# INFLUENCE OF INTRAVENOUS INFUSION OF SESAME OIL EMULSION ON FLUID DISTRIBUTION

by

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## I. INTRODUCTION

In addition to having twice the caloric value of carbohydrate and protein, fat has the lowest specific dynamic action among the three main foodstuffs. Needless to say, because of its hydrophobic nature, it is the most effective caloric source among the main foodstuffs both when it is taken in as food and when it is stored in the body. In addition to its advantage as a source of calories, recent study in fat metabolism has gradually revealed that fat plays a very important role in the composition of tissue cells and in the fulfilling of their function.

However, fat has been considered significant as a caloric source only, and since it is actively synthesized from other nutrients in the body, the amount of intake per day has not been decided, or rather it has been considered unnecessary to decide it. Moreover, fat supplementation has not been recommended clinically because only its harm has been emphasized in relation to its influence on ketosis and liver function, fatty liver, arteriosclerosis and obesity. Accordingly, in surgery, too, when liver function is disturbed and the amount of liver glycogen is decreased postoperatively, fat supplementation has been rather limited while a plentiful supplementation of glucose and protein has been encouraged. Recently, however, it has become gradually recognized that the basic constituting element of tissue cells is lipoprotein, and therefore enough fat of good quality has to be supplied in addition to protein to provide a perfect supply of nutrients in surgical cases in which the primary object is the repair and reconstruction of tissues. Fat is no longer significant as a caloric source only, but it also plays an important role in the fulfilment of living functions and the construction of tissues. Accordingly, postoperative reconstruction of tissues and recovery of function are impossible without a supply of fat.

Research workers in our laboratory had noticed this important role of fat, and succeeded in manufacturing 20% sesame oil emulsion after several years' effort to obtain a fat emulsion which could be infused intravenously. It has already been demonstrated clinically by them that pre- and postoperative infusions of this emulsion are very effective. Kuyama and Hanafusa in our laboratory observed that when this emulsion was repeatedly infused intravenously before and after operation, it caused a remarkable economization of protein and stored fat, and therefore it could prevent postoperative complications, and the patient could recover sooner from surgery. This effect was believed to be brought about not only because the sesame oil emulsion was utilized as a caloric source in the body, but also because the essential fatty acids such as linoleic acid and linolenic acid which were contained abundantly in the emulsion worked as constant elements and accelerated the repair of tissues and the recovery of function. NAGASE in our laboratory pointed out that a deficiency of essential fatty acids can cause the development of increased capillary permeability and dispose towards edema. If this is so, it is easy to see that the supply of fat could greatly influence fluid distribution. Therefore, the author administered large amounts of fat containing a high percentage of essential fatty acids both pre- and postoperatively gastrectomy patients and made observations on fluid distribution from the clinical view-point.

## II. MATERIALS AND METHODS

1) Fat Emulsion and Method of Infusion

As mentioned, 20% sesame oil emulsion was used. This emulsion contained 7% glucose. 100 cc of this emulsion was diluted about 5 times with RINGER's solution and was infused intravenously by drip method once a day. It is desirable to supply an appropriate amount of glucose solution and various vitamins simultaneously to carry out fat metabolism in vivo smoothly and to help the infused fat exert its most nutritious effect. For this purpose, 500 cc of 5% glucose solution, 40 cc of 20% glucose solution, 10~20 mg of vitamin $B_1$, 20 mg of vitamin $B_2$, and 200 mg of vitamin C were usually added to the aforementioned emulsion diluted previously with RINGER's solution, and infused intravenously by drip method in about one hour. Sometimes, when it was needed, 100 cc of 9.2% Moriamin-S solution, a crystalline amino-acid preparation was added to the emulsion.

2) Methods

A. Measurement of Circulating Plasma Volume and Extracellular Fluid Volume

The solution for injection of 0.3% Evansblue (T-1824) and 5% Rhodansoda (Sodium thiocyanate) manufactured by Daiichi Pharmaceutical Co. were used as reagents. The test was started early in the morning when the patients were in a postabsorptive state, and no transfusion, food or drink was given before the completion of this test. In order to take pure plasma, blood was collected with a syringe to which heparin had been applied and dried.

The measurement of circulating plasma volume was done by GREGERSEN et al.'s method, the effectiveness of which has been confirmed by NAGASU and ORISHIGE.

