Feeding a 14% coconut oil/0.5% cholesterol (CNO/chol) diet to rabbits resulted in plasma triglycerides that were, on average, 15 times higher than basal levels. Plasma triglycerides in rabbits fed a 14% olive oil/0.5% cholesterol (OO/chol) diet were significantly below baseline levels. Differences in postprandial triglyceride response and postheparin plasma lipoprotein lipase activity (LPL) in various feeding conditions were studied to determine the mechanism of the hypertriglyceridemia. Postprandial triglyceride responses after the first high fat/cholesterol meal were more prolonged in CNO/chol rabbits than in OO/chol rabbits; postprandial triglyceride responses after chronic CNO/chol feeding were significantly greater compared to OO/chol rabbits. When long-term CNO/chol rabbits were given one OO/chol or corn oil/chol meal, postprandial triglyceride peaks were greatly diminished, suggesting that these unsaturated fat meals may alter triglyceride clearance capacity. LPL activity was 400% higher than basal levels in chronically fed OO/chol rabbits but changed very little in chronically fed CNO/chol rabbits. Twenty-four hours after a single OO/chol meal was fed to chow-fed rabbits, LPL doubled; one CNO/chol meal was associated with only a 40% increase. Feeding a single OO/chol or corn oil/chol meal to chronically fed CNO/chol rabbits resulted in a 30% to 50% increase in LPL activity, while increased LPL may be partially responsible for the hypertriglyceridemia observed in OO/chol feeding. Aortic cholesterol was substantially higher in CNO/chol rabbits. Triglyceride was approximately eight times greater in livers from CNO/chol-fed rabbits than in those fed OO/chol, but liver cholesterol was only about one-third as much as that in OO/chol rabbits. (Arteriosclerosis 10:421–429, May/June 1990)

Methods

Animals and Diets

Female New Zealand White rabbits (Becken Research Animal Farm, Sanborn, NY) weighing between 2.5 and 3.5 kg each were used in all experiments. The rabbits were caged individually and had free access to water. They were offered daily 100 g of a diet containing 85.5 g of commercial chow (Purina Lab Rabbit Chow 5321, St. Louis, MO), 0.5 g of cholesterol, USP (ICN Biochemicals,
Cleveland, OH, and 14 g of either hydrogenated coconut oil (ICN Biochemicals, Cleveland, OH), olive oil (Felippo Berio, Luca, Italy), or corn oil (Mazola, Best Foods, Englewood Cliffs, NJ). The cholesterol was dissolved in the oil at 120°C, added to chow, and mixed thoroughly. Food consumption was monitored daily by weighing the food remaining each day. Body weights were recorded approximately every 10 days. All animal protocols were in accordance with Cornell University Guidelines.

In general, the following experiments had more rabbits in the CNO/chol groups; we have observed in previous experiments that variability among rabbits fed CNO/chol is greater than in rabbits fed OO/chol.

Experimental Design

Experiment A: Postprandial Lipids in Acute and Chronic Fat Feeding

Twenty-one rabbits were randomly assigned to two groups (CNO/chol, n=14 or OO/chol, n=7). The rabbits were fed commercial chow until the first day (Day 1) of the study. On Day 1, 0 hour (fasting) blood samples were collected from the marginal ear vein (4% NaNO, 0.4 M ethylenediaminetetraacetate [EDTA], pH 7.4, 0.01 ml/ml blood). The rabbits were then given their first 100 g test meal containing 0.5 g of cholesterol and 14 g of either coconut oil (CNO/chol) or olive oil (OO/chol). All test meals were consumed within 6 hours of feeding. Blood samples were taken at 6, 12, 18, 24, and 36 hours after the test meal was presented. The next meal was given after the 36-hour blood sample was taken. From Day 2 to Day 26, the rabbits were continued on their assigned diets. On Day 27, the postprandial protocol described above was repeated.

