Use of Liquid-crystal Thermography to Evaluate Sympathetic Blocks

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Sympathetic nerve blocks are frequently used in the treatment of vasospastic disease and as diagnostic tools for other peripheral vascular diseases. Frequently, it is difficult to determine the effectiveness of such blocks by objective criteria because subjective criteria may be lacking. The methods suggested to test for efficacy objectively are qualitative or semiquantitative. In this category belong 1) venous dilatation, 2) the sympathoaural reflex, 3) abolition of sweating demonstrated by the ninhydrin test, 4) comparison of skin temperatures in the blocked and unblocked extremities. The limitations of these tests are especially evident in those cases where circulation to the extremity is affected in a patchy distribution.

The ideal test for the evaluation of sympathetic nerve blocks should: 1) allow quantitative assessment of changes in the circulation to the whole area affected by the block, 2) be noninvasive, 3) be readily available, 4) be inexpensive. A method that appears to fulfill these criteria is liquid-crystal thermography. I have evaluated the use of thermography with cholesteric liquid crystals to assess the effectiveness of sympathetic nerve block of the upper extremity.

Liquid thermography has been used by others for location of the placenta and detection of breast cancer. This technique produces color thermograms over a large skin area with a temperature sensitivity of 0.1 degree C and a spatial resolution of 1,000 lines per inch. The method is inexpensive, noninvasive, safe, and the color change with temperature has a time constant of 0.1 seconds.

Liquid crystals are compounds that have color–temperature sensitivity when in the cholesteric phase. The cholesteric phase is a state of matter with a molecular arrangement intermediate between a solid and a liquid. For some compounds, cholesteric phase exists in a specific temperature range: above and below this range, the compound exists as a liquid and as a crystalline solid, respectively. In the cholesteric phase the molecular arrangement produces maximal scattering of a specific wavelength of light and the other wavelengths are transmitted through the material. When viewed against a black background the scattered light shows an iridescent color and the transmitted light is absorbed by the black background. A small change in temperature alters the molecular order and changes the wavelength that is subject to maximal scattering. A given cholesteric liquid crystal always shows the same color at a given temperature. Many esters of cholesterol have these properties, and their color–temperature responses have been characterized so that a combination of esters can be used to measure temperatures from -20 to 250 C.

The materials used in these experiments are commercially available (as kits) from Liquid Crystals Biosystems, Inc., 26101 Miles Ave., Cleveland, Ohio 44128. The kit consists of four aerosol cans containing crystals with ranges of 30–33 C, 31–34 C, 32–35 C and 33–36 C, and aerosol cans containing water-soluble black base, at a cost of $50.00. A conservative estimate is that there is enough material for 40 patients in each kit.

The coldest temperature of each range shows as red and orange and the warmest as blue and violet; intermediate temperatures show as yellow and green. Below and above the range the only color visible is that of the black base.

REPORT OF A CASE

A 55-year-old white man was admitted to the Veterans Administration Hospital, Miami, complaining of intermittent claudication and paresthesias in both feet and the left hand, of one month's duration. He had adult-onset diabetes mellitus of...
An angiogram of the left arm (fig. 1) showed normal subclavian, axillary and brachial arteries. The ulnar artery was completely occluded approximately 1 cm past its origin, with minor reconstitution in the distal arm. There was marked narrowing of the radial artery and its interosseous branches with almost complete occlusion in its distal portion close to the wrist joint. At this point small collaterals reconstituted a portion of the palmar arch. The circulation to the hand and wrist was markedly diminished. The Anesthesiology Department was consulted to determine whether there was a vasospastic component in the patient's disease that could be helped by sympathectomy.

METHODS

The left stellate ganglion was blocked on two separate occasions with 20 ml 0.25 per cent bupivacaine with epinephrine, 1:100,000, using the technique described by Moore. Prior to administration of the block, the temperature of the forearm was determined with a skin thermometer probe (Yellow Springs Instrument Company). The oil in the skin was removed with a solution of 70 per cent ethyl alcohol, and the black base was sprayed on and allowed to dry. The 31-34°C crystals were then sprayed on and allowed to dry. Room temperature was kept at 20°C. After a 10-minute period for equilibration, control photographs (not shown) were taken, using Kodak Ektachrome film with electronic flash. The temperature range of the crystals was chosen so that the warmest areas prior to the sympathetic block corresponded to a blue color. A second set of pictures was taken 15 minutes after administration of the block.

RESULTS

Prior to stellate-ganglion block, skin temperatures, as measured by liquid-crystal thermography, were less than 31°C (black) in the third, fourth and fifth fingers; 34°C (blue) in the forearm and thumb; 31°C (red) in the second finger; 32-33°C (orange-green) in the distal portion of the palm, 33-34°C (blue-green) in the thenar eminence, and 33°C (green) in the hypothenar eminence. After stellate-ganglion block skin temperatures were more than 34°C (black) in the thumb, forearm, and thenar and hypothenar eminences; 34°C (blue) in the distal portion of the palm and second finger; 33-34°C (green-blue) in the proximal phalanges of the third,
Severe Hyperthyroidism Associated with Hydatidiform Mole

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In 1955, Tissie and associates reported three cases of hydatidiform mole associated with clinical hyperthyroidism that disappeared within a few days after delivery of the mole. Since that time, similar cases with increasingly sophisticated hormonal studies have been reported.

Three different normal thyroid stimulators, i.e., pituitary thyrotropin, chorionic thyrotropin, and long-acting thyroid stimulator (LATS) have been described. Kenimer and associates3 reported that when human chorionic gonadotropin activity fell below 150–170 units/ml, thyroid-stimulating activity was undetectable, and they calculated human chorionic gonadotropin...