The measurement of extracellular fluid volume was done by the method reported by CRANDALL, ANDERSON and SUNAHARA, namely GREGERSEN and STEWART's method in which rhodansoda was used.

B. Measurement of Serum Colloidal Osmotic Pressure

This was measured by KROGH-NAKAZAWA's first method

C. Measurement of Protein and Albumin Concentrations in Serum

Since serum colloidal osmotic pressure is maintained by serum proteins, especially albumin and $\alpha$-globulin (as confirmed by SVEDBERG and FARKAS), the protein and albumin concentrations in the serum were measured by BIURET's method in parallel with the measurement of serum colloidal osmotic pressure. In this measurement, 23% sodium sulfite anhydrate solution is not adequate to separate albumin and globulin completely, and $\alpha$-globulin may be mixed in the albumin solution. Therefore, 28% sodium sulfite anhydrate solution was used it this study to obtain pure albumin.

## III. RESULTS AND DISCUSSION

The objects of this study were limited mainly to gastrectomy patients. However, even so generalizations could not be made. Those who had gastric perforation preoperatively, serious disturbance of liver function, hypoproteinemia, anemia, adreno-cortical hypofunction, dehydration or edema were excluded. In considering the patients' condition and observing serum protein concentration and fluid distribution in the body, the author chose only those who had about the same condition of nutrition at the time of hospitalization and slight dehydration. Furthermore, attention was paid to the length of the operation, bleeding and postoperative complications, and patients who resembled each other at these points too, were finally chosen as the objects of this study. Therefore, the results reported in this paper are the average of the values measured in these patients. Gastrectomy was performed on these patients under closed circuit anesthesia.

1) Influence of Infused Fat Emulsion on Serum Colloidal Osmotic Pressure

The average value of serum colloidal osmotic pressure measured in healthy adults by KROGH-NAKAZAWA's first method was 364.3 mm $H_2O$ (maximum 388.0 mm $H_2O$, minimum 335.0 mm $H_2O$). This result was consistent with the values measured by other scholars (c. f. FARKAS's description). The average protein concentration in serum which was used for the measurement of serum colloidal osmotic pressure was 7.37 g/dl (maximum 8.07 g/dl, minimum 6.50 g/dl), and the average concentration of albumin was 4.69 g/dl (maximum 5.70 g/dl, minimum 4.20 g/dl).

As was mentioned before, serum colloidal osmotic pressure was considered to have a certain relation to serum protein concentration, especially albumin. YOUMAN and YOSHIKAWA stated that serum colloidal osmotic pressure could be figured out by the following formula from protein and albumin concentrations in serum.

Serum colloidal osmotic pressure mm $H_2O$ = protein concentration in serum (g/dl) × [21.4 + 5.9 × albumin concentration in serum (g/dl)]

The values of serum protein and albumin obtained in this study were used in this formula. The average thus obtained was 362.5 mm $H_2O$ (maximum 412.0 mm $H_2O$, minimum 312.0 mm $H_2O$), and it agreed roughly with the measured value though there was a little difference.

A) Successive Changes in Serum Colloidal Osmotic Pressure and Serum Protein and Albumin Concentrations Following a Single Infusion of Sesame Oil Emulsion

KUYAMA and FUJINO in our laboratory rapidly infused sesame oil emulsion, which was not diluted with RINGER's solution and had nothing added to it, intravenously into experimented animals and humans and observed the changes in serum protein concentration and serum protein fractions. The intravenously infused fat was first phagocytized by alveolar phagocytes, stellate cells of the liver and reticuloendothelial cells of the spleen in the form of *O*-lipoprotein. Then it was changed from glyceride into phospholipid in these cells, and finally transmitted into the tissue cells of the whole body via the blood circulation in the form of $\alpha$- and $\beta$-lipoprotein. The changes accompanying the metabolism of the infused fat in the body was reflected in the serum protein concentration and serum protein fractions. However, in the actual clinical application, sesame oil emulsion was always diluted five times with RINGER's solution and intravenously infused very slowly by drip. So it is necessary to know the changes in concentration of serum protein and albumin and serum colloidal osmotic pressure under these such conditions also. For this purpose, the successive changes in serum colloidal osmotic pressure, and in serum protein and albumin concentrations was observed in healthy adults after a drip intravenous infusion of 100 cc of 20% sesame oil emulsion diluted five times with RINGER's solution in one hour. The amount of intravascular circulating fluid increased temporarily because the large amount of RINGER's solution infused together with the

