BLOOD CHOLESTEROL DURING ETHER ANESTHESIA.*

BY ABRAHAM MAHLER.

(From the Department of Biological Chemistry, Lebanon Hospital, New York.)

(Received for publication, June 4, 1926.)

Certain chemical changes in the blood during ether anesthesia are similar to those occurring in diabetes mellitus. Ross and Davis (1) have shown that in dogs the hyperglycemia of ether anesthesia is due to a direct depression of the internal secretion of the pancreas by ether. In man the same effect is observed, so that during the course of narcosis the subject shows temporarily a disturbance in carbohydrate metabolism similar to that which occurs in diabetes mellitus. Further similarity in the two conditions is shown by the occurrence of acidosis and lipemia in each. Bloor (2) in his work corroborated the finding by Reicher (3) of a definite rise in total blood fat during ether anesthesia. The part which cholesterol plays in this lipemia and its relation to glucose metabolism and the internal secretion of the pancreas is the problem studied in this paper.

Cholesterol determinations were done on whole oxalated blood according to the recent technique of Leiboff based on the Liebermann-Burchard reaction (4). In this method fat-free paper discs are saturated with a known quantity of blood and extracted with chloroform in a special tube attached to a reflux condenser.

The results indicate total cholesterol; i.e., free cholesterol plus esters of cholesterol with fatty acids. Blood glucose determinations were made according to the method of Folin and Wu.

The cases studied were patients operated upon at Lebanon Hospital. There was no special choice, except that only adults receiving a prolonged ether anesthesia were selected. They received the usual preoperative preparation. Morphine was given ½ to 1 hour before anesthesia and prior to that nothing by mouth.

* This work was done under auspices of the Dr. A. J. Rongy Fellowship in Surgical Pathology at Lebanon Hospital, New York.
Blood Cholesterol

for at least 14 hours. Anesthesia was induced with nitrous oxide and continued during the first 2 or 3 minutes only.

In the first group of cases, as shown in Table I, simultaneous blood cholesterol and blood glucose determinations were made at varied intervals during the progress of anesthesia. In the second group of cases, as shown in Table II, cholesterol determinations alone were made. Control determinations were made in all cases immediately prior to the induction of anesthesia. Only control figures and the final figures near the end of anesthesia are given. Intermediate determinations are omitted in order to simplify the table. Table III, however, shows several of the cases in detail.

A study of Tables I and II shows that there is a definite rise in total blood cholesterol during the progress of ether anesthesia. This rise is roughly proportional to the rise in blood glucose and both are roughly proportional to the duration of anesthesia. The

<table>
<thead>
<tr>
<th>Case</th>
<th>Hospital No.</th>
<th>Controls</th>
<th>Under anesthesia</th>
<th>Rise</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cholesterol</td>
<td>Glucose</td>
<td>Time (min)</td>
</tr>
<tr>
<td>1</td>
<td>91113</td>
<td>190</td>
<td>138</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>91029</td>
<td>160</td>
<td>105</td>
<td>65</td>
</tr>
<tr>
<td>3</td>
<td>91034</td>
<td>180</td>
<td>78</td>
<td>70</td>
</tr>
<tr>
<td>4</td>
<td>90335</td>
<td>187</td>
<td>87</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>91200</td>
<td>184</td>
<td>101</td>
<td>45</td>
</tr>
<tr>
<td>6</td>
<td>91180</td>
<td>173</td>
<td>105</td>
<td>65</td>
</tr>
<tr>
<td>7</td>
<td>91257</td>
<td>160</td>
<td>91</td>
<td>70</td>
</tr>
<tr>
<td>8</td>
<td>91426</td>
<td>150</td>
<td>97</td>
<td>65</td>
</tr>
<tr>
<td>9</td>
<td>91147</td>
<td>160</td>
<td>163</td>
<td>30</td>
</tr>
<tr>
<td>10</td>
<td>91498</td>
<td>185</td>
<td>114</td>
<td>40</td>
</tr>
<tr>
<td>11</td>
<td>91521</td>
<td>172</td>
<td>108</td>
<td>40</td>
</tr>
<tr>
<td>12</td>
<td>91576</td>
<td>190</td>
<td>121</td>
<td>50</td>
</tr>
<tr>
<td>13</td>
<td>91572</td>
<td>228</td>
<td>119</td>
<td>40</td>
</tr>
<tr>
<td>14</td>
<td>01850</td>
<td>176</td>
<td>105</td>
<td>22</td>
</tr>
<tr>
<td>15</td>
<td>91733</td>
<td>150</td>
<td>110</td>
<td>50</td>
</tr>
<tr>
<td>16</td>
<td>91734</td>
<td>180</td>
<td>116</td>
<td>35</td>
</tr>
<tr>
<td>17</td>
<td>91686</td>
<td>177</td>
<td>110</td>
<td>90</td>
</tr>
<tr>
<td>18</td>
<td>91761</td>
<td>162</td>
<td>120</td>
<td>90</td>
</tr>
</tbody>
</table>
### TABLE II.

