SERUM LIPID LEVELS IN IRON DEFICIENCY ANEMIA
AND EFFECTS OF VARIOUS TREATMENTS

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Summary Effects of anemia on serum total cholesterol and triglyceride levels were studied in Sri Lanka. In subjects with hemoglobin (Hb) levels of less than 9.0 g/100 ml, there was a significant relationship between Hb and cholesterol levels (r=0.53). This relationship was not seen in subjects with Hb levels equal to, or greater than, 9.0 g/100 ml. Triglyceride levels were independent of Hb levels. Total cholesterol levels were elevated following an increase in Hb levels by transfusion and iron treatment. It was suggested that the concentration of red blood cells may affect cholesterol synthesis or mobilization from tissue to plasma.

Keywords iron deficiency anemia, cholesterol, triglycerides, transfusion, iron treatment

Effects of anemia on lipid levels in blood have been studied both in human (1-4) and in animal (5-12). The lipemia in iron-deficient and anemic animals is associated with elevated triglyceride levels while cholesterol levels may (9) or may not (7, 11) be elevated. Lipemia is also found in response to acute hemorrhage in animals (10, 12). On the contrary, lower cholesterol levels were reported in anemic humans by Elwood et al. (1) and Rifkind and Gale (3). But Fujii and Shimizu (2) found no significant difference in total cholesterol levels between subjects with hemoglobin (Hb) levels less than 10.9 g/100 ml and greater than 12.0 g/100 ml. These studies suggest that there is a certain critical level of Hb for cholesterol decrement.

Thus, this study was carried out to determine the relationship between serum total cholesterol and/or triglyceride levels and that of Hb. Furthermore, effects of

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various treatments of anemia on these lipid levels were studied in order to provide some evidence as to whether the lipid to Hb relationship was a causal one.

METHODS

Ninety-seven subjects from Sri Lanka (4 males and 93 females ranging in age from 22 to 65 years) were studied. Hemoglobin (cyan methemoglobin method), serum total cholesterol (13) and triglyceride levels (14) were measured. Their corresponding Hb levels ranged from 2.5 to 15.9 g/100 ml.

Seven of the severely anemic subjects (1 male and 6 females) with a mean Hb level of 3.5 ± 0.4 g/100 ml (± SEM) were transfused i.v. with 570 ml of fresh whole blood. These subjects had a serum iron level of 28 ± 6 μg/100 ml and total iron binding capacity of 454 ± 29 μg/100 ml (15). One and seven days after transfusion a blood sample was taken again from the brachial vein for Hb, cholesterol and triglyceride determination. These subjects were treated with iron dextran on the 7th day following transfusion.

Ten of the moderately anemic subjects (2 males and 8 females) with an initial Hb level of 6.6 ± 0.6 g/100 ml were treated with 30 to 50 ml of Imferon i.v. Their Hb, cholesterol and triglyceride levels were checked 4, 8 and 12 days after the infusion of Imferon.

RESULTS

The relationship between Hb and serum total cholesterol levels is shown in Fig. 1. Although a significant positive correlation \( r = 0.53, p < 0.001 \) was found in subjects with Hb levels lower than 9.0 g/100 ml, there was no significant tendency in subjects with Hb levels greater than, or equal to, 9.0 g/100 ml. The cholesterol levels in Sri Lankans were similar to those reported for India (4), but lower than subjects from South Wales (1). The correlation coefficient between Hb and triglycerides was very low (0.10).

In response to whole blood transfusion i.v., Hb level was elevated from 3.5 ± 0.4 to 5.9 ± 0.7 within 1 day and to 6.3 ± 0.6 g/100 ml 7 days after transfusion. Following the elevation of Hb levels by transfusion, cholesterol levels increased significantly (Fig. 2), while triglyceride levels did not change.

Serum total cholesterol levels increased significantly \( p < 0.05 \) from 141 ± 6 to 182 ± 11 mg/100 ml 12 days after iron treatment (Fig. 2). But triglyceride levels were stable during the same period.

DISCUSSION

Serum total cholesterol (Fig. 1) and triglyceride levels were within the normal range (16) with few exceptions, even in moderately or severely anemic subjects. However, a significant positive correlation \( r = 0.53 \) was found between cholesterol

Fig. 1. The relationship between hemoglobin (Hb) and serum total cholesterol (Chol). The linear regression line in subjects with Hb levels of less than 9.0 g/100 ml was Chol = 10.2 × Hb + 95.3, and Chol = 3.4 × Hb + 154.7 with Hb levels greater than, or equal to 9.0 g/100 ml. One subject whose Hb level was 11.1 g/100 ml had a cholesterol level of 358 mg/100 ml. This point was also included in the calculation of r, but is not shown in the figure. The mean ± SEM shown by ▲ was cited from the data of Elwood et al. (1) in subjects from South Wales with Hb < 10.5 and ≥ 10.5 g/100 ml. The data shown by △ were obtained from the study of Sen et al. (4) in India.

Fig. 2. Changes in hemoglobin and serum total cholesterol in response to iron treatment and whole blood transfusion.

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and Hb in severely anemic subjects with a Hb concentration of less than 9.0 g/100 ml. This results suggests that severe anemia lowers cholesterol levels but moderate anemia does not.

The increase of cholesterol levels following Hb elevation by transfusion may or may not be due to the effect of cholesterol in transfused blood. Lewis and Iammarino (11) suggested a high lipid metabolism, showing a significant fall in triglyceride levels following elevation of Hb levels 24 hr after transfusion in animals. Although it was not significant, the mean triglyceride level was also lower one day after than before transfusion in our study. Cholesterol levels increased significantly following the elevation of Hb levels by Imferon injection i.v. Such results were also found by Elwood et al. (1) and Sen et al. (4). Elwood et al. (1) stated that cholesterol concentration was lower in more anemic subjects because an increased volume of serum in anemia carries the same total load of cholesterol. Due to the dilution effect, anemic blood contains low levels of cholesterol. However, total blood volume should almost be the same in anemia even though the total number of red blood cells is less. The constitution of serum might be constant while the total volume of blood increases. If this were true, triglyceride levels should have changed with the same tendency as cholesterol. But this was not the case.

London and Schwarz (17) showed an insignificant synthesis of cholesterol by red blood cells, and they concluded that cholesterol is exchanged between cell and plasma dynamically. However, the increase in cholesterol levels following improvement of anemia shown by Fujii and Shimizu (2), Sen et al. (4) and our data suggest that red blood cells have some effects on cholesterol synthesis or its mobilization from tissue to plasma.

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