**Table. 1** Changes of Serum Colloidal Osmotic Pressure, Serum Protein and Albumin Concentration Following a Single Infusion of Sesame Oil Emulsion.
(Healthy adults; Mean value)

| Interval after Infusion | Changes of Serum Colloidal Osmotic Pressure | Protein Concentration (gr/dl) | Albumin Concentration (gr/dl) |
|---|---|---|---|
| Before | – | 7.3 | 3.6 |
| 30minute | –13.1 | 6.8 | 3.2 |
| 1 hour | –17.2 | 6.5 | 3.4 |
| 2 hour | –20.6 | 6.3 | 3.4 |
| 4 hour | –18.5 | 6.3 | 3.2 |
| 6 hour | –10.6 | 6.8 | 3.7 |

**Table. 2** Method of Infusion (Infused by intravenous drip method, once a day)

| Group | Preoperative 5 Days | Postoperative 7 Days | 8~10th Postoperative Day |
|---|---|---|---|
| Control Group | 600cc of Ringer's Solution<br>40cc of 20% Glucose Solution<br>Various Vitamins | 600cc of Ringer's Solution<br>500cc of 5% Glucose Solution<br>40cc of 20% Glucose Solution<br>Various Vitamins | 600cc of Ringer's Solution<br>40cc of 20% Glucose Solution<br>Various Vitamins |
| Fat Group | 100cc of 20% Sesame Oil Emulsion<br>500cc of Ringer's Solution<br>40cc of 20% Glucose Solution<br>Various Vitamins | 100cc of 20% Sesame Oil Emulsion<br>500cc of Ringer's Solution<br>500cc of 5% Glucose Solution<br>40cc of 20% Glucose Solution<br>Various Vitamins | 100cc of 20% Sesame Oil Emulsion<br>500cc of Ringer's Solution<br>40cc of 20% Glucose Solution<br>Various Vitamins |

**Table. 3** Changes in Serum Albumin Concentration of Gastrectomy Patients (Mean value %).

| Group | Before Infusion | Day after Operation | | | | |
|---|---|---|---|---|---|---|
| | | Before Oper. | 2nd | 5th | 10th | 15th |
| Fat Group | 100 | 100.5 | 94.0 | 85.6 | 97.3 | 92.0 |
| Control Group | 100 | 99.7 | 105.6 | 79.8 | 85.5 | 89.7 |

**Table. 4** Changes in Serum Colloidal Osmotic Pressure of Gastrectomy Patients (Mean value %).

| Group | Before Infusion | Day after Operation | | | | |
|---|---|---|---|---|---|---|
| | | Before Oper. | 2nd | 5th | 10th | 15th |
| Fat Froup | 100 | 105.4 | 103.5 | 91.4 | 89.6 | 87.7 |
| Control Group | 100 | 99.9 | 96.1 | 85.3 | 82.0 | 81.0 |

sesame oil emulsion diluted the serum. But the intravascular fluid was gradually transmitted extravascularly and the fluid distribution returned to its former state in about 6 hours (Table 1). In other words, when a large amount of emulsion diluted with RINGER's solution was intravenously infused, the body maintained the infused fluid well within the vessels, and transmitted it gradually extravascularly; therefore, there was no danger of causing sudden dilatation of intercellular space by sudden extravasation of the infused fluid.

B) Changes in Serum Colloidal Osmotic Pressure and Serum Albumin Concentration Following Repeated Infusion of Sesame Oil Emulsion

The patients, chosen as described above, were divided into two groups. The changes in serum albumin concentration and serum colloidal osmotic pressure after the infusion by the method shown in Table 2 were investigated comparatively. The results are shown in Tables 3 and 4. Needless to say, the oral water intake during the experiment was regulated so that both groups would have about the same amount (Table 5). In the group receiving fat, the serum albumin concentration was slightly increased before operation by the sesame oil emulsion, and the serum colloidal osmotic pressure increased a little in parallel with it. On the other hand, in

**Table. 5** Comparison of Oral Water Intake

| Day before and after Operation | Fat Group | Control Group |
|---|---|---|
| − 5 | 1400 | 1350 |
| − 4 | 1350 | 1290 |
| − 3 | 1340 | 1370 |
| 2 | 1420 | 1230 |
| − 1 | 1220 | 1200 |
| Operation | 0 | 0 |
| 1 | 0 | 0 |
| 2 | 0 | 0 |
| 3 | 330 | 240 |
| 4 | 590 | 580 |
| 5 | 530 | 660 |
| 6 | 750 | 785 |
| 7 | 945 | 900 |
| 8 | 1080 | 740 |
| 9 | 1175 | 1010 |
| 10 | 1045 | 950 |
| 11 | 1010 | 950 |
| 12 | 1060 | 1100 |
| 13 | 1135 | 1130 |
| 14 | 1220 | 1150 |

