



## Temperature and Blood Flow in Macules of Lepromatous Leprosy<sup>1,2</sup>

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Destruction of both sensory and autonomic nerve fibers within the dermis is characteristic of leprosy and, in association with other clinical features, may be sufficiently pathognomonic to establish the diagnosis without demonstrated presence of acid-fast bacilli.

Subjective sensory testing for superficial touch, pain, and heat appreciation is often rendered unreliable by emotional factors and problems of communication. Objective evidence of nerve destruction is provided by the axon flare response to intracutaneous histamine and the methacholine chloride (mecholy) stimulation of local sweating. We here report a demonstration of impaired vasoconstrictor fibers as reflected in altered local temperature and blood flow in leprosy skin lesions. Our experience with clearance methods for measuring dermal blood flow and the availability of rapidly responding telethermographic equipment (<sup>4</sup>), facilitated this pilot study.

### REPORT OF CASE

A 38 year old Mexican man was referred to us for evaluation of skin lesions associated with neurologic deficiency. He had been a professional guitarist until 10 years previously when he lost sensation in his fingers. We established a diagnosis of lepromatous leprosy.

His hands were weak, deformed and numb and there was impaired control of finger movement. There were numb areas on the feet, legs and trunk, a painless plantar ulcer, and nasal stuffiness. On the trunk and extremities, there were about 30 irregularly ovoid, hairless, pale or slightly erythematous lesions, from 1.5 to 40 cm. in diameter (Fig. 1). Although slight thickening was discernible in several of these lesions when observed by side-lighting, none were palpable. The largest of the involved areas were anesthetic to pinprick and light touch and did not respond with flare after intradermal histamine injection nor by sweating after mecholy (modified Wada technic (<sup>6</sup>)). The Mitsuda reaction was negative.

Histopathologic specimens from the lesions showed a dermal infiltrate of foamy histiocytic cells, most pronounced about nerves, vessels, and sweat glands. There were large numbers of single and clumped acid-fast bacilli, both intracellularly and extracellularly.

### METHODS AND RESULTS

**Temperature studies.** Temperature studies were conducted with an infrared telethermometry system, whose thermal discrimination is 0.2°C. It consists of an infrared camera and an oscilloscope on which the thermal image is displayed in a continuous range of gray tones; warm areas appear lighter than cold areas (Figs. 2, 3). Temperature of any area can be evaluated by matching it to a gray scale. Any range of temperatures can be emphasized to establish an isotherm intensifying the corresponding areas of the cathode ray oscilloscope record and the temperature scale to saturated white. Such a thermal pattern is shown in Figure 4. Most anesthetic areas of the large hypopigmented macules were 0.3

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<sup>4</sup> "Thermovision" Model 652, AGA Corporation, Lidings, Sweden.

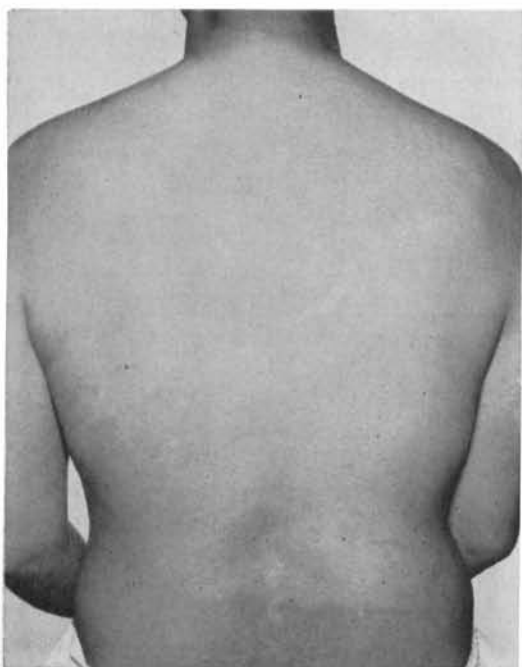


FIG. 1. Large anesthetic, hypopigmented macules on left scapular and right lumbar areas.

to 2°F warmer than the surrounding normal skin; areas in which sensation was retained were not hyperthermic.

**Blood flow studies.** The sites tested were an area of normal skin in the left scapular region and an adjacent hypopigmented macule which was 1.7°F warmer. After the patient had been resting in the prone posi-

tion for 15 minutes in a temperature controlled room at 25°C the isotope clearance technic was used to estimate the cutaneous blood flow (<sup>2</sup>).

