ANTISPASMODIC EFFECTS OF SOME IRANIAN MEDICINAL PLANTS

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ABSTRACT

Alcoholic and water extracts of many medicinal plants are commonly used in German folk medicine and other countries as antispasmodics. However, so far no data on dose relationships or comparisons of the antispasmodic effects with reference substances have been available for most of these plant extracts. Using acetylcholine as the stimulating agent, the antispasmodic effect of preparations of Mentha piperita (leaves), Citrus aurantium (peels), Foeniculum vulgare (fruits) and Carum carvi (fruits), consisting of one part of the plant and three and one half parts ethanol (31% w/w) was investigated on isolated guinea pig ileum and the results were compared with that of atropine. All the extracts shifted the dose-response curves of acetylcholine to the right in a dose-dependent manner and also showed a significant increase of the ED₅₀ and the dose ratios of acetylcholine-induced contractions, and a significant decrease of the maximal possible contractility. When the antispasmodic activities of M. piperita and C. aurantium were compared with the activity of atropine, it was evident that their effects were less than that of the usual therapeutic dose of atropine in man. But when the antispasmodic activities of F. vulgare and C. carvi were compared with the activity of atropine, it was found that their effects were slightly greater than that of the usual dose of atropine.

INTRODUCTION

It has been known that atropine has an antispasmodic effect both in vivo and in vitro on most types of smooth muscle. But occurrence of side effects and many contraindications of this drug have limited its use as a safe therapeutic agent. Alcoholic and water extracts of many medicinal plants are commonly used in German folk medicine and other countries as antispasmodics. In experimental animals, chamomile, peppermint, caraway, melissa and fennel have been shown to have antispasmodic activity. However, so far no data on dose relationships and comparisons of the antispasmodic effects with reference substances have been available for most of these plant extracts. Using acetylcholine as the stimulating agent, we investigated the antispasmodic effect of M. piperita (leaves), C. aurantium (peels), F. vulgare (fruits) and C. carvi (fruits) on isolated guinea pig ileum and compared their results with the antispasmodic effect of atropine.

MATERIALS AND METHODS

Chemicals

Acetylcholine chloride and atropine sulfate were used as bases.

Plants

M. piperita (leaves), C. aurantium sp. amara
Antispasmodic Iranian Medicinal Plants

The quality of the four Iranian plants used was equal to that in the German pharmacopeia, 6th edition. One part of the chopped, dried plant was extracted with 3.5 parts of ethanol (31% w/w) in a percolator according to Extracta Fluida in the German pharmacopeia, 6th edition. The alcohol concentration of all extracts used in the experiments was 30%.

Animals

Male albino guinea pigs weighing 300 to 400 g were used in all experiments. The animals were equally divided into five groups as follows:
1. Atropine-exposed group.
2. *M. piperita*-exposed group.
3. *C. aurantium*-exposed group.
4. *F. vulgare*-exposed group.
5. *C. carvi*-exposed group.

The animals were sacrificed by a blow on the head. The ileum was removed and cleansed, and the preparation was then suspended in a 10 ml organ bath containing aerated Tyrode solution. The temperature of the bath was maintained at 37°C. Solutions of the drugs were added to the bath and the drug-induced effects on the tissue were recorded by kymograph.

Procedure

The procedure used was similar to that described by Caddum and Picarelli. The antispasmodic effects of atropine and plant extracts has been measured in terms of dose-ratio. The concentration of the various doses of atropine and plant extracts was maintained in the bath by adding the drug and plant extracts to one of the reservoirs from which the bath could be refilled. In order to avoid errors due to the persistence of effects, a separate ileum preparation was used for each experi-

Figure 1 Dose-response curves of acetylcholine-induced contractions of the isolated guinea pig ileum in the absence (O) and in the presence of 10 ml (X) and 20 ml (O) of (A) *Mentha piperita* and (B) *Citrus aurantium*; and 7.5 ml (X) and 10 ml (O) of (C) *Foeniculum vulgare* and (D) *Carum carvi*.
Figure 2. Dose-response curves of acetylcholine-induced contractions of the isolated guinea pig ileum in the absence (O) and in the presence of 1 ug/l (X), 5 ug/l (O) and 10 ug/l (A) of atropine.

