Continuous Observation of Single Sweat Gland Activity

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Abstract: A small ion-free solution-perfusion chamber has been developed to continuously observe the single sweat gland activity (SSGA) at the skin surface by conductivity measurement. The chamber has a very small open space of 0.2 mm² at the bottom and has a transparent view field. Ag-electrodes were installed inside the chamber and by perfusing purified water through the chamber at a constant flow rate conductivity was measured before and just after washed out sweat. Single sweat pores were visualized by starch/iodine method and magnifying lens. SSGA was observed by attaching the chamber on single sweat pores at palm and finger tip skin surface when the subjects were sitting resting position and doing hand (non-experimental) grasping with a dynamometer. Different types of continuous SSGA were observed from sweat pores.

INTRODUCTION

Several techniques have been developed to measure sweating, however most of them are insufficient for measurement of instantaneous sweating which is observed mostly during psychological stress. Under this type of certain condition, sweat gland discharge sweat periodically. Quantitative and time relations of these periods of activity are very difficult to determine if the system can not respond first. A system was developed for continuous measurement of electrolyte content in sweat relies on the electrical conductivity measurement of sweat which was allowed very first response [1]. As a continuation and improvement a smaller ion-free solution perfusion chamber has been developed in this study for continuous observation of SSGA at the skin surface.

MATERIALS AND METHODS

Visualization of the sweat pores:
To visualize sweat pores we used a classical starch/iodine method[2]. For this the skin surface to be examined was painted with a solution of 2 gm iodine in 100 ml absolute alcohol. After it became perfectly dry, this skin area was covered with a layer of the mixture of 50 gm very fine starch powder and 100 ml castor oil. The starch powder soon precipitates and deposits into a thin layer over the skin surface. As soon as sweat droplets are produced, they were visible a minute black spots through the transparent layer of the mixture.

Construction of the perfusion chamber:
Figure 1 shows the cross section of the perfusion chamber of dimensions 20x20x20 mm and weight of 17.5 gm. It was constructed using acrylic and silver and attached a twelve-times magnifying lens on the upper side. The chamber has a transparent view field at the middle and using the magnifying lens the bottom portion can be visible clearly. Two 1.2 mm diameter holes were made vertically at both sides and a 0.5 mm diameter hole was made horizontally at lower portion to connect the former two vertical holes through the chamber and formed perfusion path. Two plastic tubes were attached at the upper ends of the hole to easily flow the purified water through chamber, and silver was installed inside the chamber at the inlet and outlet as the electrodes and were connected with a conductivity meter to measure conductivity. A very narrow open space of 0.2 mm² is made at the bottom middle portion on the perfusion hole as shown in Fig.1 to wash out of sweat at the skin surface perfusing by the purified water.

Fig.1 Cross section of the perfusion chamber.

To estimate the response time of the chamber, a small amount of electrolyte solution was injected into the constantly flowing purified water through the chamber. The flow rate of the syringe pump was maintained at 1.91 ml/min, the open space was closed, and the 90% response time was measured as 0.75 s. To calibrate the chamber, different known low concentrations of NaCl solution were passed through at a constant flow rate same as before and the conductivity of each of these solution was measured. The conductivity of the solution inside the chamber was almost linearly
correlated with the concentrations of NaCl solution \( (r = 0.995) \).

**Measurement system and procedure:**

The measurement system is same as [1], water reserved in a reservoir (made of Teflon\(^5\)), and was purified by continuously flowing through an ion-exchange column. One side of the chamber was connected with the reservoir by plastic tube and the other side of the chamber was connected with a withdrawn-type 50 ml steady flow syringe pump. After visualized the sweat pores at the skin surface using starch/iodine method and magnifying lens, selected a sweat pore and wiped out the surroundings by clean gauge and attached the chambers open space on the single sweat pore by a two-sided adhesive tape after cut out same space as the open space of the chamber. The purified water was flowing through the chamber at a constant flow rate of 1.91 ml/min and conductivity of the purifying solution was measured after washed out sweat water so that the electrolytes in sweat can be measured because Na\(^+\) and Cl\(^-\) are the most numerous ions in sweat. At the time of calibration of our system we also found almost linear correlation between concentration of NaCl solution and conductivity measurement.

The examples of results shown in Figs. 2(a) and (b) demonstrate that periodic sweating due to hand grasping are reflected clearly in the conductivity measurement by attaching the chamber on single sweat gland.

In conclusion, from obtained results it seems that we developed a system for continuous observation of single sweat gland activity by conductivity measurement.

**REFERENCES**