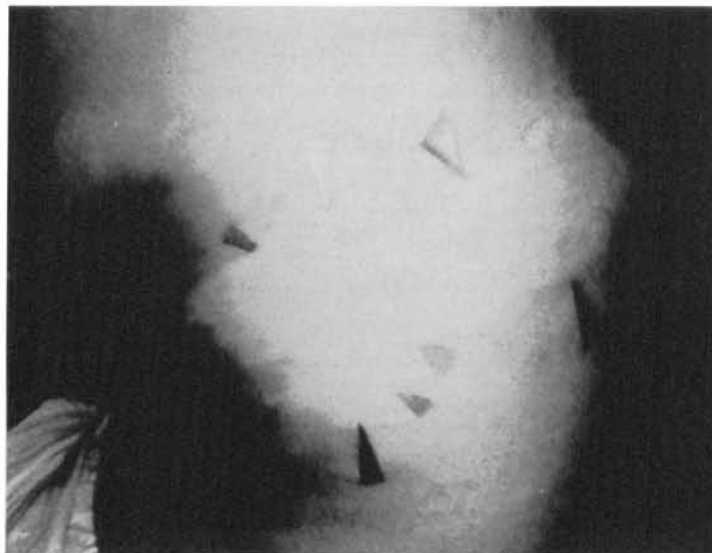
Isotonic saline solution containing about 0.5 microcurie of I<sup>131</sup> labelled iodoantipyrine (IAP) in a volume of 0.05 ml. was injected intracutaneously with a 27 gauge needle. The rate of removal of the IAP was monitored with a scintillation counter and rate meter coupled to a T-Y recorder. When counts had returned to background levels, the studies were repeated with similar injections at these sites with the isotope in 0.05 ml. of saline containing one part per million of norepinephrine.

The clearance of IAP from the normal skin areas was 10.6 per cent per minute; clearance from the adjacent macule was 18.9 per cent per minute, i.e., 78 per cent greater. When the studies were repeated with norepinephrine in the vehicle, slight blanching was noted at both injection sites. Within the lesion this blanching was more intense but less extensive. Under these conditions clearance from normal skin was reduced to 6.25 per cent per minute while clearance from the lesion was reduced to 1.25 per cent per minute.

## DISCUSSION

These findings confirm an earlier report (<sup>7</sup>) that temperature of the leprosy skin lesion may be elevated. The hyperthermia

FIG. 2. Close-up of large anesthetic and hypopigmented macule (ca. 9 inches by 3 inches) of left scapular area. IAP clearances were done in center of this lesion and on normal skin 3 cm. above upper border of lesion.



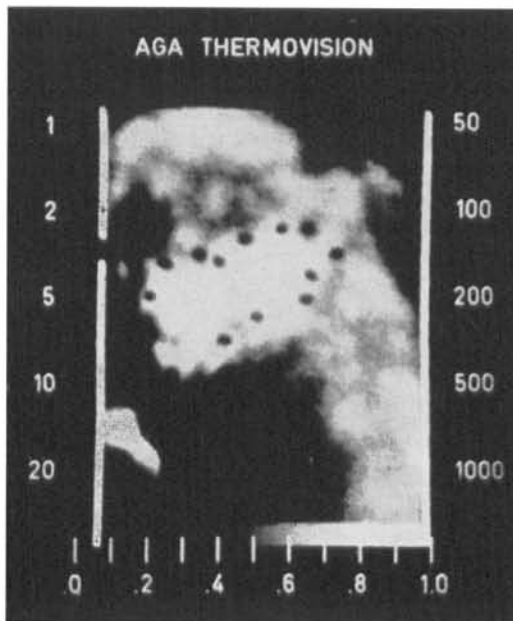


FIG. 3. Thermographic appearance of lesion in Figure 2. Warmest area in lightest tone, corresponds closely to extent of macule, outlined with markers. Relative temperature of any area can be estimated by matching its tone to gray scale at bottom of illustration. Temperature range (indicated by black bar or scale at left side of illustration) is  $2^{\circ}\text{C}$ .

in the anesthetic areas suggests a local hyperemia. This possibility was supported by the clearance data. Because iodoantipyrene is a fat soluble compound it can move rapidly across the walls of all small blood vessels, so that its removal from the tissue is flow limited, and affords a measure of blood flow at the injection site (<sup>5</sup>). Thus, the increased clearance of this compound in the macule indicates an elevated local cutaneous blood flow. This hyperemia may be ascribed to either an inflammatory tissue reaction or the loss of autonomic constrictor influence.