**Blood Cholesterol during Ether Anesthesia. Mg. per 100 Cc. of Blood.**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Time. (min.)</td>
<td>Cholesterol.</td>
</tr>
<tr>
<td>1</td>
<td>92385</td>
<td>172</td>
<td>35</td>
<td>196</td>
</tr>
<tr>
<td>2</td>
<td>92440</td>
<td>160</td>
<td>35</td>
<td>190</td>
</tr>
<tr>
<td>3</td>
<td>92800</td>
<td>184</td>
<td>15</td>
<td>190</td>
</tr>
<tr>
<td>4</td>
<td>92565</td>
<td>182</td>
<td>52</td>
<td>221</td>
</tr>
<tr>
<td>5</td>
<td>92573</td>
<td>190</td>
<td>30</td>
<td>222</td>
</tr>
<tr>
<td>6</td>
<td>92590</td>
<td>176</td>
<td>50</td>
<td>211</td>
</tr>
<tr>
<td>7</td>
<td>92598</td>
<td>184</td>
<td>70</td>
<td>234</td>
</tr>
<tr>
<td>8</td>
<td>92577</td>
<td>200</td>
<td>55</td>
<td>240</td>
</tr>
<tr>
<td>9</td>
<td>92641</td>
<td>176</td>
<td>30</td>
<td>201</td>
</tr>
<tr>
<td>10</td>
<td>92634</td>
<td>180</td>
<td>35</td>
<td>208</td>
</tr>
<tr>
<td>11</td>
<td>92636</td>
<td>195</td>
<td>35</td>
<td>225</td>
</tr>
<tr>
<td>12</td>
<td>92665</td>
<td>175</td>
<td>25</td>
<td>200</td>
</tr>
<tr>
<td>13</td>
<td>92738</td>
<td>188</td>
<td>45</td>
<td>223</td>
</tr>
<tr>
<td>14</td>
<td>92705</td>
<td>100</td>
<td>40</td>
<td>215</td>
</tr>
<tr>
<td>15</td>
<td>92806</td>
<td>168</td>
<td>60</td>
<td>209</td>
</tr>
<tr>
<td>16</td>
<td>92839</td>
<td>170</td>
<td>60</td>
<td>215</td>
</tr>
<tr>
<td>17</td>
<td>92843</td>
<td>183</td>
<td>35</td>
<td>216</td>
</tr>
<tr>
<td>18</td>
<td>92928</td>
<td>170</td>
<td>45</td>
<td>210</td>
</tr>
<tr>
<td>19</td>
<td>92903</td>
<td>200</td>
<td>55</td>
<td>243</td>
</tr>
<tr>
<td>20</td>
<td>93021</td>
<td>180</td>
<td>30</td>
<td>220</td>
</tr>
<tr>
<td>21</td>
<td>93062</td>
<td>150</td>
<td>20</td>
<td>172</td>
</tr>
<tr>
<td>22</td>
<td>93104</td>
<td>193</td>
<td>30</td>
<td>218</td>
</tr>
<tr>
<td>23</td>
<td>93107</td>
<td>171</td>
<td>40</td>
<td>206</td>
</tr>
<tr>
<td>24</td>
<td>93130</td>
<td>175</td>
<td>20</td>
<td>193</td>
</tr>
<tr>
<td>25</td>
<td>93163</td>
<td>186</td>
<td>60</td>
<td>226</td>
</tr>
<tr>
<td>26</td>
<td>93175</td>
<td>160</td>
<td>30</td>
<td>186</td>
</tr>
<tr>
<td>27</td>
<td>93170</td>
<td>171</td>
<td>30</td>
<td>201</td>
</tr>
<tr>
<td>28</td>
<td>93212</td>
<td>184</td>
<td>30</td>
<td>214</td>
</tr>
<tr>
<td>29</td>
<td>93227</td>
<td>166</td>
<td>60</td>
<td>203</td>
</tr>
<tr>
<td>30</td>
<td>93208</td>
<td>142</td>
<td>50</td>
<td>185</td>
</tr>
<tr>
<td>31</td>
<td>93245</td>
<td>150</td>
<td>25</td>
<td>185</td>
</tr>
<tr>
<td>32</td>
<td>93235</td>
<td>187</td>
<td>40</td>
<td>227</td>
</tr>
<tr>
<td>33</td>
<td>93256</td>
<td>182</td>
<td>40</td>
<td>212</td>
</tr>
<tr>
<td>34</td>
<td>93300</td>
<td>171</td>
<td>30</td>
<td>200</td>
</tr>
<tr>
<td>35</td>
<td>93318</td>
<td>175</td>
<td>45</td>
<td>192</td>
</tr>
<tr>
<td>36</td>
<td>93321</td>
<td>169</td>
<td>30</td>
<td>194</td>
</tr>
<tr>
<td>37</td>
<td>93358</td>
<td>193</td>
<td>25</td>
<td>223</td>
</tr>
</tbody>
</table>
rise in cholesterol is progressive, without any intermediate levels or drops. This is shown in Table III in which some of the above cases are given in detail.

