The influence of acupuncture on salivary flow rates in healthy subjects

I. DAWIDSON, M. BLOM, T. LUNDEBERG* & B. ANGMAR-MÅNSSON

Department of Cariology and *Department of Physiology and Pharmacology, Karolinska Institutet, Stockholm, Sweden

SUMMARY This study investigated the influence of acupuncture stimulation on the salivary secretion of eight healthy subjects. The salivary flow of each subject was measured before, during and after every acupuncture session. The unstimulated, chewing-stimulated and citric acid-stimulated flows were investigated, in combination with manual and electrically stimulated acupuncture. The results showed a significant increase of the unstimulated salivary flow both during and after the manual acupuncture stimulation as compared to baseline levels. There was no effect on the unstimulated salivary flow with electro-acupuncture. The stimulated salivary flow was not affected by manual acupuncture, while the electrically stimulated acupuncture led to a significant decrease of the chewing-stimulated salivary flow. The improvement of the unstimulated salivary secretion in healthy subjects was in accordance with our previous findings in xerostomic patients. It is possible that the salivary secretion is influenced by the augmented release of neuropeptides caused by acupuncture. Some neuropeptides have been shown to affect salivary secretion as well as capillary blood flow.

Introduction

The inability to produce a sufficient amount of saliva is a well known symptom, associated with such systemic diseases as Sjögren's Syndrome, hypothyroidism and others. Many medications, as well as irradiation treatment of tumours in the face and neck also cause xerostomia (Bertram, 1967; Spielman et al., 1981). A dry mouth condition is quite distressing for the patient, because of problems with speaking, eating and swallowing. Infections of the oral mucosa and rapidly progressing caries are also common in xerostomic patients. There are many ways of alleviating the discomfort of dry mouth, mostly using saliva substitutes and the stimulation of salivary flow. Medications, such as pilocarpine, and electrical stimulation have been tried. However, all these methods give only short-term relief (Greenspan, 1990; Sreebny et al., 1992). Recently, we have shown that xerostomia can be treated successfully with acupuncture. The results of those studies showed that acupuncture treatment led to an increase of the salivary flow rates in many of the xerostomic patients, and the effect lasted during the 12-months' observation period (Blom, Dawidson & Angmar-Månsson, 1992; Blom, Dawidson & Angmar-Månsson, 1993a). To elucidate the mechanisms behind the effect of acupuncture on salivary secretion, we conducted studies in which we tried to measure various factors that influence salivary flow during acupuncture stimulation. The blood flow in the skin overlying the parotid gland of patients suffering from Sjögren's Syndrome was investigated and the results showed an increase in that blood flow during and after the acupuncture treatments. It is possible that an increase of the blood flux in the salivary glands may be one of the mechanisms behind the positive effect of acupuncture on the metabolism of the salivary glands, which leads to an increase of the salivary flow (Blom et al., 1993b). Another approach
was to study the influence of acupuncture on the release of neuropeptides in the saliva of healthy subjects. Some neuropeptides have been shown to have a significant influence on the composition and flow of the saliva, as well as on the local blood flow (Ekström, Månsson & Tobin, 1987; Månsson & Ekström, 1991). The preliminary results of our study showed an increase in the release of the neuropeptides CGRP and VIP during and after the acupuncture sessions, while NPY increased only during and not after the acupuncture sessions (Dawidson et al., 1994). Studies conducted by Yao (1993) indicate that different neuropeptides are involved in the effects of acupuncture, and it has also been shown that acupuncture increases the blood flow and neuropeptide release in both rats and humans (Kaada, 1987; Lundeberg, 1993). The aim of this study was to investigate the influence of two modes of acupuncture (manual and low-frequency – 2 Hz electrically stimulated acupuncture) on the salivary flow rates of healthy subjects. The release of the neuropeptides was measured as well, and those results will be published separately.

