9771 P

Differences in Temperature of Skin and Muscles of the Lower Extremities Following Various Procedures.*

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During the past 2 years we have been investigating the regulation of the circulation in the muscles of the lower extremities. Variations in the temperature of tissues were accepted as indicating variations in the blood flow to those tissues. Thermocouples were used to determine skin surface temperatures, and the temperatures of the muscles were established by thermocouple needles inserted deep into these structures. Associated changes in body temperature were noted by means of a continuous registering rectal thermometer. In each experiment stabilization of skin, muscle, and room temperatures were obtained before any procedure was begun. Temperature observations were continued for a period of from 2 to 5 hours in each instance.

The application of heat to the upper extremities (Landis test) produced striking elevation in the surface temperature of the skin of the feet, but the muscle temperature of the legs remained unchanged. Paravertebral injections of novocaine were followed by a marked rise in skin surface temperature but no change occurred in the temperature of the muscles. Paravertebral injections of alcohol, which produce a more prolonged effect than novocaine, likewise failed to cause any elevation in calf muscle temperature although the skin surface temperature rose. Following spinal anesthesia the calf muscle temperature remained unchanged, while the temperature of the surface of the skin became markedly elevated. Intravenous injections of hypertonic sodium chloride solution were followed by elevation of both skin and muscle temperatures. Intramuscular injections of pancreatic tissue extract (Sharpe & Dohme No. 568) were not followed by any change in skin or muscle temperature. Intravenous injections of adrenalin produced a striking rise in the temperature of muscles which had a good circulation and a fall in skin temperature. Where the circulation was poor, the degree of muscle temperature elevation was less marked. It has been shown experi-

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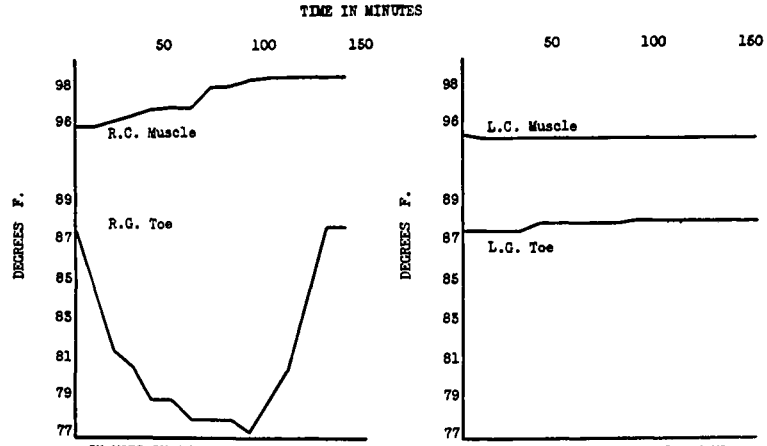
mentally by Gunning[1] and by Hoskins, Gunning and Berry[2] that adrenalin causes dilatation of the blood vessels in skeletal muscles. This work has been reviewed by Wright.[3] The data which have been collected in this investigation are to be presented in more detailed publications. One typical chart of each experiment is shown at this time.

The usual assumption that increase in skin circulation of the extremities is accompanied by an increase in muscle circulation is not substantiated by these observations. The application of heat to the forearms, and the induction of paravertebral or spinal anesthesia, while producing a marked increase in circulation of the skin, fails to influence the circulation of the muscles. Clinical observations of the failure of ganglionectomy and paravertebral injections of alcohol to relieve intermittent claudication are in accord with these findings.

Definite elevation of both skin and muscle temperatures follows intravenous injections of hypertonic salt solution. Continuous observations of the rectal temperatures during and for several hours after such intravenous injections show very slight rise (0.2° to 0.5°F.) or no rise in body temperature. The mechanism by which this increased circulation in the muscles is obtained is not yet clear. Patients with peripheral vascular disease treated with intravenous injections of hypertonic salt solution regularly show improvement