**Table. 6** Method of Infusion (Infused by intravenous drip method, once a day)

| Group | Preoperative 5 Days | Postoperative 7 Days | 8～9～10th Postoperative Day |
|---|---|---|---|
| Control Group 1. | 600cc of Ringer's Solution<br>40cc of 20% Glucose Solution<br>Various Vitamins | 600cc of Ringer's Solution<br>500cc of 5% Glucose Solution<br>40cc of 20% Glucose Solution<br>Various Vitamins | 600cc of Ringer's Solution<br>40cc of 20% Glucose Solution<br>Various Vitamins |
| Control Group 2. | 600cc of Ringer's Solution<br>40cc of 20% Glucose Solution<br>Various Vitamins | 1000cc of Ringer's Solution<br>1000cc of 5% Glucose Solution<br>40cc of 20% Glucose Solution<br>Various Vitamins | 600cc of Ringer's Solution<br>40cc of 20% Glucose Solution<br>Various Vitamins |
| Fat Group | 100cc of 20% Sesame Oil Emulsion<br>500cc of Ringer's Solution<br>40cc of 20% Glucose Solution<br>Various Vitamins | 100cc of 20% Sesame Oil Emulsion<br>500cc of Ringer's Solution<br>500cc of 5% Glucose Solution<br>40cc of 20% Glucose Solution<br>Various Vitamins | 100cc of 20% Sesame Oil Emulsion<br>500cc of Ringer's Solution<br>40cc of 20% Glucose Solution<br>Various Vitamins |

the control group, both serum albumin concentration and serum colloidal osmotic pressure tended to decrease slightly before operation as compared with the values found on hospitalization. These preoperative values were measured immediately before operation, that is, after purgatives, enema and gastric lavage, and while the results of the control group showed that these manipulations had a harmful effect on the body, the values in the fat group were even better than those at the time of hospitalization in spite of these manipulations. Also the postoperative course was much better in the fat group than in the control group, and this was believed to be due to the economization of protein caused by the infusion of the sesame oil emulsion (clarified by KUYAMA and HANAFUSA).

2) Influence of Infusion of Sesame Oil Emulsion on Fluid Distribution

About 70% of the weight of a living body is due to fluid, and it is divided into intracellular and extracellular components. The extracellular fluid accounts for about 20% of the body weight, 1/4 of this being intravascular and 3/4 intercellular. In other words, both blood-plasma and intercellular fluid are called extracellular fluid. The main chemical difference between blood-plasma and intercellular fluid is that the latter contains less protein, a non-permeable component. The intracellular fluid accounts for about 50% of the body weight.

It was necessary to clarify how the simultaneous infusion of sesame oil emulsion with RINGER's solution would influence such fluid distribution in the body, because it was suspected that the intravenous infusion of this sesame oil emulsion which is a kind of colloidal solution, different from the usual injected solutions, might cause a disturbance in fluid metabolism.

A) In Healthy Adults

To clarify this problem, 100 cc of 20% sesame oil emulsion which was not diluted with RINGER's solution was intravenously injected in the usual way repeatedly for 15 days. 80 cc of 20% glucose solution and various vitamins were given together. Then changes in the amounts of circulating plasma volume and extracellular fluid volume were examined. As shown in Fig. 1, no overhydration or dehydration was caused by repeated infusions of sesame oil emulsion, and the fluid distribution in the body was kept constant throughout the period of this experiment.

B) Gastrectomy Patients

The above experiment showed that the clinical use of sesame oil emulsion did not influence fluid distribution in healthy adults, but it was not sufficient to conclude from this experiment that this emulsion could be used harmlessly before and after operation. Therefore, 100 cc of 20% sesame oil emulsion diluted five times with RINGER's solution was repeatedly infused every day before and after operation in gastrectomy patients, and the changes in fluid distribution were investigated. The patients were divided into three groups, and the changes in circulating plasma and extracellular fluid volume were investigated in each group. The infusion was given to each group by the method shown in Table 6. The total amount of blood transfusion in each group was regulated to 400 cc preoperatively and 500～600 cc postoperatively. Also the amount of oral water intake was regulated so that every group would have about the same amount (Table 5).

