

One of the biggest problems in diagnosing complex regional pain syndrome (CRPS) is the lack of a diagnostic test that would quantify the symptoms of the syndrome. The International Association for the Study of Pain (IASP) criteria established in 1994 do not include any technical tests, simply because there is no test that has been proven to diagnose this syndrome¹.

the affected side in comparison to the opposite side. Since 1902, with Dr. Paul Sudeck's description of radiographic changes in patients with CRPS, a conventional bilateral x-ray of the hand has been standard for CRPS diagnosis³. During the first stage of CRPS (0-3 months), x-rays usually look normal, while in later stages (3-12 months) osteopenia appears on the x-rays⁴. Positive findings can be

Bone Scans

Bone scanning is best for demonstrating bone-based disease and clarifying neurological lesions found by x-rays⁷. This is accomplished by measuring the blood flow through the skeleton⁷.

Bone scanning, used for CRPS since the mid-1970s, tells only of significant changes that occur during the subacute period, during the first year⁸. This test is often used to differentiate CRPS from other causes of pain⁹. The three-phase bone scan, which uses immediate and delayed images to study blood flow, is especially useful to CRPS study. These scans show increased blood flow into the CRPS-affected area with an increase in diffuse activity during the "blood pool phase" described below³.

The patient lies on a table while a gamma camera circles his or her body, taking images as the scan progresses⁷. A radioactive tracer is injected into the patient that concentrates in the bones. A technician takes images of the body area in question during the initial phase of "blood flow," then again when the blood "pools" in the area⁸. Two hours later, images will show the tracer in the actual bones during the "delayed phase."

Bone Density Tests

A bone density test measures how many grams of bone mineral content are packed into a segment of bone¹⁰. The higher the mineral content, the denser the bones are. Bone density equates to bone strength.

There are several different kinds of machines that can measure bone density; central machines measure the hip, spine, and total body, while peripheral machines measure the finger, wrist, kneecap, shin bone, and heel¹¹.

CRPS Diagnosis: A review of diagnostic tools

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There are, however, tools that help practitioners document their clinical findings of autonomic, sensory, and motor function and dysfunction, but they cannot be used to validate a diagnosis of CRPS, and often are not covered by insurance. We have described the various tests that might be suggested and their relation to CRPS.

Imaging Techniques

Radiographs (x-rays)

Plain radiographs (x-rays) show the parts of the patient that absorb or block the rays. This captured image can be collected on photosensitive film, digital imaging plate, or fluoroscope². The essential radiograph is developed film exposed to x-ray or gamma ray.

In a patient with CRPS, x-rays show the status of mineralization in the bones of

observed in chronic stages, but also can be related to disuse atrophy⁵. According to a recent study in Germany, specificity is high for x-rays and "plain radiographs facilitate the diagnosis [of CRPS] as soon as bony changes develop"⁶.

J. H. B. Geertzen, MD, PhD, professor and rehabilitation specialist at Groningen University Medical Center in the Netherlands reported in a personal communication to RSDSA that he "always used x-rays to look for missed fractures."

Because this method is less invasive than some of the other diagnostic tests mentioned, it is often used as a preliminary test to view bone mineralization status and track it through the disease process. Demineralization with disuse and loss of function of the CRPS-affected area increases with time³.

According to Dutch treatment guidelines, only four studies of bone density measurement are currently available, none of which contained data on the specificity or sensitivity of this test for CRPS diagnosis¹². In one of the studies, out of 60 patients with shin bone fractures, the 18 that developed CRPS had lower bone densities than those that did not develop CRPS¹³.

MRI, fMRI, PET, and SPECT

Magnetic resonance imaging (MRI), functional MRI (fMRI), positron emission tomography (PET), and single photon emission tomography (SPECT) are among a group of non-invasive imaging techniques that measure biological activity throughout the body¹⁴. While MRIs and fMRIs use magnetic fields and radio waves to produce two- or three- dimensional images without radioactive tracers, PET and SPECT techniques measure concentrations of radioactive tracers to produce two- or three- dimensional images¹⁴.

Skin Temperature Measurement

Infrared Thermometry, Laser Doppler Flowmetry, and Infrared Thermography

These three diagnostic processes measure skin temperature differences, which track vascular movement (blood flow). The difference is in the method of tracking the incidence, sensitivity, and specificity of the temperature changes.