The adrenergic constrictor postganglionic innervation of cutaneous vessels maintains a normal state of partial constriction by a slow but continuous train of impulses. Interruption of the fibers removes the constrictor stimulus and results in vasodilation and increased cutaneous blood flow (<sup>4</sup>). Destruction of nerve fibers in leprosy might be expected to have this effect. The in-

crease in local blood flow in inflamed tissue, however, might explain our observations equally well.

The sensitivity of vessels to norepinephrine was used to differentiate between these alternative possibilities. Alpha adrenergic receptor sites of denervated vessels are more sensitive than normal vessels to direct stimulation by norepinephrine (<sup>1, 3</sup>) while vessels involved in inflammatory reactions are hyposensitive to this catecholamine (<sup>8</sup>). Since equal doses of norepinephrine produced greater reduction in IAP clearance within the lesion than in adjacent normal skin, we believe this demonstrated hypersensitivity tends to confirm the loss of vasoconstrictor tone in the lesion.

These observations based on a preliminary report of a single case may not necessarily hold true for all leprosy lesions. However, since blood flow dependent functions, such as temperature and clearance, vary with the state of the autonomic nerve fibers, it seems highly probable that they re-

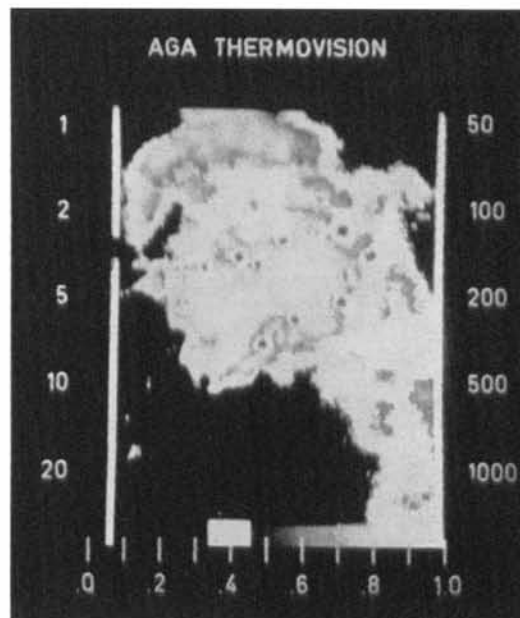


FIG. 4. Isotherm set at temperature of same lesion. Areas of similar temperature (in this case, hyperthermic extent of lesion) highlighted in white. Relative temperature of isotherm indicated by white bar on gray scale at bottom of illustration.

flect destruction of these postganglionic nerves paralleling the progressive damage of pain fibers, which leads first to hypoesthesia and paresthesia and only subsequently to hypesthesia and anesthesia.

### SUMMARY

Temperature and blood flow studies were made of lepromatous skin lesions in a Mexican male by means of infrared telethermometry and  $I^{131}$  labeled iodoantipyrene isotope clearance technics respectively. It is concluded that the hyperthermia found in anesthetic areas is due to local hyperemia. To distinguish between an inflammatory tissue reaction, and loss of autonomic constrictor influences as responsible for this hyperemia, local sensitivity to norepinephrine was tested. Since there was a clear hypersensitivity in the area of the lesion, we concluded that there was autonomic degeneration.

### RESUMEN

Estudios de la temperatura y del flujo de la sangre fueron hecho de lesiones lepromatosas de la piel en un varón mejicano por la técnica de teletermometría infraroja y, respectivamente, por el "clearance" de isótopos rotulados con  $I^{131}$ -iodoantipyrina. Se concluye que la hipertermia encontrada en regiones anestéticas se debe a hiperemia local. Para distinguir entre una reacción inflamatoria del tejido, y pérdida de influencias constrictoras autonómicas como responsables por esta hiperemia la sensibilidad a norepinefrina fue probado. Desde que hubo clara hipersensibilidad en la región de la lesión, concluimos que hubo degeneración autonómica.

### RÉSUMÉ

Chez un sujet mexicain de sexe masculin, on a mené des études se rapportant à la température et au débit sanguin au niveau des lésions lépromateuses de la peau, au moyen de techniques recourant respectivement à la téléthermométrie en infra-rouges et au clearance iso-

topiques de l'iodoantipyrène marquée au  $I^{131}$ . On en conclut que l'hyperthermie observée dans les zones d'anesthésie est due à l'hyperémie locale. Dans le but de distinguer entre une réaction inflammatoire des tissus, et une perte des influences de constriction autonome, comme facteurs responsables de cette hyperémie, on a testé la sensibilité locale à la norépinephrine. Une nette hypersensibilité était mise en évidence dans la zone de la lésion; on en conclut, dès lors, qu'il existait une dégénération autonome.

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