An Analysis of Coronary Flow and Related Factors Following Vagotomy, Atropine, and Sympathectomy

By J. C. Scott, Ph.D., and T. A. Balourdas, M.D.

Coronary blood flow in the dog has been measured by the nitrous oxide desaturation method before and after acute bilateral cervical vagotomy, intravenous injection of atropine, and chronic sympathectomy. Vagotomy and atropine markedly increased coronary flow, myocardial oxygen consumption, and heart rate, but decreased left ventricular efficiency. Chronic sympathectomy resulted in the following smaller but statistically significant changes: a decrease in coronary flow, myocardial oxygen consumption, and heart rate, but an increase in left ventricular efficiency.

Increasing the oxygen content of the arterial blood decreased the coronary flow. A comparison of diallylbarbiturate acid and urethane with morphine and chloralose anesthesia gave similar flow values, but cardiac efficiency was increased in the latter case.

An analysis of the relationships between coronary flow, left ventricular oxygen consumption, and the arteriovenous oxygen difference is presented.

MEASUREMENTS of coronary blood flow in man and in the dog have been made with increasing frequency in recent years, due to the application of the nitrous oxide method. The popularity of the method is based upon the fact that the measurements may be made under comparatively normal circulatory conditions and that the observations may be repeated at suitable intervals. However, a sufficient number of experiments to permit statistical analysis is often necessary.1 Despite certain disadvantages2 the method appears to be the most suitable one for studying the effects of experimental conditions where progressive changes are to be observed.

The experiments reported here were undertaken to study the effects on coronary flow of cardiac denervation by acute bilateral cervical vagotomy, intravenous injection of atropine, and chronic sympathectomy. The effects of these procedures were studied by Essex et al.,3 but their results have been questioned because the measurements were made with a thermostromuhr. As our study progressed it became apparent that the changes in the oxygen content of the arterial blood associated with the nitrous oxide method and the type of anesthetic employed were two important variables. Accordingly, we have evaluated the effects of inhalation of high oxygen-nitrous oxide mixtures and administration of chloralose versus diallylbarbituric acid and urethane anesthetic.

METHODS AND CALCULATIONS

Mongrel dogs weighing 17 to 22 Kg. were anesthetized with either diallylbarbituric acid and urethane pentobarbital or with morphine and chloralose. The nitrous oxide desaturation procedure, essentially as described by Goodale and Hackel4 was employed. In 25 experiments a commercially available gas mixture of 21 per cent oxygen, and 15 per cent nitrous oxide in nitrogen was used. Due to the comparatively low arterial blood oxygen values obtained with this mixture, succeeding experiments (approximately 100) were performed with a gas mixture containing no nitrogen. This was prepared at the time of each experiment by metering the oxygen and nitrous oxide into a Douglas bag. Unfortunately, this method did not produce a uniform concentration, so that the mixture varied from 15 to 20 per cent nitrous oxide in oxygen. The use of the high oxygen mixture necessitated a preliminary period of 45 to 60 minutes of breathing pure oxygen, in order to obtain complete denitrogenation. Cardiac output was determined by the direct Fick method, mixed venous blood being obtained from a catheter in the pulmonary artery. Blood pressure was measured...
FACTORS INFLUENCING CORONARY FLOW

