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Brief Note

Evaluation of the Lipid Emulsion Test as a Reticuloendothelial Functional Test

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Key words : lipid emulsion test — reticuloendothelial function — phagocytic activity

The condition of liver diseases should be evaluated by both diagnostic imaging of the liver and the hepatic functional tests. And then the choice of treatment for liver diseases depends especially on the hepatic functional reserve. Many tests of the functional reserve of the hepatic parenchymal cells are in use, but as yet no test of the reticuloendothelial system (RES) including the Kupffer cells has been clearly established. It has been reported that the principle of measuring reticuloendothelial (RE) function is based on the kinetics of clearance from the blood stream of a substance injected intravenously.[1] However, no ideal substance has been found that will satisfy Benacerraf's criteria.[2] The lipid emulsion test was developed by Saba[3] and has been used clinically as a RE functional test by Kim[4] and Hirasawa.[5] The present study was undertaken to evaluate the effectiveness of this test as a RE functional test. The rates of disappearance of various doses of lipid emulsion from the blood (=K value) of rabbits were examined and then optimum dose of lipid emulsion was chosen. This report also investigated the relationship between the lipid emulsion test and the CsFe test, a RE functional test using iron-chondroitinsulfate compound, which has been studied in detail by Ota[6] and has been used widely.

Materials and Methods: The experiments were carried out of 20 New Zealand white rabbits weighing about 3 kg. The doses given to rabbits were 0.1, 0.2, 1, 2 and 5 ml of lipid emulsion per kg of body weight. Blood samples were obtained at 3, 6, 9 and 12 minutes after administration of each doses. The amount of lipid emulsion in the blood was measured spectrophotometrically at a wavelength of 580 nm. The half-time ($T_{1/2}$) of the lipid emulsion of each dose was calculated on a semilogarithmic chart. The K value is expressed by the equation of Biozzi *et al.*[7]:

$$K = (\log C_1 - \log C_2) / (T_2 - T_1)$$

where C_1 is the concentration of injected substance in the blood at the time of T_1 and C_2 is the concentration of injected substance in the blood at the time of T_2. Thus the K value can be obtained by the following equation:

$$K = \log 2 / T_{1/2}$$

The lipid emulsion test and CsFe test were also examined in thirteen rabbits which had undergone experimental transcatheter arterial embolization (TAE). The rates of clearance of CsFe from the blood ($=K_{CsFe}$) were determined according to the method of Ota.[6]

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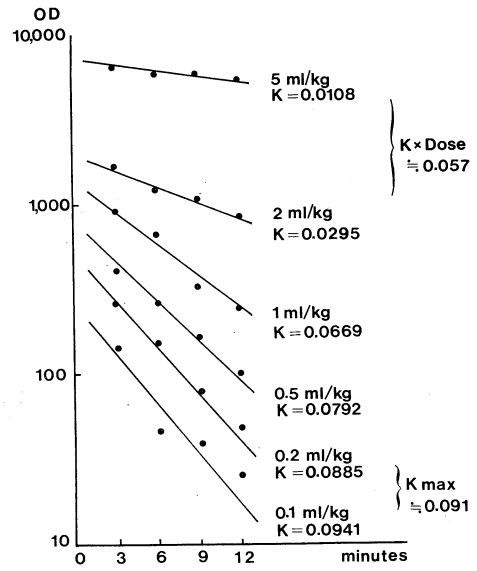

Fig. 1. Disappearance curve after intravenous administration of lipid emulsion in different doses in normal rabbits. (critical doses=0.63 ml/kg)

Results and Discussion: The clearance of various doses of lipid emulsion from the blood in rabbits are plotted in Fig. 1. The removal of each dose followed a single exponent of the time. The K value for high doses (5 ml/kg, 2 ml/kg) was found to vary inversely with the injected dose. The K value for small doses (0.1 ml/kg, 0.2 ml/kg) was found to be almost constant. Biozzi *et al.*[1] reported that when high doses of carbon particles were used, the product K × Dose was remarkably constant. This K value has since been called the "phagocytic index". They also reported that assay methods using a relatively small number of particles were most suitable for the measurement of blood flow through the liver. The present study showed that the product K × Dose was almost constant (K × Dose $\fallingdotseq$ 0.057) in the rabbits receiving 5 ml or 2 ml lipid emulsion per kg. It is therefore suggested that a K value of above 2 ml of lipid emulsion per kg in rabbits clearly shows the phagocytic activity of the RES. In rabbits administered 0.1 ml or 0.2 ml of lipid emulsion per kg, the K values reached a constant maximum value ($K_{max} \fallingdotseq 0.091$). This was considered the K values for liver blood flow. The critical dose of demarcation between the injected dose of lipid emulsion required to measure the phagocytic index and liver blood flow was calculated to be 0.63 ml/kg.

From these results, it is suggested that the optimum dose of lipid emulsion required to measure the phagocytic activity of the RES in rabbits is 2 ml/kg. Therefore, we used a dose of 2 ml of lipid emulsion per kg to determine the phagocytic index (K_{LET}).

Fifty-two paired K_{LET} and K_{CsFe} from thirteen rabbits which underwent experimental TAE are plotted in Fig. 2. K_{LET} correlated well with K_{CsFe}. The effectiveness of the lipid emulsion test as a RE functional test was found

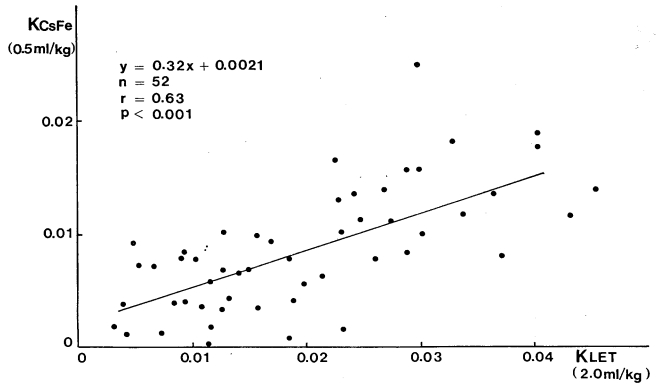

Fig. 2. Relationship between K_{LET} and K_{CsFe}. K_{LET} was in good correlation with K_{CsFe}.

to be similar to that of the CsFe test. Clinically, the lipid emulsion test is a more convenient means for determining RE function. Therefore, measurement of K_{LET} using the lipid emulsion test seems to be useful in evaluation of the condition of liver diseases.

However, it must be understood that neither lipid emulsion nor CsFe satisfy Benacerraf's criteria[2] for ideal substances. Furthermore, K_{LET} and K_{CsFe} only demonstrate the rate of clearance of lipid emulsion and CsFe respectively from the blood as phagocytic activity, which is one of the RES functions. Further progress in finding an ideal substance which can measure the phagocytic activity of the RES and which can be used in a new functional test for the RES is expected.

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