On Day 37, 10 of these CNO/chol rabbits were utilized in a "meal switch" experiment: five of the CNO/chol rabbits were continued on 100 g of the 0.5% cholesterol, 14% coconut oil diet. The other five CNO/chol rabbits were fed one test meal of the 0.5% cholesterol/14% olive oil diet. The 10 CNO/chol rabbits were selected on the basis of their previous postprandial responses to obtain a wide range of postprandial triglyceridemia. The rabbits were paired by matching plasma triglyceride values; each member of the pair was then randomly assigned to one of the other of the dietary regimens. Blood samples were taken at 0, 6, 12, 18, 24, and 36 hours. The rabbits were returned to their originally assigned diets for the duration of the study (85 days). Every 7 to 10 days, blood samples were taken 18 hours after a meal for lipid determinations throughout the study. Postheparin plasma LPL was determined at 18 to 20 hours after a meal on Day 0, Day 20 (which is approximately when plasma triglycerides in CNO/chol rabbits began to increase steeply), and Day 49 (when plasma triglyceride began to plateau).

Experiment B: Lipoprotein Lipase after Single High Fat Meal

Postheparin plasma LPL was determined in 14 Chow-fed rabbits. The animals were then fed either a single 14% coconut oil/0.5% cholesterol meal (n=9) or a 14% olive oil/0.5% cholesterol meal (n=5). Twenty-four hours after this meal, the LPL was determined again.

Experiment C: Lipoprotein Lipase after Meal Switch

The meal switch experiment from Experiment A was repeated in a third group of seven rabbits. In addition to the postprandial curves, LPL was determined before and after the meal switch as follows: the rabbits were fed 14% coconut oil/0.5% cholesterol for 35 days. On Day 35, LPL was determined. On Day 36, a 14% olive oil/0.5% cholesterol meal was fed to all seven rabbits after a 0 hour blood sample; postprandial plasma samples were taken for triglyceride and cholesterol at 6, 12, 18, and 24 hours after the meal. On Day 37, LPL was determined again. Rabbits were returned to the CNO/chol diet until Day 40. The above protocol was repeated on Days 40, 41, and 42 in the same rabbits; however, a 14% corn oil/0.5% cholesterol meal was given to the seven rabbits rather than olive oil/cholesterol.

Experiment D: Lipoprotein Lipase in Absence and Presence of Dietary Cholesterol

Lipoprotein lipase was determined at 18 to 20 hours after a meal in rabbits from other unrelated experiments which were fed for at least 1 month either chow (n=4), high fat coconut oil (n=4), high fat corn oil (n=3), or high fat olive oil (n=2). Cholesterol (0.5% wt/wt) was then added to these diets, the rabbits were fed for 11 days, and LPL was determined again.

Chemical Analyses

Lipid Analyses

In all experiments, plasma samples were analyzed for plasma cholesterol and triglyceride by enzymatic methods (AutoFlow Cholesterol High Performance Kit [236691]; Reagen Set Triglycerides GPO [701912]; Boehringer Mannheim Biochemicals, Indianapolis, IN). At high levels of plasma cholesterol (>150 mg/dl) or triglyceride (>150 mg/dl), the plasma was diluted with saline before analysis. A standard plasma pool stored frozen in small volumes was assayed in each determination to confirm reproducibility.

After 85 days of experimental feeding, the rabbits from Experiment A were sacrificed by an overdose of sodium pentobarbital (Pentobarbital, Nembutal, Abbott Laboratories, #(rno), NJ). The rabbits were perfused with approximately 500 ml of saline into the left ventricle and out through the superior vena cava to remove blood. The aortas were removed and rinsed with 0.9% NaCl. Excess fat was removed from the adventitial side, and the aortas were then opened longitudinally, divided into thoracic and abdominal sections, weighed, and stored at -20°C for later analysis. The livers were also excised, weighed, and stored at -20°C. Abdominal and thoracic aortas and liver samples were extracted overnight in 20 volumes of 2:1 (vol/vol) of chloroform/methanol. Aliquots were dried, saponified, and analyzed for total cholesterol content by the method of Zak et al.1 Liver triglycerides were isolated from other lipid components on precoated thin-layer chromatography plates (Silica Gel 60; EM Science,
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were counted in ACS scintillant (Amersham). Total lipase
azide, pH 10.0) was added. The 3H- and 14C-oleic acid
acid partition coefficient. To each tube, 0.17 ml of borate