Table 1.—Average Values of Coronary Flow and Related Factors

<table>
<thead>
<tr>
<th>Column</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drug</td>
<td>Atropine</td>
<td>Atropine</td>
<td>—</td>
<td>Atropine</td>
<td>—</td>
<td>Atropine</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>No. of cases</td>
<td>10</td>
<td>10</td>
<td>12</td>
<td>10</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>25</td>
<td>20</td>
<td>23</td>
</tr>
<tr>
<td>CBF</td>
<td>123 ± 9.0</td>
<td>137 ± 13</td>
<td>108 ± 7.0</td>
<td>56.5 ± 5.4</td>
<td>94.3</td>
<td>44.7</td>
<td>108</td>
<td>65.7 ± 4.9</td>
<td>64.8 ± 2.9</td>
<td>79.8 ± 4.9</td>
</tr>
<tr>
<td>C SS</td>
<td>6.71</td>
<td>7.14</td>
<td>5.01</td>
<td>5.79</td>
<td>7.13</td>
<td>5.03</td>
<td>6.82</td>
<td>6.54</td>
<td>6.09</td>
<td>3.73</td>
</tr>
<tr>
<td>Cor. A-V O2</td>
<td>13.3 ± 1.57</td>
<td>12.5 ± 1.5</td>
<td>14.5 ± 1.1</td>
<td>13.6 ± 0.48</td>
<td>12.27</td>
<td>16.68</td>
<td>14.08</td>
<td>13.5 ± 0.48</td>
<td>15.7 ± 3.7</td>
<td>12.9 ± 4.3</td>
</tr>
<tr>
<td>L.V. O2 cons.</td>
<td>16.4 ± 1.5</td>
<td>16.9 ± 1.6</td>
<td>16.0 ± 0.97</td>
<td>7.46 ± 0.49</td>
<td>11.68</td>
<td>7.65</td>
<td>14.86</td>
<td>8.96 ± 0.79</td>
<td>10.2 ± 0.64</td>
<td>10.4 ± 0.63</td>
</tr>
<tr>
<td>MAV</td>
<td>99.4 ± 3.8</td>
<td>138 ± 7.1</td>
<td>139 ± 5.6</td>
<td>99.6 ± 5.0</td>
<td>103</td>
<td>112.3</td>
<td>133.3</td>
<td>116 ± 2.6</td>
<td>108 ± 2.7</td>
<td>97.0 ± 8.0</td>
</tr>
<tr>
<td>CVR</td>
<td>0.846 ± 0.14</td>
<td>1.02 ± 0.07</td>
<td>1.34 ± 0.09</td>
<td>1.89 ± 0.20</td>
<td>1.14</td>
<td>2.67</td>
<td>1.20</td>
<td>1.95 ± 0.10</td>
<td>1.77 ± 0.12</td>
<td>1.34 ± 0.09</td>
</tr>
<tr>
<td>Heart rate</td>
<td>192 ± 15</td>
<td>172 ± 14</td>
<td>184 ± 9.0</td>
<td>81.7 ± 9.4</td>
<td>140</td>
<td>49.0</td>
<td>204</td>
<td>68.9 ± 5.6</td>
<td>96.4 ± 12</td>
<td>98.0 ± 8.7</td>
</tr>
<tr>
<td>L.V. work</td>
<td>21.1 ± 21</td>
<td>3.53 ± 44</td>
<td>3.70 ± 19</td>
<td>2.58 ± 21</td>
<td>2.14</td>
<td>2.67</td>
<td>2.97</td>
<td>2.41 ± 25</td>
<td>2.44 ± 18</td>
<td>2.80 ± 47</td>
</tr>
<tr>
<td>L.V. eff.</td>
<td>8.3</td>
<td>13.01</td>
<td>11.34</td>
<td>19.9</td>
<td>9.93</td>
<td>20.63</td>
<td>11.1</td>
<td>17.66</td>
<td>15.8</td>
<td>16.6</td>
</tr>
<tr>
<td>CI</td>
<td>2.14</td>
<td>2.71</td>
<td>2.14</td>
<td>2.54</td>
<td>2.22</td>
<td>2.53</td>
<td>2.23</td>
<td>2.20</td>
<td>2.21</td>
<td>2.86</td>
</tr>
</tbody>
</table>

*All values were obtained with the dog breathing 15 to 20 per cent nitrous oxide in oxygen, except those given in column 10, where the standard mixture 21 per cent of oxygen, 15% nitrous oxide in nitrogen was employed.

± = standard error of the mean. Dial. ureth. = Dial-Urethane pentobarbital sodium anesthesia. Chloralose = chloralose morphine anesthesia. Atropine = atropine sulfate intravenously. Acute B vag. = acute bilateral section of cervical vagosympathetic trunk. Chronic sympa. = chronic sympathectomy. BCF = coronary blood flow (ml/100 Gm/min.). MAV = arterial blood pressure (mm. Hg). CVR = coronary vascular resistance = MAPB/CBF. L.V. work = left ventricular work (Kg. M./min.). L.V. eff. = left ventricular efficiency (%).

CI = cardiac index.

in the femoral or iliac artery with a Lilly manometer. Oxygen consumption was determined with a closed circuit spirometer. Blood gases were measured by methods described by Kety.5 Sympathectomy was performed in two steps, the sympathetic chain from the middle cervical ganglion to T VI or T VII being removed on one side at a time. Measurements of the effect of sympathectomy were made from three to six weeks after the second step.

