A SWEAT REFLEX DUE TO PRESSURE ON THE BODY SURFACE

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Lying on one side causes a noticeable increase of sweating over the upper part of the body and a decrease at a similar rate over the lower part of the body. This phenomenon was called “hemihidrotic reflex” by Kuno (1) and was analysed experimentally by Ogata and Ichihashi (2). They concluded that the sweat reflex is caused not from the position of the head but from that of the body; that the congestion of the lower part of the body gives rise to sweating because dilatation of the blood vessels in the lower part of the body stimulates mechanically some sensory nerves which elicit a sweat reflex. However, we reached a different conclusion by the following experiments.

METHODS AND RESULTS

1. Observation with the naked eyes. The hemihidrosis can be observed only with the naked eyes or by touching with fingers. By pushing one side of the body against a wall or a post in the standing position we noticed the increase of sweating on the opposite side. Similar results were obtained in the sitting position by pushing either one side of the back against the back of a chair or one side of the chest wall against the arm of a chair with both hands held up. Coinciding with this sweat reflex unusual dilatation of the blood vessels was seen on the skin of the face and the bulbar conjunctive. This sweat reflex was obtained also by pushing the side of the chest with a small box or even with an end of a pencil.

2. Experiments measuring the amount of sweat. With the filter paper (24 cm.²) directly placed on the skin to be tested, the increase of its weight was measured quickly by torsion balance at certain intervals (3-10 minutes). The symmetrical part of the back of the hand, the upper part of the back, and the forechest were chosen as the measuring areas. The magnitude of the error of this method was not over ± 3 mgm. The room temperature was usually maintained at 30° C. The subject sits on a chair and lies his hands on the table in front of him or upon his legs. The side of the chest on the axillary line at the height of the nipples is pressed with small cushion, a small box (10 cm. times 8 cm.), or an end of a pencil, the diameter of which is about 1 cm. Figure 1 represents the sweat secretion on the back of both hands by this method.

In order to examine more fully the influence of the posture of the body upon the sweat reflex, we employed the following experiments. With the body declined backwards from the standing position at an angle of 30° and the body

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Fig. 1. Black line, sweat secretion on the back of right hand. White line, that on the left. I: Sitting upright on a chair. II: Pressing the right side of the chest with the end of a pencil. III: Pressing the left side of the chest with the same. IV: Pressing the left side of the chest with a small cushion. V: Pressing the right side of the chest with the same. VI: No pressing being applied.

Table 1.
Subject: K. T. 39yrs. Room temperature 32° C.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Amount of sweat on the right side of the chest</th>
<th>Amount of sweat on the left side of the chest</th>
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<tbody>
<tr>
<td>A</td>
<td>62 mg/24 cm² 67 &quot; &quot;</td>
<td>47 mg/24 cm² 49 &quot; &quot;</td>
</tr>
<tr>
<td>B</td>
<td>34 &quot; &quot;</td>
<td>23 &quot; &quot;</td>
</tr>
<tr>
<td>C</td>
<td>7 &quot; &quot;</td>
<td>30 &quot; &quot;</td>
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weight supported with the hands, the amount of sweating was the same on both sides (Tab. 1A). Even in a declined posture rightwards at the angle of 30° the condition of sweating does not change essentially from the above case provided no pressure is applied on any side of the body (Tab. 1B). Application of pressure on the right side of the chest in the same posture with a small wooden piece increased markedly the sweating on the left half of the body and equally inhibited sweating on the right side of the body (Tab. 1C). Furthermore, on declined position rightwards at the angle of 90° which support was obtained by spreading the extremities as in a hoop (training machine), the hemihidrosis was not seen. Fig. 2B indicates these results. At C in Fig. 2, the left side of the

Fig. 2. Black line, sweating on the right side of the back. White line, that on the left side.
chest wall was then pressed in the same posture as above mentioned and it was found that the sweating was augmented on the right side and reduced on the left side. At D in the same figure, the pressure was released in this same standing position and the sweating on both sides became equal.

We were able to obtain similar results either by pricking the same portion of the skin with a needle under local subcutaneous anesthesia with the sense of pressure only remaining (Fig. 3) or by pinching the skin of the same place (Fig. 4). We could not recognize this sweat reflex with electric faradic stimulation of skin or tactile stimulation.

From these experiments it can be concluded that the hemididrotic reflex is not caused by congestion of blood vessels of one side of the body, but by pressure upon certain parts of it.

