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SKIN BLOOD FLOW IN ATOPIC DERMATITIS*

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Persons with atopic dermatitis are thought to have disturbances in the "tone" and the reactivity of cutaneous vessels. Alteration in vascular tone are suggested by observations that atopic individuals have fingertip temperatures which are lower than normal (1, 2, and 3). Alteration in vascular reactivity is suggested by the frequent occurrence of white dermographism (4, 5, and 6), delayed blanching following intracutaneous injection of acetylcholine (6, 7) or mecholyl (8, 9) or the topical application of nicotinic acid esters (10, 11, and 12), the occasional absence of "flare" in the histamine test (11, 12, and 13) and the finding that fingertip temperature of atopic individuals falls more rapidly in a cold room and rises more slowly in a warm room than does that of a normal person (2, 13).

These observations, based on changes in skin color and temperature, provide only indirect evidence as to the nature of vascular disturbance. Nonetheless, they are commonly interpreted as indicating that persons with atopic dermatitis have altered peripheral vascular function.

By use of methods now available it is possible to obtain a more selective and quantitative evaluation of vascular function. We sought quantitative confirmation of the alleged alteration in vascular state in atopic individuals by measurement of changes in the cutaneous blood flow. Skin blood flow was measured by capacitance plethysmography with counterpressure as described by Hyman, *et al.* (14). By subtracting blood flow measurements with counterpressure from total flow, an estimate of skin blood flow is obtained. In all cases, occlusion of the circulation in the hand and arm distal to the measured segment was obtained by use of a cuff inflated to suprasystolic pressures.

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MATERIALS AND METHODS

All blood flow determinations were made on the proximal portion of the left forearm in a temperature controlled room at 25° C ± 1° C. Measurements were made with the patient lying supine in bed, with the left arm elevated above heart level. Capacitance changes were measured with a capacitance plethysmograph and recorded on a Bauch and Lomb VOM 5 recorder. Capacitance changes were correlated to volume changes by means of an electrical calibration system as described by Hyman and Wong (15).

After the subject had rested for 10 minutes, six consecutive determinations of total forearm blood flow were made at 30 second intervals. The mean of these 6 values was used in calculations. After a rest period of 3 minutes the procedure was repeated with a 6 cm wide counterpressure cuff inflated to a pressure of 35 mm Hg. The mean of these measurements was taken to indicate muscle blood flow. Skin blood flow was calculated from the difference between total segment flow and flow through muscle.

Measurements were made on a control group of 18 persons and on 27 persons with atopic dermatitis. The control group ranged in age from 21 to 81 and was drawn from men and women personnel and patients of the dermatology ward of the Los Angeles County General Hospital. No persons in the control group had a personal or family history of eczema, asthma, hay fever, or allergic rhinitis. The in-patients included in the control group had localized dermatitis that did not involve the upper extremities. None was on systemic anti-histamine or steroids, or on topical steroids to the upper extremities.

The group with atopic dermatitis ranged in age from 16 to 41 and was drawn from the dermatology ward and clinic of the Los Angeles County-University of Southern California Medical Center. All patients carried a diagnosis of atopic dermatitis, based on: 1) a history of long-standing, recurrent, pruritic dermatitis involving the flexural surface of extremities with onset in childhood, and 2) a record by a dermatologist confirming the existence of flexural dermatitis at some time in the past. For the purpose of subsequent analysis the atopic

TABLE I

Skin blood flow in ml/100 cc tissue/min in forearm of normal persons and persons with atopic dermatitis

Group	No. of persons	Blood flow (ml/100 cc tissue/min)	Standard deviation
Control	18	1.38	±.56
Atopics			
Clear skin	11	.59	±.26
Chronic lesions	15	1.30	±1.07
Acute lesions	1	7.69	

persons were divided into 3 sub-groups according to whether or not the upper extremities were free of lesions at the time of the study and, if lesions were present, as to whether they were acute and erythematous or chronic and lichenified. Apart from 4 subjects with acute or chronic skin lesions, all other persons in the study had been taken off all medications for 2 days prior to the study.

RESULTS

Skin Blood Flow. The mean value for skin blood flow in the control group was 1.38 ± .56 ml/100 ml tissue/min (Table I). This value compares with similar determinations reported in the literature. In persons with atopic dermatitis, skin blood flow varied according to the presence and nature of skin lesions. In cases with no skin lesions on the forearm, skin flow was low: the mean for the 11 persons in this subgroup was .59 ± .26 ml/100 cc tissue/min., and the difference from the mean of the control group had a $P < .001$.

Consistent with the inflammatory condition, the one atopic with acute skin lesions had a skin flow of 7.69 ml/100 cc tissue/min, or approximately 6 times the normal value. Atopics with chronic, lichenified skin lesions had skin flows of intermediate value which did not differ significantly from those in control groups.

Total and Muscle Flow. Mean value for total and muscle flow in the control group were 3.18 ± 1.30 and 1.76 ± 1.01 ml/100 ml tissue/min. respectively (Table II). The sub-group of atopic individuals with clear skin was found to have a significantly lower total forearm flow. The mean value was 1.98 ± .82 ml/100 cc tissue/min. This decrease could not be accounted for by the decrease in skin flow alone, and suggests a decrease in muscle flow. On calculation, however, mean value for muscle flow in this sub-group differed from the corresponding measurement in the controls by an amount at the borderline of statistical significance, P being equal to .3–.4.