Atropine sulfate was given intravenously, 0.2 mg./Kg. Coronary flow and related measurements were made before and after 10 minutes after the administration of atropine. Acute bilateral cervical vagotomy was performed and the measurements were made before and shortly after atropine. In all experiments the animals breathed through a tracheal catheter sealed by a rubber cuff.

Cardiac index was calculated by dividing the cardiac output by the surface area, and the latter was estimated by the formula:1 Surface area = body weight (Kg.) 2/3. Coronary vascular resistance was calculated by dividing the mean arterial blood pressure in mm. Hg by the coronary flow in ml./100 Gm. left ventricle/min.

Left ventricular weight at autopspy was determined by a modification of the method of Herman.3 Left ventricular efficiency was calculated by dividing the work, expressed as kilogram meters per minute, by the total left ventricular oxygen consumption converted to equivalent kilogram meters per minute. In dogs which were not killed at the end of the experiment, the weight of the left ventricle was estimated by multiplying the body weight by 0.0043, the ratio of weight of the left ventricle to body weight obtained in our series of dogs. Although this value differs slightly from the 0.0049 reported by Goodale,4 it was thought to represent more accurately our own experimental group of animals. The error in calculation is constant in experiments in which double runs were done on the same day (atropine and vagotomy). In the chronic sympathectomy experiments in
TABLE 2.—Average Oxygen Content of Arterial Blood in the Dog with Nitrous Oxide Method

<table>
<thead>
<tr>
<th>Authors</th>
<th>No. of dogs</th>
<th>Vol. (%</th>
<th>Anesthesia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foltz et al.</td>
<td>47</td>
<td>16.72</td>
<td>Nembutal, pentobarbital</td>
</tr>
<tr>
<td>Goodale et al.</td>
<td>22</td>
<td>17.1</td>
<td>Dial-Urethane, pentobarbital</td>
</tr>
<tr>
<td>Spencer et al.</td>
<td>12</td>
<td>16.62</td>
<td>Nembutal</td>
</tr>
<tr>
<td>Balourdas and Scott</td>
<td>27</td>
<td>16.66</td>
<td>Dial-Urethane, pentobarbital</td>
</tr>
<tr>
<td>Balourdas and Scott</td>
<td>23</td>
<td>21.74*</td>
<td>Dial-Urethane, pentobarbital</td>
</tr>
</tbody>
</table>

*Using 15 to 20 per cent nitrous oxide in oxygen.

which observations were made several weeks apart, all of the dogs gained weight and showed an apparent increase in myocardial efficiency in spite of the fact that the weight factor in the denominator of the equation would tend to decrease the value. Since errors in weighing or predicting the weight of the left ventricle cannot be evaluated, and the area drained by the coronary sinus is variable, estimates of efficiency are presented here only to indicate the direction of change.

RESULTS

The results of 119 experiments are summarized in table 1, which consists of the mean values and the standard error (±) of the measured or calculated factors. With the exception of column 10, all of the data were obtained with the dog breathing a gas mixture of 15 to 20 per cent nitrous oxide in oxygen. The data of column 10 were obtained with the standard gas mixture of 21 per cent oxygen, 15 per cent nitrous oxide in nitrogen. Although the nitrous oxide concentrations were not identical in the two mixtures, the blood values for nitrous oxide at the end of the 15 minute breathing period were sufficiently close to minimize the possibility of this gas, having a specific effect upon the coronary flow. The mean and the range of blood nitrous oxide concentrations and coronary flow revealed no apparent correlation. The influence of the several procedures with either anesthetic may be noted by comparing the values in the appropriate column. The more conspicuous effects are summarized as follows.

Acute Bilateral Vagotomy (Column 3 with column 8). This procedure increased to a marked degree coronary blood flow, left ventricular oxygen consumption, and heart rate, but decreased coronary resistance and left ventricular efficiency.

Atropine (Columns 1 and 2 with 9 and 8). The effects of atropine were quite similar to those of vagotomy, with an even greater increase in coronary blood flow. The characteristics of chloralose anesthesia in the normal dog persisted under atropine, i.e., mean blood pressure, resistance, and ventricular efficiency were somewhat higher than with diallylbarbituric acid and urethane, while the heart rate was lower.