Triton X-100, pH 8.4) was added, and the mixture was

intervals with 30-second pauses in between (Branson

sonicated in an ice-water bath for seven 30-second

reaction was stopped with 1.4:1.2:1.0 (vol/vol/vol) meth-

substrate, a mixture of triolein and 3H-triolein in CHCl3 were

placed in a glass counting vial and dried under a stream

were calculated and expressed as micromoles of fatty
acid released per milliliter of plasma per hour at 37°C. LPL
was calculated by subtracting hepatic lipase activity from
total lipase activity. A standard frozen (−70°C) posthe-
parin, chow-fed rabbit plasma pool was assayed at four
levels for each determination. Over a 4-month period, an
average value (±SEM) for this standard was 24.3±0.47
μmol of fatty acid released/ml plasma/hour for all aliquots
assayed (n=20).

Hepatic lipase activity did not differ between groups in
any experiment and generally comprised 10% to 20% of
total lipase activity. Therefore, we report values only for
LPL activity.

Data Analysis
Postprandial Triglyceride Curves and Average
Plasma Lipids
The area under the postprandial triglyceride curve was
determined by calculating the area under the curve from
t=0 to t when plasma triglyceride returned to the t=0
glyceride level. If plasma triglyceride did not return to
t=0 levels, the area under the curve was determined from
t=0 to t=24.
The average plasma cholesterol for each animal was
determined from the area under the plasma cholesterol-
time curve. These values were then averaged for each
group. Average plasma triglyceride values for each group
were determined in the same manner.

The data were analyzed by paired and unpaired
Student’s t test.

Results
Experiment A
Animals and Food Consumption
No significant differences in basal or final weights
between the two groups were observed (CNO/chol,
2990±44 [basal] to 3830±81 [final]; OO/chol, 2980±90
[basal] to 3820±143 [final]). All rabbits consumed 100 g
diet each day until Day 39. From Day 39 to the end of
the study, the CNO/chol group consumed 87%±10%
(mean±SD) of their daily diet, and the OO/chol group
consumed 91%±13%. This difference was not statisti-
cally significant. After Day 57, four rabbits (two CNO/chol
rabbits and two OO/chol rabbits) were removed from the
study because they had died or were eating poorly and
appeared jaundiced.

Postprandial Lipids
Postprandial plasma lipid profiles after the first high fat
plus cholesterol meal were determined to ascertain
whether a single CNO/chol meal would affect plasma
lipids differently than an OO/chol meal. Until the first high
fat plus cholesterol meal, all rabbits were chow-fed.
Rabbits were then randomly assigned to either the coco-
ut oil (n=14) or the olive oil (n=7) regimen and were
maintained on the designated diet for the duration of the
study. (Note the exception for rabbits involved in the
meal switch experiment as described in the Methods
section.) Figure 1 shows the change in plasma triglyc-
eride (Figure 1A) and cholesterol (Figure 1B) over the
36-hour period following the first test meal of either CNO/chol or OO/chol. Postprandial plasma triglycerides were not significantly different between groups at any time point (Figure 1A). Table 1 shows means (±SEM) for the t=0 plasma triglycerides for each group, the changes in postprandial triglyceride (the highest postprandial triglyceride attained in each rabbit minus the t=0 value), and the area under the postprandial curve for each group for Day 1, Day 27, and the meal switch on Day 37. The area under the postprandial triglyceride curve was determined by integrating the area under the curve from t=0 to t when plasma triglyceride returned to the t=0 triglyceride level. On Day 1, there were no significant differences between groups in the t=0 triglyceride and the peak triglyceride. However, the area under the triglyceride curve was significantly lower in OO/chol rabbits: peak postprandial triglyceride occurred sooner in OO/chol rabbits and returned to the t=0 triglyceride level sooner in these rabbits than in CNO/chol rabbits. Thus, although the peak height was similar for both groups, the duration of the triglyceridemia was shorter in OO/chol rabbits, leading to a smaller area under the curve. Even though rabbits were randomly assigned to the groups, the t=0 plasma cholesterol (Figure 1B) was significantly lower in animals to be given the OO/chol diet. Plasma cholesterol for both groups increased at a similar rate throughout the 36-hour period.

