J. Physiol. (1957) 138, 445–448

# A COMPARISON OF THE HEAT ELIMINATION FROM THE NORMAL AND NERVE-BLOCKED FINGER DURING BODY HEATING

By I. C. RODDIE, J. T. SHEPHERD and R. F. WHELAN
*From the Department of Physiology, The Queen's University of Belfast*

(*Received* 3 *June* 1957)

Lewis & Pickering (1931) found that body heating caused vasodilatation in the little fingers of patients with Raynaud's disease. Ulnar nerve block did not cause a similar vasodilatation but prevented vasodilatation when the subject was subsequently heated. They concluded that nerve block had removed the influence of vasodilator fibres to hand vessels. This result has been confirmed by Fatheree & Allen (1938), but the phenomenon has not been observed in the normal hand.

During body heating, blocking the vasomotor nerves to the normal hand does not reduce the blood flow through it (Sarnoff & Simeone, 1947; Arnott & Macfie, 1948; Gaskell, 1956). While this finding provides strong evidence that the blood vessels of the normal hand are supplied exclusively with vasoconstrictor fibres, another explanation could be that during body heating a stable vasodilator substance is formed in the skin. If this is so, blocking the nerves during body heating would not immediately decrease the flow but only when the vasodilator substance had been either removed or destroyed. Support for such a possibility was provided by Fox & Hilton (1956), who demonstrated bradykinin-forming activity in sweat collected from the hand and forearm during body heating, and have more recently found bradykinin activity in skin tissue fluid during heating (Fox & Hilton, 1957).

In the present experiments the heat elimination from a nerve-blocked finger was compared with that from an intact finger before and during body heating. It was considered that if a stable vasodilator substance were normally formed in digital skin as a result of sympathetic activity during body heating, nerve block carried out before heating commenced would prevent its subsequent formation on that side. If this were the case and the substance played an important part in the hand vasodilatation, the heat elimination on the nerve-blocked side would be less than on the intact side at the height of heating.

It was found, however, that during body heating the heat elimination from the nerve-blocked finger was of the same order as, or greater than, that from the intact finger.

## METHODS

The experiments were carried out on four healthy men comfortably seated in a room at 20–23° C. With the arms in the dependent position, the heat elimination from the distal phalanges of the left and right little fingers to water at 29° C was measured using standard calorimeters (Greenfield & Shepherd, 1950). Nerve block was performed by infiltration of 2–3 ml. of 2% lignocaine with adrenaline (1:50,000) around the ulnar nerve at the elbow. Body heating was carried out by immersing the subject's feet and calves in stirred water at 42–44° C and wrapping him in blankets.

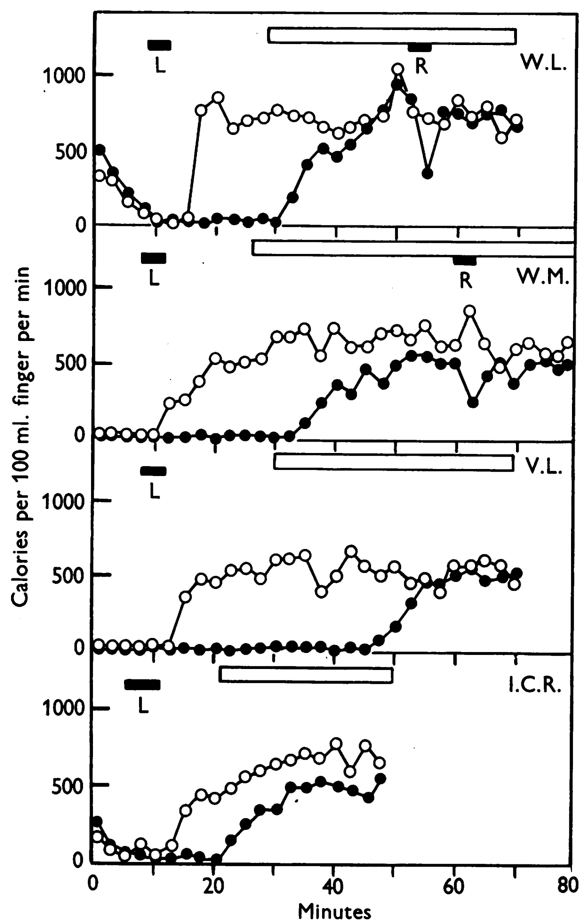


Fig. 1. The effect of nerve block and of body heating on the heat elimination from the finger tips of four subjects. ○, Heat elimination from distal 2·8 cm of left little finger; ●, heat elimination from distal 2·8 cm of right little finger; $\overline{\text{L}}$, left ulnar nerve block; $\overline{\text{R}}$, right ulnar nerve block. The clear rectangles represent the periods of body heating. Each point represents the heat elimination measured over a period of 1 min.

