THE PERMEABILITY OF THE HUMAN SKIN TO WATER*

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The permeability of the human skin is known to be restricted to lipids and fat solvents. The permeability of the uninjured human skin to water has been denied by several investigators (1). However in the present study on the permeability of the human skin to water, data is presented which shows the necessity of the modification of our present concepts.

MATERIALS AND METHODS

The work on the skin permeability was carried out on several persons at our research centre. A transparent finger-plethysmograph was specially constructed to fit compactly over the finger of the subject under study, in such a manner that it was water proof. However it did not obstruct the cutaneous flow of blood. The proximal end was sealed to the finger by a thin rubber membrane. The distal end was connected to a finely calibrated pipette for recording. The whole system was filled with the fluid and fixed vertically in order to augment the fluid inflow of water (Fig 1). All the experiments were carried out in at constant room temperature of 37°C. Preliminary studies indicated that in hypertonic saline (1.2 %) and in isotonic saline (0.9%) no changes in volume were observed. Important changes were noticed when the hypotonic solution (distilled water) was used in the plethysmograph, indicating inflow of water. After fifteen minutes the reading was taken and the difference calculated in order to determine the inflow of water (Table 1).

TABLE 1

Showing the average inflow of water in different subjects.

Croup No.	Inflow at the end of 15 minutes.
1.	0.15 ml.
2.	0.20 ml.
3.	0.18 ml.
4.	0.14 ml.
5.	0.21 ml.
6.	0.21 ml.
7.	0.18 ml.

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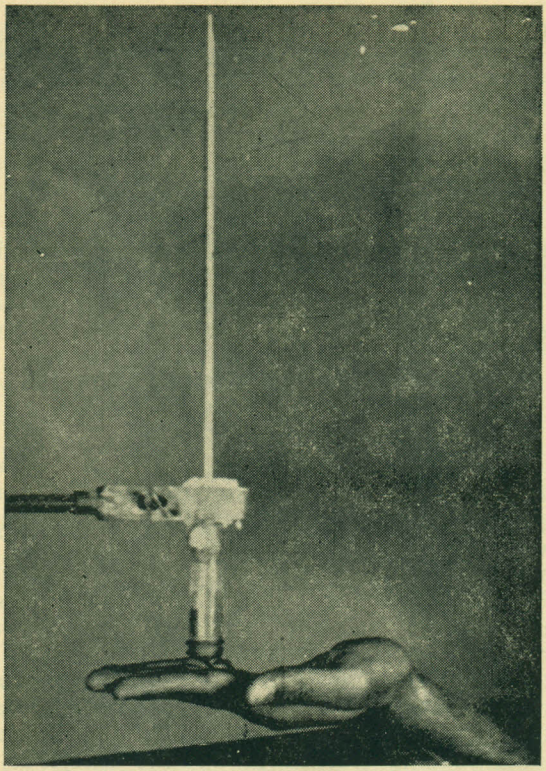

Fig. 1. Figure showing the 'vertical—type' finger plethysmograph, while recording the water-inflow.

RESULTS

The finger in the hypotonic saline showed complete avascularity. The area which had been immersed was raised and oedematous locally. The surface was corrugated with projections alternating with depressions parallel to the long axis of the finger. The nail bed also appeared avascular. While recording, the meniscus in the calibrated pipette fluctuated, in accordance to the beats of the radial pulse. The avascularity appeared in the form of spots and then gradually spread to the rest of the area. Subjectively there was a feeling of numbness and slight heaviness.

When the immersion of the finger was prolonged to 45 minutes the skin became insensitive to touch and there was hypoaesthesia. The external surface appeared blanched.

DISCUSSION

The present studies indicate that the avascularity is local, being only in the immersed area. As the experiments were Carried out in a constant temperature room of 37°C the temperature factor was completely controlled. This contradicts the opinion of Rothman and others as quoted by Calvery, Draize, and Lang (2) who believed that the skin of man and higher animals which contain the spinosum and granulosum layers act as barriers to water. Though no experimental proof was given for the above hypothesis, it was further thought that the frog's skin, which lacks these layers, is freely permeable to water.

Since the inflow of water was seen only in the hypotonic solution and not in others, it may be regulated by osmotic pressure. A passive diffusion is more probable than active absorption since water is seen to diffuse in all physiological membranes. The water after penetrating the epidermis, probably accumulates in the interstitial spaces, giving rise to the local oedematous condition. This may be due to the partial constriction of the capillaries, as is indicated by the avascularity. Whether the avascularity is a safety mechanism, whereby the body prevents excessive water intake into the blood compartment, (under rare conditions as in water logging in wet trenches and in those engaged in underwater studies for long), is a matter deserving further studies.

The avascularity has been shown, not to be due to local temperature changes since the experiment was carried out under constant temperature conditions. Whether it is due to the presence of specific receptors situated in the skin, which are sensitive to these osmotic changes and have an action on the capillaries (either directly or through the vasomotor mechanism) also requires further investigation.

SUMMARY

Hypotonic solutions can penetrate portions of the skin, especially the fingertips. The skin, on being immersed in water for long periods, gave certain characteristic reactions in the form of local oedema preceded by a profound avascularity. The cause of this local avascularity may possibly suggest the presence of certain specific receptors, situated in the skin, which being sensitive to osmotic changes may control the vascularity.

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