THE COLD-REACTION TEST FOR PERIPHERAL VASOMOTOR DISTURBANCES IN RHEUMATISM

BY

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The experiments to be described have been carried out on patients suffering from various forms of rheumatism, but mostly from rheumatoid arthritis, at the Harrogate Royal Bath Hospital. The test has also been used in cases of incipient Raynaud's and other arterial diseases of the extremities, the results of which may form the subject of another paper.

Benatt and Taylor (1940) made use of the contrast bath as a test for vascular response, and found that patients with rheumatoid arthritis gave a normal response to heat and cold unless there was a marked postural deformity. Other authorities, on the contrary, find that a defective peripheral circulation is a usual concomitant in all forms of chronic rheumatism. Thomson and Gordon (1926) speak of signs of vasomotor instability. Pemberton (1929) refers to evidence indicative of a disturbance of the circulation. Bisset and Woodmansey (1932) give support from observations of capillary circulation. Halls Dally (1933) claims that chronic rheumatism is due to an inherent failure in the heat-regulating mechanism of the body. Fox and van Breemen (1934) say "... the disturbances in the blood circulation of the skin must certainly be considered ... as a causal factor." The feeble vascular response as a secondary factor in severe rheumatoid arthritis was emphasized by D. H. Collins (1938) at the International Congress. The defective peripheral circulation is instanced by Dunlop, Davidson, and McNee (1942); and, in the aetiology of rheumatoid arthritis, Kersley (1945) says "disturbances in vasomotor function are particularly important."

A hot application causes dilatation of the small vessels in the area, with hyperaemia. A cold application causes constriction, with ischaemia. Moreover, as Gibbon and Landis (1932) have pointed out, when a limb is immersed in hot water a rise in temperature also occurs in the other limbs. Similarly a cold application to one limb causes a fall in temperature of the others. The responses in remote areas to varying thermal stimuli form part of the heat-regulating mechanism of the body, and depend upon the intactness of the sympathetic nerves, and on a change in the temperature of the blood reaching and exciting the appropriate centre in the brain. The process is discussed by Abramson (1944). The procedure adopted in the contrast-bath treatment (Woodmansey, Collins, and Ernst, 1938) aims at re-educating these responses so that the small vessels which appear unduly sensitive to cold, and remain persistently closed for an indefinite period, may re-admit a partial blood flow before the tissues become undernourished, and may fully dilate again when the environmental temperature becomes favourable. We may term it "active vascular exercise" as opposed to the "passive vascular exercise," by suction and compression, which has been advocated.

Method

In the following series of experiments the response to cold by a large number of patients has been tested by a uniform method. The subject sits quietly, for not less than 20 minutes, in a room thermostatically controlled at 65° F. The temperature of each hand is then taken by holding the wire junction of the thermo-electric skin thermometer between the terminal pads of thumb and middle finger. This particular site is chosen because of the dense anastomotic bed in the finger tips, where any circulatory change is rapidly reflected in the temperature. Several preliminary readings are taken at intervals to ascertain the temperature level at rest. At this stage, one hand is immersed, covering the underside of the forearm to the elbow for 1 minute in water at 15° C. It is then removed and dried by dabbing with a towel to avoid friction. Temperature readings are resumed on both hands, and recovery curves plotted.

Results and Discussion

Tests have been performed on 41 patients chosen without reference to their clinical condition. Lack of space precludes the reproduction of all the curves, but the relevant information is tabulated. They are found to fall into three main groups. The first group, 6 in number, reacted in a normal way. The second group, of 18, showed a delayed response varying in degree and in the shape of the curve. The third group consists of 17 persons, all with very pronounced vascular defects, whose hands remained cold with no sign of recovery during the experiment. In the specimen curves shown, the dotted line represents the temperature taken on the immersed hand; the continuous line, the temperature on the non-immersed hand. The hatching shows the period of immersion. It should first be pointed out that, in health, the temperature of the skin never remains constant for long, and small rises and falls in the curve are to be expected. Such minor fluctuations may therefore be disregarded in assessing the character of a curve.
The character of the curves for a normal subject is shown in Fig. 1. There is an immediate sharp fall in the immersed hand due to direct contact with the cold water. The reaction starts almost at once and is complete—i.e. the original temperature is attained—in 9 minutes. No significant fall occurs in the non-immersed hand.

**Fig. 1.—Normal curve of a healthy subject.**

(1) **NORMAL**  
M 24 Wt 10st  
34°C  
32  
30  
28  
26  
24  
10 MINUTES 20

(2) **RHEUM. ARTH.**  
F 49 Wt 10st 6lb  
36°C  
34  
32  
30  
28  
26  
24  
22  
10 MINUTES 20

**Group 1.**—Fig. 2 shows the type of rheumatoid arthritic subject which gives a normal response. The curves of each case in Group 1 in the Table are similar in features to Fig. 1. The reaction starts from the cold with little or no delay, and is complete in every case in 13 minutes. In none is the short immersion sufficient to depress the temperature of remote limbs more than a degree or so. Another point to notice is that the final temperature is 30°C. or higher.

**Group 2.**—This group consists of cases showing a vascular defect in widely differing stages of severity, with either a short, medium, or long delay in the reaction. When once the recovery is initiated it may proceed rapidly up to as much as 6 degrees per minute. There is usually a considerable fall in temperature of the non-immersed hand. The recovery in both hands generally takes place at about the same time. Fig. 3 shows the medium-lag type. Here the effect of the cold is sufficient to cause a noticeable fall in temperature in the non-immersed hand, from which recovery does not begin for 10 minutes. In Fig. 4 there is a lag of 20 minutes. In both these cases, after the point of complete recovery there is a minor fall, probably due to long sitting without movement. In a subsidiary group, illustrated by Fig. 5, the temperature of the non-immersed hand is not affected; and, though the immersed hand soon begins to recover, the recovery is a long and gradual struggle. There are a few cases in Group 2 with curves intermediate in character between those of Figs. 3 and 5. The Group 2 curves are characterized by a long reaction time, even when the reaction starts promptly. The final temperature is usually lower than in Group 1.

**Group 3.**—Fig. 6 represents the large number of cases showing no reaction whatever. In this group, therefore, there are no figures in the reaction time column. The initial and final temperatures are

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**Explanation of Curves**

The dotted line represents the temperature taken on the immersed hand. The continuous line represents the temperature on the un-immersed hand. The hatching shows the period of immersion.
Fig. 4.—A very prolonged delay before the response takes place.

Fig. 5.—Indicating the long gradual process of recovery in this type.

Fig. 6.—The very refractory case with no sign of recovery during the test.
invariably low. The low initial temperature, however, is by no means an absolute criterion of a Group 3 case, for it is found frequently that the cold application acts as a stimulant so that the final temperature is much higher than the initial temperature (cf. Fig. 4).

No attempt has yet been made to correlate the findings with clinical condition or with blood pressures or sedimentation rates.

Conclusions

The observations indicate that in a large majority of the cases of rheumatoid arthritis at the Royal Bath Hospital a vascular defect is present. The test may be considered a useful index showing the degree of resilience of the patient in coping with adverse temperature conditions and the integrity of the remote response mechanism. It thus provides more information than can be deduced from the customary tests based on circulation times, the reactive hyperaemia test of Lewis, pulsation, or the plethysmograph.

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