Materials and methods

Subjects and saliva sampling

Eight healthy subjects were enrolled in this study – 4 males and 4 females aged between 23 years and 41 years (mean, 31.5 years). All but one were students or dentists at the Dental School in Stockholm, well acquainted with the salivary flow test procedures used as standard in the Department of Cariology (Ericson & Mäkinen, 1986). Prior to the start of the study, the experimental design was approved by the ethical committee at Huddinge Hospital. The participants were informed about the study in writing and they were asked to refrain from eating, drinking and smoking for at least one hour prior to each experiment. Their salivary secretion was measured on different occasions before the start of the study (unstimulated saliva, paraffin-chewing stimulated whole saliva, whole saliva stimulated with 1% citric acid). Each individual participating was tested at approximately the same time of day to allow for differences in saliva production during the day. The collected saliva was quantified by weight and 1 g was considered to respond to 1 mL. After the initial tests were completed, all subjects underwent the following experimental procedures on three different occasions. Saliva was collected for 20 min under the conditions described above. Thereafter the acupuncture treatment was given for 20 min, while the saliva was continuously collected, and after the acupuncture needles were removed, the collecting of saliva continued for another 20 min. These three experiments were repeated with electro-acupuncture. All saliva samples were treated in the same way as those in the initial tests.

The acupuncture procedure

The acupuncture sessions were carried out by an experienced acupuncturist, and the same points were used as for the treatment of xerostomia in earlier studies (Blom et al., 1992; Blom et al., 1993a). The following points were used bilaterally: St3, St6 in the face, Li4 in the hands and St36 and Sp6 in the legs (Fig. 1; Mann, 1981). The disposable needles used were Chinese, made of stainless steel, Hwato 0.32 x 40 mm. After standard sterilizing of the site, the needles were inserted through the skin to a depth of 5–10 mm, and manipulated until the needle sensation (DeQi) was obtained. DeQi is described as a feeling of heaviness and ache, sometimes combined with the sensation of a current originating from the point where the tip of the needle is placed (Anon., 1980). When that sensation was achieved, the needles were left in situ and not manipulated again unless a needle was displaced or the subject reported increasing pain or total loss of the DeQi sensation, in which case it was adjusted. All three experiments were repeated using electro-acupuncture. Low-frequency electrical stimulation (2 Hz) was evoked with a Multiple Electronic Acupunctoscope (Chinese WQ-10DI). The needles at points St6 and Li4 were connected to the electro-pulser bilaterally, and the electrical current was adjusted to produce a pulsating sensation, which was not painful (2–4 mA). The electrical stimulation was applied during the whole period the needles were in situ (20 minutes). Otherwise these experiments did not differ in any way from the experiments carried out with manual acupuncture.

Statistical methods

Wilcoxon Matched Pairs test for two dependent samples was used in order to test the significance of the changes in the salivary flow rates.
Results

The results of the study are shown in Table 1.

Unstimulated saliva

A significant increase ($P < 0.01$) of unstimulated salivary flow was found both during and after the manual acupuncture stimulation as compared to baseline levels. Mean increase of the salivary flow rates was 28% during the acupuncture treatment, and 36% after the needles were removed. Electrically stimulated acupuncture had no effect on unstimulated salivary flow.

Stimulated saliva

There was a significant decrease in the flow rates of chewing-stimulated saliva during the electrically stimulated acupuncture treatment. There were no significant changes otherwise, but a tendency towards decrease in the salivary flow rates, especially during and after the electrically stimulated acupuncture.

Discussion

In accordance with our previous findings in xerostomic patients, present results showed that manual acupuncture induced a significant increase in unstimulated salivary flow in healthy subjects. These findings indicated that acupuncture affects the autonomic nervous system (ANS). The functions of the salivary glands are under the influence of both the parasympathetic and sympathetic nervous systems, which combine their effects on the salivary flow. The salivary glands are innervated by sensory, parasympathetic and sympathetic nerve fibres. Stimulation of the parasympathetic system leads to a strong increase of salivary flow which has a low protein content. Stimulation of the sympathetic system gives a low, protein-rich, viscous salivary flow (Emmelin, 1987; Garrett, 1987). Apart from the primary or classic transmitter substances (noradrenaline in the sympathetic system and acetylcholine in the parasympathetic system) there are other substances that function as transmitters in the nerve fibres — neuropeptides (Gibbins, 1990; Ichikawa et al., 1990). The release and functions of the neuropeptides have been studied concerning their influence on the salivary glands. Animal studies reveal that administration of substance P (SP) and neurokinin A (NKA) increases the salivary secretion, SP to a greater degree than NKA. Calcitonine gene-related peptide (CGRP) produces a delayed (1–2 min) increase of the salivary secretion, smaller than that caused by SP. Vasoactive intestinal polypeptide (VIP) does not affect salivary flow but causes protein release. SP, VIP and CGRP all significantly increase the blood flow in the salivary glands. Neuropeptide Y (NPY) causes vasoconstriction and inhibits the release of noradrenaline. VIP causes vasodilation and augments the effect of acetylcholine on salivary secretion (Uddman et al., 1990;
Table 1. The differences in salivary flow rates (%) between baseline levels and during and after acupuncture stimulation