According to GAMBLE, when dehydration occurs, the body tries to maintain the circulating plasma volume and intracellular fluid volume constant changing the intercellular fluid volume. However, when dehydration becomes more intense due to insufficient fluid supply, the intracellular fluid volume will inevitably decrease. Therefore, in order to determine the extent of disturbance in fluid distribution, it would be most desirable to measure extracellular fluid volume and make it the index. In this study, too, extracellular fluid volume was measured in each of the three groups, and the condition of the fluid supply was thereby determined.

First, the effect of the preoperative fluid supply for 5 days on the extracellular fluid volume was determined. The results are shown in Fig. 2. In the fat group, extracellular fluid volume increased and tended to reach the level of that in healthy adults. On the other hand, in the control group to which only RINGER's solution was given, it tended to decrease because of preoperative purgatives, enema and gastric lavage, and a preoperative supplement of RINGER's solution did not make up this deficit. As this result shows, a preoperative supply of fat is very important for the improvement of dehydration, and a extra fluid and salt alone does not at all improve fluid metabolism. The most worrisome complication of the operative invasion is shock. The main factors causing shock are considered to be preoperative dehydration, anemia, hypoproteinemia, disturbances in liver function and adrenal hypofunction. In order to prevent shock due to dehydration during the operation and to make the postoperative course smooth, it is necessary to have the patients in slight overhydration prior to operation. Besides, surgical patients are usually somewhat dehydrated preoperatively. When these points are considered, the rationality of a preoperative fat supply can be well understood. In addition, the fact that a shortage

**Fig. 1** Changes in Circulating Plasma Volume and Extracellular Fluid Volume Following Repeated Infusion of Sesame Oil Emulsion (Healthy adults: Mean value).

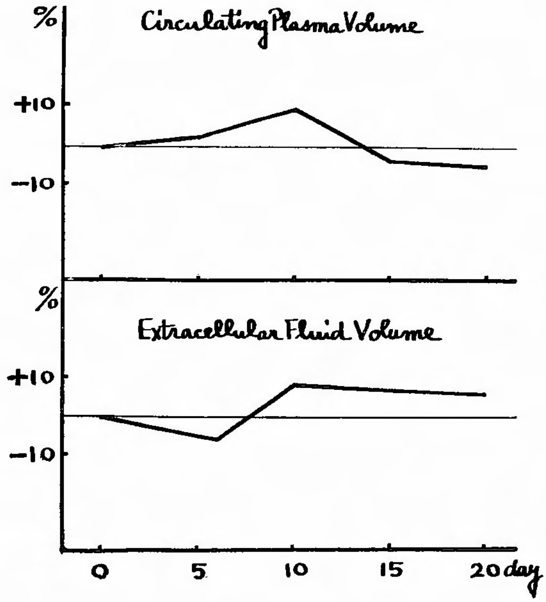



**Fig. 2** Changes in Extracellular Fluid Volume before Operation Following Repeated Infusion of Sesame Oil Emulsion (cc/kg).

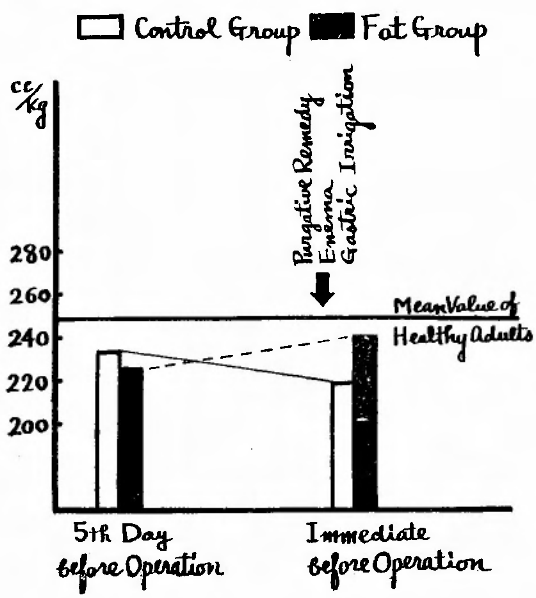


**Fig. 3** Changes in Circulating Plasma Volume before Operation Following Repeated Infusion of Sesame Oil Emulsion (cc/kg).