### TABLE III.

**Blood Cholesterol during Ether Anesthesia.** Mg. per 100 Cc. of Blood.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Time.</td>
<td>Cholesterol.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>min.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>92565</td>
<td>182</td>
<td>5</td>
<td>182</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12</td>
<td>187</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20</td>
<td>199</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>30</td>
<td>205</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>42</td>
<td>214</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>52</td>
<td>221</td>
</tr>
<tr>
<td>18</td>
<td>92928</td>
<td>170</td>
<td>3</td>
<td>169</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td>172</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>17</td>
<td>180</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>29</td>
<td>188</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>38</td>
<td>198</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>45</td>
<td>210</td>
</tr>
<tr>
<td>24</td>
<td>93130</td>
<td>175</td>
<td>5</td>
<td>175</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>180</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>20</td>
<td>193</td>
</tr>
<tr>
<td>29</td>
<td>93227</td>
<td>166</td>
<td>7</td>
<td>168</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>14</td>
<td>175</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>23</td>
<td>185</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>38</td>
<td>190</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>49</td>
<td>198</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>60</td>
<td>203</td>
</tr>
<tr>
<td>36</td>
<td>93321</td>
<td>169</td>
<td>5</td>
<td>169</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>172</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>16</td>
<td>180</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>30</td>
<td>194</td>
</tr>
</tbody>
</table>

The third group of cases, as shown in Table IV, was studied exactly as the first group, except that 10 units of insulin were given subcutaneously 2 hours before the induction of anesthesia. Blood cholesterol and glucose determinations were made during anesthe-
### TABLE IV.
Blood Cholesterol and Glucose during Ether Anesthesia, Insulin 2 Hours Preoperative. Mg. per 100 Cc. of Blood.

<table>
<thead>
<tr>
<th>Case</th>
<th>Hospital No.</th>
<th>Controls</th>
<th>Under anesthesia</th>
<th>Rise</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cholesterol</td>
<td>Glucose</td>
<td>Cholesterol</td>
</tr>
<tr>
<td></td>
<td></td>
<td>min.</td>
<td></td>
<td>min.</td>
</tr>
<tr>
<td>1</td>
<td>93359</td>
<td>194</td>
<td>100</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>93374</td>
<td>214</td>
<td>118</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>93434</td>
<td>186</td>
<td>97</td>
<td>80</td>
</tr>
<tr>
<td>4</td>
<td>93168</td>
<td>174</td>
<td>110</td>
<td>55</td>
</tr>
<tr>
<td>5</td>
<td>93455</td>
<td>200</td>
<td>89</td>
<td>15</td>
</tr>
<tr>
<td>6</td>
<td>93445</td>
<td>192</td>
<td>105</td>
<td>30</td>
</tr>
<tr>
<td>7</td>
<td>93471</td>
<td>166</td>
<td>90</td>
<td>30</td>
</tr>
<tr>
<td>8</td>
<td>93441</td>
<td>196</td>
<td>115</td>
<td>25</td>
</tr>
<tr>
<td>9</td>
<td>93517</td>
<td>208</td>
<td>109</td>
<td>30</td>
</tr>
<tr>
<td>10</td>
<td>93553</td>
<td>192</td>
<td>87</td>
<td>30</td>
</tr>
<tr>
<td>11</td>
<td>93551</td>
<td>180</td>
<td>102</td>
<td>30</td>
</tr>
<tr>
<td>12</td>
<td>93596</td>
<td>158</td>
<td>112</td>
<td>30</td>
</tr>
<tr>
<td>13</td>
<td>93614</td>
<td>177</td>
<td>100</td>
<td>80</td>
</tr>
<tr>
<td>14</td>
<td>93629</td>
<td>180</td>
<td>98</td>
<td>45</td>
</tr>
<tr>
<td>15</td>
<td>93689</td>
<td>218</td>
<td>105</td>
<td>30</td>
</tr>
<tr>
<td>16</td>
<td>93701</td>
<td>166</td>
<td>96</td>
<td>40</td>
</tr>
<tr>
<td>17</td>
<td>93722</td>
<td>200</td>
<td>110</td>
<td>50</td>
</tr>
<tr>
<td>18</td>
<td>93755</td>
<td>194</td>
<td>112</td>
<td>50</td>
</tr>
<tr>
<td>19</td>
<td>93838</td>
<td>174</td>
<td>89</td>
<td>40</td>
</tr>
<tr>
<td>20</td>
<td>93851</td>
<td>170</td>
<td>107</td>
<td>30</td>
</tr>
</tbody>
</table>