Postprandial lipid profiles were repeated after 27 days of high fat plus cholesterol feeding to determine the long-term effect of the two oils on postprandial plasma lipids. Figures 1C and 1D show the plasma triglyceride and cholesterol profiles of both groups for the 36-hour postprandial period on Day 27. A postprandial triglyceride peak was evident in both groups, although it was very small in the OO/chol rabbits. By 24 hours, which would normally have been the time when the next meal would have been fed, plasma triglyceride in the OO/chol group had returned to t=0 levels; in CNO/chol rabbits, plasma triglyceride at 24 hours remained elevated above t=0 levels. Table 1 shows that on Day 27 the differences between groups for all three variables were highly significant. For both groups, plasma cholesterol did not appear to change over time (Figure 1D). After 27 days of high fat plus cholesterol feeding, plasma cholesterol was already three to four times as high (Figure 1D) in CNO/chol rabbits as in OO/chol rabbits.

A time effect was evident: pre- and postprandial plasma triglyceride were significantly higher in CNO/chol rabbits on Day 27 compared to Day 1, whereas in OO/chol rabbits, plasma triglycerides were significantly lower than on Day 1 (compare Figure 1A to 1C; in Table 1, the increase from 68.4±9.5 to 290±54 is significantly different at p<0.001. For OO/chol rabbits, the decrease from 88.0±12.9 to 35.7±8.0 is significant at p<0.005), thus suggesting that feeding high levels of olive oil is hypotriglyceridemic.

The results from Day 27 suggest that chronic CNO/chol feeding may affect clearance of postprandial triglyceride-rich particles. Theoretically, if clearance of CNO/chol particles was hindered because the particles themselves were altered, then feeding one OO/chol meal to rabbits that had chronically been fed CNO/chol would result in diminished postprandial triglyceride peaks.

Alternatively, if chronic CNO/chol feeding caused a physiological change in the animal, then feeding one OO/chol meal to CNO/chol rabbits would not be expected to result in lowered postprandial triglycerides, unless a single OO/chol meal could reverse the decreased triglyceride clearance capacity. Figure 2 shows the percent change in postprandial triglyceride in 10 chronically fed CNO/chol rabbits which were fed one high fat/cholesterol meal of either CNO or OO on Day 37. CNO/chol rabbits fed a CNO/chol meal showed a 60% increase in plasma triglyceride peaking at 18 hours; at 24 hours, plasma triglyceride was still 10% to 20% higher than it had been at t=0. However, in CNO/chol rabbits fed one OO/chol meal, postprandial plasma triglyceride increased only 10% to 20% and peaked at 12 hours; thereafter, plasma triglyceride decreased very rapidly. By 24 hours, when animals would normally have received their next meal, plasma triglyceride was >40% lower than it had been at t=0. Table 1 shows a summary of the Day 37 meal switch experiment. Plasma triglycerides of the two groups at t=0 did not differ significantly, but CNO/chol rabbits fed one OO/chol meal had significantly lower postprandial triglyceride peaks; the area under the triglyceride curve was also substantially lower in the rabbits fed one OO/chol meal and very closely resembled the area under the postprandial triglyceride curve found in chronically fed OO/chol rabbits (compare to area for OO/chol rabbits on Day 27, Table 1).

