EFFECT OF ATROPINE ON PULMONARY DIFFUSING CAPACITY IN MAN

BY

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SUMMARY

Pulmonary diffusing capacity was measured in eighteen subjects on twenty-one occasions. On fourteen occasions, atropine was administered, and the DL three-quarters of an hour later fell significantly. Seven pairs of observations at intervals of three-quarters of an hour, without the intervening administration of atropine, showed no significant change in DL. It is concluded that the administration of atropine, in the circumstances of these observations, causes a significant fall in DL. It is suggested that this fall cannot be adequately explained on the basis of an increased respiratory deadspace, but is compatible with a shift of blood out of the lungs.

The effect of atropine in therapeutic doses on respiratory function is not well known. Grollman (1962) states that its only effect is to relax the bronchi, and that the respiratory centre is unaffected. Severinghaus and Stupfel (1955) found an increase in anatomical deadspace after atropine, and interpreted this change as evidence for the effect of atropine on normal bronchomotor tone. Daly, Ross and Behnke (1963) found that 2 mg of atropine given intravenously to normal volunteers produced a fall in diffusing capacity (DL), and concluded that atropine causes a shift of blood out of the lungs. In the present study atropine was given in a dose and by a route which are commonly used clinically, and the effect on normal volunteers was observed.

METHODS

Material.
The subjects were seven male and eleven female members of the hospital staff, aged 18–46 years, who gave no history of cardiac, respiratory, or other serious disease.

Procedure.
DL was measured by a modification (Rotman and Woolf, 1963) of Bates’ end-tidal sampling technique (Bates, Boucot and Dormer, 1955), with the subject in the sitting position. In this modification, the DCOI formula is used for those subjects who have a tidal volume of 700 ml or more, and the DCOII formula for those with a tidal volume less than 700 ml (see appendix). In one series of fourteen experiments, DL was determined before, and then again three-quarters of an hour after, the intramuscular injection of 0.6 mg of atropine sulphate. This injection made the subject’s mouth distinctly but not uncomfortably dry. No attempt was made to restrict the subjects’ activities between the determinations.

In a series of seven control experiments, two determinations of DL were made, three-quarters of an hour apart, but without the intervening administration of atropine.

RESULTS

After atropine was given, DL fell by an average of 4.96 ml/min/mm Hg (Standard Error (SE) of mean difference = 1.05) (table I). This is statistically significant (P<0.001). In those pairs of determinations in which no atropine was administered, DL was higher in the second of the pair, by an average of 0.54 ml/min/mm Hg (SE of mean difference = 0.59) (table II). This is not significant (P>0.05).

DISCUSSION

The investigation was undertaken to determine whether a therapeutic dose of atropine has any effect on the pulmonary diffusing capacity. The DL after atropine fell significantly (P<0.001), although the magnitude of the fall varied greatly from subject to subject. An increase in respiratory deadspace, which has been shown to occur with atropine (Higgins and Means, 1915; Severinghaus
EFFECT OF ATROPINE ON PULMONARY DIFFUSING CAPACITY IN MAN

TABLE I

Difference between diffusing capacities before, and three-quarters of an hour after, atropine 0.6 mg by intramuscular injection.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Before atropine</th>
<th>After atropine</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>V</td>
<td>VT</td>
<td>DL</td>
</tr>
<tr>
<td>T.F.</td>
<td>9.08</td>
<td>753</td>
<td>29.2</td>
</tr>
<tr>
<td>J.G.</td>
<td>13.2</td>
<td>1320</td>
<td>28.6</td>
</tr>
<tr>
<td>J.R.</td>
<td>12.3</td>
<td>725</td>
<td>39.2</td>
</tr>
<tr>
<td>J.T.</td>
<td>11.4</td>
<td>1900</td>
<td>31.2</td>
</tr>
<tr>
<td>F.Mc.</td>
<td>16.68</td>
<td>596</td>
<td>25.1</td>
</tr>
<tr>
<td>B.B</td>
<td>22.2</td>
<td>718</td>
<td>21.2</td>
</tr>
<tr>
<td>L.T.</td>
<td>22.8</td>
<td>813</td>
<td>22.2</td>
</tr>
<tr>
<td>F.M.</td>
<td>8.97</td>
<td>448</td>
<td>30.5</td>
</tr>
<tr>
<td>A.S.</td>
<td>8.12</td>
<td>812</td>
<td>16.9</td>
</tr>
<tr>
<td>D.H.</td>
<td>6.16</td>
<td>385</td>
<td>15.7</td>
</tr>
<tr>
<td>M.G.</td>
<td>10.58</td>
<td>482</td>
<td>20.2</td>
</tr>
<tr>
<td>V.P.</td>
<td>10.38</td>
<td>798</td>
<td>26.9</td>
</tr>
<tr>
<td>V.S.</td>
<td>12.8</td>
<td>712</td>
<td>29.4</td>
</tr>
<tr>
<td>S.H.</td>
<td>18.9</td>
<td>996</td>
<td>26.2</td>
</tr>
</tbody>
</table>

Mean difference = 4.96
SE = 1.05
P < 0.001

V = ventilation (l./min BTPS).
VT = tidal volume (ml).
DL = pulmonary diffusing capacity (ml/min/mm Hg).

