

# Computerized Thermography in Post-Stroke Reflex Sympathetic Dystrophy

Linda A. Hershey, M.D., Ph.D., James C. Montoro, B.S., and Michael Anbar, Ph.D.

● We are examining the use of computerized thermography as a noninvasive modality for identifying patients with post-stroke reflex sympathetic dystrophy. Using a standardized protocol, we examined the hands of six men, two of whom had post-stroke reflex sympathetic dystrophy (RSD), two of whom had stroke alone, and two of whom were age-matched normal controls. Although we found nearly as much left-right temperature asymmetry in the control hands as in those of patients with RSD, one distinguishing feature of RSD seemed to be the temperatures recorded at the tips of the fingers. Fingertips were cooler than the rest of the hand in RSD patients, whereas they were warmer in controls. This finding was most consistently present in prone, rather than supine, thermograms.

Reflex sympathetic dystrophy (RSD) is thought to be caused by focal dysfunction of the autonomic nervous system. It manifests itself with pain, tenderness, swelling, and sensations of coldness or burning in the distal extremity.<sup>1,2</sup> Reflex sympathetic dystrophy develops in the weak limb in about 12.5% of patients after hemiplegic stroke.<sup>3</sup> Methods currently used to diagnose RSD include scintigraphy and roentgenography, which have sensitivities of 60% and 69%.<sup>4</sup>

Liquid crystal thermography and infrared thermography have both been used to demonstrate regional cutaneous hypothermia in hands affected by RSD,<sup>5,6</sup> but reproducible and quantifiable diagnostic criteria that distinguish post-stroke RSD patients from stroke controls or normal age-matched controls have not yet been developed. However, computerized thermography is capable of measuring infrared emission from the skin with a degree of spatial resolution and quantitative precision that should allow smaller temperature differences to be detectable over more circumscribed anatomic areas. Furthermore, while computerized thermography is currently being applied to the study of RSD produced by nerve injury and soft-tissue trauma, little attention has been focused on post-stroke RSD. Therefore, compared computerized thermograms of the hands of pa-

tients with clinically definite post-stroke RSD with those of stroke controls and normal age-matched controls in order to develop guidelines for future validation studies.

## Methods

Six men signed written informed consent to participate in a study protocol approved by the Human Studies Committee of the Buffalo VAMC. Four had signs of an acute ischemic stroke that had lasted longer than 24 hours. All were alert, were capable of following two-step commands, and were able to sit up in a chair. In none of the patients were the neurologic signs the result of a seizure. None showed evidence of cerebral tumor or hemorrhage on computerized tomography (CT) examination. In the RSD cases, upper extremity pain and tenderness were not the result of shoulder subluxation, nerve root injury, arthritis, or rash.

Two of the men had definite RSD according to the clinical criteria of Kozin et al.<sup>2</sup>: pain and tenderness in the distal extremity, signs or symptoms of vasomotor instability, and swelling. Neither had dystrophic skin changes. Both had scintigrams that were read as "diagnostic" of RSD by nuclear medicine specialists who were unaware of how the patients met Kozin's criteria.

The patients were ushered into a room that was kept at a temperature (70–72 F). They removed outer clothing to the waist and they donned short-sleeved gowns, then remained seated for 15 min prior to thermography, their arms resting on a portable examining table that was covered with bubbled plastic insulation material. No subject had had his arms exposed to direct sunlight, performed vigorous exercise, smoked a cigarette, or drunk a cup of coffee within one hour of the thermogram (the latter interval was 20 min in one patient).

The computer-aided thermography equipment used (Dorex\*) measures infrared emission from the region of interest with a temperature resolution of 0.1°C. The subjects' hands were held prone for 1 min, then supine

*From the Departments of Neurology and Biophysics, State University of New York at Buffalo and the Neurology Service, Buffalo Veterans Administration Medical Center, Buffalo, New York.*

\*DOREX Computer Aided Thermography Systems, 1019 North Main St., Orange, CA 92667.