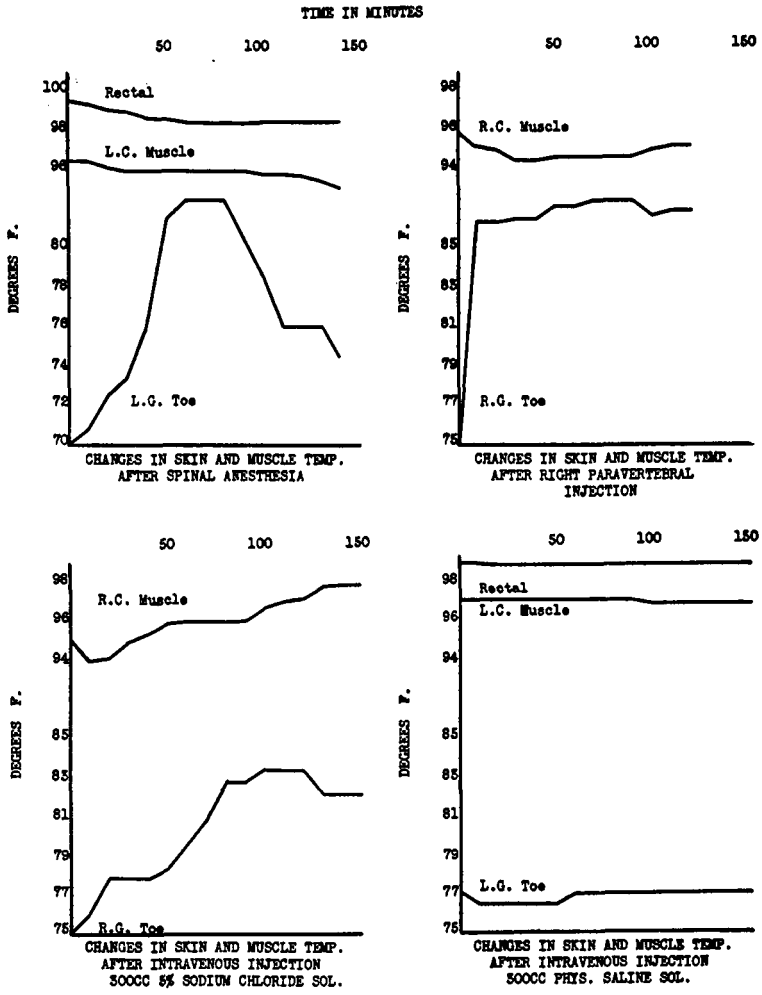
CHANGES IN SKIN AND MUSCLE TEMP. AFTER INTRAVENOUS INJECTION OF 2CC OF 1-1000 ADRENALIN IN 500CC OF PHYS. SALINE SOLUTION

CHANGES IN SKIN AND MUSCLE TEMP. AFTER INTRAMUSCULAR INJECTION OF 5CC PANCREATIC TISSUE EXTRACT

1 Gunning, R. E. L., *Am. J. Physiol.*, 1917, **43**, 395.

2 Hoskins, Gunning and Berry, *Am. J. Physiol.*, 1916, **41**, 513.

3 Wright, *Applied Physiology*, 6th Edition, Oxford University Press, London, 1936.



in walking. The demonstration that such injections cause an elevation in the temperature of the muscles adds experimental evidence to substantiate the value of this form of treatment. From the limited number of forms of treatment that we have studied thus far, it is the only method that appears to increase the circulation in both skin and muscles.

A pronounced rise in muscle temperature is produced by intravenous injections of adrenalin. Adrenalin stimulates the sympathetic nervous system to cause vasoconstriction. This is indicated by a striking fall in skin surface temperature. The response in muscles is an elevation rather than a fall in temperature. The thera-

peutic possibilities of this hormone for the relief of intermittent claudication are being investigated.

It is, of course, well known that the circulation in the skeletal muscles can be increased by chemical means or in response to increased work. The purpose of this presentation is to show that such changes in circulation do not appear to be effected through a nervous mechanism.

9772

Induction of Oestrous Changes in the Monkey and Bitch by Triphenyl Ethylene.* †

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It has been shown previously (Robson and Schönberg[1]) that triphenyl ethylene will induce oestrous changes in the genital organs and mating in ovariectomized mice and hypophysectomized rabbits. The effects in mice may last for several months. In the present experiment the action of this substance has been investigated in monkeys and in a bitch.

Two monkeys (*Macacus rhesus,* weighing 4.25 kg. and 3.8 kg. respectively) were ovariectomized and the first injection was given 24 and 31 days later. At the time of the first injection the sexual skin was pale in both animals. The substance was injected subcutaneously in solution in oil.

Monkey I received 1.2 gm. at the first injection, 1.0 gm. 4 days later and 1.2 gm. 8 days after the first injection. Eleven days after the first injection the whole sexual skin, including the base of the tail, became red and somewhat swollen and the redness and swelling increased during the ensuing week and was then maintained until the animal was killed for postmortem examination, 26 days after the first injection. Histological examination showed that the vaginal wall was very thick and consisted of an outer almost completely cornified zone and an inner zone of nucleated cells. The condition was similar to that produced by the injection of oestrin in the ovariecto-

* This is part of work carried out in collaboration with Professor A. Schönberg on the activity of certain synthetic oestrogenic substances.

† The expenses of this investigation have been defrayed by a grant from the Medical Research Council.

[1] Robson, J. M., and Schönberg, A., *Nature,* 1937, **140**, 196.