Chronic Sympathectomy (Columns 4 and 9, 6 and 8). The most prominent effects of this procedure were reduction of coronary blood flow, left ventricular oxygen consumption, arteriovenous oxygen difference and heart rate. Left ventricular efficiency was increased. These effects were more marked with chloralose anesthesia, but the number of cases is small.

Variation in Blood Oxygen Content (Columns 9 and 10). The lower arterial and venous oxygen values resulted in a greater coronary blood flow and cardiac index. The arteriovenous oxygen difference and resistance were reduced. Table 2 indicates that the standard nitrous oxide mixture commonly employed gives a relatively low arterial blood oxygen content regardless of the anesthetic which is used.

Chloralose versus Diallylbarbituric Acid and Urethane Anesthesia. Coronary flow and cardiac index were essentially the same but they were maintained with a lower ventricular oxygen consumption, arteriovenous oxygen difference, and heart rate, with chloralose anesthesia. Accordingly, ventricular efficiency was greater.
FACTORS INFLUENCING CORONARY FLOW

Table 3.—Significance of Difference in Mean Values of Table 1*

<table>
<thead>
<tr>
<th>Column 9-10</th>
<th>9-1</th>
<th>9-4</th>
<th>8-2</th>
<th>9-8</th>
<th>3-2</th>
<th>8-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comparison of 2 procedures</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% change</td>
<td>+23</td>
<td>+90</td>
<td>-13</td>
<td>+108</td>
<td>+1.4</td>
<td>+27</td>
</tr>
<tr>
<td>P (_x_i - x_j)</td>
<td>0.03 &lt;0.001</td>
<td>0.05 &lt;0.001</td>
<td>0.5 &gt;0.05</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% change Cor. A-V O(_2)</td>
<td>-18</td>
<td>-15</td>
<td>-13</td>
<td>-14</td>
<td>-14</td>
<td>7</td>
</tr>
<tr>
<td>P (_x_i - x_j)</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
<td>0.2</td>
<td>&lt;0.001</td>
<td>0.15</td>
</tr>
<tr>
<td>% change L.V. O(_2) consumption</td>
<td>+1.96</td>
<td>+61</td>
<td>-27</td>
<td>+89</td>
<td>-12</td>
<td>+5.5</td>
</tr>
<tr>
<td>P (_x_i - x_j)</td>
<td>&gt;0.50</td>
<td>&lt;0.001</td>
<td>0.005 &lt;0.001</td>
<td>0.30</td>
<td>0.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>% change MAPB</td>
<td>-10.2</td>
<td>-8</td>
<td>-7.8</td>
<td>+15</td>
<td>+7.4</td>
<td>+4.3</td>
</tr>
<tr>
<td>P (_x_i - x_j)</td>
<td>0.30</td>
<td>0.75</td>
<td>0.12</td>
<td>0.0075</td>
<td>0.04</td>
<td>0.5</td>
</tr>
<tr>
<td>% change CVR</td>
<td>-24</td>
<td>-52</td>
<td>+6</td>
<td>-48</td>
<td>+10</td>
<td>-24</td>
</tr>
<tr>
<td>P (_x_i - x_j)</td>
<td>0.02</td>
<td>&lt;0.001</td>
<td>0.50</td>
<td>&lt;0.001</td>
<td>0.25</td>
<td>0.01</td>
</tr>
<tr>
<td>% change Heart rate</td>
<td>+2.73</td>
<td>+100</td>
<td>-14</td>
<td>+150</td>
<td>-27.8</td>
<td>-6.5</td>
</tr>
<tr>
<td>P (_x_i - x_j)</td>
<td>&gt;0.5</td>
<td>&lt;0.001</td>
<td>0.5</td>
<td>&lt;0.001</td>
<td>0.04</td>
<td>0.5</td>
</tr>
</tbody>
</table>

*Classification is based on changes in coronary flow relative to L.V. oxygen consumption. P \(_x_i - x_j\) = probability that difference of means has occurred by change. Abbreviations are the same as table 1.

Discussion

Effects of Vagotomy or Atropine. The increased coronary flow and heart rate associated with the administration of atropine or bilateral cervical vagotomy conform very closely to the results obtained by Essex and co-workers, and thus confirm qualitatively the accuracy of the thermostromuhr as used by these workers. It is important to note that the increased flow is accompanied by a proportionally greater increase in myocardial oxygen consumption so that the efficiency of the left ventricle is decreased. The increased heart rate with atropine was always associated with an increase in the oxygen content of the coronary sinus blood.