### TABLE V.
Blood Cholesterol and Glucose during Nitrous Oxide Anesthesia. Mg. per 100 Cc. of Blood.

<table>
<thead>
<tr>
<th>Case</th>
<th>Hospital No.</th>
<th>Controls</th>
<th>Under anesthesia</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Cholesterol</td>
<td>Glucose</td>
</tr>
<tr>
<td></td>
<td></td>
<td>min.</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>92394</td>
<td>193</td>
<td>97</td>
</tr>
<tr>
<td>2</td>
<td>92536</td>
<td>185</td>
<td>115</td>
</tr>
<tr>
<td>3</td>
<td>92494</td>
<td>203</td>
<td>120</td>
</tr>
<tr>
<td>4</td>
<td>92898</td>
<td>177</td>
<td>112</td>
</tr>
<tr>
<td>5</td>
<td>93371</td>
<td>190</td>
<td>105</td>
</tr>
</tbody>
</table>
sia and controlled as before. The figures in this group of cases show a small rise in glucose as compared to those cases receiving no insulin and a negligible rise in cholesterol within the limits of error in the methods of determination.

In order to determine the effect of nitrous oxide alone, several cases are shown in Table V studied in the same way as those in the first and second groups. These cases received only nitrous oxide and oxygen. The figures show no material change either in cholesterol or glucose.

**DISCUSSION.**

In this study patients receiving ether anesthesia show a rise in total blood cholesterol, which is proportional to the rise in blood glucose and the duration of anesthesia. Patients receiving insulin several hours before anesthesia show no material rise either in blood cholesterol or glucose. Nitrous oxide was used in the first few minutes of induction in all cases. It is shown to have no influence upon either blood cholesterol or glucose.

It appears that, in addition to the disturbance in glucose metabolism, there is a disturbance in the blood cholesterol during ether anesthesia which is related to the internal secretion of the pancreas. A deficiency or suppression of insulin during ether anesthesia leads to hypercholesterolemia and hyperglycemia. If this deficiency is provided for by giving insulin at a proper interval before anesthesia is begun, these changes in blood cholesterol and glucose do not occur. Ether therefore seems to influence blood cholesterol concentration through the medium of the pancreatic internal secretion in a way which does not occur in diabetes mellitus. In diabetes the rise in cholesterol occurs slowly and only in cases of severity and long standing and returns to normal very slowly long after blood glucose has reached the normal level (5). There is no uniform direct relation between the glucose and cholesterol in the blood of diabetics (6). In ether anesthesia, on the other hand, cholesterol runs parallel to glucose concentration and rises rapidly. Further, blood cholesterol in ether anesthesia is very readily influenced by insulin administration, but in diabetes cholesterol is not so sensitive to insulin administration. The relation of blood cholesterol changes to the pancreatic internal secretion in ether anesthesia appears to be very intimate.
CONCLUSIONS.

1. In ether anesthesia in man there is a definite rise in the total cholesterol content of the blood.

2. The rise in total blood cholesterol is roughly proportional to the rise in the blood glucose and the duration of anesthesia.

3. There is no material rise in blood cholesterol or glucose during ether anesthesia if insulin is administered several hours before anesthesia is begun.

4. The internal secretion of the pancreas is partially suppressed during ether anesthesia.

5. Insulin appears to be one of the factors controlling the cholesterol content of the blood and during ether anesthesia the relation is close.

BIBLIOGRAPHY.

BLOOD CHOLESTEROL DURING ETHER ANESTHESIA
Abraham Mahler


Access the most updated version of this article at http://www.jbc.org/content/69/2/653.citation

Alerts:
  • When this article is cited
  • When a correction for this article is posted

Click here to choose from all of JBC's e-mail alerts

This article cites 0 references, 0 of which can be accessed free at http://www.jbc.org/content/69/2/653.citation.full.html#ref-list-1