Table 1. Effect of medicinal plant extracts on acetylcholine-induced contractions of the isolated guinea pig ileum. Results are expressed as ED₉₀ and dose ratios of acetylcholine (ug/ml) in the presence and absence of plant extracts, and as maximal possible contraction in response to acetylcholine.

<table>
<thead>
<tr>
<th>Extracts</th>
<th>m/l</th>
<th>No *</th>
<th>Aver. ED₉₀ of acetylcholine in ug with extracts</th>
<th>Dose ratios**</th>
<th>Maximal possible contraction (%)***</th>
</tr>
</thead>
<tbody>
<tr>
<td>M. piperita</td>
<td>10.0</td>
<td>8</td>
<td>451.5 ± 12.7</td>
<td>2.8 ± 1.01</td>
<td>95.1 ± 2.6</td>
</tr>
<tr>
<td></td>
<td>20.0</td>
<td>8</td>
<td>3466.6 ± 20.7</td>
<td>18.3 ± 3.5</td>
<td>72.7 ± 4.3</td>
</tr>
<tr>
<td>C. aurantium</td>
<td>10.0</td>
<td>8</td>
<td>97.6 ± 4.6</td>
<td>2.2 ± 1.1</td>
<td>97.1 ± 1.5</td>
</tr>
<tr>
<td></td>
<td>20.0</td>
<td>8</td>
<td>338.6 ± 12.5</td>
<td>10.2 ± 2.8</td>
<td>80.7 ± 2.0</td>
</tr>
<tr>
<td>F. vulgare</td>
<td>7.5</td>
<td>8</td>
<td>65.1 ± 6.9</td>
<td>4.1 ± 1.1</td>
<td>86.2 ± 3.8</td>
</tr>
<tr>
<td></td>
<td>10.0</td>
<td>8</td>
<td>1285 ± 30.0</td>
<td>61.1 ± 5.6</td>
<td>74.7 ± 3.5</td>
</tr>
<tr>
<td>C. carvi</td>
<td>7.5</td>
<td>8</td>
<td>130.6 ± 15.5</td>
<td>4.5 ± 1.1</td>
<td>83.5 ± 3.9</td>
</tr>
<tr>
<td></td>
<td>10.0</td>
<td>8</td>
<td>1876.6 ± 38.8</td>
<td>64.7 ± 5.9</td>
<td>58.8 ± 4.9</td>
</tr>
</tbody>
</table>

* No. = number of experiments  
** Dose ratios were calculated by ratios of doses of acetylcholine causing equal contractions in the absence and presence of plant extracts  
*** Maximal possible contraction was calculated by comparing the maximal possible contraction in the presence and absence of plant extracts.

The antispasmodic effects of atropine and the plant extracts were then measured in terms of dose-ratio. The results given in the figures and tables are expressed as the percent of maximal possible contraction due to acetylcholine. The ED₉₀ given in the tables were calculated by parallel line assay method in the presence of the antispasmodics and dose ratios were calculated in their presence and absence (acetylcholine alone). The percents of maximal possible contractions in the experiments were also compared with 100% maximal effects of acetylcholine (controls).
RESULTS

As shown in Figure 1 and Table 1, ethanolic extracts of M. piperita, C. aurantium, F. vulgare and C. carvi significantly shifted the dose-response curve of acetylcholine to the right and therefore increased the median effective dose (ED₅₀) and the dose ratios of acetylcholine in a dose-related manner. A significant increase of the ED₅₀ and the dose ratios of acetylcholine were observed at a dose of 20mll for M. piperita, C. aurantium, and F. vulgare; and 10mll for C. carvi. Atropine sulfate also shifted the dose-response curve of acetylcholine to the right in a dose-related manner (Fig. 2).

We also observed the effect of ethanol on acetylcholine-induced contractions of isolated guinea pig ileum. Ethanol did not significantly shift the dose-response curve of acetylcholine to the right and therefore did not increase the median effective dose of acetylcholine in a dose-related manner.

As indicated in Table 1, 10mll and 20mll extracts of M. piperita and C. aurantium, and 7.5mll and 10mll extracts of F. vulgare and C. carvi respectively, employed in this study, significantly decreased the maximal possible contraction in response to acetylcholine, whereas there was no such effect with either of these concentrations of atropine.

