく理解される。

6) 本実験成績よりすると血清単独補体結合性の増大は生体内リポイド体の新生とよく平行するが同時に之が含有脂肪酸の酸化が円滑に行われねばならず、斯くして全身組織細胞の機能亢進を来し、それによつて招来された1つの現象とみなさるべきものであつて、決して単なる脂肪の網内系刺戟作用、更には本脂肪乳剤のアレルギー性等にもとづくものとは考え難い。

7) (RR) 曲線の推移からみて、本脂肪乳剤を静脈内へ注入するにあたり、メチオニン、リボフラビン、ビタミンC、ニコチン酸アミドの併用は極めて合理的である。

以 上