Postheparin plasma LPL activities of the groups in Experiment A were determined to assess the long-term effects of the two fats on LPL activity. Figure 3 shows the change in
Table 1. Postprandial Plasma Triglycerides

<table>
<thead>
<tr>
<th>Day and diet group</th>
<th>t=0 (mg/dl)</th>
<th>Change in TG* (mg/dl)</th>
<th>Area† (mg/dl·hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CNO/chol (n=14)</td>
<td>68.4±9.5</td>
<td>62.6±9.6</td>
<td>716±97§</td>
</tr>
<tr>
<td>OO/chol (n=7)</td>
<td>88.0±12.9</td>
<td>42.7±5.9</td>
<td>368±56</td>
</tr>
<tr>
<td>Day 27</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CNO/chol (n=14)</td>
<td>290±54†</td>
<td>119±14†</td>
<td>1570±185†</td>
</tr>
<tr>
<td>OO/chol (n=7)</td>
<td>35.7±8.0</td>
<td>33.4±3.1</td>
<td>411±56</td>
</tr>
<tr>
<td>Day 37, meal switch</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CNO/chol (n=5)</td>
<td>265±93</td>
<td>107±17†</td>
<td>1502±387†</td>
</tr>
<tr>
<td>CNO/chol rabbits fed one OO/chol meal (n=5)</td>
<td>238±90</td>
<td>31.4±19</td>
<td>356±157</td>
</tr>
</tbody>
</table>

The values are means±SEM.
*Change in TG=highest postprandial triglyceride value minus t=0 hour value.
†Area=area under the postprandial triglyceride curve from t=0 to t when plasma triglyceride returned to t=0 level.
§Significant difference between CNO/chol and OO/chol, p<0.001.
| Significant difference between CNO/chol and OO/chol, p<0.01.
| Significant difference between CNO/chol and CNO/chol rabbits fed one OO/chol meal, p<0.01.

CNO/chol=coconut oil/cholesterol, OO/chol=olive oil/cholesterol.

Figure 2. Percent change in postprandial plasma triglyceride in rabbits chronically fed coconut oil and cholesterol, that were fed one 14% coconut oil plus 0.5% cholesterol meal (●, n=5) or one 14% olive oil plus 0.5% cholesterol meal (○, n=5). Means±SEM.

LPL in CNO/chol and OO/chol rabbits over time. Postheparin LPL activity increased significantly in both groups from Day 0 to Day 20. From Day 20 to Day 49, LPL continued to increase substantially in OO/chol rabbits, but, in CNO/chol rabbits, LPL activity returned nearly to the Day 0 level.

Experiment B. Lipoprotein Lipase after Single High Fat Meal

In a second group of rabbits, we tested whether a single CNO/chol meal or OO/chol meal fed to chow-fed rabbits would alter LPL activity. LPL was determined in chow-fed rabbits (n=14). Rabbits were then fed either one CNO/chol meal (n=9) or one OO/chol meal (n=5), and LPL was again determined at 24 hours after the meal.

Table 2 shows the results of this experiment. Twenty-four hours after feeding a single OO/chol meal, the increase in LPL was more than 100%, whereas for CNO/chol, LPL was increased only 40%. To control for the possible effects of the heparin injections on LPL, we determined LPL in four chow-fed rabbits after a single heparin injection and again after a second heparin injection 48 hours later. LPL (µmol/ml/h±SEM) did not differ (17.8±3.3 vs. 17.4±3.4).

Experiment C. Lipoprotein Lipase after Meal Switch

In a third group of rabbits, we tested whether a single OO/chol meal given to chronically fed CNO/chol rabbits...
Table 2. Increase in Lipoprotein Lipase after Single Olive Oil/Cholesterol or Coconut Oil/Cholesterol Meal