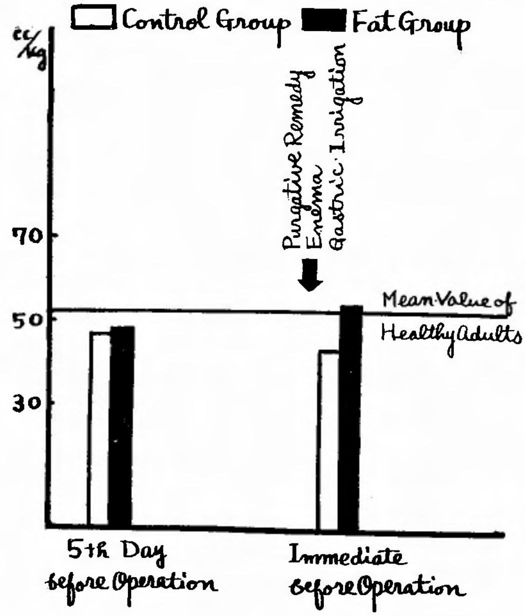
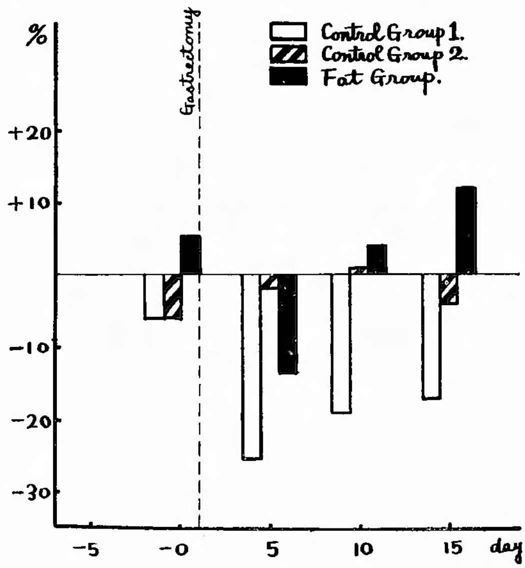
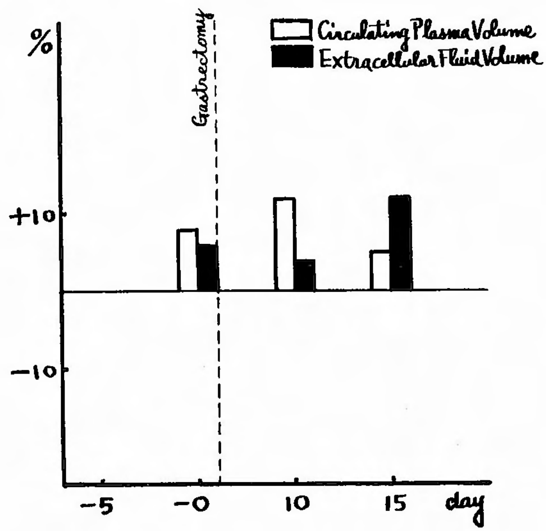



**Fig. 4** Changes in Extracellular Fluid Volume of 3 Gastrectomy Groups (cc/kg)).




of essential fatty acids in the body has a bad effect on adrenocortical function and that a supply of fat of good quality is necessary to maintain liver function and liver glycogen content which has been proved by NAGASE and MATSUDA in our laboratory, makes it imperative to pay close attention to the preoperative fat

**Fig. 5** Corrective Changes in Circulating Plasma Volume and Extracellular Fluid Volume of the Fat Group.




supply. GUGGENHEIM has further pointed out that a shortage of lipotropic agents can cause a marked decrease in the liver's ability to destroy antidiuretic hormone which is secreted by the pituitary gland at the time of an operative invasion. So, from this standpoint too, a plentiful supply of essential fatty acids as lipotropic agents is important in the preoperative stage. The changes in circulating plasma volume parallel those in extracellular fluid volume as shown in Fig. 3. These facts show that the infusion of sesame oil emulsion is effective in decreasing dehydration.

While the patients who had gastrectomy after infusion of sesame oil emulsion did very well with fluid metabolism, control group 1 showed marked postoperative dehydration, and their extracellular fluid volume was greatly decreased even on the 15th postoperative day as compared with that at the time of hospitalization. Control group 2 to which a fluid supply of 2000 cc was given daily postoperatively had a much better course than control group 1; nevertheless water metabolism on the 15th postoperative day had not returned to the level at the time of hospitalization, and was far from the level of healthy adults (Fig. 4).