Infrared thermometry records the distribution of skin temperature. The most known use of this technology is for fever measurement, specifically ear and forehead thermometers. In CRPS testing, each area of the skin is then compared with the identical contralateral area⁵.

Dutch treatment guidelines indicate that “a difference of 1.5°C [or 34.7°F] is recommended as a way of differentiating between normal posttraumatic syndromes and

patients with CRPS”¹². Possible drawbacks of this kind of measurement include a low sensitivity; temperatures can vary from one point to another within the same area; and temperatures are not constant over time¹².

Laser doppler flowmetry measures the skin’s “capillary blood flow to local thermal stimulation”¹⁵. When a peripheral vascular disease is suspected, the blood flow deviates from the normal pattern, which also affects the skin temperature. Unlike thermography, which can measure a specific area, laser doppler flowmetry is more effective over a larger area. During laser doppler flowmetry, laser light is delivered to the tissue surface through an optical fiber, and the reflected light is collected by a second fiber, which is stored in a single probe¹⁶.

A recent study involving different uses of laser doppler flowmetry found that CRPS is not associated with “the perfusion increase in patients’ limbs, or between patients and healthy controls. The study found that CRPS was not associated with impairment of microvascular endothelial function. However, it was concluded that this may reflect the diversity of the CRPS disease process”¹⁶. Basically, this diagnostic process only reflects impairment in some CRPS patients, but it does provide otherwise unknown insight into abnormalities in blood perfusion.

Infrared thermography uses an electronic thermographic apparatus to create computer-generated images that display changes in temperature. According to Philip Getson, DO, such “changes are controlled by the sympathetic nervous system and alterations in the sympathetics cause alterations in thermal (infrared) imaging which do not conform to [skin temperature] patterns.”¹⁷ This testing is sensitive to skin temperature changes to one-tenth of one degree centigrade.¹⁷

In regard to CRPS, Dr. Getson claims that the lack of symmetry in skin temperature

patterns confirms an initial clinical diagnosis¹⁷. This temperature difference is often dramatic and using the thermal imaging camera is hundreds of times more sensitive than palpation alone¹⁷.

According to Dutch treatment guidelines, infrared thermography is reliable for measuring diffuse versus local temperatures, and is good for testing temperature change due to hot and cold stimuli¹².

Sudomotor Function Tests

Resting Sweat Output (RSO) and Thermoregulatory Sweat Test (TST)

Resting sweat output (RSO) is the measurement of basal sweat secretion, while the thermoregulatory sweat test (TST) measures this sweat secretion following the heating of the body¹². During TST, the patient is covered in an orange powder and placed in a hot environment to induce sweating. As the orange powder turns purple in areas of sweat secretion, physicians can determine abnormal sweat patterns.

Cheliminsky et al reported that “RSO predicted the diagnosis of CRPS with 94% specificity, and the specificity was 98% when RSO was combined with an abnormal QSART result, the best laboratory correlate of the clinical diagnosis”¹⁸.

Quantitative Sudomotor Axon Reflex Test (QSART)

The quantitative sudomotor axon reflex test (QSART) is used to assess the small nerve fibers, which are linked to the sweat glands. It is often used to diagnose painful small fiber neuropathy when nerve conduction test results are normal, disturbances of the autonomic nervous system, and complex pain disorders⁹. QSART measures sweat response and gives information on the function of the sudomotor reflex loops. It is a valuable test, but because it examines axon reflex,

it cannot be used to test the effect of an inhibition to the sympathetic stimulus⁵. By testing responses to outside stimuli, this test is useful for quantifying the allodynia often associated with CRPS. A combination of abnormal resting sweat output and QSART produces a specificity of 98%, which corresponds with the observed symptoms of CRPS³.

R. Norman Harden, MD, Director of the Center for Pain Studies at the Rehabilitation Institute of Chicago, says that “since there has been no validation research for QSART, it must be considered experimental and is not considered diagnostic in any context. Its ‘accuracy’ (ie, sensitivity and specificity) has not been properly assessed. QSART is generally unavailable except in a few academic centers, and therefore is not generally available nor of general utility.”