<table>
<thead>
<tr>
<th>Acupuncture</th>
<th>Subject</th>
<th>Mean</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td></td>
<td></td>
<td>+84</td>
<td>+32</td>
</tr>
<tr>
<td>Manual</td>
<td>Not stimulated</td>
<td>+13</td>
<td>+59</td>
</tr>
<tr>
<td></td>
<td>Chewing stimulated</td>
<td>-19</td>
<td>+15</td>
</tr>
<tr>
<td></td>
<td>After AP</td>
<td>-2</td>
<td>+38</td>
</tr>
<tr>
<td></td>
<td>Citric acid stimulated</td>
<td>-35</td>
<td>-21</td>
</tr>
<tr>
<td></td>
<td>After AP</td>
<td>-11</td>
<td>-5</td>
</tr>
<tr>
<td></td>
<td>Electrical</td>
<td>During AP</td>
<td>-14</td>
</tr>
<tr>
<td></td>
<td>Not stimulated</td>
<td>-31</td>
<td>+33</td>
</tr>
<tr>
<td></td>
<td>Cheewing stimulated</td>
<td>+8</td>
<td>-13</td>
</tr>
<tr>
<td></td>
<td>After AP</td>
<td>-8</td>
<td>+18</td>
</tr>
<tr>
<td></td>
<td>After AP</td>
<td>-39</td>
<td>+14</td>
</tr>
</tbody>
</table>

n.s., not significant; AP, acupuncture.

Ekström et al., 1988; Månsson & Ekström, 1991; Tobin et al., 1991). All these neuropeptides have also been found in healthy human salivary glands (Hauser-Kronberger et al., 1992; Herbst, Kummer & Heym, 1992) as well as in those affected by Sjögren’s Syndrome (Konttinen et al., 1992). Our earlier studies have shown that acupuncture increases salivary flow in xerostomic patients (Blom et al., 1992; Blom et al., 1993a), and that the blood flow in the skin overlaying the parotid gland was increased by similar acupuncture stimulation in patients suffering from Sjögren’s Syndrome (Blom et al., 1993b). Further studies showed that this stimulation led to an increased release of some neuropeptides into the saliva of healthy subjects (Dawidson et al., 1994). Those subjects also experienced a significant increase in their unstimulated salivary flow during and after manual acupuncture stimulation.

It is our conclusion that manual acupuncture stimulation affects the ANS, causing a rise in the activity of the parasympathetic system, which leads to an increased salivary production by way of the enhanced release of neuropeptides. The neuropeptides have a dual effect: they cause both an increase of salivary secretion as well as vascular dilation with a resulting increased blood flow through the salivary glands. Our results showed no significant changes in the stimulated salivary flow, which differed from the effects of acupuncture treatment on xerostomic patients (Blom et al., 1992; Blom et al., 1993a). A possible explanation for this finding could be that healthy subjects secrete quite large amounts of saliva in response to chewing or to a strong taste (e.g. citric acid). The volumes of saliva produced by such ‘natural’ stimulation might greatly exceed any salivary flow increase that might be caused by acupuncture stimulation and subsequent neuropeptide influence, and therefore show no difference between the normal stimulated salivary flow with or without additional acupuncture stimulation. It is possible that the difference seen between manual and electrically stimulated acupuncture is related to different effects on the sympathetic system – manual acupuncture stimulation induces an inhibition of sympathetic tone thereby increasing the salivary flow, while electrical stimulation may have little or even the opposite effect.

The influence of acupuncture on neuropeptide release and its effect on salivary flow rates needs to be investigated further to elucidate the positive effect of acupuncture treatment on the salivation of xerostomic patients.

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References


Correspondence: Dr Irena Dawidson, Department of Cariology, Karolinska Institutet, School of Dentistry, Box 4064, 141 04 Huddinge, Sweden.
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