<table>
<thead>
<tr>
<th>Basal LPL*</th>
<th>Increase in LPL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Olive oil/cholesterol</td>
<td></td>
</tr>
<tr>
<td>19.4</td>
<td>21.2</td>
</tr>
<tr>
<td>18.6</td>
<td>15.0</td>
</tr>
<tr>
<td>22.9</td>
<td>14.2</td>
</tr>
<tr>
<td>19.8</td>
<td>36.3</td>
</tr>
<tr>
<td>14.9</td>
<td>18.6</td>
</tr>
<tr>
<td>Mean±SEM</td>
<td>19.1±1.3</td>
</tr>
<tr>
<td>Coconut oil/cholesterol</td>
<td></td>
</tr>
<tr>
<td>16.9</td>
<td>7.2</td>
</tr>
<tr>
<td>19.4</td>
<td>9.6</td>
</tr>
<tr>
<td>28.9</td>
<td>9.2</td>
</tr>
<tr>
<td>25.8</td>
<td>5.1</td>
</tr>
<tr>
<td>27.6</td>
<td>9.8</td>
</tr>
<tr>
<td>22.4</td>
<td>12.1</td>
</tr>
<tr>
<td>21.6</td>
<td>11.5</td>
</tr>
<tr>
<td>26.8</td>
<td>3.5</td>
</tr>
<tr>
<td>18.6</td>
<td>13.7</td>
</tr>
<tr>
<td>Mean±SEM</td>
<td>23.1±1.4</td>
</tr>
</tbody>
</table>

Values are given in µmol/ml/hour.

* LPL value for chow-fed rabbits prior to first coconut oil/cholesterol or olive oil/cholesterol meal.

† Significantly different from coconut oil/cholesterol increase, p<0.02.

LPL = lipoprotein lipase.

would have an acute effect on postheparin plasma LPL activity. LPL was determined in rabbits fed CNO/chol for 35 days (n=7). The seven rabbits were then fed one OO/chol meal, and LPL was again determined at 24 hours after the initial LPL value. Postprandial plasma triglyceride and cholesterol levels were also determined during this period. To ascertain whether the effects observed were unique to olive oil, the same protocol was followed in the same rabbits 5 days later, except that rabbits were switched from CNO/chol to one 14% corn oil/0.5% cholesterol meal. The results are shown in Figure 4. Figure 4A shows increases in LPL activity (µmol/ml/h±SEM) from 22.8±1.7 to 34.0±3.8 at 24 hours after a single OO/chol meal, and from 23.3±2.0 to 38.5±1.8 after a corn oil/chol meal, compared to no change with daily CNO/chol feeding. Figure 4B shows the percent change in postprandial plasma triglyceride in CNO/chol rabbits fed a single meal of either OO/chol or corn oil/chol. By 24 hours, plasma triglyceride had decreased 40% from t=0 levels. The modest increase and rapid decrease in plasma triglyceride was similar with both types of oil and resembled the percent change in triglyceride in CNO/chol rabbits fed one OO/chol meal from the earlier experiment (see Figure 2). Plasma cholesterol tended to decrease, despite a dietary cholesterol input of 500 mg, but this apparent decrease was not statistically different from t=0 cholesterol values (data not shown).

Experiment D. Lipoprotein Lipase Activity in Absence and Presence of Dietary Cholesterol

We also tested whether the presence of dietary cholesterol was essential to induce the changes in LPL activity observed with high fat/cholesterol feeding. Figure 5 shows LPL activity in rabbits fed chow, high-fat coconut oil, corn oil, or olive oil before and at 11 days after the addition of dietary cholesterol to these diets. In all dietary situations except the coconut oil group, LPL activity was dramatically increased at 11 days after the addition of cholesterol.

Plasma and Tissue Lipids

The average plasma cholesterol and triglyceride, aortic cholesterol, liver cholesterol, and triglyceride contents for
HYPERTRIGLYCERIDEMIA AFTER COCONUT OIL/CHOLESTEROL

Figure 5. Lipoprotein lipase (LPL) activity in the absence and presence of dietary cholesterol. -CHOL. Before the addition of cholesterol, rabbits were fed for at least 1 month on chow (n=4), high fat coconut oil (n=4), high fat corn oil (n=3), or high fat olive oil (n=2). +CHOL. Rabbits were then placed on either a 2.5% corn oil/0.5% cholesterol diet (control), or a 14% coconut, corn, or olive oil/0.5% cholesterol diet for 11 days. Error bars represent SEM.