There was a marked elevation in total and muscle flow in the one atopic with acute skin lesions. However, the apparent increase in muscle flow in this case could be an artifact since, under conditions of high skin flow the counterpressure technique may not occlude all cutaneous capillaries. This error would tend to overestimate true muscle flow and consequently underestimate blood flow through the skin.

DISCUSSION

The most significant finding of this study is the marked decrease in the flow of blood through the skin of the forearm of persons with atopic dermatitis when this part of the body is free of lesions. The method used to measure cutaneous flow has been described previously and its validity established in normal persons (14). However, there is reason to believe that when pressure within small blood vessels is increased, as when skin flow is high, the counterpressure of 35 mm Hg may not completely occlude the cutaneous vessels. The result is an abnormally high apparent flow through muscle, and a corresponding decrease in apparent skin blood flow (16). This probably explains the marked elevation in muscle flow noted in the atopic individual with acute dermatitis. However, there is no way in which a similar error could account for the low skin flows observed in persons with atopic dermatitis and clear skin, since in these individuals total blood flow

TABLE II

Total and muscle blood flow in ml/100 cc tissue/min in forearm of normal persons and persons with atopic dermatitis

Group	No. of persons	Total blood flow (ml/100 cc tissue/min)	Muscle blood flow (ml/100 cc tissue/min)
Control	18	3.14 ± 1.30	1.76 ± 1.01
Atopics			
Clear skin	11	1.98 ± .82	1.58 ± .92
Chronic lesions	15	3.07 ± 2.04	1.76 ± 1.07
Acute lesions	1	15.7	4.15

was also low and muscle flow was within the low normal range.

Blood flow through an organ is proportional to mean arterial pressure and inversely proportional to hemodynamic resistance within the organ. Total hemodynamic resistance in a tissue is, in turn, a reflection of the level of vasoconstrictor tone, i.e. the caliber of the individual resistance vessels (mainly arterioles) and the number of patent parallel pathways available for perfusion. The decreased blood flow observed may be interpreted as:

1. An increase in vasoconstrictor tone, which is most pronounced in, but not limited to the cutaneous vessels, or
2. A lower than normal blood pressure, or
3. A diminished number of vascular pathways through the skin due to capillary atrophy.

Most of the studies of vascular function in persons with atopic dermatitis have concentrated on the altered reactivity evidenced by white dermographism, delayed blanching to mecholyl, decreased histamine flare, and temperature response to hot and cold environment. However, reactivity and tone are separate and distinct physiological properties of vessels and may change independently of one another; tone cannot be inferred from reactivity.

The only studies which bear directly on alteration of tone are those in which a lower than normal fingertip temperature was found in atopic individuals (1, 2 and 3). This finding is difficult to interpret since it has not been confirmed by more recent studies. Abrams and Farber (17) found a low fingertip temperature only in men with mild atopic dermatitis, while all women with atopic dermatitis and men with severe atopic dermatitis had an increase in fingertip temperature. Varovier and Hahn (18) found elevated fingertip temperature in both male and female atopic individuals with mild or moderate dermatitis. It should also be noted that the innervation of the vessels of the hand is different from that in other cutaneous areas, so that the tone of hand vessels does not necessarily reflect the state of vessels elsewhere in the skin. Illustrative of this point is that in every study where a low fingertip temperature was found in atopic dermatitis, the skin temperature of other parts of the body was normal or elevated.

The argument that atopic individuals may have a tendency to low mean blood pressure is primarily based on a study by Eyster *et al.* (13) who found that the average blood pressure in a group of 24 persons with atopic dermatitis in their late teens and early 20's was 100/67. In conflict, is a recent study by Varovier and Hahn (18) in which no difference in systolic blood pressure was found between 14 normal children and 14 children with atopic dermatitis and asthma.

Atrophy, or decrease in number of cutaneous vessels does not seem to be a feature of atopic dermatitis. In biopsies of acute atopic dermatitis the cutaneous vessels appear dilated (19) and perhaps increased in number (20). This is consistent with our observations that in such cases there is an increase in skin flow. In the biopsies of normal skin of persons with atopic dermatitis abnormalities in the number or dilation of vessels have not been reported (20).

Our own study, though it demonstrates an apparent decrease in flow of blood through the skin and muscle of atopic individuals still leaves open to speculation the cause of this change. Assuming that there is no alteration in number of cutaneous vessels, the greater decrease in flow through the skin than through muscle may indicate that changes in tone played a more important role than did changes in blood pressure, since a decrease in flow secondary to lower blood pressure might be expected to affect both areas to the same degree. The concurrent determination of blood pressure and blood flow should help to clarify this point and also provide quantitative estimates of peripheral vascular resistance.

SUMMARY

Total, muscle and skin blood flow were measured in the forearm of 27 persons with atopic dermatitis and in a control group of 18 persons. A marked decrease in the skin flow and a smaller decrease in muscle flow were found in those atopic individuals who were free of skin lesions. The reason for this change is still open to speculation. One person with atopic dermatitis and acute skin lesions had a marked increase in skin flow, while atopic individuals with chronic dermatitis had skin flows which were not significantly different from those of normal persons.

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