Effects of Sympathectomy. The reduction in coronary blood flow but the increase in cardiac efficiency of the chronic sympathectomized animals are in striking contrast to the effects of vagotomy. In both groups the coronary blood flow and oxygen consumption follow the heart rate, and this may be the dominant variable. Although the changes in flow and oxygen consumption are relatively small their p values (table 3) would suggest that the direction
of change is indicated correctly. Essex et al. reported no effects from sympathectomy. It is difficult to say whether this discrepancy is due to the inadequacies of the thermostromuhr or to the fact that our sympathectomy was more extensive and that our observations were made over a longer period of time postoperatively.

Variation in Blood Oxygen Content. The low oxygen content of the blood, particularly of the coronary sinus, would indicate that a relative hypoxia was associated with the standard nitrous oxide mixture. The per cent saturation of the hemoglobin for this series was not determined, so that a distinction between the anoxic and anemic types of anoxia cannot be made. Wide variations in hemoglobin from dog to dog or in the same dog from day to day have been reported. Almost complete saturation of hemoglobin must have been present in the other series, since these animals were breathing pure oxygen followed by a period of breathing 15 to 20 per cent nitrous oxide in oxygen. It is of interest to note that the lower oxygen series showed an increase in cardiac index as well as coronary blood flow and that the percentage change was almost identical in each case.

The significant difference in coronary blood flow when a high oxygen mixture is used justifies the suspicion that mild hypoxia may mask some of the variables determining coronary flow in many of the experimental procedures that have been employed in the past. A linear correlation between the coefficient of oxygen utilization and the arterial oxygen saturation or oxygen content has been reported. Although the interpretation of this relationship might be questioned on statistical grounds, there is no question about the importance of maintaining a high arterial blood oxygen during experimental studies of the factors regulating coronary flow.

Chloralose versus Diallylbarbituric Acid and Vrethane Anesthesia. The average value of coronary flow in the dog appears to depend in part on the type of anesthetic employed. Because the barbiturates are known to depress the vagus, it was decided to compare the effects of diallylbarbituric acid and urethane with chloralose. The latter was chosen because of its well-known ability to maintain or even enhance reflex activity, particularly of the carotid sinus. Although the average flow was the same with the two anesthetics, chloralose is preferable in view of the increased efficiency demonstrated in several of the procedures listed in table 1.

The Relation of Arteriovenous Oxygen Difference to Coronary Blood Flow and to Left Ventricular Oxygen Consumption. In a recent review article, Gregg and Sabiston have emphasized the importance of relating the coronary arteriovenous oxygen difference to coronary blood flow (CBF). They have suggested that the increased flow associated with a decreased A-V O₂ which is brought about by changes in extra vascular compression or from the effect of substances acting upon the coronary vessels should be called passive or benign dilatation. On the other hand when the increased flow is associated with an increased A-V O₂, as in conditions of stress, the oxygen supply to the heart is relatively expensive and the dilatation may be termed the malignant type.

An examination of the relationship between CBF, A-V O₂, and oxygen consumption of the myocardium clearly shows that the effect of flow upon A-V O₂ can be demonstrated only if changes in flow are stated relative to the oxygen consumption. This is true because

\[
\text{CBF} = \frac{\text{Oxygen consumption}}{\text{A-V } O_2}
\]

Therefore

\[
\text{A-V } O_2 = \frac{\text{Oxygen consumption}}{\text{CBF}}
\]

It now becomes apparent that any increase in CBF relative to oxygen consumption must result in a decrease in coronary A-V O₂. The possible combinations thus decreasing A-V O₂ are, class 1:

\[
(a) + \quad (b) 0 \quad (c) - \quad (d) - \quad (e) -
\]

\[
+ + \quad + + \quad + 0 \quad +
\]

\[
\text{Oxygen consumption} \quad \text{CBF}
\]

where +, −, and 0 represent increase, decrease and no change respectively, and the double sign means more intense change.
Conversely any decrease in coronary flow relative to oxygen consumption must result in an increase in A-V O₂, and the opposite combinations are, class 2:

\[
\begin{align*}
\text{(a) } & \quad 0 \\
\text{(b) } & \quad + \\
\text{(c) } & \quad 0 \\
\text{(d) } & \quad + \\
\text{(e) } & \quad + \\
\end{align*}
\]

\[
\frac{\text{Oxygen consumption}}{\text{CBF}}
\]