The stress of operative invasion causes an increase in decomposition of body protein, a negative nitrogen balance, and decrease in the serum protein concentration, the albumin fraction and the A/G ratio. It goes without saying that a series of reactions such as oliguria, retention of sodium and chloride, and loss of potassium are also evoked. Postoperative oliguria is believed to be due to the action of the antidiuretic hormone secreted from the posterior lobe of the hypophysis at the time of operative stress. The so-called "recovering diuresis", an acute polyuric state, is observed on the 5~6th postoperative day when a disposition of antidiuretic hormone is caused by destruction of the hormone in the body and hyperthyroidism is induced. Since postoperative oliguria and retention of fluid and sodium are so marked, fluid infusion, during this stage of accelerated secretion of antidiuretic hormone should be kept to a minimum to avoid edema of the operative wound and pulmonary complications. Slight dehydration is preferable at this stage. The stage of postoperative recovering diuresis coincides with the stage in which oral feeding is begun, and dehydration can easily be evoked. When the author observed pre- and postoperative changes in extracellular fluid volume in the fat group from this view-point, the emulsion was effective in improving preoperative dehydration, then, induced slight dehydration immediately after operation, and further prevented dehydration at the stage of recovering diuresis, thus keeping fluid metabolism stable. These facts were believed to support the appropriateness of administration of the emulsion.

As shown in Fig. 5, extracellular fluid volume and circulating plasma volume were well balanced and changed in parallel with each other in the fat group. That is, there was no imbalance in fluid distribution in the body. These data give only an outline and further detailed investigation into changes in fluid distribution is needed before final conclusions can be drawn. However, the following conclusion may be permitted from the data obtained here. Administration of fat pre- and postoperatively helps to keep serum albumin concentration and serum colloidal osmotic pressure normal by its protein economizing action. This is believed to be one of the factors which stabilize fluid metabolism in the pre- and postoperative stages. But, in correlating observations on fluid distribution, serum colloidal osmotic pressure and other factors, it is essential to understand NAGASE's theory that a supply of fat, especially of essential fatty acids is necessary to keep capillary permeability normal and that a deficiency causes increased capillary permeability and disposes towards edema. This function is probably related to the fact that the cell membrane as a kind of lipoprotein complex plays an important role in the separation of the extra- and intracellular fluid components, in the selection or limitation of movement of fluids, and the regulation of fluid metabolism.

## IV. CONCLUSION

The sesame oil emulsion developed in our laboratory has remarkable nutritional effects as OSA, KUYAMA and HANAFUSA have proved. However, since it is a kind of colloidal solution, there is naturally some question whether intravenous infusion may cause exaggerated changes in fluid distribution. The results of this studies on the changes in extracellular fluid volume and circulating plasma volume after intravenous infusion of the emulsion in healthy adults revealed that there is no such danger at all. Further, when it was infused simultaneously with RINGER's solution, the infused fluid moved extravascularly very slowly and fluid distribution did not deviate from the normal state too much. The infused fat changes into phospholipid from glyceride and goes into tissue cells as $\alpha$- and $\beta$-lipoprotein. This $\alpha$-lipoprotein effects blood elements such as serum albumin and $\alpha$-globulin which are essential to keep normal colloidal osmotic pressure and inhibits acute extravasation of the infused fluid. Therefore, infusion of sesame oil emulsion together with RINGER's solution seems to be rational. In addition, a postoperative increase of fat in the blood corresponding to the decrease in serum protein and albumin concentration is believed to be an appropriate biological reaction to maintain serum colloidal osmotic pressure and postoperative fat supply, so fat emulsion infusion is rational at this point, too.