The test itself involves the technologist or physician placing four electrodes filled with acetylcholine on three areas of the leg and one area on the wrist¹⁹. A mild electrical stimulation is then run through the electrodes, which in turn stimulates the sweat glands. This produces a tingling sensation that is measured subjectively.

Neurophysiological Tests

Nerve Conduction Velocity (NCV)

Nerve conduction velocity (NCV) helps determine the health of peripheral nerves by testing the speed of the signals through the nerve. Electrodes are placed on the skin over the nerve at various locations that give off mild electrical impulses, which in turn stimulates the nerve²⁰.

Dutch treatment guidelines state that NCV is vital for determining a diagnosis between CRPS types 1 and 2¹². According to the Rommel study, 16 of 35 CRPS patients were found to have impaired nerve conduction²¹. If nerve conduction values are 20% above the norm, a peripheral

nerve condition or CRPS type 2 must be assumed²¹.

Somatosensory Evoked Potentials (SSEP)

The somatosensory evoked potentials (SSEP) test the somatosensory trajectory from the peripheral nerve to the cerebral cortex²². Recording electrodes are placed near the stimulation sites for clinical diagnosis, which include the median nerve at the wrist, the common peroneal nerve at the knee, and the posterior tibial nerve at the ankle²².

Dutch treatment guidelines report that “SSEP is indicated for CRPS-I patients if a central dysfunction is suspected in light of neurological tests. If the results are abnormal, further investigation is necessary”¹².

Quantitative Sensory Testing (QST)

Quantitative sensory testing (QST) assesses damage to the small nerve endings, which detect changes in temperature, and the large nerve endings, which detect vibration²³. QST is typically used to assess the severity and location of nerve damage and to determine if a neuropathy is responding to treatment²³.

QST uses a computer testing system to measure how the nerves involved react to vibration and changes in temperature. These test results are then compared to unaffected patients and the patient’s unaffected side^{5,23}. The patient will feel mild vibrations, as well as hot and cold sensations^{5,23}. The procedure is non-invasive^{5,23}. The subjective responses of the patient to the superficial stimuli are also measured, and in the case of CRPS, provide information pertaining to peripheral nerve function and sensory abnormalities^{3,5}. Although QST detects such abnormalities, they are not specific to CRPS, making QST useful for confirming symptoms, but not diagnosis³.

The Vaneker et al study found that those who initially responding as “cold” patients

(having more pain with cold stimulation than warm) upon initial CRPS diagnosis had more pain during electrical stimulation and disease progression eight years later²⁴. These patients also had poorer clinical pain outcomes over time than the “warm” patients, possibly making QST a good indicator of disease progression²⁴.

Sympathetic Nerve Blocks

Sympathetic nerve blocks are essentially injections of a local anesthetic at various places in the body, which in turn block the sympathetic nerves of each area. The only way a doctor can find out if a CRPS patient’s pain is sympathetically-maintained pain (SMP), which is pain stemming from problems in the sympathetic nervous system, is to do a sympathetic nerve block²⁵. CRPS patients can be said to have SMP if they experience pain relief from sympathetic nerve blocks²⁵.

Raja et al pointed out that only some patients with CRPS respond to a sympathetic nerve blockade, and they proposed that patients’ pain be defined as “sympathetically-maintained” or “sympathetically-independent” according to their response to temporary sympathetic nerve blocks²⁶.

According to Stanton-Hicks, although a positive response to a sympathetic block was necessary historically before a diagnosis of CRPS would be made, because it is not known how the sympathetic nervous system is involved in the pathophysiology of CRPS, it is necessary to abandon this convention²⁷.

Since current critiques of sympathetic nerve blocks raise concerns about the benefit to risk ratio of permanent sympathetic nerve damage, and identifying which patients will have pain relief from more invasive procedures, according to an editorial by Max and Gilron, more research must be done on this technique²⁸.

Conclusions

While the aforementioned diagnostic techniques could be useful for eliminating other disorders from the clinical diagnosis or confirming clinical symptoms, it is important to remember that there is no test validated for CRPS diagnosis. Because none of these tests are validated for diagnosis, although they might be suggested by physicians, they might not be covered by insurance companies.

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