Class 1 (a) to (e) might be compared to the benign dilatation, and class 2 (a) to (e) be compared to the malignant dilatation types of Greeg and Sabiston. An analysis of our data in terms of this classification may be made from table 3. In this table the comparison of two experimental states is made in terms of the percentage change of the several variables. The \( p \) value for the significance of the difference is also listed. It should be noted that only one of the comparisons listed falls in class 2. If an increase in the A-V O₂ value is accepted as evidence of stress on the myocardium, it would appear that acute bilateral cervical vagotomy falls in this category, while the other procedures such as administration of atropine or sympathectomy are situations to which the heart adjusts its blood flow by increasing the coronary flow more than the oxygen consumption, and hence decreases the A-V O₂. Table 3 also lists the calculated coronary resistance and the percentage change. All of the changes in resistance which are statistically significant show a decrease which may be interpreted as indicative of coronary vasodilatation.

The data reported here emphasize some of the variables which may influence coronary blood flow values when the nitrous oxide method is used. They neither deny nor affirm the suggested vasomotor role of the extrinsic nerve supply to the heart. Of the several variables considered, the heart rate appears to be closely associated with coronary blood flow and myocardial oxygen consumption. A statistical analysis of these and other factors will be presented elsewhere.11

**Summary**

The removal of cardiac vagal control by either surgical section or intravenous injection of atropine markedly increases coronary blood flow and myocardial oxygen consumption but decreases ventricular efficiency. These responses are closely associated with a great increase in heart rate. Sympathectomy produces changes in the opposite direction, i.e., flow and oxygen consumption are decreased but efficiency is increased. The heart rate is decreased.

The evidence presented indicates that an enriched oxygen-nitrous oxide rebreathing mixture prevents a mild degree of hypoxia which has been present in most of the published experimental data, and that this hypoxia is associated with an increased coronary blood flow. Chloralose anesthetic is preferable to diallylbarbituric acid and urethane, as a greater left ventricular efficiency is observed in the former case. With the variations in experimental procedure reported in this paper an increased coronary flow is usually associated with a decrease in coronary arteriovenous oxygen difference. Only in the case of acute bilateral vagotomy did the arteriovenous oxygen difference increase with increasing flow. The effect of coronary flow upon coronary arteriovenous oxygen difference can only be stated if the changes in flow are considered in relation to the myocardial oxygen consumption.

**Summario in Interlingua**

Le elimination del governamento vagal super le corde—sia per section chirurgic, sia per injection intravenose de atropina—aumenta marcatemente le fluxo de sanguine coronari e le consumption myocardial de oxygeno sed reduce le efficacia ventricular. Iste responsas es intimemente associate con un forte augmento del frequentia cardiac. Sympathectomia produce alterationes in le direction contrari: Le fluxo e le consumption de oxygeno es reduceite.

Le datos hic presentate indica que le inricchimento del oxygeno in le mixtura de re-respiration a contento de oxydo nitrose preveni le leve grado de hypoxia que es mentionate in le majoritate del publicaciones de datos experimental e, in plus, que ille hypoxia es associate con un augmento del fluxo de sanguine coronari. Anesthesia a chloralose es preferibile al uso de Dial-Urethano proque illo resulta in un plus grande efficacia sinistro-
ventricular. Es reportate variationes de technica experimental que ha resultate in le observation que un augmentate fluxo coronari es usualmente associate con un reduction del differentia arterio-venose in le oxygeno del sanguine coronari. Il eseva solmente in le caso de acute vagotomia bilateral que le differentia arterio-venose de oxygeno se augmentava con un augmento del fluxo. Le effet del fluxo coronari super le differentia arterio-venose del oxygeno in le sanguine coronari pote esser establite solmente si le alterationes del fluxo es considerate in relation al consumption myocardial de oxygeno.

REFERENCES
An Analysis of Coronary Flow and Related Factors Following Vagotomy, Atropine, and Sympathectomy

J. C. SCOTT and T. A. BALOURDAS

Circ Res. 1959;7:162-168
doi: 10.1161/01.RES.7.2.162

Circulation Research is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 1959 American Heart Association, Inc. All rights reserved.
Print ISSN: 0009-7330. Online ISSN: 1524-4571

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://circres.ahajournals.org/content/7/2/162