TABLE II

Difference between pulmonary diffusing capacities determined about three-quarters of an hour apart.

<table>
<thead>
<tr>
<th>Subject</th>
<th>DL1</th>
<th>DL2</th>
<th>Difference DL1 minus DL2</th>
</tr>
</thead>
<tbody>
<tr>
<td>M.R.</td>
<td>21.7</td>
<td>21.3</td>
<td>0.4</td>
</tr>
<tr>
<td>J.G.</td>
<td>23.8</td>
<td>27.4</td>
<td>-3.6</td>
</tr>
<tr>
<td>R.P.</td>
<td>20.9</td>
<td>20.8</td>
<td>0.1</td>
</tr>
<tr>
<td>T.F.</td>
<td>27.2</td>
<td>25.8</td>
<td>1.4</td>
</tr>
<tr>
<td>J.T.</td>
<td>32.1</td>
<td>33.0</td>
<td>-0.9</td>
</tr>
<tr>
<td>M.D.</td>
<td>19.8</td>
<td>20.4</td>
<td>-0.6</td>
</tr>
<tr>
<td>J.L.</td>
<td>18.9</td>
<td>19.5</td>
<td>-0.6</td>
</tr>
</tbody>
</table>

Mean difference = 0.54
SE = 0.59
P > 0.5

and Stupfel, 1955; Daly, Ross and Behnke, 1963), if neglected in the calculation of the DCOI formula would result in a small drop in DL, but, using the DCOII formula an increase in deadspace of 60 ml has been shown not to alter DL (Bates, Boucot and Dormer, 1955). A change of even this magnitude was not observed by any of the authors. In the present investigation, all the subjects showed a fall in DL after atropine, irrespective of their tidal volume and of the corresponding calculation formula used. The fall, therefore, cannot be accounted for on the basis of an increase in deadspace alone, but is probably due to the shift of blood out of the lungs and diminished pulmonary capillary blood volume, which Daly, Ross and Behnke (1963) have described.

APPENDIX

DCOI = \( \frac{V_T (V_T - V_D) \times R (F_I - F_E)}{(F_E \times V_T - F_I, V_D) \times (P - 47)} \)

DCOII = \( \frac{(V_I \times F_I) - (0.97 \times V_E \times F_E)}{(P - 47) \times (0.945 \times F_E)} \)

V_T = Tidal volume.
V_D = Assumed deadspace, calculated as subject's weight in pounds expressed as ml plus instrumental deadspace (Radford, Ferris and Kriete, 1954).
V_I = Inspired minute volume.
V_E = Expired minute volume.
R = Respiratory rate.
F_I = Concentration of inspired carbon monoxide.
F_E = Concentration of mixed expired carbon monoxide.
F_E = Concentration of end-tidal carbon monoxide.
P = Barometric pressure.
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REFERENCES


BRITISH JOURNAL OF ANAESTHESIA

L'EFFET DE L'ATROPINE SUR LA CAPACITÉ DE DIFFUSION DANS LE POUMON CHEZ L'HOMME

SOMMAIRE

La capacité de diffusion dans le poumon a été mesurée chez dix-huit sujets par vingt et un expériences. De l'atropine fut administrée pendant quatorze de ces dernières. Quarante-cinq minutes plus tard la DL diminua de façon notable. Sept observations couplées relevées à des intervalles de quarante-cinq minutes—sans nouvelle administration d'atropine—ne montrèrent aucune modification notable de la DL. L'auteur en tire la conclusion que l'administration d'atropine provoque, dans des conditions dans lesquelles eurent lieu les expériences, un abaissement notable de la DL et que cette chute ne peut être expliquée comme conséquence d'une augmentation de l'espace respiratoire mort, mais qu'elle serait compatible avec un déplacement du sang hors des poumons.

AUSWIRKUNGEN VON ATROPIN AUF DIE LUNGENDIFFUSIONS-KAPAZITÄT BEIM MENSCHEN

ZUSAMMENFASSUNG