Table 3. Plasma, Aortic, and Liver Lipids

<table>
<thead>
<tr>
<th>Lipids</th>
<th>CNO/chol (n=12)</th>
<th>OO/chol (n=5)</th>
<th>Chow§ (n=11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plasma cholesterol (mg/dl)</td>
<td>1923±201*</td>
<td>680±157</td>
<td>70±5</td>
</tr>
<tr>
<td>Plasma triglyceride (mg/dl)</td>
<td>659±112*</td>
<td>44±5</td>
<td>80±9</td>
</tr>
<tr>
<td>Aortic cholesterol (mg/g tissue)</td>
<td>16±2.21</td>
<td>5.8±2.4</td>
<td>1.0±0.05</td>
</tr>
<tr>
<td>Liver cholesterol (mg/g tissue)</td>
<td>28±4.04</td>
<td>74±16</td>
<td>2.2±0.1</td>
</tr>
<tr>
<td>Liver triglyceride (mg/g tissue)</td>
<td>288±43*</td>
<td>35±11</td>
<td>3.3±0.2</td>
</tr>
</tbody>
</table>

Values are means±SEM.  
*Significantly different from OO/chol, p<0.001.  †Significantly different from OO/chol, p<0.01.  ‡Significantly different from OO/chol, p<0.02.  §Long-term chow-fed rabbits from unrelated experiment.  
CNO/chol=coconut oil/cholesterol, OO/chol=olive oil/cholesterol.

Discussion

In previous studies, we observed that a CNO/chol diet in rabbits induces mild to severe hypertriglyceridemia, but that an OO/chol diet does not. The present studies were conducted to examine the effects of these two diets on lipolytic activity in the postprandial state to determine the possible mechanisms of the hypertriglyceridemia associated with CNO/chol feeding. We use “postprandial” to refer to events occurring during the absorptive phase. In rabbits given a high dose of fat such as in these experiments, the absorptive period is quite long. Eight hours after rabbits were presented with a meal containing 14 g of labeled fat and 0.5 g of cholesterol, 70% to 75% of the label still remained in the gut, primarily in the stomach and small intestine. At 24 hours, 15% still remained in the gut (unpublished observations). We cannot conclude, however, how much of the postprandial triglyceridemia observed in CNO/chol rabbits is associated with intestinal particles versus liver particles.

It was shown that chronic feeding of a CNO/chol diet leads to significantly higher fasting plasma triglycerides, larger postprandial triglyceride responses, and lower postheparin plasma LPL activities compared to OO/chol feeding, suggesting that a decreased clearance capacity is at least partially responsible for the hypertriglyceridemia. These results are similar to those of Groot et al., in whose study rats consuming diets rich in palm oil had higher postprandial triglyceride levels and lower LPL activity than rats fed sunflower seed oil rich diets. In humans, it has been shown that long-term polyunsaturated fat (fish or vegetable) feeding leads to greatly diminished postprandial triglyceride peaks compared to saturated fat feeding. However, these studies did not find differences in LPL activity between groups.

In our studies, plasma triglyceride levels in chow-fed rabbits 24 hours after a single OO/chol meal were 50% lower than the plasma triglyceride immediately preceding the OO/chol meal, whereas in CNO/chol animals, plasma triglycerides had only returned to baseline levels (Experiment A). In parallel, LPL of chow-fed rabbits was >100% higher at 24 hours after a single OO/chol meal compared to only a 40% increase in LPL after a single CNO/chol meal (Experiment B). This differential LPL effect may explain, at least in part, the lower postprandial triglyceride response in rabbits after a single OO/chol meal. The new lower fasting triglyceride levels in most OO/chol rabbits persisted for the duration of the study.