## RESULTS

The results of the four experiments on the four subjects are shown in Fig. 1. At the beginning of the experiments the heat elimination from both finger tips was similar. The left ulnar nerve was then blocked and this resulted in a large increase in the heat elimination from the left finger tip owing to release of vasoconstrictor tone in the digital vessels. When the heat elimination from the nerve-blocked finger tip became steady at the new level the subject was heated by immersing his feet and calves in warm water. The heat elimination from the intact finger tip then increased until it approached or reached the level of heat elimination from the nerve-blocked finger: in no case was the heat elimination from the intact finger greater than that from the nerve-blocked finger. In two of the experiments (W. L. and W. M.), the right ulnar nerve was then blocked. This procedure caused no appreciable alteration in the heat elimination from the right finger tip.

## DISCUSSION

Interpretation of these results must be made with certain reservations. A quantitative comparison of heat elimination from two finger tips necessitates a constant degree of immersion of the fingers in the calorimeters. In the present experiments this was rendered less certain since it was difficult for the subject to co-operate in assessing the depth of the anaesthetized finger in the calorimeter. However, the depth of immersion of the nerve-blocked finger was carefully checked at intervals throughout the experiment.

In two of the experiments the heat elimination from the normal finger was less than that from the nerve-blocked finger at the height of heating. This may have been because the degree of heating was insufficient to cause a full release of vasoconstrictor tone, but this is unlikely in the case of W. M., since nerve block did not further increase the heat elimination. A further possibility is that the precooling effects on arterial blood may have been different on the two sides. However, precooling was minimized by wrapping the arms in woollen cloth. It might be argued that during body heating the hand blood vessels are so dilated, owing to full release of vasoconstrictor tone, that the presence of a local vasodilator substance might be unable to dilate the vessels further. However, application of local heat to the hand can further increase flow through the hand of a subject at the height of body heating, which would suggest that body heating does not maximally dilate hand vessels (Roddie & Shepherd, 1956). It is possible of course that the vessels of the fingers behave differently from those of the whole hand.

Within the limits of these reservations the results suggest that sympathetic activity does not result in the formation of a stable vasodilator substance in the hand which plays an important part in the vasodilatation during body heating. The findings therefore support the conclusions of Sarnoff & Simeone (1947), Arnott & Macfie (1948) and Gaskell (1956) that the hand dilatation during body heating can most easily be explained by release of vasoconstrictor tone.


SUMMARY

1. The heat elimination from a nerve-blocked and an intact finger was compared before and during body heating in four subjects.

2. During heating the heat elimination from the intact finger approached but did not exceed that from the nerve-blocked finger.

3. It is concluded that sympathetic activity during body heating does not result in the formation of a stable vasodilator substance in digital skin.


REFERENCES


ARNOTT, W. M. & MACFIE, J. M. (1948). The effect of ulnar nerve block on the blood flow in the reflexly vasodilated digit. *J. Physiol.* **107**, 233–238.

FATHEREE, T. J. & ALLEN, E. V. (1938). Sympathetic vasodilator fibres in the upper and lower extremities. *Arch. intern. Med.* **62**, 1015–1028.

FOX, R. H. & HILTON, S. M. (1956). Sweat gland activity as a contributory factor to heat vasodilatation in the human skin. *J. Physiol.* **133**, 68–69*P*.

FOX, R. H. & HILTON, S. M. (1957). Sweat gland activity, bradykinin formation and vasodilatation in forearm skin. *J. Physiol.* **137**, 43–44 *P*.

GASKELL, P. (1956). Are there sympathetic vasodilator nerves to the vessels of the hand? *J. Physiol.* **131**, 647–656.

GREENFIELD, A. D. M. & SHEPHERD, J. T. (1950). A quantitative study of the response to cold of the circulation through the fingers of normal subjects. *Clin. Sci.* **9**, 323–347.

LEWIS, T. & PICKERING, G. W. (1931). Vasodilatation in the limbs in response to warming the body; with evidence for sympathetic vasodilator nerves in man. *Heart*, **16**, 33–51.

RODDIE, I. C. & SHEPHERD, J. T. (1956). The blood flow through the hand during local heating, release of sympathetic tone by indirect heating and a combination of both. *J. Physiol.* **131**, 657–664.

SARNOFF, S. J. & SIMEONE, F. A. (1947). Vasodilator fibres in human skin. *J. clin. Invest.* **26**, 453–459.