DISCUSSION

Alcoholic extracts of M. piperita, C. aurantium sp. amara, F. vulgare and C. carvi which have been prepared from crude dried parts of plants under similar conditions exhibited different qualitative and quantitative effects on the contraction of isolated guinea pig ileum (Fig. 1 and Table 1). As far as the shift of the dose-response curve of acetylcholine to the right is concerned, with concentrations of 10mll M. piperita, 20mll C. aurantium, 7.5mll F. vulgare and 10mll C. carvi, a significant antispasmodic effect was observed. The plant extracts not only produced a shift of the dose-response curve of acetylcholine to the right, but also decreased the maximal contractile effect in response to acetylcholine in the following order: using 7.5 mll alcoholic extracts of C. carvi and F. vulgare, the former was more active than the latter; with a concentration of 10mll the results in decreasing order of activity were C. carvi, F. vulgare, M. piperita and C. aurantium. With 20mll, M. piperita was more active than C. aurantium. All these effects of the alcoholic extracts have been shown to be reversible.

Therefore, it appears that when the effect of the four plant extracts are compared on the basis of their dose ratios by 10mll in our study, both C. carvi and F. vulgare have the most pronounced activity, whereas M. piperita and C. aurantium were only of little effect. The dose ratios of the four plant extracts by 10mll were in the following order: 64.7, 61.1, 2.8 and 2.2 for C. carvi, F. vulgare, M. piperita and C. aurantium respectively. From our data, no conclusion about the mechanism of action of the plant extracts can be made. The antispasmodic activity of these extracts may possibly be, at least in part, due to their contents of essential oils.

In the treatment of abdominal spasms, 0.5-1.0mg of atropine is generally used. This corresponds to approximately 7µg/l atropine in the experimental medium. As far as the dose ratios are concerned, in our study, the effect of 10mll C. aurantium and M. piperita is equivalent to 0.5-0.6µg/l of atropine, whereas the effect of 20mll corresponds to 3.5.3µg/l atropine. This indicates that the antispasmodic effect of C. aurantium and M. piperita extracts is by far less than that of the usual therapeutic dose of atropine. The effect of 7.5µg/l F. vulgare and C. carvi is equivalent to 0.7-1µg/l atropine, whereas the effect of 10µg/l corresponds to 11.5-12µg/l atropine. This indicates that the antispasmodic effect of F. vulgare and C. carvi in concentrations of 10µg/l is slightly greater than that of the usual dose of atropine. These results indicate that the Iranian plant extracts of F. vulgare and C. carvi may be used in severe abdominal spasms in place of atropine, and extracts of C. aurantium and M. piperita should not be used in severe spasms. Rather, they may be used in subjective abdominal discomfort and meteorism. It is conceivable that the insignificant antispasmodic effect of the above two extracts may be sufficient for the treatment of minor spasms, while F. vulgare and C. carvi may be used in severe abdominal spasms.

Table II: Effect of atropine on acetylcholine-induced contractions of the guinea pig ileum. Results are expressed as ED₅₀ and dose ratios of acetylcholine (µg/ml) in the presence and absence of atropine, and as maximal possible contraction in response to acetylcholine.

<table>
<thead>
<tr>
<th>Drug</th>
<th>µg/l</th>
<th>No.</th>
<th>Aver. ED₅₀ of acetylcholine in µg with extracts</th>
<th>Dose ratios</th>
<th>Maximal possible contraction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atropine</td>
<td>1</td>
<td>8</td>
<td>204 ± 12.4</td>
<td>4.4 ± 1.1</td>
<td>98.2 ± 1.6</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>8</td>
<td>444.1 ± 22.3</td>
<td>17 ± 3.2</td>
<td>97.5 ± 4.9</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>8</td>
<td>2231.8 ± 63.3</td>
<td>52.8 ± 5.3</td>
<td>97 ± 2.7</td>
</tr>
</tbody>
</table>

Maximal possible contraction was calculated by comparing the maximal possible contraction in the presence of atropine, with experiments without addition of atropine. Dose ratios were calculated by ratios of doses of acetylcholine, causing equal contractions in the absence of atropine.
C. carvi extracts may be used in severe abdominal spasms. However, further evidence is necessary to support this view.

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REFERENCES