When chronically fed CNO/chol rabbits were given one OO/chol meal, postprandial triglyceride curves were greatly diminished and, in fact, resembled the postprandial triglyceride curves of chronically fed OO/chol rabbits. In a separate experiment (Experiment C), feeding one high fat OO/chol or corn oil/chol meal to chronically fed CNO/chol rabbits was associated with increased LPL activity and a concurrent 40% decrease in plasma triglyceride after 24 hours. Whether the increase in LPL activity is entirely responsible for the decrease in postprandial plasma triglyceride is not known. These effects of olive oil in rabbits differ from those of fish oil in humans; Harris et al. found that giving a single fish oil meal to humans on
a saturated fat diet did not lower postprandial triglyceride peaks. That both OO/chol and corn oil/chol have similar effects on plasma triglycerides and LPL suggests that it may be the removal of the highly saturated coconut oil rather than the presence of olive oil that is responsible for the changes observed during the meal switch experiments. However, feeding a single OO/chol meal to rabbits previously fed chow also increased LPL and lowered plasma triglyceride. It, therefore, seems more reasonable to ascribe the effect to the presence of unsaturated fat, rather than to the removal of the saturated fat.

It is worth noting that, in these experiments, dietary cholesterol is essential to produce the hypertriglyceridemic effects of coconut oil. Feeding rabbits a 14% coconut oil diet without cholesterol did not produce hypertriglyceridemia. Feeding a low fat diet, or a high fat corn oil, olive oil, or coconut oil diet without cholesterol resulted in LPL activities slightly above values in chow-fed rabbits, yet, when cholesterol was added to these diets, LPL increased dramatically in the OO/chol and corn oil/chol groups (Experiment D). LPL was unchanged in the CNO/chol rabbits. Why dietary cholesterol is necessary for the triglyceride and LPL effects is not understood.

In agreement with a previous study, plasma triglyceride and cholesterol and aortic cholesterol were substantially higher in the CNO/chol rabbits than in the OO/chol rabbits. Liver triglyceride was also considerably higher in CNO/chol rabbits. Although liver cholesterol was elevated in all cholesterol-fed rabbits, it was significantly higher in OO/chol than in CNO/chol rabbits. Other studies in rabbits have also shown higher levels of liver cholesterol after olive oil feeding compared to other unsaturated fats. The physiological significance of such an increase in liver cholesterol should be studied, particularly if the consumption of large amounts of olive oil by humans would also lead to an accumulation of cholesterol in the liver.

The present studies have shown that the elevated fasting and postprandial triglycerides in long term CNO/chol rabbits may result, at least in part, from a decreased clearance capacity. However, several other mechanisms are possible. First, OO/chol particles may be more readily hydrolyzed by LPL than CNO/chol particles. However, other studies in rabbits have also shown higher levels of liver cholesterol after feeding coconut oil than in CNO/chol rabbits. Other studies in rabbits have also shown higher levels of liver cholesterol after feeding coconut oil than in CNO/chol rabbits.

The potential importance of lipemic responses during the postprandial phase for atherosclerosis has been addressed. In the present studies, it was observed that in CNO/chol rabbits, both peak height and duration of postprandial curves varied greatly, even among rabbits with similar fasting plasma cholesterol and triglyceride. Variation among OO/chol rabbits was very small. It follows that the arterial walls of the animals with greater postprandial responses may be exposed to higher levels of postprandial triglyceride and the cholesterol associated with triglyceride-rich lipoproteins for longer periods of time. Therefore, rabbits with exaggerated postprandial responses to a high fat cholesterol diet may ultimately develop more arterial lesion than rabbits with diminished postprandial responses, despite similar postabsorptive plasma lipid values. For species that spend a large part of time in the postprandial state, such as humans in developed nations, postprandial lipemic response may be an important indicator of risk in the development of atherosclerosis.
HYPERTROPHY OF AORTIC WALL AFTER COMBINED TREATMENT WITH CHOLESTEROL AND COCONUT OIL

Index Terms: triglycerides • coconut oil • olive oil • cholesterol • lipoprotein lipase • postprandial lipemia • liver lipids
Postprandial lipemia and lipoprotein lipase in the rabbit are modified by olive and coconut oil.

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