Generally speaking, surgical patients are dehydrated preoperatively, an important cause of various postoperative complications. At this state there is latent loss of potassium. This, on the one hand, accelerates the loss of potassium, and on the other hand, increases extracellular fluid volume, disposes towards edema and causes oliguria or even shock. This is the reason why operation should not be performed without careful control of preoperative dehydration, and slight preoperative overhydration is even preferable to make the postoperative course smooth. Therefore, if necessary, preoperative fluid infusion together with such hormones as androgen (testosterone propionate etc. which accelerate protein assimilation and fluid retention), sodium, chloride and potassium, are recommended to overcome preoperative dehydration. According to the present investigation, infusion of RINGER's solution alone does almost nothing to improve dehydration if administration of a purgative, enema or gastric lavage is done preoperatively. It was demonstrated that the combined infusion of sesame oil emulsion and RINGER's solution was ideal. Repeated preoperative intravenous infusion of 100 cc of 20% sesame oil emulsion diluted 5 times with RINGER's solution is the most rational way to improve preoperative dehydration and even if purgative, enema or gastric lavage is done preoperatively, there is no danger of abnormal deviation of extracellular fluid or circulating plasma volume. Moreover, if administration of the emulsion is continued postoperatively together with RINGER's solution and 5% glucose solution, the postoperative course is ideal. That is, fat should be supplied not only postoperatively, but also preoperatively from the view-point of fluid metabolism.

This effect of fat supplementation on fluid metabolism may be partly explained by KUYAMA and HANAFUSA that infusion of the emulsion induces a marked protein sparing action, keeps serum albumin concentration normal, and thus inhibits a fall in serum colloidal osmotic pressure. However, when changes in fluid distribution before and after operation are studied in correlation with serum colloidal osmotic pressure, we should also consider NAGASE's experimental results showing that fat —— especially essential fatty acids —— is a fundamental substance which is needed to keep capillary permeability normal and that the cell membrane as a kind of lipoprotein complex plays an important role in the separation of intra- and extracellular fluid layers, and the regulation of fluid metabolism. Furthermore, it can be easily surmised fat has a great influence on adrenal function. More detailed studies should be undertaken on these points to clarify the essential mechanism of fat on fluid metabolism.

## V. SUMMARY

The influence of the administration of fat on fluid metabolism was studied clinically and generally using 20% sesame oil emulsion which was developed in our laboratory.

1) Infusion of sesame oil emulsion causes neither overhydration nor dehydration.

2) The combined use of the emulsion and RINGER's solution has no side effects. On the contrary, it is most rational from the view-point of fluid metabolism.

3) The preoperative combined use of the emulsion and RINGER's solution is very helpful in overcoming preoperative dehydration.

4) When the administration of the emulsion plus RINGER's solution is continued throughout the pre- and postoperative stages, the postoperative course is very smooth. In the stage of postoperative oliguria, the emulsion is useful in keeping a state of slight dehydration. Then at the stage when the patient is apt to be dehydrated because of recovering diuresis and the transition from parenteral to oral feeding, it counteracts dehydration and restores fluid distribution to a healthy state very soon.

5) The effect of the emulsion on fluid metabolism may be partly explained by its protein sparing action which keeps serum albumin concentration normal and inhibits a fall in serum colloidal osmotic pressure. However, the significance of fat as a constant element should also be taken into consideration.

6) These data suggest that there is a close relationship between fat and adrenal functions.

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## 和文抄録

# 経静脈性ゴマ油乳剤注入の生体内水分分布に及ぼす影響

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教室創製の20%ゴマ油乳剤を応用し，脂質の投与が水分代謝に如何なる影響を及ぼすかという点について臨床的に，しかも概括的に追求して次のような結論に達した．

(1) ゴマ油乳剤の静脈内注入は生体に水分過剰や脱水を招来する怖れは全くない．

(2) それがリンゲル氏液と併用されても，生体に過大な悪影響を及ぼすことはなく，生体内水分代謝の面からみてもリンゲル氏液との併用は合理的である．

(3) 術前にリンゲル氏液とゴマ油乳剤を併用することは，よくある術前の脱水状態を改善するのに極めて有効である．

(4) 手術前後を通じて，これを応用すると，術後の経過は極めて順調である．即ち Stress response としての術後乏尿時には軽い脱水状態にもち来たし，更に非経口的食餌から経口的食餌に移行する，ともすれば脱水に陥りがちとなる時期には，脱水状態の発現を抑制し速かに健常人の水分分布状態に復せしめる作用がある．

(5) ゴマ油乳剤の投与が生体の水分代謝に及ぼす上記のような効果は，一つはそれが有する蛋白質節約作用によつて血漿アルブミン濃度を可及的正常に保持し，従つて血清膠質滲透圧の低下を抑制するためと考えられる．しかし，このことのみでは以上の現象を完全に説明することは出来ないのであつて，それは脂質の有するConstant elementとしての意義をも同時に充分に考慮にいれる必要がある．

(6) 以上の研究成績はまた脂質と副腎皮質機能との間にも密接な関係のあることを憶測せしめるものである．