3. Distribution of pressure points over the body surface. The degree of sensitivity of pressure points for the sweat reflex was examined by means of Minor’s method on fifty men. Fig. 5 represents these results schematically. # refers to the pressure points on the skin where this sweating reflex was recognized without exception after a short interval (30 sec. - 2 min.). # means the pressure points having without exception a relatively long latent period (2 to 5 min.). + refers to less sensitive pressure points having a latent period over five minutes. ± means the skin area over which this reflex is not always observed. — refers to the skin points over which this reflex cannot be elicited.
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As shown in this figure the axillary portion is most sensitive for pressure stimulation and the sensitivity becomes proportionately weaker the greater the distance from this area. Outer surface of upper arm and the entire leg seems to have no receptors for this stimulation. We could not evoke this reflex from the sole although it was obtained to some extent from the palms of the hands.

4. Time process of the above reflex. We employed two methods of recording the changes of sweating, one of which was the use of a hygrometer and the other was the use of a photoelectric cell, the principle of the latter being based upon the changes of the photoelectric current by changes in strength of the coloring reaction of iod paralleling the amount of sweat formation. It was noted that the sweating occurred almost immediately after pressing the body surface.

In minimal sweating conditions the amount of sweating fluctuated at a period of from 5 to 7 minutes. This phenomenon was often observed when the sensitivity of the subject was reduced by standing in a cold environment for a time. Under these conditions the sweating reflex could not be obtained by pressure. The absence of sweating reflex was also often seen in fatigue and intensely sweating conditions.

We can conclude from the above mentioned facts that the sweat reflex is caused reflexly from the cutaneous receptors for pressure on one side influencing the excitability of the sweating center of the brain, thence down the efferent pathways to excite the sweat glands on the opposite side and inhibit the sweat glands on the same side.

5. Sweating reflex by the pressure on the both sides of the body. When both sides of the body were pressed, the sweating secretion increased markedly on both sides in winter (Fig. 6), but decreased in the summer. The mechanism for this action has not yet been explained, but it is probable that the sweating center has different excitability in summer and winter.
6. Changes in the sweat secretion due to changes of posture from a standing position to a lying position. From the conclusion that the reflex mechanism of hemihidrosis was a result of pressure upon one side of the body, we supposed that another sweating reflex which was noticed by Ogata & Ichihashi (3) at standing and lying might also be caused by pressure and not by postural changes. In order to investigate this supposition a specially designed apparatus shown in Fig. 7 was used. A subject was laid in a supine or prone position on the board which was inclined at the angle of about 30° against the floor so that he could then be lifted up along this inclined board by the sole or hip supporter (1 in Fig. 7), which was able to move up and down easily by means of three pulleys (2, 3, 4, in Fig. 7). By this method a strong pressure was placed upon the soles of the feet or the hip without a change of posture. The forechest and the thigh were chosen as areas for measurement of sweating. If the board was inclined gradually from a horizontal position to 60° inclination no change of sweating condition was observed compared with that of a supine position, but if the inclination of the board reached 80°–90° the upper part of the body showed remarkable reduction of sweat, this being due perhaps to both soles containing the entire body weight (Fig. 8, I and II). If the supporter of the apparatus above mentioned was placed on the soles and the whole body was lifted, holding the board at a constant inclination (30°), similar results as that observed in the postural change from lying to standing was obtained (Fig. 8, IV). When the hip were pressed instead of pressing the both soles, this sweating reflex was also elicited.
From all these results we can conclude that the sweating reflexes all of which have been previously supposed to have been caused by postural change, are reflexes caused by pressure upon the body surfaces.

7. Effect of pressure on sweating from mental causes. Mental sweating was observed by the psychogalvanic skin reflex. When the mental sweating was being evoked by stimuli such as electric shock or mental arithmetric, one side of the chest wall was pressed by a small wooden block with the result that the palm of the opposite hand showed a marked change in P.G.R. (Fig.9), releasing a reduction of the sweating. On the contrary the palm of the same side showed less or no change. We reached the conclusion from these results that pressure...
on the body side also influenced mental sweating.

SUMMARY

1. In a moderately sweating condition pressure upon one side of the body evokes without exception a hemihidrosis of the opposite side.
2. In similar conditions, pressure upon the soles or hip evokes the upper and lower sweating reflex.
3. Pressure on one side of the body does influence sweating from mental origin.

BIBLIOGRAPHY